

STARTLING STORIES

Vol. 19, No. 2

A THRILLING PUBLICATION

May, 1949

A Complete Novel



FLIGHT INTO YESTERDAY

By CHARLES L. HARNESS

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STARTLING STORIES, Published every other month by Better Publications, Inc., N. L. Pines, President, at 4860 Diversey Ave., Chicago 39, Ill. Editorial and executive offices, 10 East 40th St., New York 18, N. Y. Entered as second-class matter November 22, 1946, at the post office at Chicago, Illinois, under the act of March 3, 1879. Copyright, 1949, by Better Publications, Inc. Subscription (12 issues), \$3.00; single copies, \$1.25; foreign and Canadian postage extra. In correspondence with this magazine please include postal zone number, if any. Manuscripts will not be returned unless accompanied by self-addressed, stamped envelopes and are submitted at the author's risk. Names of all characters used in stories and semi-fiction articles are fictitious. If the name of any living person or existing institution is used, it is a coincidence.

PRINTED IN THE U. S. A.

The ROAD to

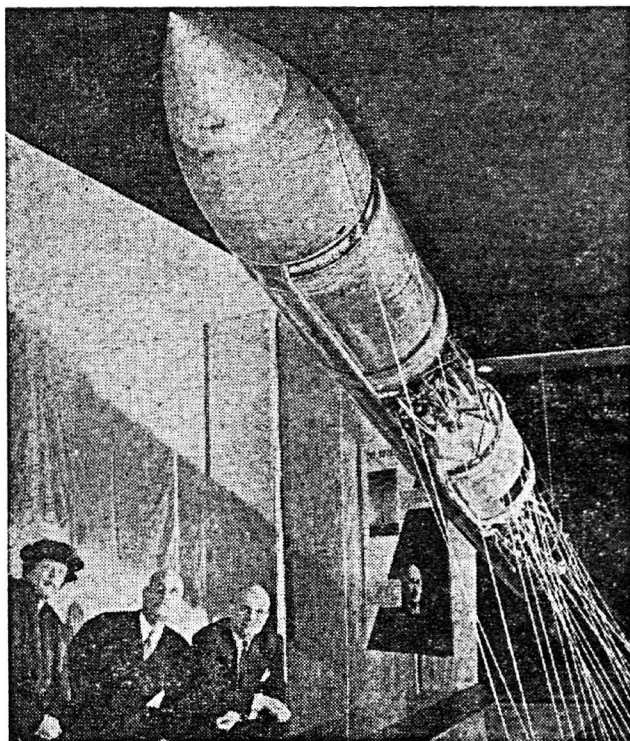
OF COURSE there is no way of checking whether this actually happened but the story goes that the workmen of Boeing's assembly line watched the first Flying Fortress take off from the runway for its first test flight.

When it had disappeared in the clouds an old foreman turned around to go back to his desk and muttered, "Oh well, there goes the last of the small airplanes."

Ten or twelve years hence the newsreel

commentators who now speak of V-2 as a "gigantic missile" are quite likely to say that V-2 and *Neptune* were the last of the small rockets. It is not difficult to prophesy that the next twelve years will bring much bigger and much better rockets. One can even go farther than that and state just what rocket engineers should be able to accomplish during the next twelve years, provided only that they don't run out of funds.

(1) A rocket capable of crossing the



*Thanks to the
development of
the "step" or
"booster" rocket,
man has it in
his power to
send a missile
to the Moon
by 1961*

General Jimmy Doolittle (right), Dr. Coddard's widow and H. F. Cuggenheim, Coddard's backer, examine the pioneer's biggest rocket

A New Series by WILLY LEY

SPACE TRAVEL

Part II THE NEXT TWELVE YEARS

Atlantic Ocean, travelling most of the way high above the earth's atmosphere. In other words a rocket with a horizontal range of 4000-5000 miles.

(2) A manned rocket with a vertical range of 500 miles or more, amounting to about twice the height of earth's atmosphere.

(3) An unmanned missile capable of reaching the moon and crashing there, marking the spot of its arrival for everybody to see.

(4) And finally—with some good luck in addition to unlimited funds—a rocket which will revolve around the earth without ever falling back, presumably to be used as a nucleus around which to build the Station in Space.

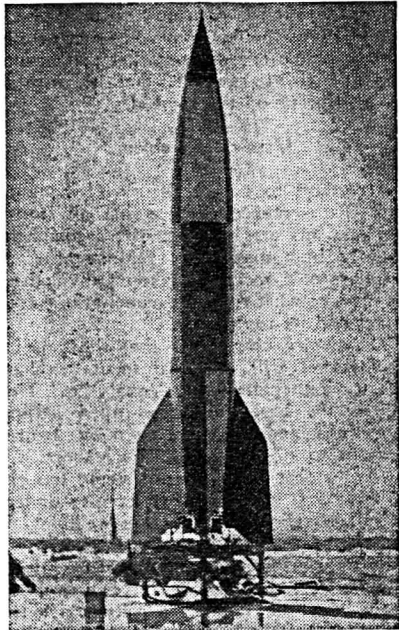
One could prophesy these things merely on the strength of the accomplishments of the last twelve years by what is technically known as "extrapolation." But mere extrapolation is always doubtful and the prophecy actually rests on much firmer grounds than that.

It so happens that the field of rocket engineering is probably unique in that the first practical steps were taken *after* the theory of rocket motion and of rocket performance had been developed quite thoroughly.

Engineering First

In stories it is a logical development that a scientist, or a group of them, evolve a complicated and elaborate theory and that they, after they are quite sure of their results, begin to attack the engineering problems. In reality however it rarely works that way.

The first steam engines were built completely without "steam tables" and other literature which now clutter up the desk of the designing engineer. The theory of airfoils, of airflow over curved surfaces and of aerodynamics in general, did not guide the pioneers of aviation. On the contrary the theory was the outcome of their hit-or-



An ex-German V-2 ready for take-off

miss experimentation. Even in the field of atomic energy the scientists largely made up theory as they went along.

But the theory of the liquid fuel rocket was ready at a time when nobody was quite sure just how a liquid fuel rocket motor would look when finished. And since this theory had proved remarkably accurate so far it may safely be used for some more prophecy.

According to the theory now— But I can't help thinking of the old Olsen and Johnson gag which "H. H. Holmes" retold in his mystery novel *Rocket to the Morgue* and which fits admirably.

It seems that early in their career these comedians had a scene laid in a hotel room

which was invaded from time to time by a drunk in search of a bathroom. When the drunk wandered in for the fifth time he looked sadly at the occupants and asked plaintively, "Are you in *all* the rooms?"

The concept which I have to mention now and on which most rocket prophesy was and is based is something which we'll find "in all the rooms" from now on until either Doomsday or the day somebody successfully applies atomic energy to rocket propulsion. And I do wish to say that I don't think these two will occur on the same day.

Mass-ratio Problem

According to rocket theory (I have to start that sentence over again) all future developments are based on the accomplishment of high mass-ratio. "Mass-ratio" is the mass of a rocket at take-off divided by the mass of what remains, namely the empty rocket and its payload.

The theory now states that the velocity of a rocket will be equal to its exhaust velocity if that mass-ratio equals "e." This "e" is the base of the so-called natural logarithms and written down in figures amounts to 2.71828—or 2.72 for short.

I know that this does not sound too exciting at first glance but we have to understand this relationship because we'll find it "in all the rooms." It controls everything else. The performance of a rocket is entirely bounded by the highest velocity which it can attain. And the highest velocity which the rocket can attain is determined by the exhaust velocity which its fuel will provide and by the fuel load or the "mass-ratio."

Let's look at an example. Supposing we want to build a rocket which can reach an altitude of 300 miles vertically when used as an instrument carrier. The same rocket would have a range of twice that figure, 600 miles, horizontally when used as a missile.

Now it can be established—I am skipping some three pages of involved mathematics at this point—that the rocket has to have a velocity of just about ten thousand feet per second for this job. If we had a fuel which has this exhaust velocity the rocket would have to have a take-off weight of 27.2 tons if ten tons of empty rocket plus payload are to reach the target.

As implied by the term "if we had a fuel" present day fuels do not provide such an exhaust velocity. The V-2 motor produces

about 7000 ft/sec. and if anything else does better than that it is a military secret. But we'll assume that we don't even get 7000 ft/sec. but only 5000 ft/sec. exhaust velocity.

The rocket that will carry 600 miles horizontally could still be built, but it would have to have a higher mass-ratio. The answer in this case is $e^2=7.4$. The rocket would have to have a take-off weight of 74 tons in order to get ten tons of empty rocket plus payload to the target.

A Tricky Business

The requirement of a high mass-ratio leads to all sorts of neat little tricks. The first liquid fuel rockets, for example, very simply had two tanks, one for the oxygen and one for the fuel. Then nitrogen pressure was put on both tanks and that pressure forced the two liquids into the rocket motor. The pressure used, incidentally, was about 300 lbs. per square inch.

It worked nicely but of course the tanks had to be strong enough to stand that pressure, with a comfortable safety factor added for the sake of those who handled the rockets. This naturally meant that the tanks were quite heavy and that the empty rocket weighed a good deal without having a really high fuel capacity. In short it could not have a good mass-ratio.

What to do about this difficulty was realized before anybody ever built a liquid fuel rocket. The thing to do was to build the tanks just strong enough to hold the fuel and to supply the necessary pressure for feeding the liquids into the motor by means of pumps.

But pumps are not weightless, the scheme would be advantageous only if the saving in tank weight was greater than the added pump weight. Hence pumps could be installed only in a big rocket, the bigger the better. The first rocket with a pump was Dr. Goddard's rocket of 1935. Of course V-2 has pumps and so does *Neptune*. But this means the mass-ratio of V-2 could be "upped" to about 3:1 and a mass-ratio of 7:1 or 8:1 will surely be realized in the near future.

Why Not Increase Velocity?

At this point somebody might ask with full justification why the rocket engineers do not simply strive to increase the exhaust velocity. The answer to that question is that they would if they could. But unless and

until somebody succeeds in utilizing atomic energy for rocket propulsion there is very little leeway. The exhaust velocity of a fuel and oxidizer combination is given by the chemical energy tied up in those fuels.

All the combinations in use (and naturally the experimenters picked the best they could find) show a theoretical maximum of about 14,500 ft/sec. Half of that has been actually obtained and one may hope that it will ultimately be about two thirds of the theoretical figure or about 10,000 ft/sec. True, hydrogen used as a fuel promises some 17,000 ft/sec. in theory and practice may squeeze out some 12,000 or even 13,000 ft/sec.

But hydrogen is so light, even when liquefied, that it is quite bulky. Furthermore it cannot be used for cooling the motor. The two disadvantages of higher tank weight and of a third liquid for cooling the motor would probably eat up most of the advantage of the higher exhaust velocity.

It may not be apparent on the surface but in the foregoing I have severely limited my own prophesying. I stated a few paragraphs ago that one might hope for a mass-ratio of something like 8:1 and I said in the preceding paragraph that an exhaust velocity of about 10,000 ft/sec. would hardly be surpassed.

If you combine these two figures you get the result that the maximum velocity one might expect from a rocket would be 20,000 ft/sec. since the mass-ratio of 7.4:1 results in a rocket velocity of twice the exhaust velocity.

Back to V-2

I consider myself temporarily "caught" at this moment and have no other defense than to point out that such a rocket would rise to an altitude of about 2250 miles! And, since the horizontal range of a missile is twice that of the maximum altitude reached in a vertical shot, the same rocket would have a horizontal range of 4500 miles! This still assumes that the earth is flat and since it is not flat, as everybody now learns even before going to grade school, the range would be longer than that!

Still, we would be stuck with a "mere" 2250 miles of vertical range and some 5500-6000 miles horizontal range if the rocketmen did not have an additional trick up their sleeves.

To understand this trick we'll fall back on

V-2 once more, not because it is the best of all possible rockets but simply because it does exist and thereby provides some substance to our reasoning. In round figures the V-2 rocket weighs 3 tons empty, carries a one ton warhead and a fuel load of 8 tons, so that the take-off weight is 12 tons.

If that one-ton warhead were discarded for another ton of fuels the rocket would obviously climb to a higher altitude since that change (assuming it to be technically possible) would improve the mass-ratio from 3:1 to 4:1.

Now let's try something else. Instead of taking off one ton of warhead and putting in one ton of fuel, we'll take off one ton of warhead and substitute another smaller rocket weighing one ton.

Which one would go higher—the rocket with the somewhat improved mass-ratio or the smaller rocket which was not only carried high by the bigger one but which also started out with the velocity reached by the lower rocket? Even with any calculation it is obvious that the smaller rocket would go higher by far.

Step Rockets

Such a combination of smaller rockets carried by bigger ones is called "step rockets." Historically the first step rockets were built in about 1700 by fireworks-making artisans who wanted a nice display. The principle was then used again in 1855 by the British Colonel Boxer for a line-carrying rocket, was patented in 1911 upon application by the Belgian inventor Dr. André Bing and patented once more later on upon application by Dr. Goddard.

But the true beauty of the thing does not seem to have been realized prior to Dr. Goddard. It is that the maximum velocity of the "last step" is the sum of the velocities of the single steps. Or, if you think of mass-ratio, that the "ideal" mass-ratio of a system of step rockets is the *product* of the single mass-ratios.

The introduction of the step principle is literally a means of spreading the required mass-ratio for a certain job over "several rooms," all of them simultaneously occupied by the same concept.

At about the time of VE Day the Germans were ready to go ahead with a rather large step rocket which was unofficially known as the "American Rocket." It was a modified

V-2, designated A-9, which was to be carried off the ground by a "lower step" (called A-10) with a take-off weight of 85 tons!

This would have been a 5000-mile missile, even though the exhaust velocity was not more than 7000 ft/sec. and the mass-ratio of each step only about 3:1. But because there were two steps, the combined or "ideal" mass-ratio would have been roughly 9:1 and that would have done the job.

Astounding News

Because of VE Day the combination rocket A-9+A-10 remained a project. But recently the rather astounding news has been released that the Germans did have a true three-step rocket during the last days of the war. The missile was a solid fuel rocket with the code-name *Rheinbote* ("Messenger from the Rhine") of which about twenty were fired into Antwerp from the vicinity of the small Dutch town of Zwolle in November 1944.

The missile was cleared from its launching rack by a booster unit with a burning time of only one second. The three steps composing the missile burned in succession, Step No. 1 for five seconds, Step No. 2 also for 5 seconds and Step No. 3 for 4.5 seconds, discarding the empty hulls of the burned out steps in succession.

The complete missile was 37 ft. 5 inches long and weighed 3773 lbs. The empty third step and the bomb it carried weighed together 297 pounds and arrived at the impact point, 137 miles from take-off, after 260 seconds.

Of course it was a somewhat high expenditure of powder and ingenuity to transport a warhead weighing by itself just 88 pounds, but it proves, if anybody should have doubted that point, that step rockets can actually be built.

The Next Twelve Years

After all these technicalities I can go back to my four predictions, namely that the next twelve years should bring a 5000 mile missile and a manned rocket capable of rising to an altitude of 500 miles or more.

As we have seen in the meantime these two predictions can be fulfilled if rocket engineers succeed in raising the exhaust velocity from the present 7000 ft/sec. to 10,000 ft/sec. and the mass-ratio from the present

3 : 1 to about 7.5 : 1. In both cases single rockets were silently assumed. In reality the step principle would almost certainly be employed.

Before we go on to prediction No. 3, the unmanned moon missile, we have to devote a few paragraphs to a side issue. While the long-range missile will crash, the high altitude rocket would have to be landed.

How does one land such a junior spaceship?

Landing Problems

In trying to answer that question we have to consider a few facts. One is that we are probably only trying to land the upper step of a two-step rocket. The other is that that upper step will be rather light, since most of the fuel has been used up. The most likely method would be to equip the upper step with short stubby wings. Wings of any kind do not help a rocket at all in taking off—in fact they are a hindrance.

But their usefulness is mostly caused by the fact that the rocket is compact and heavy at take-off and is to reach a high velocity as fast as possible if it is not to waste fuel. With a virtually empty rocket the case is somewhat different. Because only the upper step is winged the wings would cause no trouble at take-off—they would be somehow hidden in the bulk of the lower step.

When the lower step drops off the presence of the wings won't matter because the rocket will be in almost empty space. If still in the atmosphere that atmosphere will be very tenuous and will, furthermore, be traversed vertically at a fast rate. But on return the wings, supporting nothing but an almost empty metal shell, will brake the fall.

It may be that such a rocket could be actually landed like a high-speed glider but it is not likely. Judging by present-day knowledge the most likely thing will be to break the rocket up once more when its glide path has carried it to, say, ten miles above the ground.

Then the very small cabin can be separated from the remainder of the rocket and land by parachute while the rocket is left to crash. Or else the most valuable part of the rocket, motor and pumps etc. could be entrusted to another parachute while the remainder, mostly just formed sheet metal, is blown up and left to flutter to the ground in pieces.

The additional possibility of landing such a rocket on its tail, using up a fuel reserve kept for this purpose, should be kept in mind. With the aid of automatic gyro instruments which keep the rocket vertical this should not present impossible obstacles.

And now we get to the moon missile.

Moonward Bound

Because of the rather complete development of rocket theory we can forecast the performance of a moon missile with a good amount of detail. The whole missile would have to be lifted off the ground by a booster unit and to be carried first to an altitude above which air resistance does not matter any more, say fifty miles. Then the missile itself would have to accelerate to a velocity of 36,000 feet per second.

In the course of this maneuver at least one lower step would be shed so that only the uppermost step will actually attain 36,000 ft./sec.—fortunately far above the atmosphere because the air resistance for even half of that velocity would be a horrible thing to contemplate. If the accelerating was done at an average rate of 4 g's the total burning time would amount to about 500 seconds.

The moon missile, endowed with 36,000 ft./sec., would continue to rise after the fuel supply was exhausted. But it would not maintain this velocity—the gravitational attraction of the earth would steadily reduce it. The missile would lose some 30 ft./sec. at first and this loss would gradually diminish as the distance between missile and earth increased and the gravitational influence was consequently weakening.

Even so the earth's gravity would succeed, in the course of time, in nibbling the missile's velocity down to very little. After 300,000 seconds it would be almost zero. The important point is that it must show a small remainder, or the experiment turns into a failure—because after 300,000 seconds the missile has reached the "line" where the gravitational attractions of the moon and earth balance each other.

If gravity wins before the missile reaches that line it will fall back to earth. If the missile has only a small amount of velocity left it will cross the line and fall to the moon.

Supposing that it crossed the line with about two inches per second it would need 50,000 seconds to crash on the moon, with an impact velocity of close to two miles

per second, composed of the missile's motion due to the moon's attraction and of the motion of the moon itself. Since 351,000 seconds are 97½ hours the whole performance will have taken just over four days.

Plenty of Light Needed

Dr. Goddard, in calculating a similar example, suggested packing the nose of the missile with flashlight powder, so that the impact would cause a bright flash which could be seen from earth by means of a telescope.

But I think it more practical to provide a payload of some white powder, like ground glass or plaster of Paris to be blown around on impact by a small explosion. This would produce a permanent bright spot, even if the white powder should be so thinly dispersed that an observer walking over it on the moon would not be able to discover it.

How large would this missile have to be?

That, of course, depends on an enormous number of different assumptions, so that only the most general round figures could be given. If we say that the exhaust velocity has been pushed up to 10,000 ft./sec. in the meantime, the rocket proper would need a mass-ratio of about 36 : 1 but would have to be fortified by a very substantial booster unit.

Of course one cannot build a rocket with a mass-ratio of 36 : 1 as a single rocket. It becomes possible as a two-step rocket, each step with a mass-ratio of 6 : 1. If we allocate only 5 pounds for white powder, explosive charge and impact fuse we'll get a 60-ton missile, probably requiring a 150-ton booster.

The figures are big but it could be done. Not with the resources of the present-day status, but with the status that we can hope to attain during the next twelve years.

But those who'll have to make the decision on how the money is to be spent may decide that the moon missile has mainly publicity value while the same amount of cash "more or less" might buy what is now known as an "orbital rocket," a rocket which circles the earth like a small moon about 600-700 miles from the surface.

By itself such an orbital rocket would be of little use. But it may be utilized as the forerunner and cornerstone of the Station in Space.

And that is another story.