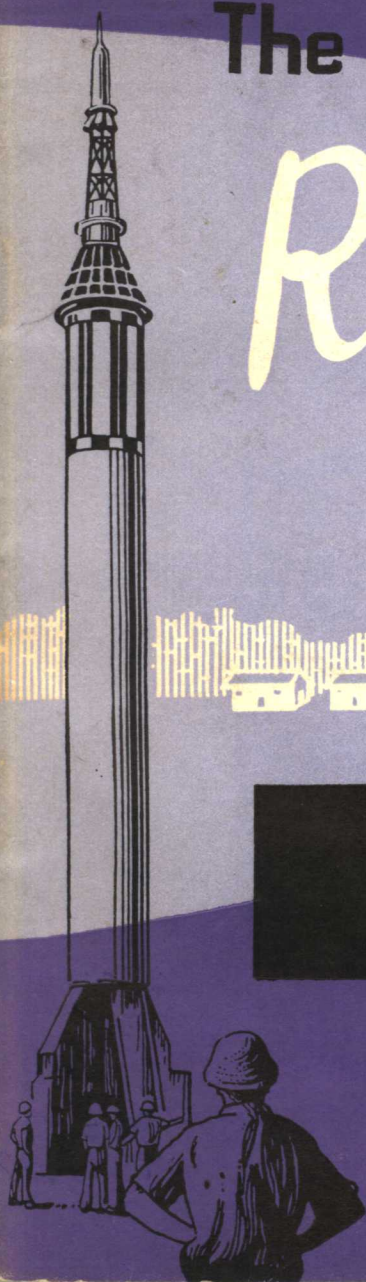


The

Rocket

英语科普注释读物

火箭



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潘绪年 陈士源 注释

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注释者的话

本书是英国科普丛书 **How It Works** 中的一个分册，由 **David Carey** 撰写。全书简单介绍了火箭的基本原理、性能和结构。

本书文字比较浅近，对较难的句子结构、习惯用法和专业用语我们作了注释，可供广大科技工作者和英语师生阅读。

在注释过程中，曾得到专业技术人员的协助，谨在此表示感谢。由于我们的水平所限，错误之处，希望读者批评指正。

1980年1月

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Introduction

Space travel is often in the news. Many films and stories have been written around this intensely interesting subject, but *none of these captured our attention more than the actual facts of man's historic landing on the Moon on 20th July 1969¹. His successful escape from the Moon's gravitational pull and subsequent safe return to Earth were equally stirring.²*

Space stories we see on the screen or read in books are sometimes based on fact, but *the imagination of the authors is used to add fiction to fact³* and make the tales as exciting as possible. But what really happens when a rocket is launched? How is it propelled? How does it travel in the emptiness of space? Why do space vehicles stay *in orbit⁴* around the Earth when their *store of propellant⁵* has been used up? These and many other fascinating questions are answered in the following pages of this book. Not all rockets are used as space vehicles—several other uses are also described.

1. 没有任何一部电影或一个故事比人类在1969年7月20日登上月球的史实更吸引人们的注意。none of后面的名词或代词单复数均可。 2. 人类成功地逃出月球的引力，接着平安地返回地球，这两件事同样地使人激动。这里的escape和return均是名词。 3. 作者通常将想象的虚构内容添加到事实中去。 4. 在轨道上。 5. (火箭)储存的燃料。

Rockets versus Aircraft

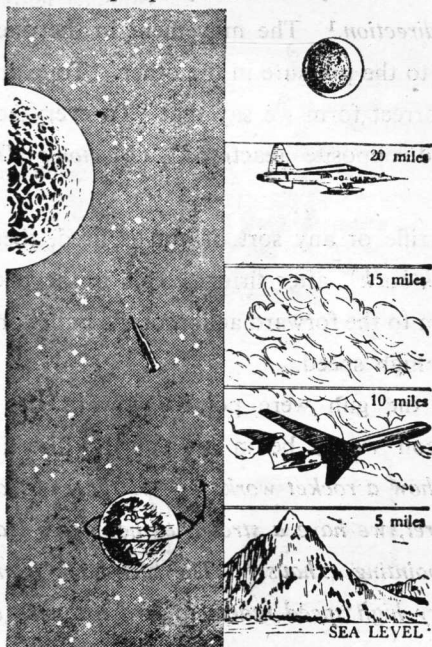
Aeroplanes rely for their operation on the atmosphere which surrounds the Earth. They are driven forward by forcing the air backward with their propellers, or with *the exhaust gases*¹ from their engines in the case of jet aircraft. *The air acting on their wings gives them lift air pressure is used for turning and banking, and oxygen from the air enables their engines to work.*²

Air is at its greatest density at sea level. As height increases the density becomes less. Five miles up, that is about the height of *Mount Everest*³, the air is only one quarter as dense as it is at sea level. *For an aeroplane this means that there is less air to push backward for forward motion, less lift for the wings and less oxygen for the engines.*⁴ At twenty miles above the Earth an aeroplane reaches its *absolute ceiling*⁵ because there is just not enough air for it to operate. It is obvious, therefore, that no aeroplane will ever fly in space, *let alone*⁶ reach the Moon.

This brings us to the essential difference between the aero-

1. 排出的气体。 2. 作用于机翼的空气给机翼以升力, 空气压力用于转弯和侧倾, 空气中的氧气使发动机进行工作。 3. “埃佛勒斯峰”是英国人沿用的旧山峰名, 指的是位于中国与尼泊尔交界处的世界第一高峰——珠穆朗玛峰 Mount Jolmo Lungma, 海拔 8848 米。 4. 对飞机来说, 就意味着为前进而向后排斥的空气减少了, 机翼的升力减少了, 提供给发动机的氧气也减少了。这里的 less air, less lift 和 less oxygen 是 there is 后面三个平行的结构。 5. 绝对升限(理论升限)。 6. 更不必说。

plane and the rocket. Rockets do not need air. They travel better above the atmosphere *where the air is so thin it offers little drag or resistance to forward and upward motion*⁷. The oxygen needed to operate the rocket's motor is carried in a tank built into the rocket itself.⁸ Once the Earth's gravitational pull has been overcome the rocket will continue on its chosen path without further propulsion.



The limitations of an aircraft compared with a rocket

7. 那里的空气非常稀薄,因此对向前或向上运动几乎没有拉力或阻力。where... motion 是定语从句,修饰 above the atmosphere; where 从句中 it offers... motion 是结果状语从句,前面省略了 that。 8. 火箭发动机运转时所需的氧是由安装在火箭内的容器携带的。needed...motor 和 built...itself 是两个过去分词短语,分别修饰 The oxygen 和 a tank。

First Principles of Rocket Propulsion

When you walk upstairs you do so by pushing *down* with your foot on each step. When you climb a rope or a tree you lift your body upward by pulling *downward* with your hands. *In fact, to move in any direction you have to exert pressure in the opposite direction.*¹ The movement in the one direction is exactly equal to the pressure in the other. To express this principle in its correct form we say that "To every action there is an equal and opposite reaction." (*Newton's Third Law of Motion.*)²

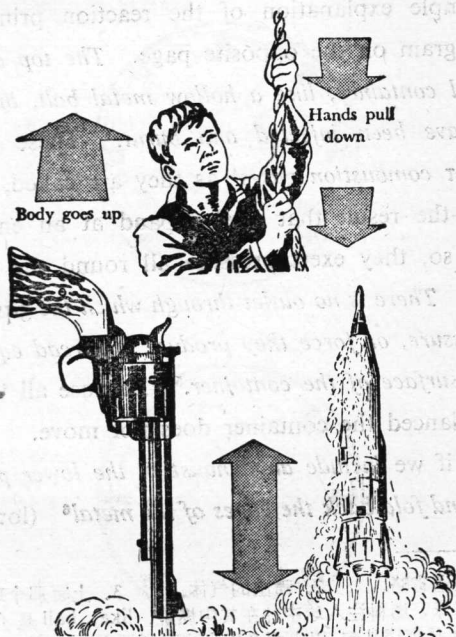
When a rifle or any sort of gun is fired, there is a sharp recoil, or *kick-back*³, after firing. This is the backward reaction of the gun to the forward action of the bullet or shell leaving the barrel at high speed.

Now, if the gun were pointed toward the ground and fired, the recoil would be in an upward direction. *That is very roughly how a rocket works except that, instead of a bullet leaving a barrel, we have a stream of hot gases leaving through a downward-pointing exhaust.*⁴ *The kick-back from these gases ejected at very high speed reacts toward the nose of the rocket*

1. 实际上,向任何方向的运动,都必须在其反方向用力。 2. 牛顿第三运动定律:“两个物体之间的作用力和反作用力总是同时存在,它们的大小相等、方向相反,作用在同一直线上。” 3. 后座力或反冲力。 4. 那是火箭如何工作的粗略情况,不同的地方是一股热气流通过向下排气口排出来,而不是子弹出膛。how a rocket works 是表语从句;except that 是连接词,引导状语从句;instead of a bullet leaving a barrel 是 except that 从句中介词短语,作状语。

and propels it upward.⁵ A gun recoils once after each bullet is fired, but, because there is a continuous stream of gases leaving the lower end of a rocket, it is forced upward in a continuous motion.

An aeroplane is propelled forward by pushing back the air. A rocket does not push back air to go forward; *its movement is caused by the action and reaction of the expanding gases in its combustion chamber*⁶.



"To every action there is an equal and opposite reaction"

5. 快速排出的气体所产生的反冲力,反作用于火箭的头部,推动火箭向上运动。
6. 火箭的运动是由燃烧室里膨胀气体的作用和反作用造成的。

Why It Works

The principle of rocket operation is so important that we must look into it more closely before going any further. *Remember that*¹ a rocket does not go upward by pushing air downward. Its upward movement is the reaction to a downward force provided by *escaping gases*².

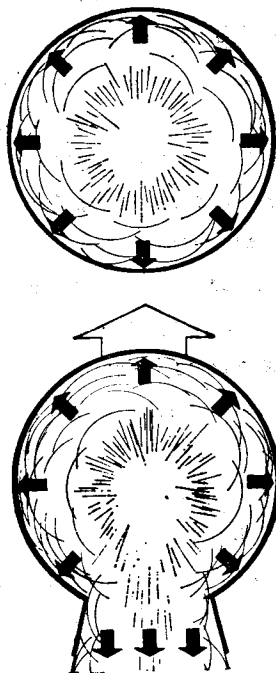
A simple explanation of the reaction principle appears in the diagram on the opposite page. *The top drawing shows a spherical container, like a hollow metal ball, into which propellents have been injected and burnt.*³ These burning propellents, or *combustion gases*⁴ as they are called, are intensely hot, with the result that they expand at an enormous rate. By doing so, they exert pressure all round the inside of the container. *There is no outlet through which the gases can escape so the pressure, or force they produce is spread equally all over the inside surface of the container.*⁵ Because all the forces are equally balanced the container does not move.

Now, if we include an exhaust in the lower portion of the container and fold back the edges of the metal⁶ (lower drawing),

1. 祈使句, 主语省略。 2. 喷出的气体。 3. 上面那个球形容器, 象一个空心的金属球, 燃料注入球中并在其中燃烧。like...ball 是介词短语; into which...burnt 是定语从句, 以上两个均为非限制性定语, 修饰 a spherical container。 4. 燃烧气体。 5. (球形容器) 没有可供气体逸出的口子, 所以燃烧气体所产生的压力或力均匀地分布在容器的内壁上。through which...escape 和 they produce 是两个定语从句, 分别修饰 outlet 和 the pressure or force; they 指 gases。 6. 在容器的下部, 开一个排气口并将其金属口子向外折。

the gases will escape through the opening and the balance of the forces in the container will be upset. The gases will escape freely through the exhaust and the upper portion will have an unbalanced upward force which will therefore move the entire container upward. This upward force is equal to the force of the gases escaping downward through the opening.

In a rocket there is a combustion chamber which works in just the same way as the open-ended container.



A diagram of the reaction principle of a rocket

Propellent Storage Tanks

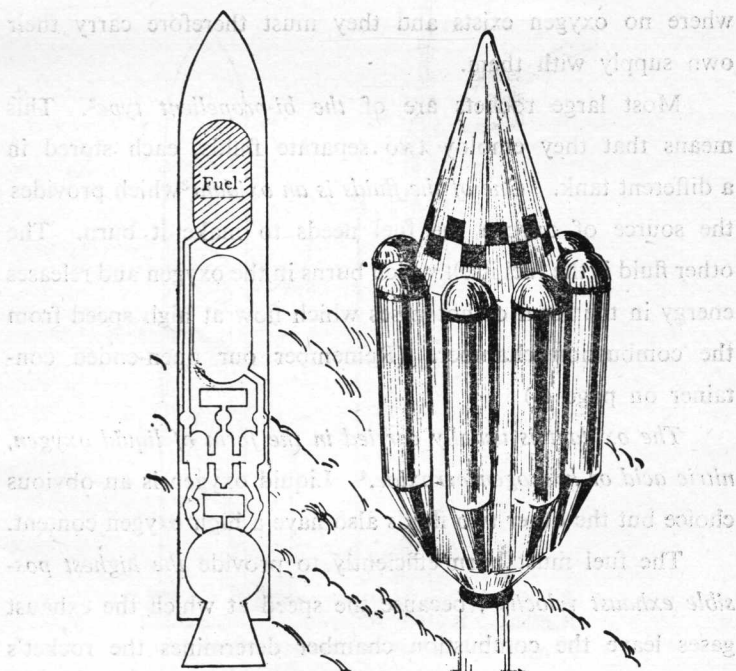
It has now been clearly established that a rocket's upward or forward motion is made possible by hot exhaust gases escaping at high speed through the opening at the rear. These gases are created by burning special propellents inside the rocket. Large tanks are built into the rocket to carry the propellents; in fact these tanks are the largest parts in the rocket's structure and the weight of propellent they contain is often as much as ninety per cent of the weight of *the whole vehicle*¹ before it is launched. It is therefore necessary to use the kind of propellents *that will give the greatest thrust for their weight and the amount of space they take up*². In other words, they must be as efficient as possible.

Similarly, *the tanks themselves must provide maximum capacity with minimum weight*³. A thin rocket will create *less drag*⁴ than a fat one as it travels up through the Earth's atmosphere, so the tanks must take up *as little sideways space as possible*⁵. To save unnecessary weight, the tank sides have to be very thin. This means that a strong material is required.

Some types of tank are built separately and then fitted into *the rocket tube*⁶. Another kind is built as part of the

1. the whole vehicle = the whole rocket. 2. 这种燃料能以其重量和所占据的体积产生最大的推力。定语从句, 修饰 propellents. 3. 容器本身必须以最小重量而提供最大的能量. 4. 较小的阻力. 5. 容器所占的地方越小越好. 6. 火箭发射管.

main structure, the sides of the rocket⁷ actually forming part of the tank. This design saves weight because the one section of material does two jobs. Tanks are sometimes made to fit round the outside of the rocket so that they can be jettisoned⁸ when they are empty and their useless weight does not have to be carried any higher than necessary.



An illustration of a Rombus rocket⁹ with jettisonable tanks, and a diagram of a fuel tank fitted into a rocket tube

7. 火箭管壁。

8. 它们可以投弃。

9. Rombus rocket: 隆巴斯火箭。

Types of Propellent

Every internal combustion engine needs oxygen to ignite the fuel¹ which provides the power. Motor car and aeroplane engines operate in the atmosphere from which their oxygen supply is drawn, but rockets travel above the atmosphere, where no oxygen exists and they must therefore carry their own supply with them.

Most large rockets are of the *bi-propellent type²*. This means that they employ two separate fluids, each stored in a different tank. *One of the fluids is an oxidant³ which provides the source of oxygen the fuel needs to make it burn. The other fluid is the fuel itself which burns in the oxygen and releases energy in the form of hot gases which flow at high speed from the combustion chamber. (Remember our open-ended container on page 6.)*

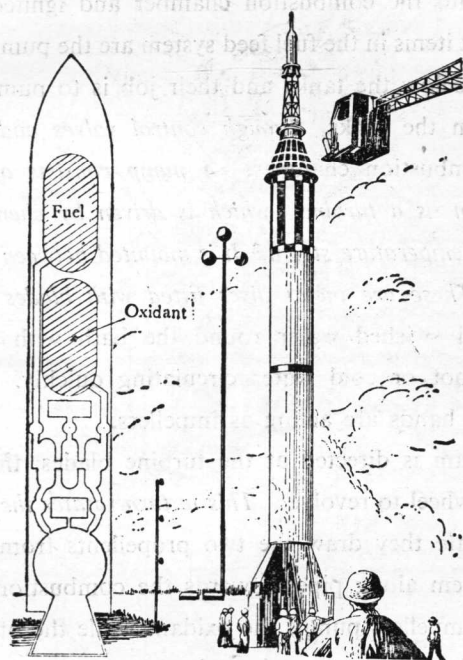
The oxidant is usually carried in the form of liquid oxygen, nitric acid or hydrogen peroxide.⁴ Liquid oxygen is an obvious choice but the other two fluids also have a high oxygen content.

The fuel must burn efficiently to provide *the highest possible exhaust velocity⁵*, because the speed at which the exhaust gases leave the combustion chamber determines the rocket's upward thrust. *The more efficient the burning, or combustion,*

1. 每一部内燃机都需要氧气来点着燃料。 2. 二元燃料型。 3. 液体燃料之一是氧化剂。
4. 通常携带的氧化剂是液氧、硝酸或是过氧化氢。
5. 最快的排气速度。

the greater the exhaust velocity, and the greater the thrust.⁶ Kerosene (paraffin)⁷ is the most commonly used fuel at present but the lighter and more energetic liquid hydrogen⁸ is gradually replacing it.

Solid fuels are sometimes used. These have the ability to be stored, without evaporating, but are not quite so powerful.



A Redstone rocket with Mercury spacecraft⁹

6. 燃烧效率越高, 排气速度就越快, 推力就越大。the more..., the more 结构, 意思是“越……就越……”, 这里 the more efficient... 代表从句, 后面代表主句。这种结构中的主句、从句都可省略某些成分。本句主句和从句中的谓语动词都省略了。 7. 煤油(石蜡)。 8. 更轻并且能量更大的液氢。 9. 带有水星航天器的红石火箭。

The Propellent Pumps

From the previous chapter we know that most large rockets use two liquid propellents, each stored in a separate tank. But before the rocket can function, these propellents have to be fed into the combustion chamber and ignited.

The first items in the fuel feed system are the pumps. These are located below the tanks and their job is to pump the propellents from the tanks, *through control valves and injectors*,¹ into the combustion chamber. *A pump consists of a bladed wheel, known as a turbine, which is driven by chemically-produced, high-temperature steam.*² *It is mounted between two turbo-impellers. These are metal discs fitted with blades or vanes.*³ We have all swished water round the bath with our hands to get the hot or cold water circulating quickly. When we do this, our hands are acting as impellers.

The steam is directed at the turbine blades, thus causing the turbine wheel to revolve. *This in turn rotates the impellers.*⁴ As they rotate they draw the two propellents from the tanks and push them along pipes towards the combustion chamber. One of the impellers pumps the oxidant while the other pumps the fuel. Great care must be taken to ensure *that the two*

1. 通过控制阀和注入器。 2. 泵是由叫做涡轮的叶轮组成，叶轮由化学产生的高温蒸气驱动。 consist of 由……组成，由……构成。 known as a turbine 是定语，修饰 a bladed wheel。 3. 它安装在两个涡轮叶轮之间，这是两个装有叶片的金属圆盘。 4. 反过来带动叶轮。