LUNAR SPACE VESSEL

Possibilities of a Rocket Flight to the Moon : Release Velocity : The Fuel Question : Stability and Control : Landing Gear

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EVER since it was realised that the propulsive effect of a rocket is the result of the reaction upon it of the acceleration imparted to the emitted gases, it has been obvious that in this reaction lay the possibility of producing tractive effect independent of the surrounding medium.

Granted that the tractive effect is there, the next question to arise is whether it is of sufficient magnitude to make possible a flight to the moon and back.

Those who have considered such a flight think of it in the following terms:—

(1) Acceleration in the shortest possible time to "Release Velocity," with jets at full blast. This velocity having been attained, sufficient momentum would have been built up to carry the ship, at steadily decreasing velocity, to the lunar orbit. The force of gravitation acting on the ship would decelerate it, but its momentum would prevent its being brought to rest. "Release Velocity" may be defined as that velocity which a body will have attained at any point in a gravitational field as the result of having been permitted to fall freely under the influence of that field from infinity to that point, by this formula:

$$V = \text{Release Velocity} = \sqrt{2g\frac{r^2}{x}}$$

where g = gravitational acceleration at surface of body, whose radius is r, x being the distance from the centre of the body to the point at which it is desired to calculate "Release Velocity."

(2) Having reached the point at which the gravitational attraction of the Earth and Moon are balanced, the ship will begin to accelerate, increasing its speed until, at the appropriate moment, rockets are discharged towards the Moon, decelerating the ship to rest on the lunar surface.

(3) On return, the ship would be accelerated; by rocket discharge to lunar "Release Velocity," and then be permitted to coast under momentum.

(4) Re-passing balance point, the ship would accelerate in free fall towards the Earth, until, at the appropriate moment, rockets were again discharged, decelerating the ship to a velocity at which it would be safe to re-enter the Earth's atmosphere. From this point the ship would complete its descent by parachute, or other air-braking device.

It will be seen from the foregoing that the project consists of two periods of acceleration and two of deceleration, under power. The total effort will be the same as if these had been four successive periods of acceleration to a fictitious velocity, V_t, known as total Velocity.

Corrections would have to be applied to the value V_t, thus obtained, to allow for various factors, such as loss of time in attaining "Release Velocity," power reserve for approach and correction manœuvres, and allowance for atmospheric drag. Further corrections will be required to compensate for any change in weight, not directly connected with fuel consumption.

Exhaust Velocity

An equation can be derived, consistent with the conservation of energy and observed experimental results, as follows:—

$$V_t = -v \log_e\frac{M_o}{M_t}$$

where V_t = total velocity, at time t, v = exhaust velocity, M_o = original mass, and M_t = mass at time t.

This equation in the form

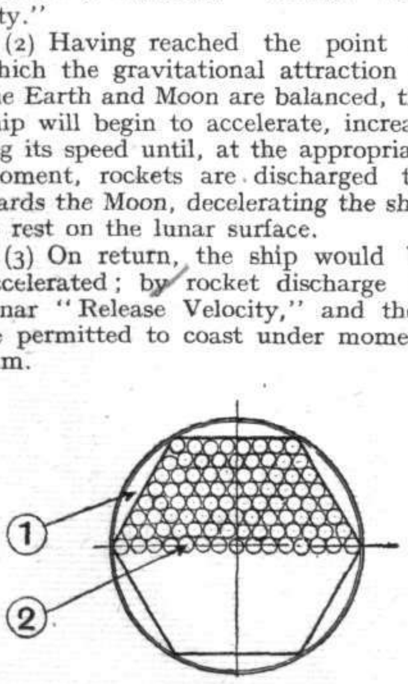
$$\frac{V_t}{\log_e\frac{M_o}{M_t}} = -v$$

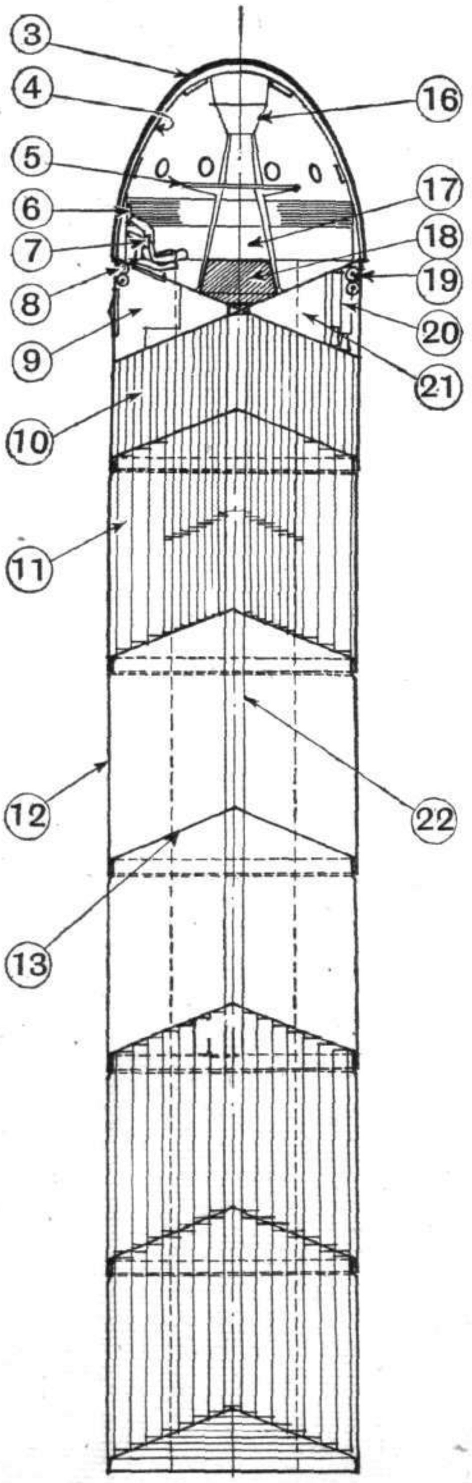
relates exhaust velocity to payload ratio, which is the reason for the prominence given to exhaust velocities by "Astronautical" experimenters.

Directly it is announced that exhaust velocities of the order of 3.9 kms./sec. have been obtained in practical experiment (after correction to vacuum performance) it will be time to consider the details of a practical space-ship, providing the fuel is sufficiently compact.

Compactness is essential to reduce both container weight and the overall dimensions of the ship to reasonable figures.

The reason advanced by some experimenters for the use of liquid fuels is that by valving and throttling the





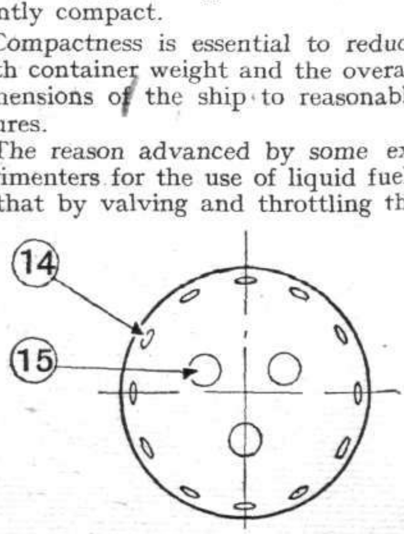


Fig. 1. **Ship complete as at departure from earth's surface:—(1) Overhang of pressure cabin; (2) Rocket tube (large size); (3) Outer shell (jettisoned after leaving atmosphere); (4) Inner shell of pressure cabin; (5) Handrail and supports; (6) Walkway; (7) Firing control; (8) Operator's couch; (9) Airlock; (10) Smaller tubes; (11) Larger tubes (side view); (12) Cage; (13) Thrust web; (14) Radial observation port; (15) Forward axial observation port; (16) Instrument panel and parachute locker; (17) Food and tool lockers; (18) Firing current power pack; (19) Torque jets; (20) Axial liquid fuel control rockets; (21) Space for air, water, and liquid fuel tanks; (22) Cable duct.**