

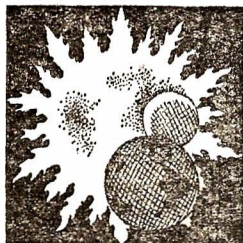
STARTLING STORIES

Vol. 19, No. 3

A THRILLING PUBLICATION

July, 1949

A Complete Novel



FIRE IN THE HEAVENS

By **GEORGE O. SMITH**

Outside the world of science, Jeff Benson was a man of no importance—until the day he stumbled on the mistake in the law of conservation of energy! 9

Two Complete Novelets

- THE SACRED MARTIAN PIG**.....Margaret St. Clair 78
Delivery of an inanimate object of worship from Mars seemed simple—but it involved George Baker in amazing escapades!
- HOLLYWOOD ON THE MOON**.....Henry Kuttner 108
Drive along Lunar Boulevard and dine at the Silver Spacesuit with Tony Quade in this Hall of Fame classic reprinted by popular demand

Short Stories

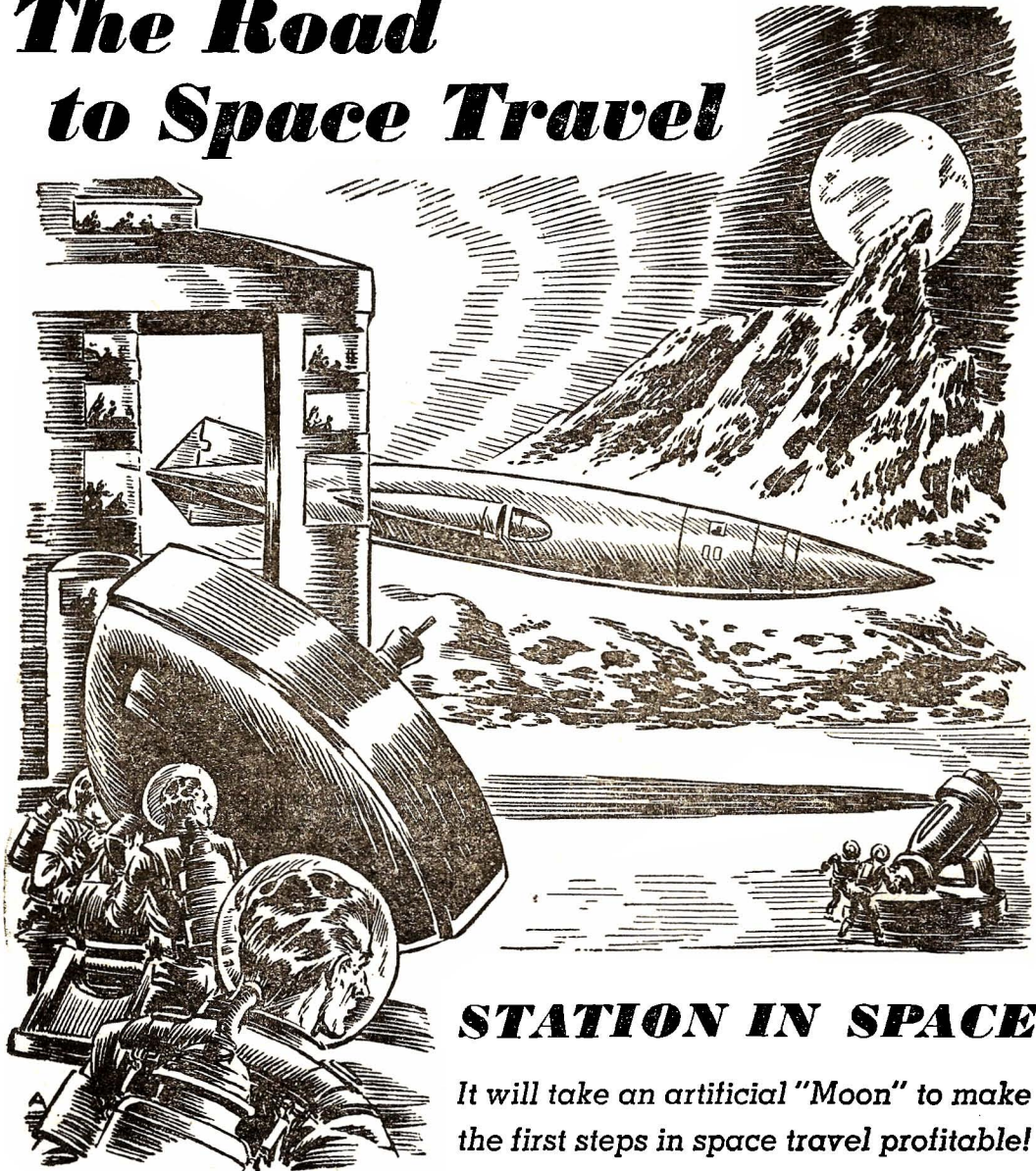
- THE UNWILLING HERO**.....Rene LaFayette 98
No hunger for glory lured Vic Harden into the reaches of space
- TRANSCIENCE**.....Arthur C. Clarke 125
Though the world may die, man will go on!
- THE ONLY THING WE LEARN**.....C. M. Kornbluth 129
If we could see clearly, would we hate our future enemy?
- THE LONELY ONES**.....Ray Bradbury 135
A strange woman on a strange planet causes curious complications

Features

- THE ETHER VIBRATES** (Announcements and Letters).....The Editor 6
- THE ROAD TO SPACE TRAVEL** (Station in Space).....Willy Ley 73
- NUCLEAR NUGGETS**.....Carter Sprague 97
- CURRENT FAN PUBLICATIONS**.....A Review 154
- THE SCIENCE FICTION BOOKSHELF**.....A Department 161

STARTLING STORIES. Published every other month and copyright, 1949, by Better Publications of Canada, Ltd., 36 Toronto Street, Toronto, 1, Canada. Entered as second-class matter at the Post Office Department, Ottawa. In correspondence with this publication please include your postal zone number, if any. Manuscripts must be accompanied by stamped, self-addressed 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. July, 1949. PRINTED IN CANADA AT TORONTO

The Road to Space Travel



STATION IN SPACE

It will take an artificial "Moon" to make the first steps in space travel profitable!

ABOUT twenty years ago a Viennese engineer and mathematician, Count Guido von Pirquet, spent a number of weeks immersed in calculations. His tools were simple—a slide rule, an astronomical handbook and some tables. The calculations

on which he spent day after day in single-minded devotion were not exceedingly difficult from the mathematical point of view but they were tedious almost beyond endurance.

The nature of the work was such that most

Third in a Series by WILLY LEY

people, had they known about it, would have made remarks like "waste of time and effort"—"foolishness disguised as science"—and whatever else was said in 1928 about a man who thought in terms of space travel. Count von Pirquet calculated the astronomical orbits which would lead a spaceship to Mars—and to Venus—and to the asteroids.

But he was especially interested in an orbit which in itself does not lead anywhere—a closed orbit around our own planet. Then he looked at orbits leading outward not from earth but from that closed orbit around earth. And then he wrote me an excited letter, telling me that he had made a surprising discovery.

He called his discovery the "cosmonautic paradoxon" but it amounted to another example of that old adage that it is the first step which is the hardest. That the first step would be the hardest even when it came to space travel had been realized all along, of course. But now von Pirquet revealed what that first hard step should be.

WHAT THEY THOUGHT

It is necessary at this point to remember what the scientists who were interested in space travel thought in those days. The first rockets, they all agreed, would be instrument-carrying rockets for the exploration of the upper atmosphere. Such rockets constituted not only a useful scientific device in themselves but would also furnish the information needed for later, more advanced rockets.

Then, it was thought, the instrument-carrying rockets for the exploration of the upper air would gradually grow to be space rockets, leaving the atmosphere completely behind. Finally such a space rocket (unmanned) would be big and powerful enough to go to the moon. Meanwhile, piloted high-altitude rockets and, a little later, manned space rockets would be built.

In the end one of those manned rockets would be able to reach the moon. At first it would probably not be a trip *to* the moon but a trip *around* the moon without landing there. And after that was accomplished it would be possible to set up a rocket to circle around the earth permanently, a small artificial moon which, by gradual accumulation of materials, would grow into a "station in space."

That such a station in space would be extremely useful as a research laboratory was

also generally conceded and one or two people added, as an afterthought, that such a station might also serve as a refueling station for spaceships.

The point is that it was unanimously agreed that such a station would be of enormous value and that it would be built at some time in the future. But opinion was equally unanimous that it would be a late by-product of space travel in general.

NO STATION—NO SPACE TRAVEL

Count von Pirquet found to his surprise that the station in space would have to be an *early* accomplishment, that without such a station there would be no space travel. Of course the whole project would still begin with high-altitude rockets followed by space rockets (today we have just about arrived at this point of the development). But, he said, the next step after that would be the station in space, not the spaceship. It would be a very difficult step to take but everything afterwards would be much easier than that first step.

He did not just say so—he proved it. The detail of his proof could not be set up on a linotype machine—but his reasoning can be made clear without much difficulty. In order to go to the moon a spaceship has to overcome the earth's gravity, which means that it has to reach a speed of seven miles per second after penetrating the atmosphere.

But if it wants to go to Mars 7 mps are not enough. Earth, Moon and ship are at about the same distance from the sun but Mars is farther out. To get there the ship also has to fight solar gravitation. And when it finally gets to Mars its own velocity and that of the planet will not match, so that some more fuel has to be expended to match velocities. Finally, if the ship is to land, it has to fight the gravitation of Mars during landing.

FUEL TROUBLE

The main trouble with all this is that the fuel which is burned not only must propel the ship but also the fuel which is still unburned in the ship. If you need a fuel reserve of, say, ten tons later on, you have to spend from sixty to four hundred tons for the purpose of taking your reserve along.

These things have a terrible habit of piling up on one another and the ship grows fast,

even on paper. It was relatively easy to calculate the mass-ratio for a Mars ship and to hope that one day we would be able to build something like that. But von Pirquet found that there was a hitherto overlooked difficulty.

It was not that very large amounts of fuel would have to be burned. It was that a ship taking off for Mars from the earth directly would have to burn *one hundred and five tons of fuel during the first second* in order to take off at all!

That did seem impossible. It still does. But in order to establish the station—and later to reach it after it has been established—the ship has to attain a speed of “only” five miles per second. It is easier to go to the station than it is to go to the moon.

Now if we imagine that each ship which goes to the station carries a small fuel reserve to be deposited there and finally used to fuel a ship that takes off for further points, we find that such a ship would start out with many advantages. To begin with it would be already outside the atmosphere and air resistance could be laughed off. Furthermore it would already have a velocity of five miles per second, the velocity with which the station moves around the earth.

To go to the moon under these conditions would mean only an additional two miles per second to be contributed by the ship itself. To go to Mars from the station would be less difficult than to go to the station from the ground!

COSTLY TRANSPORT

Of course it would be expensive to get the necessary fuel to the station. In his first set of calculations Count von Pirquet arrived at an expenditure ratio of 68 to 1, meaning that 68 pounds of fuel would have to be burned for every pound added to the reserve of the station. That figure has since been revised downward to about 42-to-1.

It is not too important which figure we accept. The important thing is that theoretically it can be done, while the direct trip is impossible even in theory. And it is nice to know that the take-off fuel consumption for a ship bound for a planet from the station amounts to about a quarter ton per second, instead of scores of tons per second.

As for the station itself it would stay in its orbit without any fuel expenditure at all, just as the moon stays in its orbit without

such expenditure. Like the real moon the orbit of this artificial moon would be an ellipse with the center of the earth in one of its focal points. Naturally it would be sometimes closer to earth than at others but one could keep these variations small.

In the preceding articles I have stated repeatedly that the theory of rocket motion and especially of space travel was far advanced at a time when experimentation was just preparing to take its first stumbling steps. The discussion of the “cosmonautical paradoxon” is proof of my statement.

All this was worked out in 1928 when the only liquid-fuel rockets in existence were Dr. Goddard's first models. And all subsequent thinking about these problems has done no more than revise original figures. It has not changed the theory itself.

ATOMIC NOT IN MIND

Of course it should now be emphasized that the theory was developed without any thought of atomic energy. In 1928 atomic energy was recognized as something that existed but that was all. Physicists knew that large amounts of energy were stored in the nuclei of atoms but only because their knowledge said that it had to be there. They had no proof that it could be released.

Some thought that there must be a way of releasing this energy because the stars seemed to draw on such a source but, even if that were true (as it actually is), there was no way of telling whether Man would be able to imitate the stars. At any event atomic energy seemed to be centuries in the future.

Now we know that atomic energy can be released at will and in at least in two ways. It can be released fast as an ultra-violent explosion or slowly in a “pile.” Since we have succeeded in releasing atomic energy we can hope that somebody will find a way of using it for rocket propulsion. Should this happen soon, before a station in space has been begun, we may wonder whether it would be begun at all.

Phrased differently—does the “cosmonautical paradoxon” hold true even with atomic energy?

This is an interesting and very important question—but it cannot be answered right now. The answer depends on how atomic energy is used for rocket propulsion. And that is something the General Staffs of at

least twenty countries and the Boards of Directors of at least forty industrial enterprises would like to know. They would pay large amounts of cash for the answer.

FUMBLING GUESSES

So far we have only a few fumbling guesses. It is obvious that the fissionable matter which produces atomic energy would not be used in the same way in which we use alcohol and liquid oxygen or nitric acid and aniline. The exhaust of the rocket would not consist of just fission products. Such an exhaust, if it could be created without taking its motor along by way of volatilization, would probably be fantastically fast but it would also be very light in mass and therefore fantastically inefficient until the rocket moved with a good percentage of its own exhaust velocity.

In order to make the exhaust of the rocket motor massive as well as fast it will be necessary to provide some relatively inert substance that can be thrown out of the exhaust nozzle. Of course the fission products would go into the exhaust too but they would constitute only a small percentage of the bulk.

In order to imagine such an atomic rocket motor at all we'll assume that the "fuel" is water in which a water-soluble salt of plutonium has been dissolved. "Firing" the motor would consist of setting off these scattered plutonium atoms in the solution in some manner. Such a motor would produce an exhaust massive enough to be efficient and fast enough to be far superior to any chemical fuel.

If it is to work in this or any parallel manner the station in space will be still useful. The expenditure ratio of getting a fuel reserve to the station may drop from 42-to-1 to perhaps 5-to-1 but the station will still have the edge. Even if we could build a ship to go to Mars from New Mexico Space Terminal directly, it would still be economical to go to the station in one kind of ship and from the station to Mars in another.

WHY BOTHER?

But, somebody is sure to ask at this point, why go to the trouble and expense of putting an artificial satellite into space? We've got a real satellite—why not just build a base on the moon?

I believe that a base on the moon will be

built just as soon as it can be done. It will be a wonderful astronomical observatory. It will be a very fine laboratory for physical, chemical, biological and other kinds of research. It will be a fine military base, which will provide lots of food for thought to rulers who believe in the righteousness of aggression (*their* aggression, naturally). But the lunar base will be a very poor spaceship base.

That conclusion can be extracted without trouble from a few sets of figures. Leaving the earth for the moon (we have had the figure repeatedly) requires a velocity of seven miles per second. Braking the fall toward the moon will require another two miles per second, with rocket motors working in the opposite direction. But from the point of view of fuel expenditure it does not matter whether we add or subtract velocity. The total velocity required to go to the moon and land there amounts to nine miles per second.

Reaching the station needs but five miles per second and the braking maneuvers will be something like a hundred feet per second. They will hardly count if the pilot knows his job.

But now we want to go from our "base" (whichever it may be) to Mars. That can be done only at certain times. Take-off must occur when the orbit of the "base" (the tangent to the orbit, to be precise) points in a certain direction. If we are on the moon that will happen once a month. If the proper time should be missed for some reason the pilot will simply have to wait for the next time. The station will circle earth once in a little more than two hours. Hence, if one opportunity is missed the next one will come a mere seventy minutes later.

TAKE-OFF

Taking off from the station the ship is supplied with a velocity of five miles per second free of charge. The moon also supplies orbital velocity to the spaceship gratis—all of 0-point-six miles per hour! And of course the moon has a gravitational grip of its own amounting to about one-and-a-half miles per second. The ship would have to fight free of the moon first.

To fight free of the gravitational attraction of even a large and elaborate station might require as much as fifty feet per second.

The moon is too far away, too slow in its orbit and too massive in itself to be useful as a refueling base for spaceships. It is just a case of bad luck for earthmen. The Martians are far better off in that respect. They have not just one but two moons which fulfill all the requirements.

They are quite close to the planet and for that reason rather fast in their orbits. And they are both small. The larger one (Phobos) measures about fifteen miles in diameter. The other (Deimos) measures a little less than eight. Phobos is closer to the planet than Deimos. And Phobos would make a fine refueling station for spaceships.

Of course one could still criticize the setup. For space travel purposes it would be better if the nearer moon were the smaller. And it would be better still if it were nearer to the planet than it actually is. The actual distance amounts to 1.4 planet diameters. 0-point-four planet diameters would be better. But even though the moons of Mars are not precisely what we would like to design they are ideal when compared to our own satellite.

A TINY "IF"

A tiny "if" might be tacked onto the last sentence, reading—"if Luna is our only satellite". Just about a century ago a French astronomer by the name of Pettit published a paper in which he claimed that earth had a second moon, very small (two miles or less in diameter, probably less), circling the earth at a distance of about 4700 miles from the surface.

It cannot be said that this paper caused a storm of interest in astronomical circles. But the idea proved intriguing enough for a few astronomers to devote some time to hunting it, although it was obvious from the outset that any object so small and so near (which therefore would pass through the field of vision very fast) could be found only by accident.

German astronomers even coined a colloquial term for it. They referred to the recurrent attempts to find it as "hunting for *Kleinchen*." But "Little Bit" (that's about the meaning of their term) was never found

and today astronomers remember the whole episode vaguely—if they remember it at all.

That "Little Bit" actually exists is highly unlikely although not impossible. If the unlikely should be true we would not have to build a station in space and could stop envying the Martians.

But what if our existing far-away, slow and big moon should yield fuel from its own natural resources? What would be the picture in that case?

SURPRISES POSSIBLE

The picture would change all right but in a somewhat unexpected manner. To begin with it has to be said that it would be very surprising if the moon should yield fuels, especially atomic fuels. The average density of the moon is about 3.3 as compared to the massive 5.5 of the earth. It is, therefore, built of lighter material and if the heavy fissionable elements occur at all they are apt to be at very considerable depths.

Only freak conditions during the evolution of the moon could have created surface deposits of any size. Finding one that does exist would be another freak occurrence. But we'll assume that fuel can be found and that mining and extracting it are no more difficult than on earth.

If all these rather farfetched assumptions should come true the most efficient way of handling the situation would be *to mine the fuel on the moon and then bring it to the station*. The fact that the moon yields fuel—if it does—may make up for its own gravity although all the navigational advantages would still be with the station. But a ship taking off from the moon for the station could carry a higher payload than a ship taking off from earth for the station.

The few people who discussed questions of this kind two decades ago usually thought of this particular problem as a question of whether there should be a space station or a base on the moon. After von Pirquet published the results of his calculations that question was decided in favor of the station.

In all likelihood we'll have a station *and* a lunar base.

●
Next in this Series—

MEDICINE AND SPACE TRAVEL, by WILLY LEY