ROCKETS

HOW THEY WORK

TRANSCRIPT AND CAPTION SCRIPT

DCMP DESCRIBED AND CAPTIONED MEDIA PROGRAM

Rockets: How They Work
Encyclopedia Britannica Films
Transcript

[suspenseful music]

(male narrator)
This is the launching site.

(over loudspeaker: man #1)
(unintelligible) the ready room.
(unintelligible) the ready room.

(over loudspeaker: man #2)
Attention please. Personnel should evacuate the area at this time. All personnel not assigned to the launching platform should leave the area at this time.

(over loudspeaker: man #1)
(unintelligible) the ready room.

(narrator)
In the blockhouse not far from the rocket, hundreds of men are at work. Most of these men are scientists and engineers.

(mission control center: man #3)
Telemetry in launch condition?

(mission control center: man #4)
Affirmative.

(mission control center: man #3)
Missile and (unintelligible)?

(mission control center: man #5)
Affirmative.

(mission control center: man #3)
Pressurization complete?

(mission control center: man #6)
Affirmative.

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(mission control center: man #7)
Main stage!
Four, three, two, one, zero.
One, two, three, four, five, six, seven.

(narrator)
All of these men have worked and waited for this moment.

[sound: rocket igniting]

(mission control center: man #8)
Look at it go.

(mission control center: man #2)
Keep going, baby!

[sound: rocket ascending]

(narrator)
Today rockets can do many things for us.

They can be military weapons, tools for scientific discovery, a means for transportation and exploration.

As rockets are used more and more, it is important to find out what makes a rocket work.

We can look for the answer in the backyard.

What makes a sprinkler spin when you turn on the water?

It's the same basic principle that makes a rocket rise from the earth.

It's called a *reaction*.

Every action has a reaction.

The action of a boy’s jump has a reaction that moves the wagon.

Often reactions aren’t noticed.

A frog doesn't care that the action of his jump has a reaction that pushes his log backwards.

[sound: frog croaking and birds chirping]

Reactions are often put to work.

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An automatic rifle is recocked by a reaction to the action of the bullet.

[sound: gun fires three times]

And the action of a stream of gases rushing out from a rocket, as we see here in slow motion, has an equal and opposite reaction that moves the rocket forward.

[sound: stream of gases rushing]

When the fuel inside a rocket burns, gases are formed that push in all directions.

The action of some of these gases rushing out the open end of the rocket has a reaction that pushes against the closed forward wall.

This reaction moves the rocket forward.

A rocket moves itself.

It doesn't need anything to push against, as you do when you use a lawn mower, and your foot pushes against the ground.

It doesn't depend on friction.

The tractor is moved forward by friction between the turning wheel and the earth.

In fact, a rocket works best out in empty space where there is no friction with air to slow it down.

[sound: patriotic music playing]

[sound: firework cracks and explodes]

The Fourth of July skyrocket is an old relative of a modern rocket.

It's much smaller and simpler, but it works in about the same way.

Like larger rockets, a skyrocket is basically a hollow cylinder.

At the fireworks factory, trained men pack the cylinder with fuel.

Then one end is closed.

But here a small hole is left.

This is called a *nozzle*.

When you close down the opening of a garden hose, the water goes faster.

In the same way, closing down the open end of a rocket by forming a nozzle increases the speed of the gases that go through it, and the rocket goes faster.

When the fuel is used up, the rocket slows down.

But if we could get more fuel to the coasting rocket, the rocket would speed up and go faster than it was moving before.

The faster the wheel of a car turns, the faster the car travels.

But an automobile engine has a top speed, and the wheels can turn only as fast as the engine can turn them.

The speed of a rocket is not limited by its engine.

As long as we can supply more fuel, the speed can be increased.

The rocket's top speed depends on the amount of fuel that it can carry with it.

But a rocket engine needs something else besides fuel.

A candle flame takes oxygen from the air.

A fire can’t burn without a supply of oxygen.

If we cover the candle, it will continue to burn until it uses up the oxygen inside the jar.

When the oxygen is gone, the candle goes out.

The fuel for rockets must burn in space where there’s little or no oxygen available, so a rocket must carry its own supply of oxygen along with it.

When oxygen is very cold, it becomes a liquid.

Liquid oxygen is being pumped into this rocket.

It will supply the rocket engine with the oxygen it needs in order to burn fuel where there is no air.

But every pound of liquid oxygen and fuel loaded aboard adds to the weight of the rocket, and the rocket must work hardest in its first moments of flight when its load of fuel is the heaviest.

First the rocket must start moving from a dead stop.

And you know that the air close to the earth is thick.

You can see the force of this thick air moving the sailboat.

At the beginning of its flight, the rocket must push its heavy load of fuel through this thick air.

By the time this rocket has reached the thinner air, high above the earth, it has used all of its fuel, and the rocket slows down and falls back to earth.

One way to use rocket fuel more efficiently is to burn it in multistage rockets.

A *multistage rocket* is simply several rockets mounted on top of each other.

The bottom rocket is called the first stage.

On top of it is the second stage and so on.

This multistage rocket has three stages.

The first stage is a big rocket.

It starts the multistage rocket moving and lifts it up through the thick atmosphere close to the earth.

This is hard work, and soon the first stage has burned all of its fuel.

Now the smaller second-stage rocket can go to work.

With a burst of speed, it leaves the big first stage behind.

It lifts the small, third-stage rocket along with it.

The second stage burns out.

The third stage is coasting at high speed through thin air when it is fired.

It needs to burn only a small amount of fuel to go very fast and very far.

If a rocket is not properly guided, its flight is likely to be short and disastrous.

[sound: explosion]

Rockets must have precisely accurate guidance systems to control their flights.

A spinning gyroscope is the heart of many rocket guidance systems.

As long as a gyroscope is spinning, it will resist changing its position, no matter how you turn the base on which it rests.

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Two gyroscopes are mounted in the nose of this rocket model.

No matter how the rocket turns off its course, the gyroscopes remain in the same positions.

The electronic brain of the rocket is able to measure the difference between the direction of the rocket as it moves through space and the direction of the spinning gyroscope, which never changes.

These measurements are sent back to the engine, which is the steering mechanism for most rockets.

An airplane is steered by moving fins on the tail and the wing in the stream of air that rushes past them. But a rocket travels where there is no thick air and where fins would have nothing to move against.

Many large rockets are steered in the same way that you steer an outboard motorboat—by turning the motor.

[sound: motor whirring and puttering]

Impulses from the electronic brain turn the rocket engine.

When the direction of the jet action turns, the direction of its reaction, which lifts the rocket, also turns and puts the rocket back on course.

(mission control center: man #2)
Attention please. Personnel should evacuate the area at this time. All personnel not assigned to the launching platform should leave the area at this time.

(mission control center: man #7)
T minus sixty seconds and counting.

(narrator)
We have seen that rocket power doesn't depend on friction, and a rocket doesn't need anything to push against.

Rocket power is a reaction to an action.

A rocket lifts itself up from the ground.

From the skyrocket to modern rockets is only a beginning in the development and use of rocket power.

(mission control center: man #7)
Main stage!
Four, three, two, one, zero.
One, two, three, four, five.

[sound: rocket igniting]

Freed from the surface of the earth and the atmosphere that surrounds it, rockets can become explorers into new worlds of knowledge.

[suspenseful music]

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This is a launching site.

A rocket is ready for launching.

The launching platform moves away.

Radar will . . .

. . . trace the rocket on its journey.

Hundreds of men are waiting for the firing.

Some are scientists. Some are engineers.

The men in the blockhouse have worked for this moment.

Count down

Ten

Nine

Eight

Seven

Six

Five

Four

Three

Two

One

Zero

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Today rockets can do . . .

. . . many things for us.

They can be military weapons or . . .

. . . tools for scientific discovery.

What makes a rocket work?

Why do sprinklers spin when the water is turned on?

This is the same principle that makes a rocket rise.

It is called a reaction.

Every action has a reaction.

The boy jumped and the wagon reacted.

Often reactions are not noticed.

Frogs do not realize actions cause reactions.

As the frog jumps, the wood is pushed back-wards.

Reactions are often put to work. An automatic rifle is . . .

. . . reloaded by the action of the bullet leav-ing the gun.

As the action of the gases rushes from the rocket exhaust . . .

. . . the reaction pushes the rocket forward.

As fuel burns inside the rocket, gases are formed.

These gases push in all directions.

Some rush out causing a reaction.

This reaction moves the rocket forward.

A rocket moves itself.

A rocket doesn't push against anything . . .

. . . as when pushing a lawnmower.

Your foot pushes against the ground.

Rockets don't depend on friction . . .

. . . as tractors do.

A tractor moves because of friction between the wheels and the earth.

A rocket works best in outer space where there is no friction . . .

. . . to slow it down.

The sky rocket we use on the Fourth of July . . .

. . . works like the modern rocket.

A small hollow cylinder is used.

At the factory, trained men pack the cylinder with fuel.

One end is closed.

A small hole or nozzle is left open.

When you close down the end of a garden hose . . .

. . . water goes out faster.

Closing down the nozzle of a rocket increases the speed of gases.

This makes the rocket move faster.

When the fuel is used up, the rocket slows down.

If we could get more fuel to the coasting rocket . . .

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. . . it would travel faster than ever.
The faster the wheels . . .

. . . of a car turn, the faster it travels.

At top speed, the wheels turn . . .

. . . only as fast as the engine can turn them.

The speed of a rocket is not limited by its engine . . .

As long as the rocket has fuel its speed increases.

But rockets need something else.

A candle takes oxygen from the air.

A fire cannot burn without a supply of oxygen.

The candle will burn until the supply of oxygen is used up.

Then it goes out.

Rockets travel in space where there is no oxygen.

They must carry their own supply of oxygen with them.

When oxygen is very cold, . . .

. . . it becomes a liquid.

Rockets use liquid oxygen.

The engine uses it instead of air.

Rockets need oxygen to burn . . .

. . . in space.

This adds weight to the rocket.

The engine works hardest at the start of the flight.

The air near the earth is very thick.

It is hard for the rocket to go through this thick air.

The force of this thick air is moving the sailboat.

At first the rocket's load is heavy.

This rocket has used all of its fuel traveling through . . .

. . . the thick air, so it falls back to earth.

This is a multi-stage rocket.

Several rockets are joined together.

Each has its own supply of fuel and oxygen.

This multi-stage rocket has three stages.

First stage

Second stage, etc.

The first stage lifts this rocket through the thick atmosphere . . .

. . . close to the earth.

All the fuel gone, the first stage drops off.

The second stage travels much faster and lifts the third stage . . .

. . . high into space where it can travel without much effort.

The third stage can travel fast and far on little fuel.

Rockets must be guided or they will fall to earth.

Rockets must have an accurate guidance system to control their flight.

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A spinning gyroscope is used in the rocket guidance system.

As long as a gyroscope spins, it will not change positions.

Two gyroscopes are mounted in the nose of this rocket.

When the rocket turns, the gyroscopes will remain in the same position.

The electronic brain measures the difference between the gyroscopes, . . .

. . . and sends this measurement to the engine.

The engine has the steering mechanism in it.

Airplanes are steered by air moving over the fins and the tail.

Rockets travel in thin air, so fins are not necessary.

Rockets are steered the same way a boat is steered . . .

. . . by turning the motor.

Impulses from the electronic brain turn the engine.

As the jet action turns, its reaction turns the rocket.

This rocket is being prepared for its flight.

The launching platform is moved away.

Everyone is tense.

The engineers are waiting for the count down.

We have seen that rockets do not depend on friction . . .

. . . or anything to push against.

Rocket power is a reaction to an action.

The rocket lifts itself from the ground.

From the sky rocket to the modern rocket . . .

. . . is only the beginning . . .

. . . in the use of . . .

rocket power.

Free from the surface of the earth and the atmosphere around it, rockets can become explorers into new worlds of knowledge.

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