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Example Provisional Patent Application (PPA)

In due course, this Provisional patent application (PPA) was re-written and filed as a utility (non-provisional) patent application in the U.S. Patent Office. The patent was eventually granted as **US Patent No. 9,868,523**

The following example is provided for educational purposes only in connection with **ELG's Practical Guide to PROVISIONAL PATENT APPLICATIONS for the Cost-Conscious Inventor**.

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APPARATUS AND METHOD FOR SAFE HIGH SPEED VTOL FLIGHT

BACKGROUND OF THE INVENTION

[0001] Description of Related Art. Since the beginning of early aviation designers and engineers in commercial aerospace and military tacticians have lusted for an aircraft, other than a helicopter, that could take-off from a runway no larger than its own shadow, vertically, then transition to high speed forward flight safely!

[0002] The idea of vertical take-off and landing (VTOL) flight for high performance commercial aircraft and military fighters has been a perplexing and obsessive goal for aircraft designers for decades.

[0003] Helicopters and autogyros could take-off vertically, however deemed too fragile, too slow, and too vulnerable for safe air commerce and/or aerial combat.

[0004] Beginning in the spring of 1954 the Convair XFY -1 Pogo was introduced, a Delta wing, turbine, driving sixteen foot, contra-rotating propellers. This radical design was a tail sitter positioning the pilot in an odd take-off and landing position, lying on his back with his feet above his head. Clearly an engineering marvel, with several successful take-offs and landings.

[0005] Referencing the acclaimed "VTOL Wheel" there are forty-five various aircraft listed, fifteen various thrust options and four different propulsive methods. To-date there has been several successful high speed military VTOL aircraft. The MD AlBAE A V -8 Harrier and the Lockheed Martin F-35 incorporate rotating jet nozzles thrust vectoring and/or lift fan technology (F-35).

[0006] On February 25, 2013 DARPA announced the VTOL X-Plane Challenge BAA-13-19. The concise description of the proposal is to design, develop and demonstrate a vertical takeoff and landing (VTOL) X-Plane with exceptional performance in vertical and cruise flight and operational capability through transition from vet1ical to Forward Flight. The purpose, to champion the design and develop technologies to integrate radical improvements in VTOL Flight.

[0007] Specifically, the VTOL X-Plane demonstrator aircraft will be designed to fly at sustained speeds between 300 kt-400 kt and demonstrate aircraft hover efficiency within 25% of the ideal power loading (at standard sea level conditions) and cruise lift-to-drag ratio no less than

10. The VTOL experimental/demonstrator aircraft will be designed to have a gross weight between 10,000 lb-12.000 lb, a useful load no less than 40% of the gross weight and a payload capacity of at least 12.5% of the gross weight.

[0008] To-date DARPA has awarded four major United States companies funding to produce flying VTOL models.

[0009] They are Boeing, Sikorsky, Karcem Aviation and Aurora Flight Sciences. These proposed designs are novel as existing technologies, most are extremely complex mechanically and unfortunately proven dangerous (V -22 Osprey).

[0010] The notion of open-exposed rotors or propellers within the human safety zone is hazardous and frightening. In the hostile military environment the scenario is more deadly with the possibility of encountering flying metal shrapnel with small arms fire.

[0011] Rotating engines or propellers are hazardous as mentioned above and introduce the rotating element of change of the thrust point, rotating mechanisms and power supplies to provide the mechanical rotating transition adding to a center of gravity issue to sustain controlled flight.

[0012] Ducted fans are a novel solution for perimeter rotating blades with humans however the intake (unscreened) is notably referenced as a vacuum for increased FOD ingestion along with the increased drag from the circular duct itself for horizontal flight. There has never been a ducted fan aircraft that has exceeded 270 kts.

[0013] The tail sitter design, Lockheed XFV-1 and Convair XFV -1 were found to be impractical and even dangerous. The legendary Kelly Johnson stated he never liked the concept and thinks it is inadvisable to land the airplane on the ground or ship deck surface! The US Navy that procured the idea stated simply- "We Agree."

[0014] "Powered" cross shafting for multiple VTOL lift sources is a Novel, required complex mechanism to assure controllability in the event of a power source failure of a multi-engine aircraft.

[0015] Rotor blade interaction is the result of large rotor blades interacting with retreating blades compressing airflow downward on the vertical axis cumulating a high decidable, mid-range acoustic signature heard for miles ahead of the aircraft!

[0016] Adverse Yaw tendencies are controllability issues around the y and x axes that cause adverse gyroscopic forces from open, exposed rotor blades and propellers and engine rotation!

[0017] The design solution for the challenge is to meet the DARPA specifications and to incorporate new methods and technologies. Keeping a conventional seating arrangement with a single point VTOL lift source that does not require "powered" cross shafting. Additionally, no large exposed pivoting engines, propellers or ducted fans. Finally, eliminate any rotor blade interaction and adverse Yaw tendencies!

DETAILED DESCRIPTION OF THE INVENTION

[0018] The present invention relates to various sizes of aircraft from micro UAVs to large commercial jet airliners, specifically the solution for safe, high speed vertical take-off and landing (VTOL) flight.

[0019] The thrust requirements for VTOL aircraft are very high and can exceed 1.4% of the aircraft gross weight, depending on density altitude and wind conditions. These high thrust requirements are needed primarily for take-off and landing, including maneuvers for hover in ground effect (HIGE) and hover out of ground effect (HOGE). The total thrust required to maintain high speed horizontal level flight is considerably less due to the aerodynamic lifting forces of the wing and fuselage surfaces. This flight parameter would minimize fuel consumption to a fraction of thrust and power requirements for VTOL flight.

[0020] An objective of this invention is to design a contained, single point VTOL lift source. The design of the invention eliminates the need for open-exposed rotor blades or propellers, powered cross-shafting and finally eliminating rotor blade interaction and any adverse yaw tendencies.

[0021] The mechanical design features, two identical large centrifugal compressors rotating on a vertical shaft in a contra-rotating direction, one inlet on top and the other inlet on the bottom. Air flow enters the inlets and then is compressed laterally by the counter rotating centrifugal compressors (CRCC). The compressed high pressure air enters a round plenum encompassing the CRCC. The compressed high pressure air is then directed to four thrust augmentation ducts that provide symmetrical VTOL lift thrust about the center of gravity of the aircraft.

[0022] Additionally, the thrust augmentation ducts are controlled to provide pitch, roll and yaw reactions for stabilized VTOL flight and ensure balanced thrust distribution transitioning to high speed level flight.

[0023] The CRCC can be powered by various power sources via a single drive shaft system connecting to the center of the vertical shaft via a 90° dual gear arrangement rotating the compressors in opposite directions.

[0024] A further mechanical design objective of this invention is realizing an alternative power arrangement of the CRCC. The CRCC is mechanically designed as a powerful compressor section, a self-contained jet engine by adding a compact combustion section, a turbine section and an exhaust outlet utilizing a single shaft. The exhaust outlet will fundamentally be the thrust augmentation ducts.

[0025] It is estimated that one, ninety-six inch CRCC with four, twenty-four inch diameter combustion sections could produce 100,000 pounds of static thrust. The CRCC engine would weigh approximately three thousand pounds.

[0026] A further object of this invention is that the CRCC is designed into the wing and upper fuselage structure to maintain a sleek aerodynamic profile to attain high speed level flight while accommodating a maximum design bulk payload and gross weight capabilities within the fuselage.

[0027] The counter rotating centrifugal compressors (CRCC) and VTOL thrust augmentation ducts installation and operation are specifically designed into the wing and upper portion of the fuselage is illustrated in the drawings in which:

[0028] Figure 1 is a top plan view of the aircraft.

[0029] Figure 2 is a isometric view of the aircraft.

[0030] Figure 3 is a side elevation view of the exterior of the aircraft.

[0031] Figure 4 is a cut away illustration of the CRCC mounted on a vertical shaft, additionally identifying the forward and aft cabin compartments.

[0032] Figure 5 is a side plan view of the CRCC along with mechanical components, bearings, housings, tie in couplers, main shaft, drive shaft, and CRCC thrust drive ring.

[0033] One example of a mid-size aircraft according to my invention is shown in Figures 1 and 2. The aircraft has a pressure thrust fuselage 10, a pair of delta wings 11 specifically designed for low drag. A forward opening canopy 12, for the crew to access the flight deck. Two turbo fan engines 13, with re-direct exhaust flow buckets 14. A vertical tail15 designed for low drag. An NI transmission housing 16 that powers the CRCC and decelerates airflow for the turbo fan engine. The CRCC inlet 17 and the CRCC louvers 18 that adjust automatically to transition from VTOL to high speed forward flight.

[0034] In Figures 3 and 4, the flight deck canopy 12, the forward cabin door 19 and aft door 20, the VTOL thrust augmentation ducts 21. The CRCC internal configuration designed into the upper fuselage and wing structure 22 the vertical CRCC shaft 23. The forward cabin 24 with the lower chin bubbles 25 for enhanced pilot visibility during VTOL flight. The AFT cabin 26.

[0035] Figure 5 shows the top CRCC 27 and bottom CRCC 28, the vertical main shaft 29 and drive shaft 30, with the drive shaft gear 31. Each CRCC has two tie in coupler bearings 32 that are bolted to the main shaft 29. The main drive shaft 29 has a small groove cut into it, to secure the tie in bearings 32 which are attached or molded into the CRCC structure. The tie in coupler 33 attached to the main shaft in the same manner as the tie in bearing coupler. The tie in coupler 33 houses a bearing that supports the drive shaft 30 which has the drive shaft gear 31 attached. When the drive shaft 30 is rotated, the drive shaft gear 31 rotates the top CRCC 27 and the bottom CRCC 28 via the thrust ring top 34 and the thrust ring bottom. The threaded shaft top 35 and the threaded shaft bottom 36 are designed to be bolted to the aircraft structure.

[0036] The top and bottom CRCC 27 & 28 in a contra-rotating manner which produces high speed, high volume airflow which is contained within a plenum 37 Figure 4.

[0037] The plenum 37 redirects the high pressure high volume airflow to four thrust augmentation ducts 21, two on each side of the aircraft. This provides the vertical thrust for VTOL operations. The thrust augmentation ducts 21 also controls stability around the yaw pitch and roll axis. Additionally, the thrust augmentation ducts rotate through the VTOL to forward flight transition and provide forward thrust for the aircraft.

[0038] An alternative arrangement of the CRCC as a powerful compressor section of a turbine engine. Several hot sections are added symmetrically to the plenum. The hot sections comprise an combustion chamber, a turbine wheel(s) and the exhaust components. Several turbine and wheel arrangements are possible. For examples, 0°-45°-90° arrangements each will meet the design criteria of various engine/exhaust locations.

[0039] Figure 6 shows the top and bottom CRCC as a turbo jet engine in the 90° configuration in which the 90° shaft has both. The counter rotating gears with airflow directors and counter rotating turbine wheels. Additionally, the 2 fuel ports and shaft stabilizer are show.

[0040] Figure 7 shows this top and bottom CRCC as a turbo jet engine in the 45° configuration in which the 45° shaft has both. The counter rotating gears with airflow directors and counter rotating turbine wheels. Additionally, the 2 fuel parts and shaft stabilizer are show.

[0041] Figure 8 shows the top and bottom CRCC as a turbo jet engine in the 0° configuration in which the 0° shaft rotates in one direction attached to the top and bottom CRCC via a gear with a bearing unit. The shaft has multiple turbine wheels attached to extract energy from the high pressure air and fuel mixture when ignited.

[0042] Figure 9 shows the bottom view of the CRCC. Bottom intake, plenum, thrust augmentation ducts, side view of the CRCC, top and bottom intake, plenum and thrust augmentation ducts.

[0043] Figure 10 shows side view and top view of this CRCC design, the shaft, blade shape. The top view shows the shaft, rotation and sweep of the CRCC blade. Typically there are 12 CRCC blades on each unit.

[0044] Figure 11 shows an alternative embodiment of a single engine VTOL cruze.

[0045] Figure 12 shows an illustration of yet another alternative embodiment referred to as the Eagle Ray, which is intended as a delivery aircraft. A light-weight package or other parcel is mounted under the aircraft within 2 protective rails. Intake air for the lower CRCC is drawn in from the raised nose portion of the aircraft.

[0046] The foregoing invention has been described in accordance with the relevant legal standards, thus the description is exemplary rather than limiting in nature. Variations and modifications to the disclosed embodiment may become apparent to those skilled in the art and fall within the scope of the invention.

What is claimed is:

1. A VTOL aircraft, as shown and described.

2. A method for providing thrust to a VTOL aircraft, as shown and described.

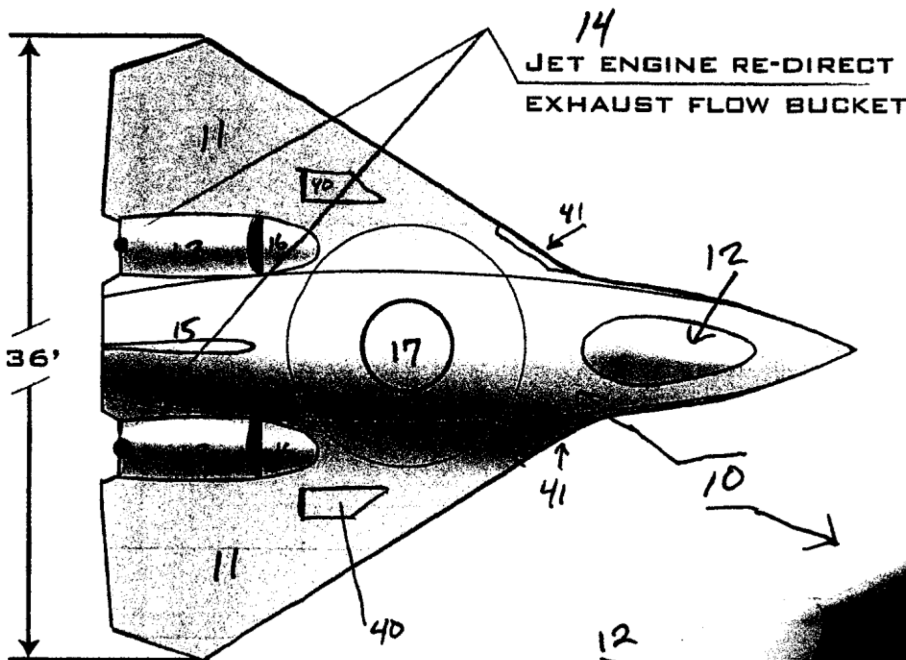

14
JET ENGINE RE-DIRECT
EXHAUST FLOW BUCKET
36'
11
40
41
12
15
17
16
10

Fig. 1

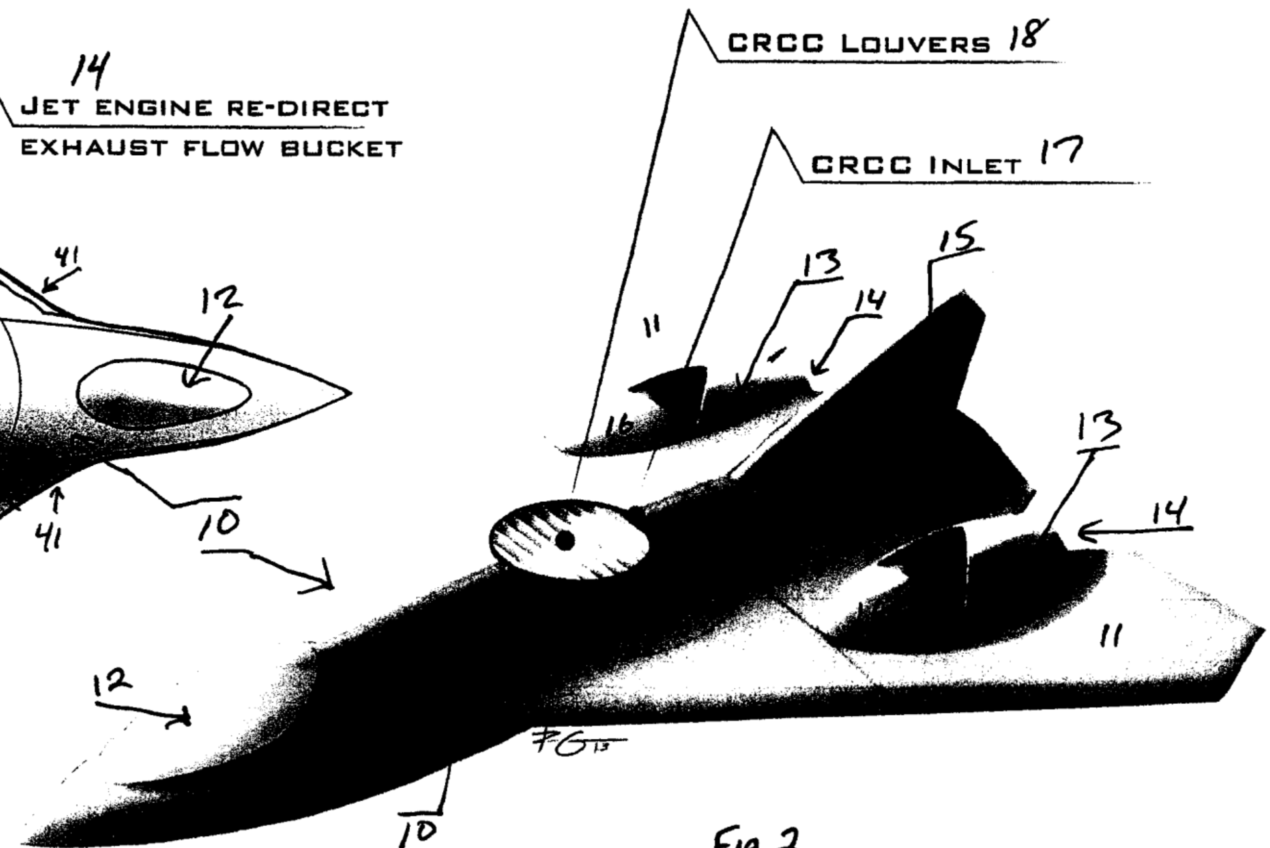
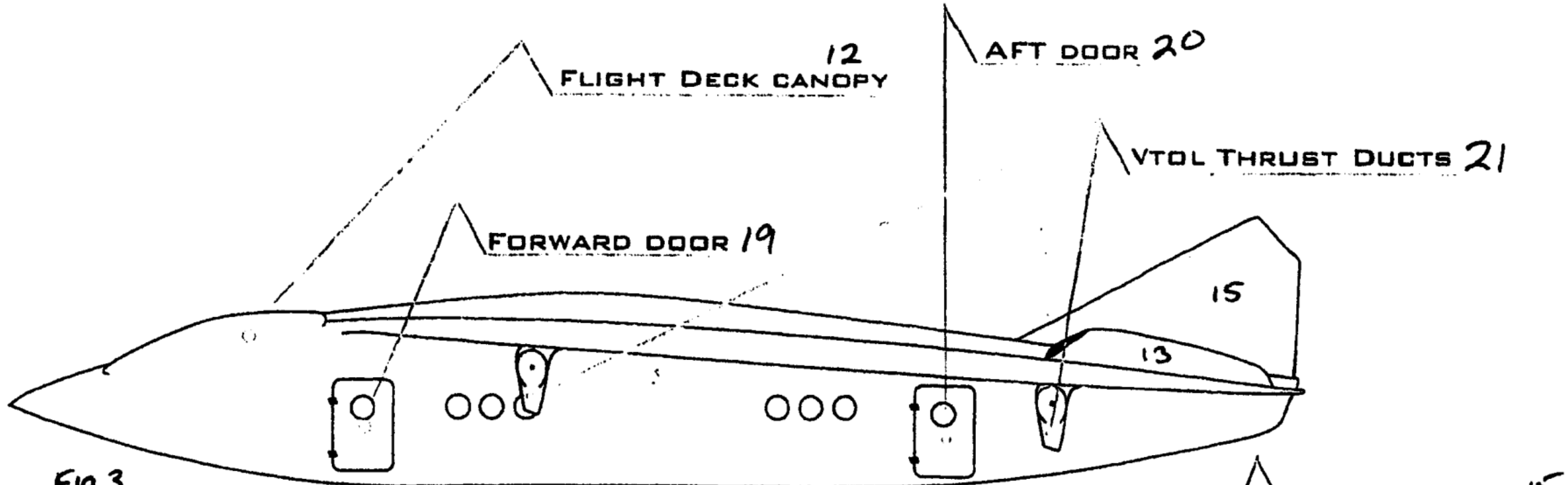
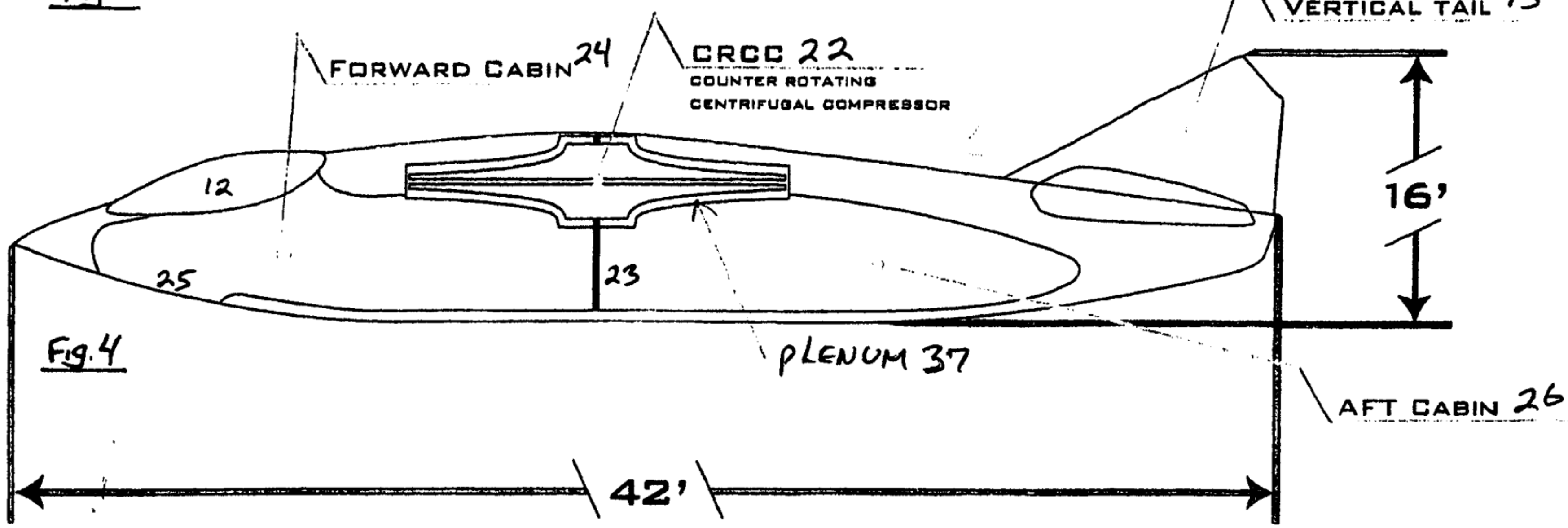

CRCC LOUVERS 18
CRCC INLET 17
15
13
14
11
16
12
10

Fig. 2



FLIGHT DECK CANOPY 12
AFT DOOR 20
VTOL THRUST DUCTS 21
FORWARD DOOR 19
15
13

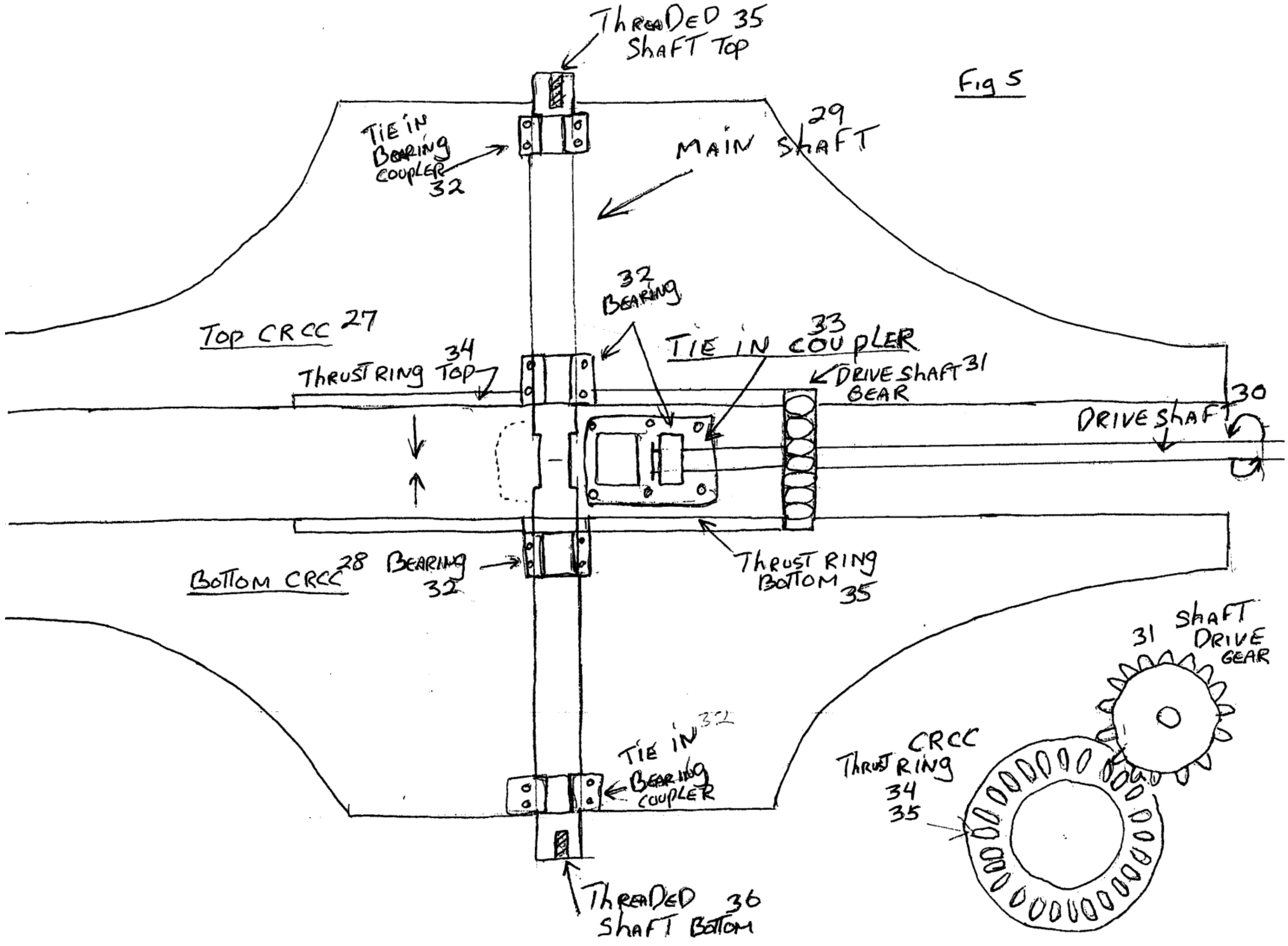
Fig.3



VERTICAL TAIL 15
FORWARD CABIN 24
CRCC 22
COUNTER ROTATING
CENTRIFUGAL COMPRESSOR
12
16'
25
23
PLENUM 37
AFT CABIN 26
42'

Fig.4

Fig 5


ThreaDeD 35
ShaFT Top
Tie in
Bearing
coupler
32
29
Main ShaFT
32
Bearing
Top CRCC 27
33
Tie in coupler
34
Thrust Ring Top
Drive shaft 31
Gear
30
Drive shaft
Bottom CRCC 28
Bearing
32
Thrust Ring
Bottom
35
31 ShaFT
Drive
Gear
Tie in 32
Bearing
coupler
CRCC
Thrust Ring
34
35
ThreaDeD 36
ShaFT Bottom

90° CONFIGURATION

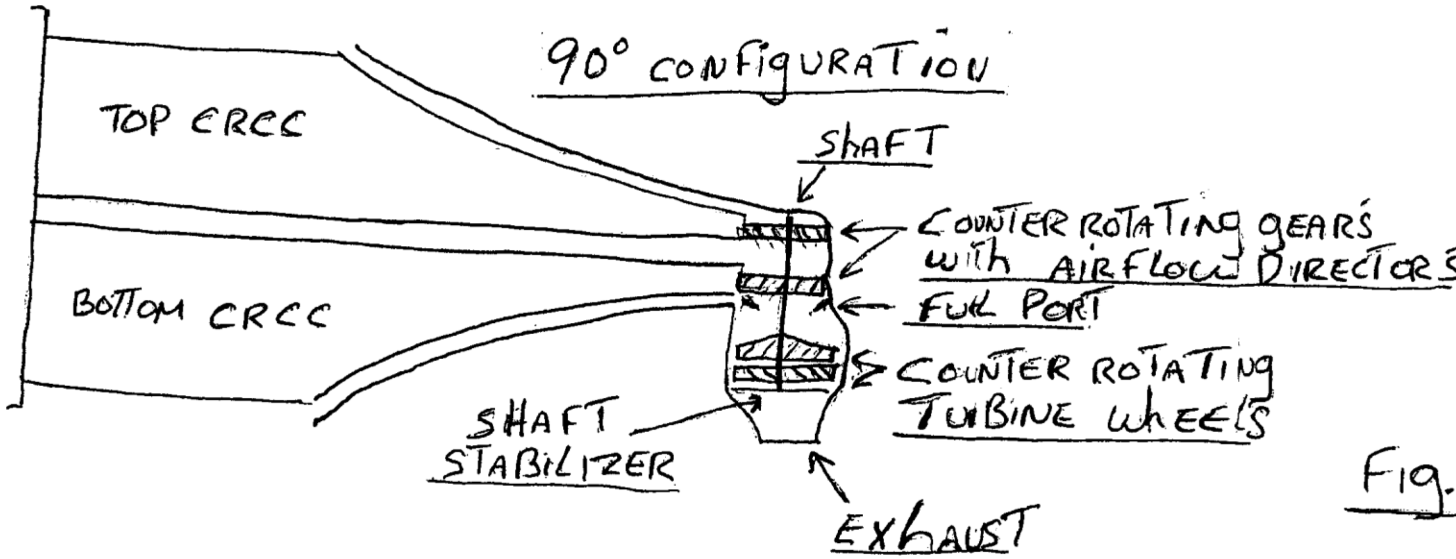


Fig.6

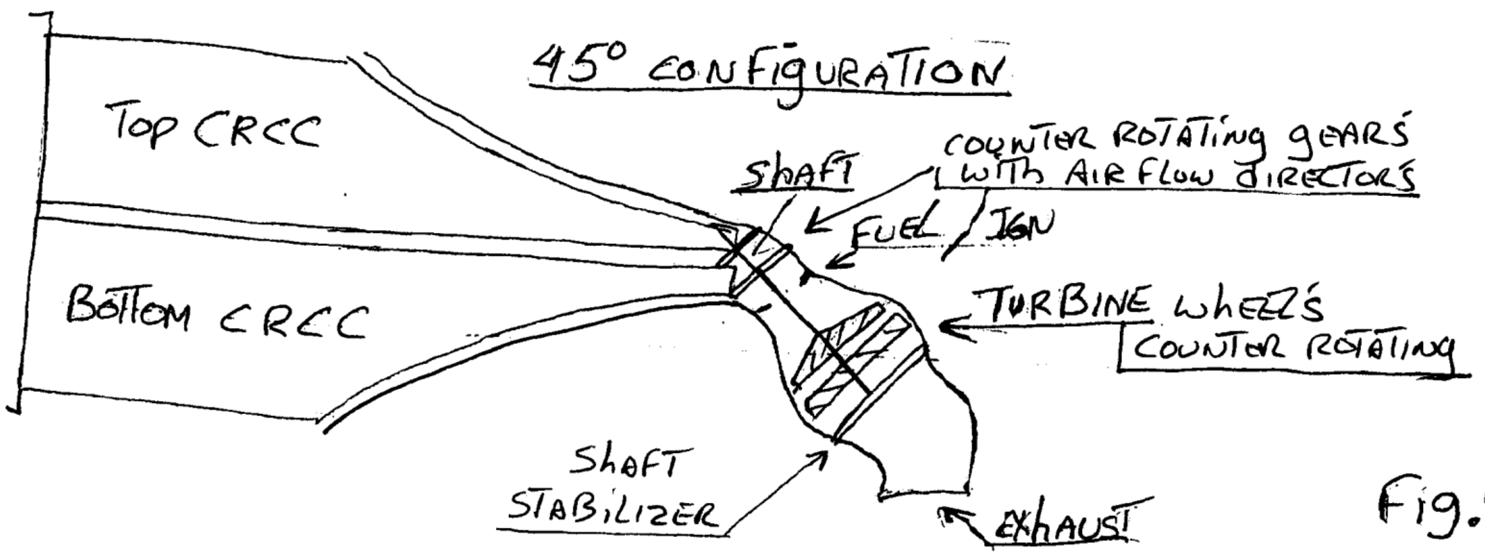


Fig.7

Fig 8

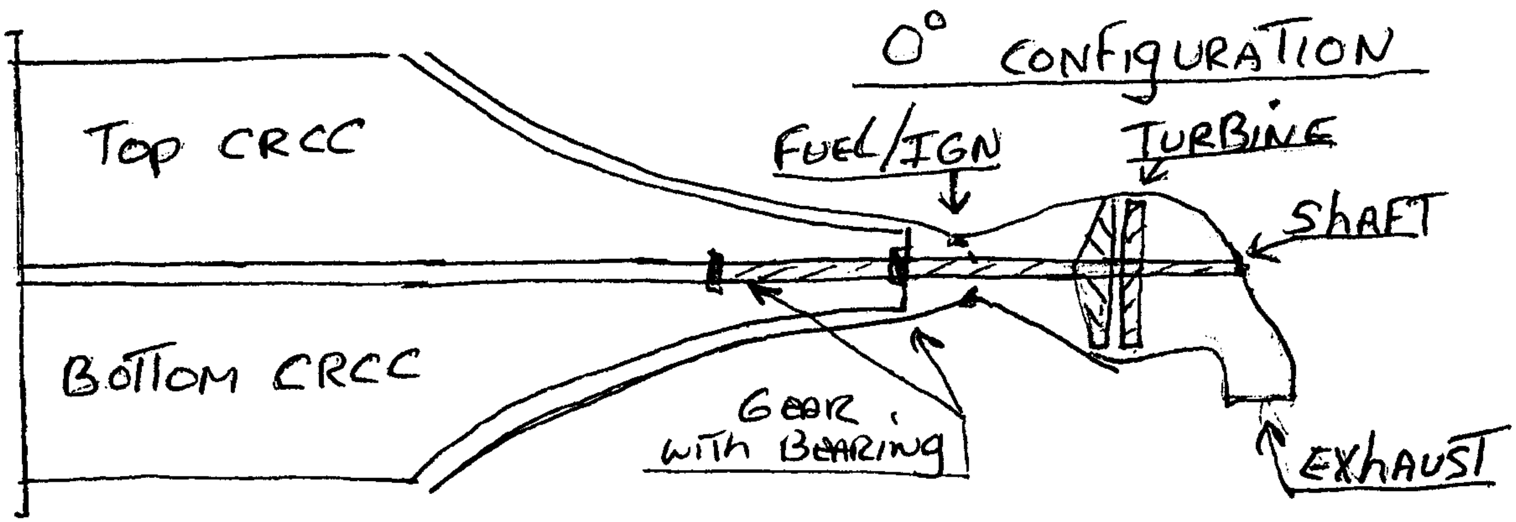
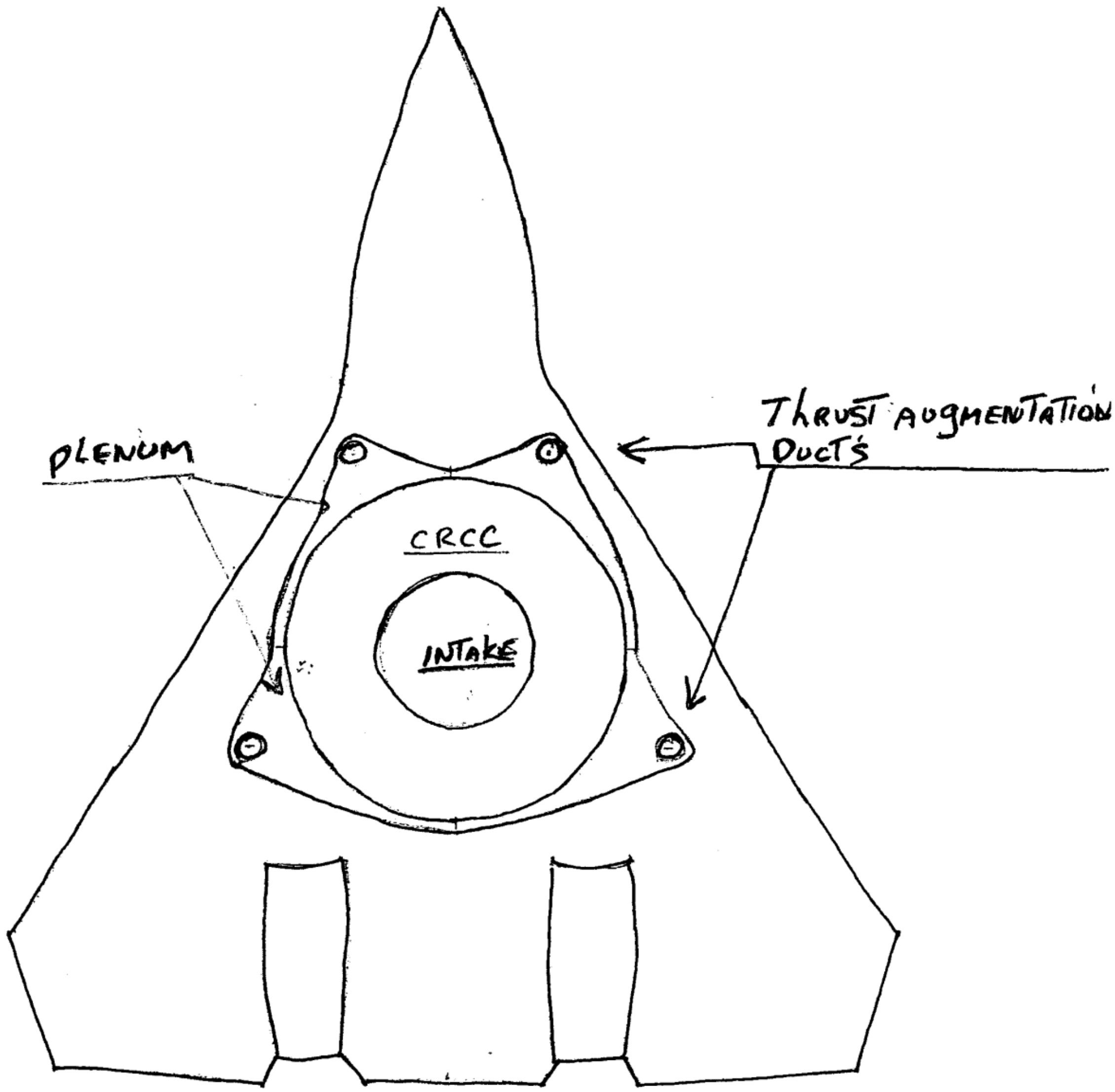

0° CONFIGURATION
Top CRCC
BOTTOM CRCC
FUEL/IGN
TURBINE
SHAFT
GEAR WITH BEARING
EXHAUST

Fig. 9

BOTTOM VIEW



SIDE VIEW

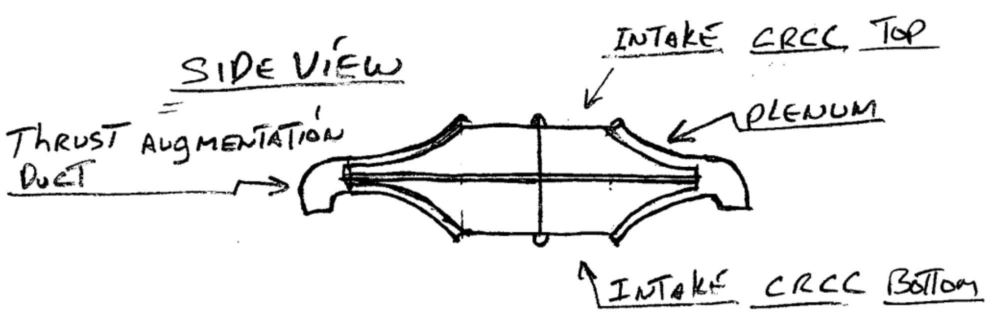
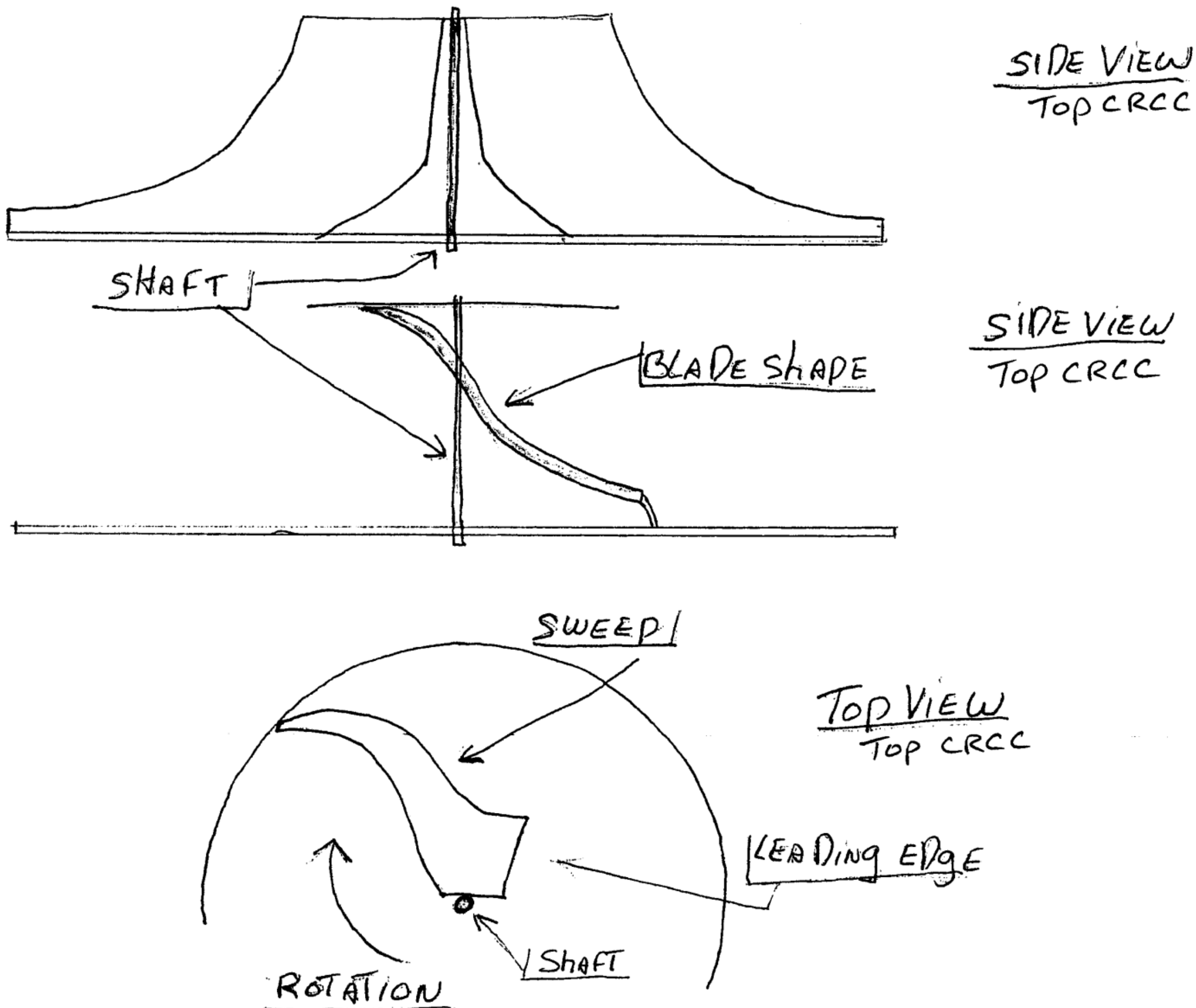


Fig. 10
CRCC Design



SINGLE ENGINE VTOL CRUZE

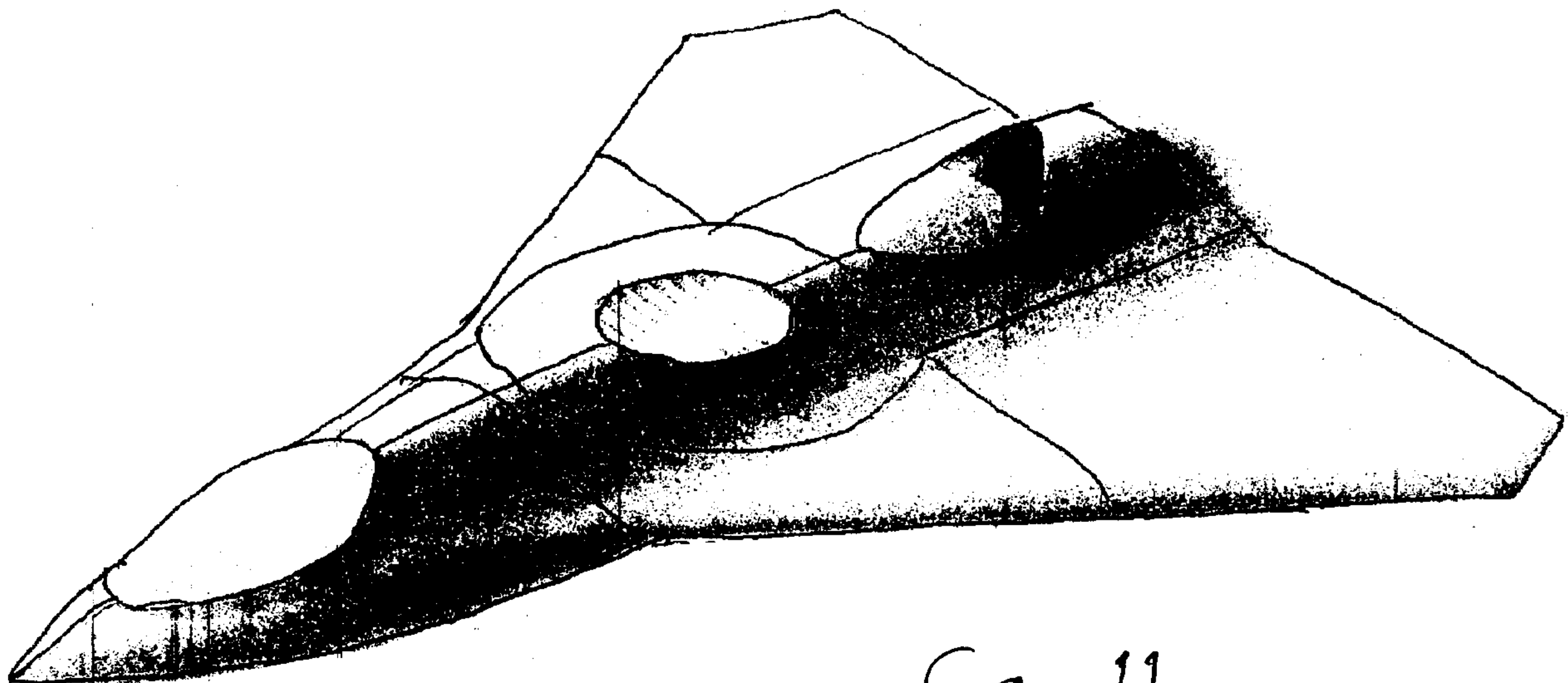


Fig. 11

EAGLE RAY

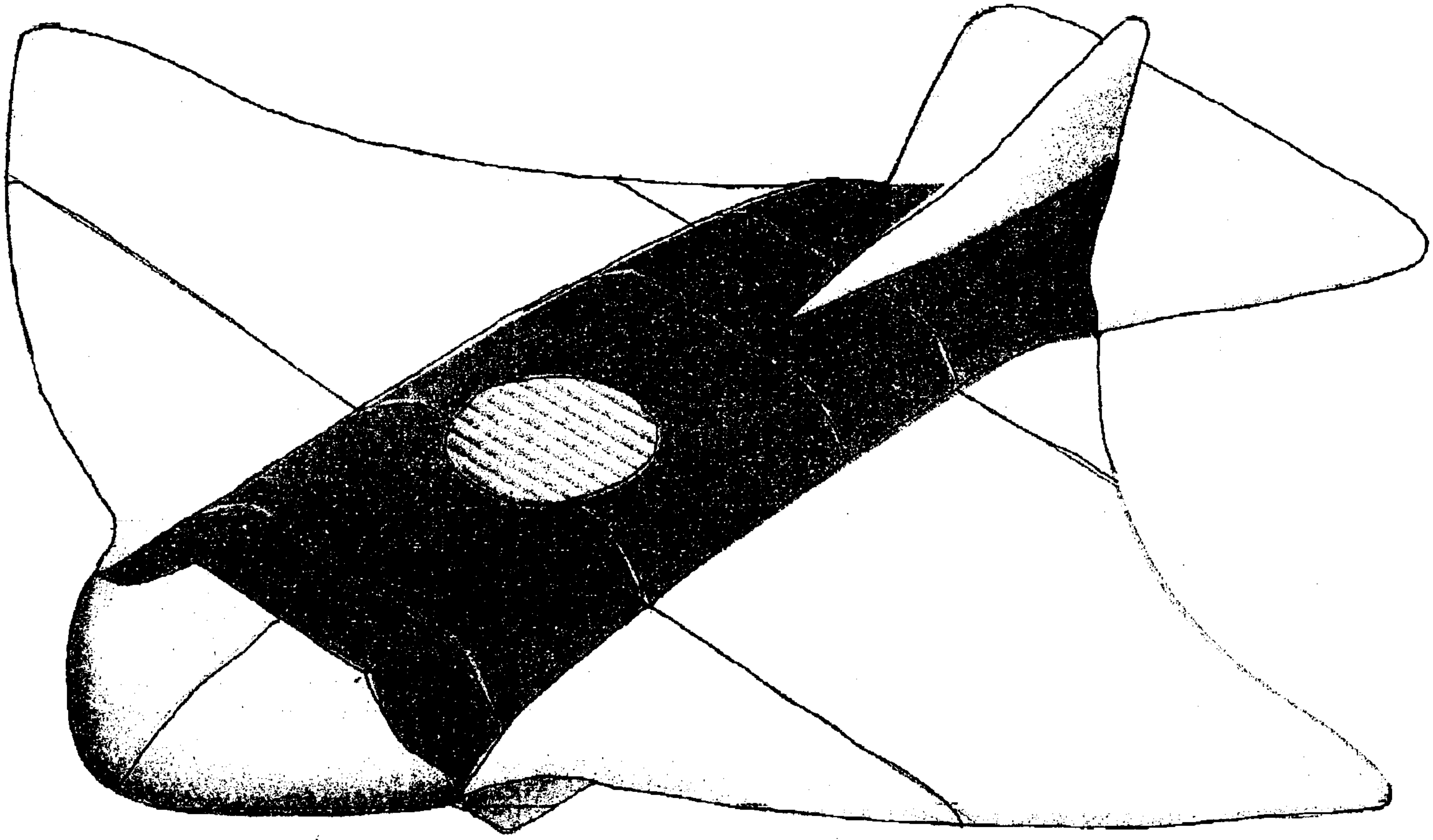


Fig. 12