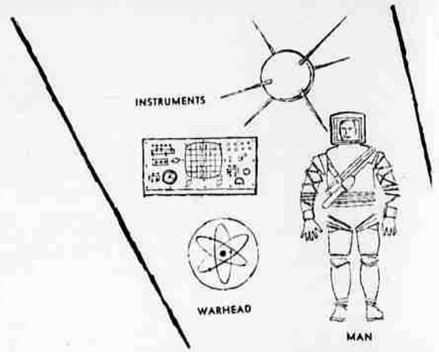
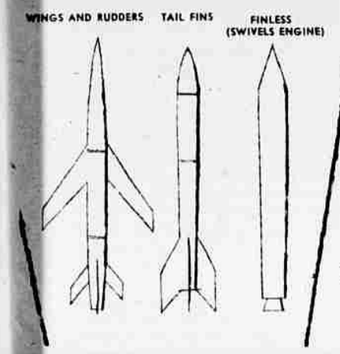
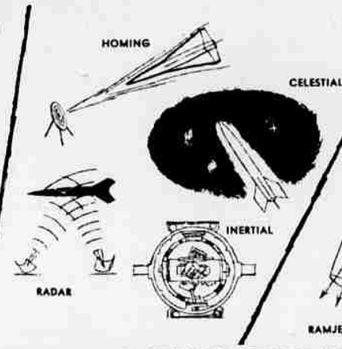
Layman's Guide to Rockets and Missiles

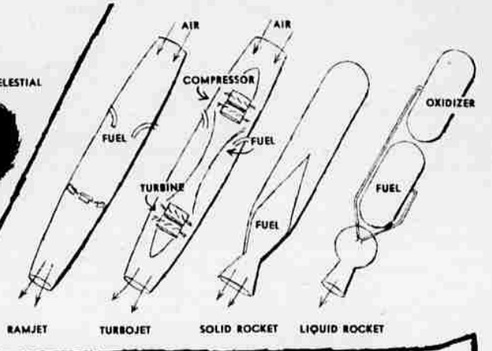
by Kevin V. Brown



1 **Payload** of missile is thing that's thrown. Military missiles throw warheads. Research missiles throw instruments (sample: satellites). Soon missiles will throw man into space.







2 **Airframe** is body of missile. It includes steering mechanism. Some use wings and rudders; some have only tail fins; some swivel engines the same as outboard motorboats.

3 **Guidance** system tells missile which way to steer. Radar types use reflected echoes; homing types, impulses from target; inertial types use gyros; celestial types track the stars.

4 **Engine** is power that throws missile. Ramjet and turbojet engines are "air-breathers," can't operate outside atmosphere. Solid-rocket and liquid-rocket engines go anywhere.

Here, in simple terms, are the things every citizen should know about the fantastic developments of the space age.

Air-to-air missiles are smallest in missile family. Fired from one aircraft against another, their role is air defense.

Falcon

F-101B with Genie

Air-to-ground missiles extend range and accuracy of conventional bombs, can also carry larger warheads.

B-50 bomber drops Rascal

Ground-to-air missiles replace antiaircraft.

Nike-Hercules

Ground-to-ground missiles include guided and ballistic missiles. Text explains basic difference. Short-range types are front-line Army artillery weapons.

Lacrosse

Intermediate- and intercontinental-range types replace long-range bombers, can carry thermonuclear warheads.

Matador take-off

Jupiter IRBM

Snark, 5,000-mile guided missile

Multi-stage missiles, including the satellite-launchers, stack two, three, or more missiles on top of one another.

Atlas ICBM

Jupiter-C

Vanguard

SUDDENLY, almost bewilderingly, we are living in the age of rockets and missiles. America's giant aircraft industries, which turned out hundreds of thousands of fighters and bombers for World War II and Korea, today are devoting more than half their production to missiles. Other firms are wholly involved in manufacturing components.

While old-time airmen claim manned aircraft will never be replaced, the demand for missiles increases steadily, decreases for pilots and planes. The dramatic impact of the earth satellites, launched by rocket-powered multistage missiles, only emphasized the presence of these weapons of the future. Details of these incredibly complex vehicles—some missiles may contain as many as 300,000 individual parts—are understood only by experts. But there are basic principles which the average person can, and should, understand. Here, in simple terms, is a primer course on rockets and missiles.

Where did it all begin?

In China, more than 700 years ago. As early as 1232—long before the invention of guns—Chinese were firing rockets in warfare. They aren't even new in America. In 1812 at Fort McHenry, "the rockets' red glare" inspired Francis Scott Key to write "The Star Spangled Banner." Until modern improvements, however, rockets were too erratic and much less effective than firearms. The first really successful rocket—and the direct ancestor of today's missiles—was the German V-2, used to bomb London during World War II.

What is a rocket?

A toy balloon is a simple rocket. When inflated, it has internal pressure that wants to get out. Release the nozzle, and the balloon spurts away.

Basically, a rocket is just a highly refined toy balloon: a pressurized chamber with one opening. The pressure, created by burning extremely powerful fuels, acts in all directions. Pressures against the side walls balance each other, but the pressure toward the nozzle is released resulting in an *unbalanced* pressure in the opposite direction. This obeys Newton's third law of motion: a force in one direction (toward the opening) creates an equal force in the opposite direction (toward the front).

A common misconception is that a rocket moves because its exhaust "pushes" on the outside air. Just the reverse is true: the exhaust merely escapes; it's the "push" on the front wall that drives the rocket forward. If it needed air to push on, a rocket could never operate in outer space where there is no air.

However, to define rockets used in modern missiles, it would be more accurate to call them rocket engines. They perform the same function as jet engines. By itself, a rocket is just a Fourth of July toy.

How many kinds of rocket engines are there?

Two, solid- and liquid-fueled.

Solid fuel is a mixture of chemicals which, when ignited, can burn by itself. It looks like a block of chalk, and can be stored in the rocket engine, ready to fire at any time.

Liquid fuel is more powerful and longer-burning, but also more complicated. Actually, two liquids are needed, a fuel and an oxidizer. The fuel must be mixed with the oxidizer before it can burn, just as gasoline must be mixed with air in a car engine.

Liquid-fuel systems are complicated because the fuel and oxidizer need separate storage tanks, plus pumps or some other pressure to force them into the rocket chamber for firing. This extra equipment adds extra weight and takes up extra space. Also, unlike solid fuel, liquid fuel can't be loaded into the missile until just before take-off.

Solid fuel, because it's compact and convenient, is widely used in smaller missiles. Liquid fuel, because it produces more power for longer periods, is used in larger missiles, which can accommodate the extra equipment.

What is a jet engine?

It's the other kind of engine used in modern missiles and airplanes. It also works on Newton's principle of action and reaction, with one basic difference. A rocket engine is self-contained; it carries both fuel and oxidizer and operates independently of the outside atmosphere. A jet engine carries only fuel, getting its oxidizer (oxygen from the air) in flight. Instead of one opening, it needs two; its gets air through the front opening, but blows its exhaust out the rear opening the same as a rocket. The thing to remember, then, is that a jet engine is an "air breather" and can't operate outside the earth's atmosphere, while a rocket engine can.

How many kinds of jet engines are there?

Two—ramjet and turbojet.

A ramjet engine is aptly called a "flying stovepipe." It's practically a hollow tube with no moving parts. The air enters the front end, is mixed with fuel and burned, and the hot gases are blown out the rear end. Its advantage is simplicity; its disadvantage is that it can't draw the air in, but must be flown fast enough *through* the air so that the air is literally "rammed" into the front end. A ramjet engine, then, needs auxiliary power—such as booster rockets—for take-off. Once in flight, however, it's capable of supersonic speeds.

A turbojet engine has moving parts. One of them, the compressor, draws air in the front end and forces it into the combustion chamber. Another, the turbine, is mounted on the same shaft as the compressor and is spun by the exhaust gases. Thus, as the exhaust rushes toward the rear opening, it spins the turbine, which spins the compressor, which draws in more air. So the whole cycle is continuous until the fuel supply is cut off.

Ramjet engines, because of the take-off problem, are confined to use in a few missiles. Turbojet engines, because they can be started on the ground, are widely used in both missiles and airplanes.

What is a missile?

It's something that's thrown. In modern terms, however, a missile is something that can throw itself and change its course in flight. Depending on its size, it's anything from an "intelligent" bullet to a pilotless airplane. It consists of four things: the thing that's thrown (the payload), the power that throws it (the engine), the thing that aims it (the guidance system), and the body that holds the whole thing together (the airframe).

How many kinds of airframes are there?

As many as there are kinds of missiles. Each missile is built for a different purpose with different equipment, and each needs its own body design, the same as airplanes or automobiles. An important part of the airframe is the control system, or steering mechanism. Some airframes have wings and rudders,

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Staff writer Kevin V. Brown was a fighter pilot during World War II and has since been a member of the Air Force Reserve. To gather material for this special Family Weekly article, he recently visited civilian and military establishments throughout the country and interviewed experts in the Pentagon and at the missile testing center at Cape Canaveral, Fla. This resulting article is an attempt to bridge the ever-widening gap between our fast-growing arsenal of missiles and what the average citizen knows about them.