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For Your Information

By WILLY LEY

THE BIRTH OF THE SPACE STATION (II)

LAST month, I told how the concept of the manned rocket in an orbital path around the Earth and its possible subsequent development into a space station was evolved and presented by Hermann Oberth in 1923. After that, very little happened for about six years and the reason was a popular book.

Oberth's original work, while not long, was very hard reading for practically everybody. There were pages upon pages of massed equations and the "clear text" which followed after such a discussion made very little sense unless you had waded through the mathematics preceding them.

Oberth was approached by his own publisher with the suggestion of writing a popular version of his work. He was not opposed to the idea in principle, as many other German scientists of that time would have been, but he did not have the time to write it. Once or twice, I believe, he actually started to, but each time a new and unsuspected and most interesting mathematical relationship turned up which, of course, had to be investigated first.

Then, one day, a professional writer came to Oberth, suggesting that they do the book in collaboration. Oberth was to supply the information and the writer—his name was Max Valier—was to do the writing.

IT did not work out well. Valier was not able to follow Oberth's mathematical reasoning on many points. He suggested "improvements." Oberth tried to explain why these suggestions, far from being improvements, would not work. Sometimes he convinced Valier, generally he did not, and he had to explain later that Valier's book was, after all, Valier's book and not his. His problem was that many other people began writing about "Oberth's ideas," but took their information from Valier.

As for the space station, Valier had not mentioned it at all. He had simply skipped that portion of Oberth's work. I am not sure whether he failed to understand the concept or just what prompted him. At any event, instead of discussing the space station concept, he described a base on the Moon. When I questioned him about that once, he declared that he could not see why anybody should bother to build a space station when we have a ready-made natural space station in the form of the Moon.

I tried to reason with him that hauling anything to the Moon is obviously much more difficult than hauling the same thing to a height of, say, 1000 miles and providing it with a lateral push so that it would take up an orbit and stay there.

Valier replied that hauling something to an orbit would require a velocity of about 5.5 miles per second (including air resistance and a safety factor) while hauling something to the Moon would require "just 1.5 miles per second more." ('Tain't so. Seven miles per second will merely get you through the Earth's gravitational field. Then you need additional fuel to brake your fall and to adapt to the orbital velocity of the Moon.) Furthermore, Valier insisted, you would have to haul "everything" to the space station's orbit, but only essentials to the Moon, where you could build what you need from raw materials to be found there. (Optimistic, to put it mildly.)

Still thinking I might win, I pointed out that if the primary purpose of a space station were to serve as a refueling place for interplanetary ships, a ship leaving from the station would have a speed of some 4.5 miles per second relative to the Earth, and would only have to make up the difference between 4.5 miles per second and the actual velocity required for the interplanetary trip, which would be some 8.5—9 miles per second relative to Earth. The moon, I then said, has an orbital velocity of only 0.6 miles per second and more than that is needed even to overcome its own gravitational field.

No go. Valier insisted that the raw material for fuel would be found on the Moon, too, so it would be unimportant that the Moon's orbital velocity is of no real help.

Since his answers were pat, while my own portion of the discussion came out slowly and gropingly, I feel sure that he had had the same discussion with Oberth before and had not been convinced. And since, as I have already said, people absorbed Oberth's ideas from Valier's book, there was no space station discussion for quite some time afterward.

THE first book largely devoted to the idea of the space station appeared in 1929. Its author was an Austrian by the name of Potocnic who wrote under the pen name of Herman Noordung. The title page of his book stated that he was an engineer and a captain in the reserve. To this day, I have failed to find out whether these two statements belonged together —meaning that he was a captain in the engineer corps—or whether one was his peacetime occupation and the other a wartime commission.

The title of the book was *Das Problem der Befahrung des Weltraums* ("The Problem of Travel in Space") and Potocnic-Noordung succeeded in getting himself into the bad graces of all the rocket men at once by producing a fantastic method for calculating overall efficiency. Another point on which he failed to make friends was his insistence that a space station should be located over the equator, 22,300 miles above mean sea level. At such a distance, the station would need precisely 24 hours to go around the Earth once. If it moved in an easterly direction, it would seem to stand still over one point of the equator.

For reasons I still don't understand, Potocnic-Noordung considered this a great advantage, though actually such a position would be full of drawbacks. The station could be seen from only one hemisphere, but it could also observe only one hemisphere. Because of the long distance—costly in fuel consumption—it could not even observe very well.

But he did have a number of interesting ideas. His proposed space station consisted of three units: the "living wheel" (as he called it), the "power house" and the "observatory."

The first was to be a wheel-shaped unit, about 100 feet in diameter, which was to spin around its hub so as to substitute centrifugal force for gravity around the rim. Of course the entrance was in the hub and he drew a diagram of a counter-rotating airlock for the hub.

Potocnic-Noordung also pointed out that there would be a slight difference in apparent gravity between the head and the feet of a man standing upright, and said that one would have to compensate for this while moving, especially if it came to vertical movements. He stated correctly that power could be had free from the Sun, by means of a condensing mirror and steam boiler pipe.

Along with these essentially correct thoughts, however, there ran a number of boners. For example, he wanted to spin the wheel so rapidly that the centrifugal force inside would be one full *g*. This would require one complete revolution in 8 seconds. Actually there is no need for one full *g* inside a space station, just as there is no need for sea-level air-pressure. Even untrained people are adaptable enough so that ⅓ *g* and about half-sea-level pressure (with a higher oxygen content) would be sufficient. This would cut down the number of revolutions per minute required and lighten the whole structure very considerably.

ANOTHER of Potocnic-Noordung's misconceptions I always look at with a smile is the design of his windows. They are slightly convex lenses and many of the windows are also equipped with a plane mirror in a frame on the outside, adjusted to reflect additional sunlight into the interior of the station. What everybody forgot until recently is that people aren't cold-blooded and that the "heating device" for a spacesuit is the guy inside. In fact, these "heating devices" are so annoyingly efficient that the main worry of the modern space engineer is how to get rid of all the surplus heat.

The second unit, the "observatory," was not described in much detail. It was merely stated that it would be cylindrical, like a boiler, to maintain pressure inside and that it would contain all the astronomical instruments. It was not supposed to rotate, but was to be connected with the main station or "living wheel" by two electric cables and a flexible air hose. It was to be properly heated simply by piping air of the right temperature into it, while the power cables were to supply electricity for the instrumentation.

The third unit, the "power house," was mostly a large parabolic mirror with a set of boiler pipes along the focal line (the description grew more and more vague) and the current generated was to be supplied to the "living wheel" or else to be stored in storage batteries.

As regards the purpose of the whole space station, Potocnic-Noordung merely paraphrased Oberth: Earth observation, astronomical observation, possible warlike action by means of a solar mirror and possible storage of fuels for long distance trips.

During the same year, 1929, there appeared a series of articles on the space station concept by another author, Count Guido von Pirquet, then Secretary of the Austrian Society for Space Travel Research. The articles were published in the monthly journal *Die Rakete* ("The Rocket") of the German Society for Space Travel, usually abbreviated as VfR.

While Potocnic-Noordung had devoted a lot of attention to design detail and virtually none at all to the optimum orbit, von Pirquet did not say a word about design detail, but calculated carefully where his space station should be located and why. In the course of these calculations, von Pirquet discovered a fundamental fact which has often been quoted since:

You can't have space travel at all with chemical fuels unless you build a space station first.

A secondary but almost equally important discovery was that the building of the space station, the necessary first step, is also the most difficult.

Everything that comes afterward is simple, or almost so, by comparison.

IT should be obvious by now that the various possible purposes of a space station are to some slight extent contradictory.

From the point of view of fuel economy, the nearer the Earth, the better.

From the point of view of Earth observation, you also do generally better if you are close, but the limits are somewhat different. You don't want to be quite as close as you would like to be from the standpoint of fuel economy.

From the point of view of refueling depot for long range trips, you may have trouble making up your mind. A "low" orbit will provide you with a higher orbital velocity, but a somewhat higher orbit might give you more room for maneuvering. The modern compromise orbit is the one advocated by Dr. Wernher von Braun — 1075 miles above sea level, which would produce a period of revolution around the Earth of precisely two hours.

Count von Pirquet solved this dilemma in a different way. Like Potocnic-Noordung, he advocated a three-unit station. But the three units were to run in three different orbits.

The one closest to Earth, the so-called Inner Station, was to revolve 470 miles above sea level with an orbital period of 100 minutes. The one farthest away, the so-called Outer Station, was to circle the Earth 3100 miles from the surface with an orbital period of 200 minutes. The third, or Transit Station, was to be on an elliptical orbit touching the other two orbits. Its distance from the surface would therefore vary from 470 to 3100 miles and its orbital period would be 150 minutes. When closely approaching either the Inner or the Outer Station, the velocity of the Transit Station would not match. There would be a velocity difference of about ¾ mile per second which would have to be adjusted for the men and materials to be transferred.

While the two statements at which von Pirquet arrived while working on the problem of the space station are still valid and correct, his suggestion for a station consisting of several units in different orbits has not borne any fruit.

AFTER the publication of these articles, there was another hiatus in the development of the space station concept, lasting longer than the first, about twenty years. But then a lot of people started work in earnest. A good many of the papers read at the Second International Congress for Astronautics in London, 1951, concerned one phase or another of the space station concept. Somewhat earlier, Wernher von Braun had published his concept in the book *Space Medicine;* a few months later, it was revised after prolonged discussions and published in its present form in the book *Across the Space Frontier*.

Needless to say that the various concepts published do not closely agree with each other, for there is room for a variety of opinions. Obviously the space station will look different if designer A assumes heating by solar radiation, something which is known and can be calculated right now, while designer B assumes that the atomic engineers will have come up with a useful small atomic reactor during the time it took the rocket engineers to produce a suitable cargo-carrying rocket to bring the space station's material up into an orbit.

Although we can predict a good deal of detail right now, some of this will be subject to change during the next decade. We can be sure of one thing only:

There will be a space station in the reasonably near future.

SLOWPOKE THOUGHT

I FORGET whether the villain drew his blaster with lightning speed or with the speed of light. No matter, for the worthy hero drew *his* with the speed of thought, so justice naturally triumphed.

This column being what it is, my readers will now expect me to tabulate the figures for these various speeds in kilometers or in miles per second. And that is just what I am going to do, not wasting any time with the well-known speed of light, but getting right down to the speed of thought.

We cannot actually measure the speed of a thought, but for this purpose we may consider thought a nerve impulse and we can measure that. If somebody drops a five-pound weight on your foot, you feel this "at once." This is not due to any fantastic speed of the nerve impulse, though, but merely to the fact that it is only about two yards from your foot to your brain.

As I said, the speed of such a nerve impulse can be measured, the main difficulty being simply that you deal with a relatively high speed over a short distance. Nothing organic which can be used for such experiments is very long. Consequently the figures found by the various experimenters differ somewhat.

The lowest figure I have seen reported was 40 meters (131 feet) per second, the highest 70 meters (226 feet) per second. That higher figure corresponds to 252 kilometers or 157 miles per hour.

In Germany, some 50 years ago, they used to say that the principle of the electric telegraph was easy to understand: just imagine a dachshund long enough to reach from one city to another. You step on its tail in Berlin and he'll bark in Hamburg. If we use that dachshund under American conditions, his tail ends at the Loop in Chicago while his head is at Times Square in New York.

Now let's translate that into neural speed.

A driver in Chicago carelessly rolls his car over the tail while hurrying out to the airport, which is some forty minutes of hard driving. While the driver fights for his reservation—"I did confirm it, Miss!"—the nerve impulse races through the long dachshund's nerve fibers, having just about passed Waterloo in Indiana when the DC-6 experimentally wags its ailerons prior to takeoff. Then there is a little delay because somebody else wants to land; the nerve impulse is still racing.

The DC-6 overtakes it in the general vicinity of Cleveland and lands at La Guardia airport while the nerve impulse is speeding somewhere to the north of Pittsburgh. The man who started it all in Chicago can wait for his baggage, stand in line for a taxi and have a leisurely meal in a restaurant on Times Square, waiting for the "bark" to arrive.

It does arrive—4 hours and 40 minutes after it was started.

All this is under the assumption that the speed of a nerve impulse actually is 70 meters per second. It may be as low as 40 meters per second, which amounts to just 90 miles per hour. Of course, inside the body, with a maximum distance of six feet to travel—14 feet in the case of a giraffe—90 mph serves as well as 150 mph and improving it to 300 mph, if that could be done, would probably not make any noticeable difference.

But when it comes to really long distances, pick something faster than the speed of a nerve impulse.

—WILLY LEY

ANY QUESTIONS?

I would like to know if you think that meteorite craters larger than Chubb Crater in Canada will be found on Earth.

Stephen Maran
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Brooklyn 16, *N. Y.*

I am convinced that craters of meteoric origin larger than Chubb Crater exist on Earth. In fact, there are several formations which are suspected of being just that.

One is Lake Bosumtvi in Ashantiland in Africa, only a few degrees from the equator. This perfectly circular lake has a diameter of six miles and the general geology of the area is

such that meteoric origin is the easiest explanation for its existence.

Another suspected crater is the so-called Pretoria Salt Pan in South Africa, which has an even larger diameter—on the order of twenty miles.

So far, the meteoric origin of these formations has not been proved, but I understand that some work on the Pretoria Salt Pan is in progress. The problem, as you can see from the foregoing, is not the finding of larger formations that might be impact craters, but establishing proof that they actually are such.

In your article on the satellites of the Solar System (March 1952 GALAXY), you spoke of Pluto as being moonless.

Is this an established fact or an assumption because of lack of other evidence?

B. Rule
Haverford, Penna.

When I said that Pluto is "moonless," I meant, of course, that no moon of Pluto is known. Since Pluto has been under pretty intensive observation from the time of its discovery, the two statements "Pluto is moonless" and "no satellite of Pluto has been discovered so far" mean pretty nearly the same thing.

Are the large constellations in the skies, such as Leo, Orion, Ursus major and minor, etc., parts of our galaxy?

Alexander Bozic
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Yes. The constellations you name, and all the others which could be listed, consist of stars that belong to our galaxy.

The only naked-eye object in the northern sky which does not belong to our galaxy is the so-called nebula in Andromeda which is the nearest *other* galaxy.

From the southern hemisphere, you can see two other objects which are not members of our galaxy—or only once removed—namely, the two Magellanic Clouds. They are clouds of stars outside our galaxy proper, but they are what some astronomers call "satellite galaxies," quite close to our own, as galactic distances go. I am not certain if it is known yet whether the Magellanic Clouds share the rotation of our galaxy, but I would expect them to do so.

Recently I heard (name deleted) say during a radio interview that the Flying Saucers originated from the star Wolf 359, about eight light-years away. What authority is there for mak-

ing such a statement? Does Wolf 359 have a planetary system? Is there any other information on this star obtainable?

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Even if there were any evidence that the so-called Flying Saucers are visitors from another solar system, the star Wolf 359 is about the silliest possible choice. If it has been picked merely because it is not very far away (as measured in light-years), I don't see why the alleged experts did not settle for Alpha Centauri.

Alpha Centauri is only about half as far away as Wolf 359. It also is a big binary, both components of which are bright stars.

Little Wolf 359 is one of the faintest stars on record. Its absolute magnitude is 18.5 and if it were not so near, we wouldn't even know that it exists. The amount of energy emitted from its surface is just about 1/50,000th of that of our own sun—it would take fifty thousand of Wolf 359's caliber to make one Sol.

We don't know whether Little Wolfie has a planetary system, but with an energy output like that, its planets would be in a sorry plight. Naturally, an "expert" would use that as a reason for coming to our solar system—and one probably will.
