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THE BELIER, CENTAURE AND DRAGON ROCKET ENGINES

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"BELIER"

March, 1961

1. Nationality: France

2. Developers : C. N. E. T / Sud Aviation

3. Normal Use :

Scientific exploration of the upper atmosphere (80 km height).

4. Technical Characteristics

4.1 General

Basis for a family of four engines.

The other three consist of "Belier" types with different auxiliary propellents.

4.2 Description (Plate I)

Single stage solid fuel engine without piloting or guidance.

It consists of:

- a head (nose) which receives the scientific material,
- a booster,
- a ring with four fins,
- a destruction device.

4.2.1 Head

See detailed memorandum.

4.2.2 Booster

On the front of the booster an intermediate piece provides for fastening the head. This piece carries the block of pins for checking the engine. (100 possible connections with the outside)

Along the side of the booster, 4 grooves of inside diameter 15 mm permit passage of cables from the head of the rocket to the hooks or catches (captors) placed in the fins.

4.2.3 Ring and fins

Aerodynamic stability is assured by four fins attached to the bottom of the booster on a removable sleeve; their adjustment or setting maintains a slow rotation that is favorable to accuracy of descent.

By construction there is (see Plate II)

- at the leading edge of each fin a socket intended to receive hooks (captors).
- at the ends of a pair of opposite fins a cylindrical housing for the hooks.

4.2.4 Destruction

Two explosive bands provide for:

- by means of one the separation of the head, which unbalances the vehicle,
- by means of the other one stopping propulsion by breaking off the bottom of the booster.
- Destruction in flight is signaled by means of a device placed in the head (see memorandum for the head).

4.2.5 Dimensions

See plate I

4.2.6 Weight

With an expendable pay load of 32 kg

total weight on the ramp	315 kg
weight after combustion	106 kg

4.3 Guidance, piloting, stabilization

No guidance or stabilization device other than fixed fins.

In order to reduce dispersion, two solid fuel impellers, mounted at the ends of a pair of fins and released after use, cause a forced rotation of the rocket around its longitudinal axis upon leaving the ramp; this rotation is maintained thereafter by the setting of the fins.

4.4 Energy sources aboard

No disposable energy sources; provision is made in the equipment in the head as necessary for the operation of the scientific apparatus.

4.5 Disposable useful load

See memorandum for the head

Expendable pay load: 32 kg.

4.6 Transportation

Transportation of the different elements of the rocket is done without difficulty in special crates by road, rail and air.

Transportation of the complete rocket from the place of assembly to the ramp is done on a special truck.

4.7 Handling

Poses no special problems. Only the placing of the booster into the assembly frame and its balancing require using some means of hoisting it. (force: 500 kg)

4.8 Launching

Done from a ramp 8 meters long.

This ramp contains:

- a device for removing the supports, (Section 4.2.2)
- electrical connections for igniting the booster and the rotation impellers.

In one already completed version, this ramp is mounted on a semi-trailer adjustable:

- continuously in elevation relative to the platform, by means of a hydraulic jack,
- in bearing by means of orientation of the semi-trailer itself.

4.9 Recovery

Can be provided for, if necessary.

4.10 Service equipment

4.10.1 Assembly support

Facility for:

- the assembly of the head, and of the sleeve of the fins on the booster,
- putting the cables in place in the grooves running along the side of the booster.

This platform can be used for the "Centaure" and "Dragon" rocket (see photos).

4.10.2 Balancing platform

Permits, by addition of weights, bringing center of gravity of the complete rocket to the axis of the tube. (see photos)

5. Performance

5.1 Normal use

- expendable pay load: 32 kg.

  (head AV., antennas, connecting cables).
- firing has been accomplished at less than 10° from the vertical.
- altitude attained: 80 km.

  (variation with useful load, plate III).

- combustion time	21 s
- maximum velocity	1370 m/s
at an altitude of	12000 m
- maximum longitudinal acceleration	13 g
- rotational acceleration at lift off	160 rad/s^2
- rotational velocity around longitudinal axis, about	6 t/s
- time for ascent to maximum altitude	2 mn 10s
- time for descent to ground	4 mn 20s
- acceptable wind for a dispersion from the point of descent of less than 16 km	5 m/s

5.2 Outline of possible performance for the case of use in space

Indications are given above concerning a first type of space application in the form of a rocket-sonde with vertical firing, equipped to gather data along its trajectory. Another area of application is opened by the extension of the zone susceptible to being "seen" by the rocket.

A "Belier" is susceptible to being seen:

for 1 minute from points located 960 km distant

for 2 minutes from points located 880 km distant

for 3 minutes from points located 700 km distant

In the same manner, a "Belier" sees for 2 minutes all cloud formations located up to 15 km altitude in a radius of 760 km.

5.3 "Belier" can be used even away from the established firing range for relatively elaborate experiments, with the use of the C. N. E. T. mobile unit which carries on the semi-trailer the necessary means for launching, tracking, telemetering, remote control and synchronization.

6. State of progress, accomplished performances.

- 15 "Belier" rockets are in the course of production at Sud-Aviation.

All Service equipment is completed.

- Three tests of the boosters on the platform have been successfully made.

- Tests of the destruction mechanism have been made on the platform with success.

The first "Belier" firings are expected to take place on 15 May, 1961.

7. Outline of modifications foreseen for use in space

None

"CENTAURE"

March, 1961

1. Nationality: France

2. Developers : CNET- Sud-Aviation

3. Normal Use :

Scientific exploration of the upper atmosphere (140 km height)

4. Technical Characteristics

Two stage solid fuel rocket without piloting or guidance:

It consists of:

- a "Belier,"
- a first stage of short combustion time,
- a sleeve with four fins,
- a separation device.

4.1 Belier

Constituting the final stage of the Centaure, it is identical to the normal Belier; however, the sleeve for the fins is extended and terminated by an assembly band that is bolted to the booster.

4.1.2 First Stage

No grooves along the booster.

4.1.3 Sleeve and fins

No antennas in the fins.

Two solid fuel impellers at the ends of a pair of fins.

4.1.4 Separation device

The separation of the first stage at the Belier is accomplished by

exploding a hollow annular charge of low power, breaking the sleeve of the Belier between the fins and the assembly band; the firing of this charge is signaled by a time-switch that is started upon lift-off of the rocket from the ramp.

4.1.5 Destruction

Considering the short combustion time of the first stage: 4.5 s, no destruction of this stage is anticipated.

The Belier carries its own normal destruction device.

4.1.6 Dimensions

See plate I

4.1.7 Weight

With expendable pay load of 32 kg

total weight on the ramp	467 kg
weight of the first stage	152 kg
weight of final stage after combustion	106 kg

4.2 Guidance, piloting, stabilization

No guidance or stabilization device other than fixed fins.

In order to reduce dispersion, two nonreleasable solid fuel impellers, mounted at the ends of a pair of fins on the first stage are fired at the same time as those of the Belier, upon leaving the ramp.

4.3 Energy Source

No disposable source.

4.4 Disposable pay load

Same as Belier (32 kg).

4.5 Transportation

The different elements of the rocket are transported without difficulty,

in special crates, by road, rail or air.

Transportation of the complete engine from the assembly location to the ramp is done on a special truck.

4.6 Handling

Poses no particular problems. Only the placing of the booster into the assembly frame and its balancing require using some means of hoisting it. (force: 500 kg).

4.7 Launching

Provision is made for launching from an 8 m long ramp that is used to fire the Belier.

Two different locations for the support removing device are anticipated on the same ramp to compensate for the differences in length of the two rockets.

4.8 Recovery

Can be provided for, if necessary, on the Belier stage.

4.9 Service Equipment

Service equipment for correctly setting up the Centaure is the same as that anticipated for Belier (assembly support, balancing platform, support for checking out the heads).

5. Performance

5.1 Normal use

- expendable pay load: 32 kg
- firing accomplished at less than 10^{o} from the vertical
- altitude attained 140 km

  (variation with pay load, plate II)
- combustion time of 1st stage 4.5 s

- combustion time of 2nd stage 21 s
- maximum velocity 1670 m/s

  at an altitude of 20,000 m
- maximum longitudinal acceleration 15 g
- rotational acceleration at take off 200 rad/s^2
- rotational velocity around longitudinal axis, about 6 t/s
- time of ascent to maximum altitude 3 m 12 s
- time of descent to ground 6 m 15 s

5.2 Outline of possible performance in the case of use in space

Indications are given above concerning a first type of application in space in the form of a rocket-sonde with vertical firing, equipped to gather data along its trajectory. Another area of application is opened by the extension of the zone susceptible to being "seen" by the rocket.

A "Centaure" is susceptible to being seen for:

1 minute from points located 1280 km distant

2 minutes from points located 1220 km distant

3 minutes from points located 1100 km distant

4 minutes from points located 920 km distant

5 minutes from points located 600 km distant

For about 4 minutes a "Centaure" sees all cloud formations up to an altitude of 15 km in a radius of 820 km.

6. State of progress-accomplished performances

- 10 "Centaure" are in the course of production at Sud-Aviation.

Service equipment normally associated with the Belier are completed.

- During the month of December, 1960, two tests of the Centaure were succesfully made on the platform.

The first firings of the Centaure are expected to take place on 15 May, 1961.

Equipment in the head identical to that of the Belier permits measuring the same parameters as on the Belier during the same flight (from the first flight of Belier and Centaure these measurements make it obvious that there is an important interest in the formula of the rockets so definite that it allows noting identical parameters on two rockets having different characteristics while using strictly the same instruments).

7. Outline for modifications anticipated for use in space

None

"DRAGON"

March, 1961

1. Nationality: France

2. Developers : C.N.E.T Sud-Aviation

3. Normal Use :

Scientific exploration of the upper atmosphere (400 km height).

4. Technical Characteristics

4.1 Description (See Plate I)

Two stage solid fuel rocket without piloting or guidance.

It consists of:

- a "Belier,"
- a first stage,
- a sleeve carrying fins,
- a separation device.

4.1.1 Belier

Constituting the last stage of the "Dragon" it is identical to the normal "Belier." However, the body of the booster is strengthened, the sleeve of the fins is extended and terminated by an assembly band that bolts onto the booster.

4.1.2 First Stage

The auxiliary booster is expected to use a "Stromboli" platform. There are no grooves along the length of the booster.

4.1.3 Sleeve and fins

No hooks along the fins.

Four double impellers on the ends of the fins for producing rotation.

4.1.4 Separation

Separation of the auxiliary booster and the "Belier" rocket is accomplished by exploding a hollow annular charge of low power, breaking the sleeve of the "Belier" between the fins and the assembly band; the firing of this charge is signaled by a time-switch that is started by the lift-off of the rocket from the ramp.

4.1.5 Destruction

Safety during firing is achieved by remotely controlled destruction in flight of the "Belier" and of the first stage, if it is not yet separated from it. The devices expected to be used permit extinguishing the booster and separation and sectioning of the "Belier" into two parts that would have no aerodynamic stability of their own.

4.1.6 Dimensions

(See Plate I)

4.1.7 Weight

With expendable pay load of 32 kg.

Total weight on the ramp	1157 kg
Weight of loaded auxiliary booster	838 kg
Weight of final stage after combustion	106 kg

4.2 Guidance-Piloting-Stabilization

The "Dragon" contains no guidance or remote piloting device.

In order to reduce dispersion, it is stabilized by forced rotation after leaving the ramp.

Variable rotational velocity in the course of flight is provided by two solid fuel impellers and maintained by the setting of the fins.

4.3 Sources of energy aboard

There are no disposable energy sources.

4.4 Disposable pay load

Same as Belier (32 kg)

4.5 Transportation

The different elements of the rocket are transported without difficulty, in special crates, by road, rail or air.

Transportation of the complete engine from the assembly location to the ramp is done on a special truck. (See Section 4.7)

4.6 Handling

Poses no particular problems. Only the placing of the booster into the assembly frame and its balancing require using some means of hoisting it. (force: 1500 kg)

4.7 Launching

"Dragon" vehicles are launched from a platform that is adjustable in elevation and azimuth. Adjustment of elevation is continuous, that of azimuth is discontinuous.

This platform consists of 3 parts:

- a base permitting azimuthal orientation of the other two elements,
- an elevating arm with a jack movement and supports, permitting adjustment of elevation,
- a launching beam, connected to the elevating arm, on which the vehicle slides during the take off.

This beam is equipped with wheels and can be brought on rails to the

assembly location in order to receive the vehicle; then brought back to the launching position, placed on the elevating arm and solidly attached to it.

Once the "Dragon" is assembled at the assembly location, it is placed directly on the launching beam.

4.8 Recovery

Can be provided for, if necessary.

4.9 Service Equipment

The "Dragon" can be made ready for use by using the service equipment for the "Belier" and "Centaure" rockets. Some modifications on this equipment are necessary, but the equipment for the working section of the "Belier" and "Centaure" rockets have been designed to easily accomodate these modifications (it is essentially a question of extending the range of reference).

5. Performance

5.1 Normal Use

- expendable pay load 32 kg
- firing accomplished at least 10° from vertical
- altitude attained 400 km

  (variation with payload, plate II)
- combustion time for 1st stage 19 s
- combustion time for 2nd stage 21 s
- maximum velocity 2650 m/s

  at an altitude of 42,000 m
- maximum longitudinal acceleration 15 g
- rotational acceleration at lift off 160 rad/s^2
- rotational velocity around the longitudinal axis, about 6 t/s
- time of ascent to maximum altitude 5 m/s

- time of descent to ground 10 m

5.2 Outline of possible performance in the case of use in space

Indications are given above concerning a first type of application in space in the form of a rocket-sonde with vertical firing, equipped to gather data along its trajectory. Another area of application is opened by the extension of the zone susceptible to being "seen" by the rocket.

A "Dragon" rocket is susceptible to being seen for:

2 minutes from points located 2150 km distant

4 minutes from points located 2000 km distant

6 minutes from points located 1700 km distant

8 minutes from points located 1200 km distant

For about 4 minutes a "Dragon" rocket sees all cloud formations located up to 15 km altitude in a radius of at least 1980 km.

6. State of progress-accomplished performances

Studies of the "Dragon" are completed; the elements of the booster have been tested on the platform.