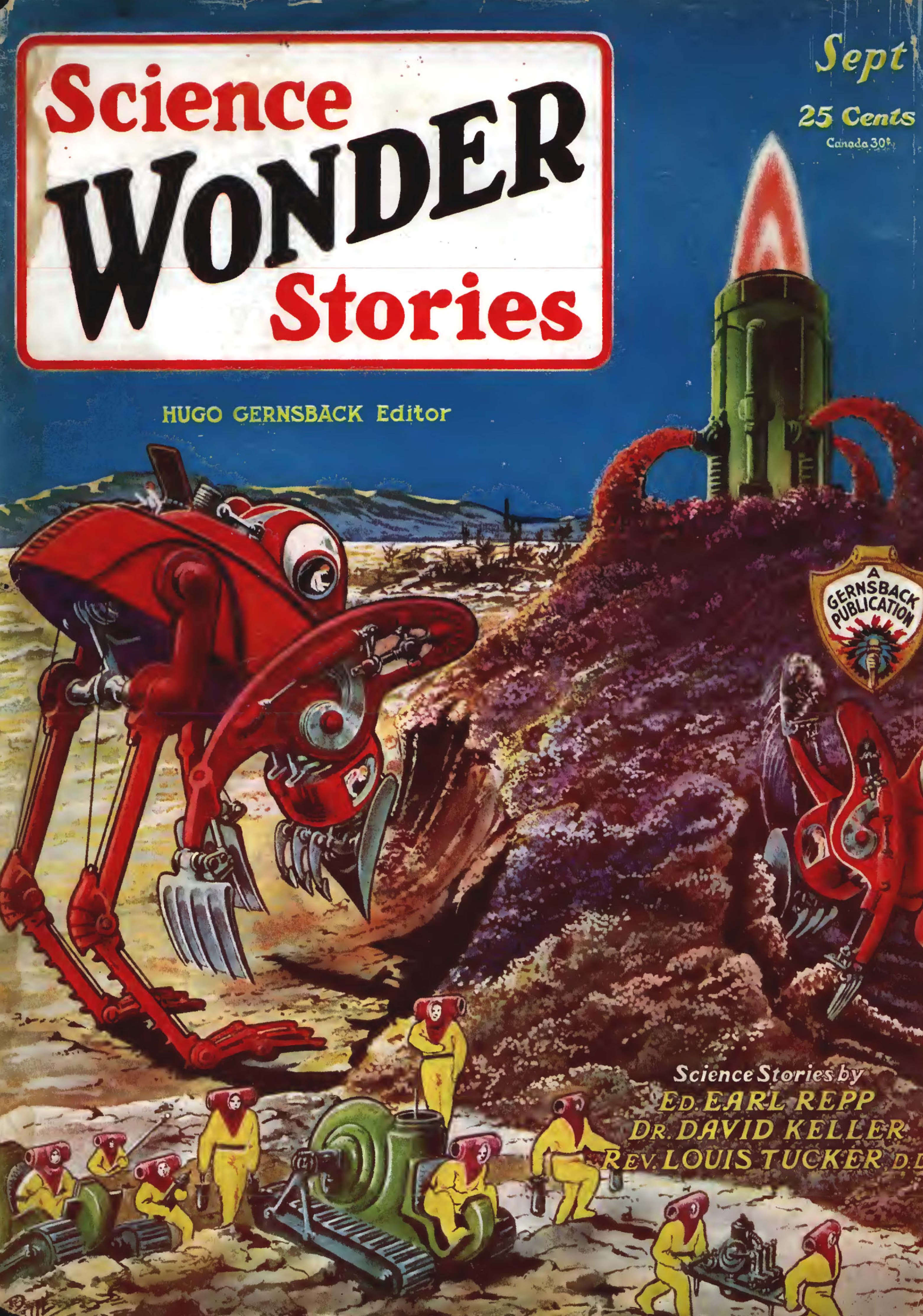
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The Problems of Space Flying

By

CAPTAIN HERMANN NOORDUNG, A.D., M.E.,

(BERLIN)

Translated from the German By Francis M. Currier

IT is quite certain that Captain Noordung's preceding articles on "Space Flying" have proven revolutionary. If the letters from our readers are an indication of what the rest of the scientific world thinks of these articles, we feel sure that they will prove prophetic in the years to come.

In this concluding installment, Captain Noordung proposes some further revolutionary thoughts, the most outstanding of which probably is his "Giant Floating Mirror," perhaps the most frightful weapon ever conceived by man.

And it should be noted that as in his preceding articles, the final installment is based upon pure scientific reasoning and there is nothing contained in any of the articles that will not come into actuality sooner or later. As a matter of fact, all of the instrumentalities so vividly depicted by this gifted and noted German engineer, could be constructed today if a sufficient amount of money were forthcoming.

CHAPTER VIII (Continued)

The Investigation of the Stars

DISTANT observation from the spatial station opens the most splendid prospects for astronomy. In this case also there is the possibility of using telescopes of any desired size, beside the advantage of having the radiation of the stars reach us unchanged. The blackness of the sky would also help, by its contrast, the observation of the radiation of stars.

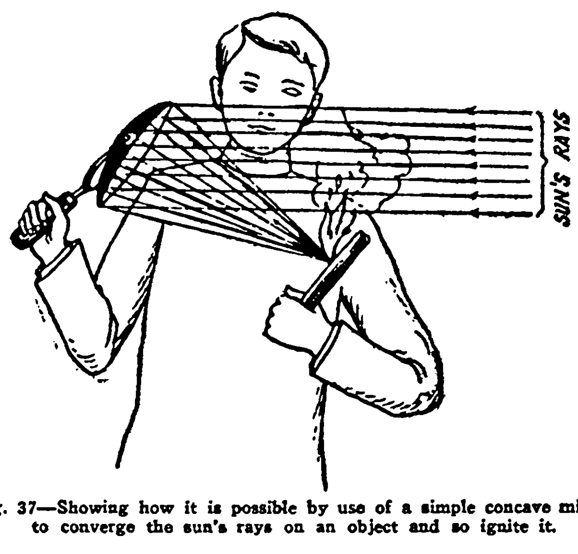

Fig. 37—Showing how it is possible by use of a simple concave mirror to converge the sun's rays on an object and so ignite it.

This latter circumstance would permit all those observations of the sun (which from the earth are possible only at total eclipse) by simple exclusion of the sun's disk through a round black shield.

Our entire solar system, with all its planets, asteroids, comets, big and little moons, etc., could be investigated in the minutest details. Even Venus and Mercury, the two "inferior" planets (that is, nearer to the sun than the earth) could be observed just as well as the "superior" planets (those farther away than the earth). From the earth, as we have remarked, this is not possible because of the phenomenon of twilight. The surfaces of all the neighboring heavenly bodies, the moon, Venus, Mars, and Mercury, could be closely examined so far as they are visible to us and could also be mapped by *telephotography.* Even the question of the habitation of the planets might probably be definitely decided.

The most interesting discoveries, however, would doubtless occur in the realm of the fixed stars. Many an unsolved problem of these extremely distant bodies would be explained. Our knowledge of cosmic events would be increased so far that we could, with absolute certainty, decide about the past and also the future fate of our own solar system and the earth.

All these researches would have, besides their other significance, the greatest importance for the further development of spatial navigation. Once we know exactly the conditions in those realms of space on the heavenly bodies, a flight into space would no longer be a trip into the unknown for much of its peril would be lost.

CHAPTER IX

A Giant Floating Mirror

YET the possibilities of an observatory in space are not yet exhausted. From the fact that the sun shines not only in infinite power but also uninterruptedly (aside from short chance passages through the shadow of the earth), use might be made also for many technical uses on earth. From the spatial station itself, the sun's rays, even on the greatest scale, could be artificially directed upon various regions on the surface of the earth by properly constructed giant floating mirrors, circling about the earth in free orbits and thus floating above it, as proposed by Oberth.

According to his suggestion, they should consist of separate facets which are so arranged in movable fashion that from one point by means of electrical influence they can be given any desired position with regard to the level of the entire mirror. By proper adjustment of the facets it would then be possible to spread the entire solar energy reflected from the mirror according to needs over wide expanses of the earth's surface, to concentrate it on individual points; or finally, when it is not needed, to let it radiate into space.

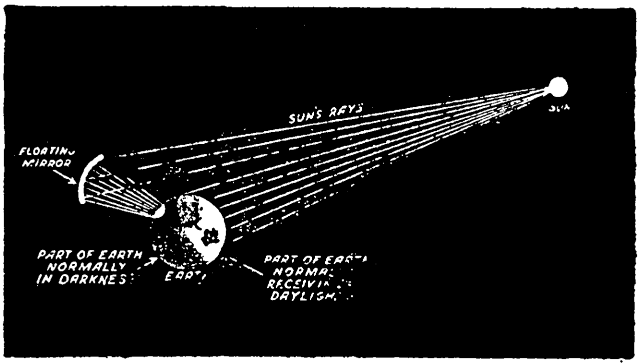

Fig. 38—How the giant mirror in space proposed by the author may be used to give perennial daylight to the earth. The mirror is on the side of the earth that is turned away from the sun. The sun's rays strike it and are reflected to the earth or any part of it, where the concentration of the rays produces the equivalent of the direct light and heat of the sun.

The fact that such spatial mirrors would be weightless because of their motion in orbits would materially simplify their manufacture. According to Oberth a circular wire network is to serve as a frame, being spread out in space, for this purpose, by rotation. In its meshes the separate facets would be placed, consisting of sheet sodium as thin as paper. According to his estimates such a mirror with a diameter of 100 kilometers would cost about $750,000,000 and would require about fifteen years to construct.

Besides this, there would probably be other possibilities of building such a giant floating mirror. With smaller diameters of only a few hundred meters, it would be possible to give the entire mirror so rigid a construction that it could be turned in its entirety about its center of gravity by means of rotary motors and could be given any desired change of position.

The electrical energy needed for guiding such mirrors would be amply available in the spatial observatory. The guiding apparatus itself would have to be in the observatory proper, so arranged that it could be used during simultaneous observations through the giant telescope, so that it would be possible to direct most exactly the illumination of the mirror on earth.

The use of this equipment would be manifold. Important harbors or airports, great railroad stations, even entire cities could be illuminated at night, cloud conditions permitting, by natural sunlight. How much coal could be saved, if for example Berlin and the other great cities were illuminated in this manner!

The Most Frightful of Weapons

THIS mirror, like every technical achievement, could also be used for the purposes of warfare and, what is more, it would provide a weapon far surpassing in frightfulness everything thus far used.

It is common knowledge that very considerable temperatures can be produced by concentrating the sun's rays with a concave mirror (such as with the aid of a burning glass). Even if the mirror is no larger than a hand, it is possible to kindle directly pieces of paper, even such things as shavings of wood, etc., which are held at its focus.

If we now assume that the diameter of such a mirror is not merely ten centimeters but several hundred or even thousand meters, as would be the case with a mirror in space, then steel would melt, and even incombustible materials could hardly resist permanently, if sunlight, so tremendously concentrated, struck them.

And assuming that the observer in space, with the aid of his mighty telescope, saw spread out before him the entire field of battle, with the country behind the lines of the enemy, with all his routes of approach by land and sea, all this like a gigantic map showing even the smallest details. Then we can form an idea of what such a spatial mirror, guided by his hand, would mean as a weapon!

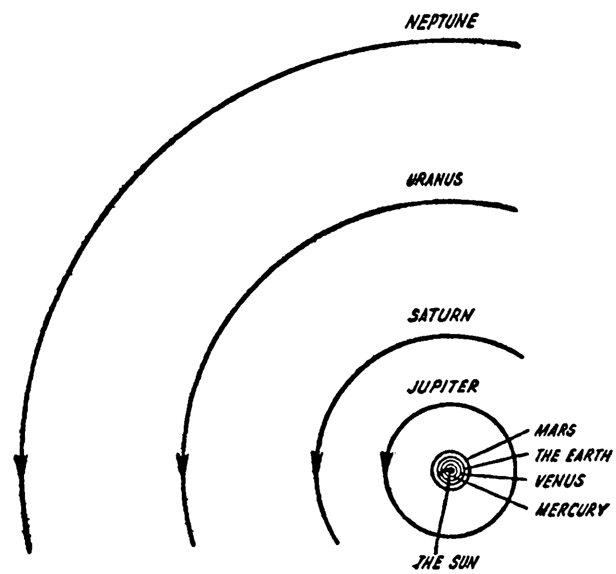

Fig. 39—Showing the sun and the orbits of the sun's planets. This indicates the relative distances of the various planets from the sun. The four minor planets, Earth, Mars, Venus, and Mercury, are only a fraction of the distance that the four major planets are from the sun.

By using it there would be no difficulty in blowing up the munition dumps of the enemy, setting fire to the depots of his supplies, and melting his cannon, armored turrets, iron bridges, the rails of important railways, etc.

Moving trains, factories important for war, even entire industrial establishments and great cities could be burned. Troops on the march or in camp would simply be carbonized, if the bundle of rays of this concentrated sunlight were passed over them. And the ships of the enemy, no matter how powerful they were or how strongly fortified the harbors in which they sought refuge, could not possibly be protected from it. They would be destroyed—burned out as we eliminate vermin from their hiding places with the blast flame.

These would be actually the rays of death! Yet they are no other than the life-giving ones which we daily desire from the sun. In this case, however, we would have "a little too much of a good thing."

Yet matters would scarcely come to all these horrors. No power would ever venture to begin a war with a nation having control over such frightful weapons.

CHAPTER X

To Distant Heavenly Bodies

IN our previous considerations we have not dealt with travels beyond the realm where the attraction of the earth is paramount. How are matters with regard to the real purpose of the journey in space, the complete separation from the earth and the reaching of distant heavenly bodies?

First, let us briefly view the stellar universe as it will be viewed from the standpoint of spatial navigation, i. e., as future realms to travel. We must therefore change and enlarge our mental outlook. For if we wish to regard the entire cosmos as our world, then what has hitherto seemed to us to be our world, the earth, will be our home in the narrowest sense. Not the earth alone! All else that is bound to it by its gravity, such as the future station in space and even the moon, must also be reckoned as part of our narrow home in the universe, as belonging to the realm of the earth. After all, how small the distance from the earth to the moon is (some 380,000 kilometers), compared with the other distances in space! It is only a hundredth of the distance of our nearest planets, Venus and Mars. And the sphere that would be made by the moon's orbit around the earth could easily find room inside the sun.

The first unit in space to consider beyond our earth is the solar system, with all the various planets belonging to it. There are eight principal planets, of which our earth is one, together with numerous other heavenly bodies. Most of the latter, the asteroids, periodic comets, meteors, etc., are of small size. Of the planets, Mercury is nearest the sun; then follow Venus, the earth, Mars, Jupiter, Saturn, Uranus, and finally Neptune. Accordingly Venus and Mars, along with the moon, are the direct neighbors of the earth.

All these heavenly bodies are permanently bound to the sun by the power of mass attraction, and compelled constantly to revolve about it, as a centre, in elliptical paths. They form the realm of the *fixed star*, the "sun." Illuminated and warmed by the splendor of its rays and also controlled by the steadfast might of its gravitational pull, they are joined in eternal union, an island in the emptiness and darkness of space. Such is our "greater home" in the universe—the solar system. This is a realm, indeed, of tremendous size: even light, though it hurries through space at the speed of 300,000 kilometers a second, takes more than eight hours to cross it directly.

Yet how tiny is this world as compared with the incomprehensible extent of the universe from which many heavenly bodies, the fixed stars, heated even to a gaseous state, send us the greeting of their shining rays. Even the nearest of them, *Alpha Centauri*, is 4.3 light-years away, that is, about 4,500 times as far as the diameter of the whole solar system! All the others, however, are much farther from us, most of them hundreds and thousands of light-years. And if there were already extinguished fixed stars nearer us, in the eternal darkness of empty space, we could never see them.

From this it is already apparent that, as for travelling to distant heavenly bodies, we can now take into account only those belonging to the solar system.

The Technique of Travelling

THE manner in which distant travel through space would have to take place would, in general, be in free orbits about those heavenly bodies in whose paramount fields of attraction the trip takes place. Within the realm of the sun, there-

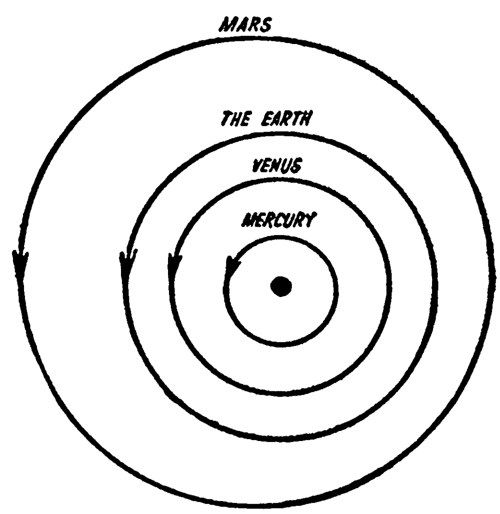

Fig. 40—Showing the sun and the orbits of the four minor planets, Mercury, Venus, Earth and Mars. This indicates also the relative distances of the orbits from each other.

fore, we must move around the latter always in some sort of free orbit, if we are not to become subject to its gravity and plunge into its sea of fire.

Certainly we need not pay special heed to this point as long as we remain in the narrower realm of the earth or of some other world in the solar system. For each of these revolves about the sun in its own free orbit, so to speak, and with it at the same time, and because of it, all the bodies belonging to it. With the earth, whose speed is 30,000 meters a second, there also revolves the moon at present; and there would revolve our future station in space (the moon and the station being both satellites of the earth). All of these bodies, going around the sun, its attraction thereby loses its direct effectiveness on them. (This is called "the stable condition of floating" as regards the sun.)

Only when the space ship passes out of the narrower region of attraction of one of the heavenly bodies, revolving around the sun, would it have to travel around the sun in a free orbit of its own. For example, if it is a question of a trip from the earth to a distant planet then, on the basis of what has been said, not only the course of this independent path *but also the time of departure from the earth must be so chosen that the space ship arrives at a point in the orbit of the planet to be visited at approximately the same time as the point is passed by the planet itself.*

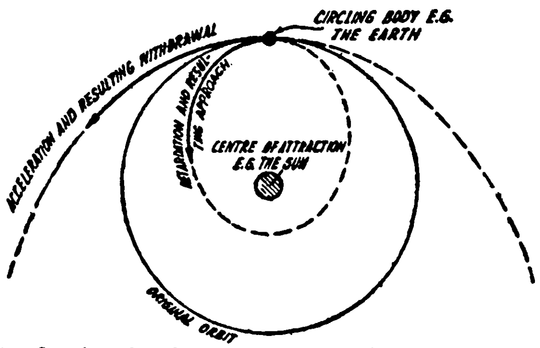

Fig. 41—Showing the effect on a body rotating about the sun of a change in its velocity. If the speed of the body, such as the earth, is accelerated it will withdraw from the sun to a new orbit. If the speed is retarded it will approach to form a new orbit.

If the ship is thus brought into the region of attraction by the planet to be visited, then the possibility is open of either circling it in a free orbit as a satellite as often as desired or descending on it. In case the planet has a blanket of air, like that of the earth, the landing can be by a method already considered for landing on the earth (Hohmann's landing manoeuver by use of decreasing ellipses). If a blanket of air such as the earth possesses is missing, then the landing can be effected only by recoil-braking—making the force that operates the ship work in the opposite direction to the direction of fall during the descent.

In order to journey within the solar system to another heavenly body, after successfully getting free from one, it would be necessary to change the orbital motion (which we would have previously acquired around the sun along with the original planet) by the assistance of the propelling force. Thereby, we would enter an independent orbit about the sun, this serving as an intermediary orbit to join the orbit of our own planet with that of the other. According to the laws of celestial mechanics, for this purpose, the original orbital motion must be altered according to the location of the goal; that is, it must be accelerated, if the ship is to go away from the sun, and retarded, if it is to approach the sun. Finally, as soon as the desired heavenly body is reached, the independent motion of the "connecting orbital path" must be changed to that which the ship must take in relation to the new planet in order to carry out the manoeuver of circling about it or of landing. The return trip would have to take place in the same way.

It is accordingly clear that in the course of such a distant trip through planetary space, repeated changes in the condition of motion are necessary. These must, each time, be effected by propulsion with artificial power and therefore require the expenditure of fuel. This expenditure, according to Hohmann's calculations, is least when the orbits of the original planet and that to be visited are not cut by the connecting orbital path of the ship but are merely touched by it.* In any event, the necessary amounts of fuel are considerable.

Still greater amounts must be added if the planet to be visited is not to be circled about but actually landed upon directly. The amount of fuel needed in fact increases with the mass of the planet and accordingly with its power of attraction. This is understood when it is considered that ascending again from it in starting the return trip requires a very considerable expenditure of energy, as is already known from such an ascent from the earth. If, furthermore, the braking on landing must be done by means of the propulsion (recoil braking), in the absence of a suitable atmosphere, then there results a further tremendous increase in the necessary fuel.

Moreover, this fuel must all be taken along on the trip from the earth, at least on the first visit to a remote planet; for we could not count beforehand on being able to secure there the fuel needed for the return trip.

CHAPTER XI

The Start from the Surface of the Earth

TO commence such a trip directly from the surface of the earth, and to overcome its gravity, it would be necessary to also lift this whole supply of fuel. According to previous remarks, this of itself demands a most extraordinary expenditure of work.

In the case at hand, at least with the efficiency of fuels now available, the amount necessary to be taken along would accordingly make up so great a part of the total weight of the ship that its construction would be hardly possible.

The only visit to a heavenly body which could be undertaken directly from the earth's surface by means of fuels known now would be the circumnavigation of the moon, for the purpose of a closer observation of the nature of its surface, especially on the side of it always turned away from the earth. In the course of this, we could be "imprisoned" by the moon, to circle about it as often as desired in a

* In other words, if the ship moves tangentially to the orbit of the planet it leaves and takes a path that brings it tangent to the orbit of the new planet, the energy required would be a minimum.—*Editor*).

free orbit, like a satellite of the moon. The amount of fuel needed for this undertaking would not be much greater than for a normal ascent from the earth to the practical limit of gravity.

The Spatial Station as a Basis for Spatial Travel

THE conditions would be considerably more favorable, however, if (as Oberth proposes) a fuel depot were constructed, floating at a proper height above the earth and constantly circling about it in a free orbit, to serve as a starting point for the trip instead of the earth. In this case only a slight expenditure of work would be needed to be entirely free from the earth, and the ship would accordingly not need to be loaded with the fuel neccessary for the ascent from the earth. Only a little more would need to be taken along than would be required for the distant trip itself.

Since the depot, as a result of its free orbital motion, would be weightless, the fuel could simply be placed there in any amount, freely floating at any point in space. If protected against the rays of the sun, even oxygen and hydrogen could be kept indefinitely in a solid state.

The supplying of it would have to be managed by a constant travelling of space ships, back and forth. This might be from the earth or from the moon. In the former case, the fuel (at least so far as it consists of liquefied oxygen and hydrogen) could be produced in great power plants operated by the heat of the tropical ocean.

The moon would be an especially advantageous base, as Max Valier suggests. There the mass, and accordingly the force of attraction, are much smaller than those of the earth, which would greatly lessen the expenditure of work needed for the ascent and therefore for the carrying of fuel from it. Certainly this presupposes that the necessary raw materials are actually present on the moon; that is, that there is at least water (even in the form of ice). The latter would be electrolytically decomposed into oxygen and hydrogen, the required energy being provided by solar power plants. Unfortunately the probability of this is not too great.

If it should be the case, however, we could use the moon also, as Hohmann suggests, for the starting point of spatial travel and accordingly make the fuel depot on it.

In spite of the many advantages of this plan, Oberth's proposal of a freely floating depot seems more favorable, because, from it, the complete release from the field of attraction of the terrestrial region (including the moon) would demand a considerably smaller expenditure of energy. Indeed, from the standpoint of economy and energy, it would be doubtless most advantageous to establish the depot one or several million kilometers from the earth, especially if the fuel has to be transported to it from the earth.

We shall nevertheless transfer it to our station in space, making the latter thereby the base for the travelling, because it is already supplied with all the equipment necessary.

An especially important part of the equipment would be the giant telescopes. Thanks to their almost unlimited efficiency, they would make it possible; first, to examine minutely, from a distance, the regions to be travelled in the stellar world. Furthermore, the space ship could be kept under constant observation during a large part of the trip, and frequently during the whole of it. By means of light signals shown by the ship at appointed times there could be a communication, at least, on one side.

Thus, the spatial station, aside from the many duties already mentioned, would be able, not only to initiate real travel about the universe, but also to serve as an operating base for all spatial journey.

The Accessibility of the Neighboring Planets

HOHMANN has thoroughly investigated the problem of visiting other heavenly bodies. According to his results, expressed in terrestrial chronology, the trip from the earth to Venus would last 146 days and that to Mars 235. A round trip including circumnavigation of both Venus and Mars at the relatively slight distance of about eight million kilometers could be performed in about a year and a half. For visiting Venus and landing upon it, including a stay of 14½ months, together with the trip there and back, not quite 2¼ years would be required.

Let us assume that the journey is to commence according to our previous observations from the spatial station, so that final release from the field of gravity of the earth would require only a little energy. The return takes place directly to the surface of the earth, so that no energy at all need be used for this. One can descend merely with braking by air resistance. Let the weight to be transported be two persons together with the provisions needed for the entire trip and all the apparatus required for observations and other purposes.

Hohmann calculates that the space exploring ship ready to start, provided with all the fuel necessary for the trip both ways, must weigh approximately as follows: for the previously mentioned round trip including circumnavigation (not landing) of Venus and Mars, 144 tons, 88 per cent of this being fuel; for the first landing on the moon, 12 tons; on Venus, 1,350 tons; on Mars, 624 tons. In the first of these three cases 79 per cent, in the other two about 99 percent of the entire weight of the ship would have to be fuel. The expulsion speed of 4,000 meters a second from the earth is assumed.

It is clear that the construction of a ship to carry rocket propulsion fuel making up 99 per cent of its entire weight would present such considerable technical difficulties that its manufacture could hardly succeed at present. Accordingly, only the moon, of all the larger heavenly bodies next to us, could at present be in question for a visit including a landing. However, we could at best approach very near the planets and circumnavigate them, without however landing on them. Still we have hope, that in the course of time by the aid of the principle of sectional construction, we may finally succeed even with the technical means known today in constructing space rockets which can even execute landings on the neighboring planets.

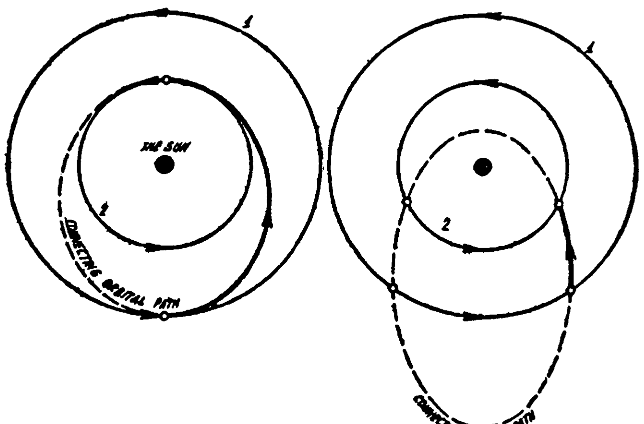

Fig 42——Showing two ways that a body can travel from one planet to another. The first way shown on the left, which is the easier, the body leaves the planet on a tangent to its orbital path and travels so that it approaches the orbit of the next planet on a tangent to its path. The smallest amount of power is required for this. By the second method, shown on the right, the body is forced to cross the orbit of one planet to get to the other. This would be necessary if the calculation as to the path to take in space has been badly done. This method takes a greater amount of power than the first, for the body is forced to travel further away from the sun and therefore overcome for a greater distance, the sun's gravitational pull.

Doubtless this exhausts all the possibilities which seem to be offered to spatial navigation in the present state of science. For the difficulties would be far greater which confront a visit to more distant planets of the solar system. It is not merely that the routes to be travelled are far longer than those hitherto considered. Since all these planets are at greatly different distances from the sun than the earth, in reaching them, the field of gravity of the sun plays a considerable part. This attraction would have to be overcome by energy. If for example we travel away from the sun (i. e., "ascend" from it), we must overcome its pull exactly in the same manner as when we travel away from the earth. This is shown in the previously mentioned change in orbital speed about the sun, necessary in distant travel through planetary space.

But if we wished to descend on one of these planets, tremendous amounts of fuel would prove necessary, especially in the case of Jupiter and Saturn. These, in consequence of their enormous masses, possess very powerful fields of gravity.

As for reaching the fixed stars, their extreme remoteness alone makes them impossible of consideration.

Distant Worlds

THIS does not affirm that we must for all time remain confined only to the region of the earth and the neighboring planets. If we succeed in increasing the repulsion speed in recoil action beyond the amount of 4,000 or perhaps 4,500 meters a second, thus far reckoned the highest practically attainable; or if we find a possibility of storing very great amounts of energy in a small space, then the situation would be entirely different.

And why should not the chemists of the future develop a propelling material far surpassing in effect those already known? It is even conceivable that in time we shall succeed in making technically serviceable, and in using to propel space ships, those tremendous amounts of energy confined in matter—energy whose existence we already know. Perhaps we shall also find a method of using, for this purpose, the electrical phenomenon of cathode radiation or by some other way to attain a tremendous increase in repulsion speed through electrical influence. There might, lastly, come into question a suitable use of the sun's radiation or of radium decomposition, etc.

Certainly natural possibilities for future investigators and inventors are still plentifully available in this respect. If success should result, then we could visit and actually set foot on many of those far-off worlds which, as yet, we only view at immeasurable distances in the starry heavens.

An ancient dream of mankind! Would its fulfillment be of any use to us? Certainly science would make extraordinary gains. No certain judgment is possible today regarding the practical value. How little we know of even our nearest neighbors among the heavenly bodies!

The moon, still a part of the region of the earth, our "narrower home" in the universe, is, of all the distant heavenly bodies, the one best known to us. It is cold, has no covering of air, and is without any higher form of life. It is a gigantic mass of rock floating in space, fissured, inhospitable, rigid in death—a world of the past.

But we have considerably less knowledge regarding the body next best known to the moon, our neighboring planet Mars. But in comparison with our knowledge of other planets our knowledge of Mars is considerable.

Mars, too, is an aged world, though not nearly so old as the moon. Its mass and therefore its force of attraction are both much less than those of the earth. It has, indeed, a covering of air, yet of far less density than that of the earth. (On its surface the air pressure is certainly considerably lower than even on our highest mountain tops). Apparently, it possesses water. A fairly large part of this may be frozen; its mean temperature seems to be much below that of the earth, even if in places, as on the Martian equatorial belt, comparatively high temperatures have been determined. Because of the thinness of the atmosphere, the differences in temperature in the day and at night are very great.

The strangest and most discussed of all Martian observations in the phenomenon of the so-called "Martian canals." Even though recently they are often regarded as merely optical illusions, we really know nothing about them.

At any rate, what we already know about Mars does not offer us enough clues to be able to form a final judgment as to whether this planet is inhabited by intelligent creatures or by any creatures at all. It would hardly be habitable for persons from the earth, chiefly because of the rarity of its atmosphere. Therefore it would offer spatial navigation an extremely interesting object of investigation from the scientific standpoint. But whether landing there would have practical value as well cannot be recognized today with certainty. It hardly appears likely however.

It is another matter with our second neighboring planet, Venus, a splendid, shining, heavenly body, known to us as "morning star" and "evening star." Its size, its mass, and therefore the force of gravity prevailing on its surface are only slightly less than those of the earth. It also has a covering of air, doubtless very similar to ours, though somewhat deeper and denser. Unfortunately Venus is hard to observe from the earth, because it always appears near the sun and therefore is only visible at twilight. Accordingly we are still entirely uncertain about its rotation on its axis. If its period is approximately that of the earth, about twenty-four hours, as is widely assumed, then Venus and the earth would have a marked resemblance.

It is, therefore, with this planet that we may most reasonably count on finding conditions of life similar to those on earth, even if the suspicion, that it is always covered with clouds, should prove correct. Even on the earth there was a highly developed life of plants and animals at a time when part of the water, now filling the oceans, was still in the form of vapor. Certainly, of all the heavenly bodies known to us, Venus offers the greatest likelihood of being suited to occupation and thereby of coming into question as a future goal of travel. Since it is also the nearest of all the planets, it might well be the most enticing object for spatial navigation.

Mercury, being still nearer the sun, offers even less favorable conditions of observation than Venus. It is the smallest of all the planets, having a covering of air, which is probably only extremely thin, and a surface apparently similar to that of the moon. For these reasons and especially because of its closeness to the sun (the solar radiation is about nine times as strong as on earth), extremely unfavorable temperature conditions must prevail there. Mercury would accordingly be hardly at all inviting as a place to visit.

Although, in considering the previously mentioned planets, it was possible to arrive at a fairly probable result, what we so far know is insufficient for the purpose in the case of those more distant, Jupiter, Saturn, Uranus, and Neptune. We have, indeed, been able to determine that they all have dense coverings of air. The question of the nature of the surfaces of these planets is, however, still entirely uncertain. With Jupiter and Saturn this is because they are so densely enveloped by condensation products (clouds of some sort or other) that we apparently do not see their real surfaces at all. In the cases of Uranus and Neptune, it is because their extreme remoteness prevents more exact observation.

Concerning their value as goals for space travel, it is difficult to say anything. Yet, merely the circumstance that we have determined, in the case of these planets, a relatively low average density (from 1/4 to 1/5 of that of the earth), leads to the conclusion that a very different physical condition must exist from that of the earth. This alone must greatly lessen our expectations of a visit.

Still, it would perhaps be possible that some of the satellites of these planets (more especially those of Jupiter) would offer comparatively more favorable prospects.

One thing is absolutely certain: the mass and consequent force of the field of gravity of each of these planets, being tremendously greater than those of the earth, would make visiting them ex-

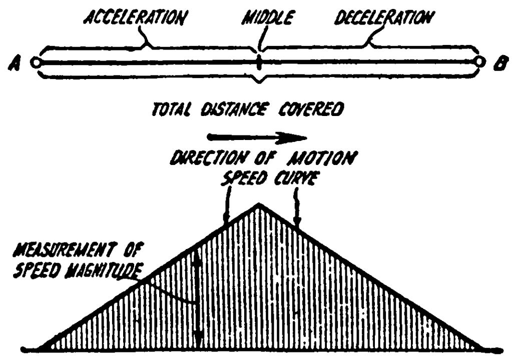

Fig. 43—A speed curve showing the method of acceleration and deceleration in going from point a to b. The body is uniformly accelerated from rest until it reaches maximum speed halfway between a and b, then it is uniformly decelerated until it comes to rest at b.

traordinarily difficult, especially in the case of Jupiter and Saturn.

Regarding, finally, the various other bodies belonging to the solar system, it is reasonably certain today that we could hardly derive any special practical benefit from visits to them.

We see, therefore, that we may not be too optimistic about the advantages to be expected of other members of the solar system. But thus far, we certainly know far too little not to let our thoughts have a free rein in these respects.

It might well be that all these worlds will prove to be entirely worthless to us. On the other hand, perhaps we would find on many of them a fertile soil, plants and animals, possibly of a sort entirely odd and strange to us. They might even be of gigantic size, like those once existing on the earth. Indeed, it is not incredible that we might find even human beings or similar creatures, maybe even possessing civilizations very different or even older than those of our ative planet.

It is even highly probable that life on distant planets, in case it exists there, is on another level than that of the earth. Then we could experience the marvel of viewing conditions from the evolution of our earthly existence: conditions of the present time, real and living, yet pictures of a past or future countless millions of years away.

Or it might be that we would find valuable substances which are very rare on earth, such for example, as radium, occurring in an easily obtainable form.

If the conditions of life discovered there were suitable for permanent occupancy, perhaps then (incredible as it may sound today) distant planets would in the course of time come into question for emigration and colonization.

As we have remarked before, there is little likelihood that there are such suitable planets among those of our solar system, with the single exception of the planet Venus.

THE END.

The Onslaught from Venus

(*Continued from page* 343)

the second line dived below them and the third drove head on into the enemy air formation.

It seemed as if the entire atmosphere of the world blazed and flamed for a split second. The three front lines, somewhat shattered, readjusted themselves to normal formation. And my own line was driving through acrid smoke, as below me fell away the grotesquely twisted fragments and wreckage of "umbrella" ships and planes. I took my hand off my guns. There was nothing to shoot at. There were no umbrella ships left.

And a few seconds later our great "sheet" of planes swept down low in an undulating dive and drove along, strafing the struggling and disordered formation of the enemy.

It was kaleidescopic. Our speed was terrific. Twenty thousand heavy calibre machine guns spat forth an instantaneous blanket of flaming death that pinned down the invaders by untold thousands. Here and there fan-ray machines raised fluttering, futile, pale canopies of would-be protection. But our shells were not of metal now. Great lumbering masses of machinery, heaved and plunged along on their queer lever-like legs, only to tumble ponderously into great shell holes, or suddenly shiver and tremble like living things, then settle down with a weakly waving metal "leg" or two, and "die."

As suddenly as I was plunged into it all I found myself out of it. Subconsciously following the line ahead, I had zoomed and looped my way into the comparative peace of a higher level. Automatically my brain registered the signals clicking in my ear phones, and I found myself streaking for a new rendezvous preparatory to a second attack.

But we never delivered that attack. We were called off. The enemy mob, which no longer could be designated as an army, was plunging frantically against our new ground positions, and for miles along that line unyielding regiments of infantry stood off the hordes of an alien planet.

The End

WE saw little of what followed. To us there were vague, hazy, scattered movements of large and small detachments of troops, and the interminable ripping and rumbling of barrages. Little more was visible from our height.

But there is no need for me to tell how the high command, finding that our lines actually had checked the demoniac fury of the Venus lunges, and knowing their entire army was in disorder, threw all available reserves into the fight, even going to the extent of arming the girls' regiments in the auxiliary services, and hurling them into the welter; how the divisions of Earth surged forward, shooting, hacking and thrusting their way irresistibly through the invaders until to the last man and woman they were beaten and hunted down to that death which they preferred to surrender. For there already exists a voluminous history of that particular phase of the struggle.

I have often wondered at what place and time during this great struggle the Venus girl Nyimeurnior met her end, and the old "miorurlia" who learned English from me. And I have often wondered too at that peculiar lack of sympathy with which my memories and my speculations as to their possible fates are tinged, for I am not by nature an unsympathetic man. There seems to be no other explanation for it that I can find than a fundamental planetary antagonism.

These people of Venus were intelligent beings, much like us of Earth in appearance and in many physical respects. Yet I could not feel for them the friendliness that I would feel for a dog, cat, yes, even for a familiar insect of this earth.

I am convinced that the civilized nations would have extended them aid and mercy as a matter of principle, even after we had experienced this peculiar repulsion upon actual contact with them. They would have been given a section of the world they could occupy in peace and relative comfort—the almost uninhabited jungles in which they tried to establish themselves for instance—had they not blindly insisted on precipitating a struggle that could end only with their extermination.

But perhaps there is some little understood law of the Universe that was only proving itself in this case. These people of Venus did not belong on Earth. And though they showed super-ability and super-power in crossing the barriers of space, and in maintaining themselves in the midst of conditions physically adverse—though they unquestionably had the intelligence to cooperate with Earth men—well, let me suggest it this way; perhaps, having had the effrontery to transgress successfully some fundamental propriety of the Universe, it was ordained that they should destroy themselves in that accomplishment.

But their vast labor and ultimate desperate terror was in vain. They might have better met their end on Venus, dying without struggle or without vain hope.

THE END