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ON THE COVER

this month is illustrated Captain Noordung's Space House. The view shown is from another space flyer with the Earth and Moon seen through the window of the observers. In the center is the space house proper, which has a total diameter of about 150 feet. The wide curved surfaces are the reflectors which collect and concentrate the sun's heat. Attached to the space house by means of flexible cables, at the left is shown the observatory and at the upper right the engine house. All three objects remain fixed in space, there being no gravity to dislodge them.

The Problems of Space Flying

By

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

(BERLIN)

Translated from the German By Francis M. Currier

WHILE the first part of Captain Noordung's article has concerned itself with the more or less technical aspect of the problems of space flying, the present installment goes directly to the heart of the whole question.

Not only does Captain Noordung give us a wonderful idea of the instrumentalities necessary for exploring inter-stellar space, but he considers so many novel points and shows us such an array of amazing new instrumentalities, that he fairly bewilders us.

These articles certainly will make history in that, for the first time they consider the problems of space flying from an engineering standpoint, coupled with a high order of scientific imagination and inventive skill.

There is hardly a problem that the author has not considered carefully from all viewpoints and he has solved some of the difficulties previously acknowledged as almost unsurmountable. In a most brilliant manner, by his invention of new instrumentalities which have not been known heretofore, he sweeps away doubts. And by the way, all of these inventions are based upon sound engineering and excellent science.

Captain Noordung at the same time has revolutionized all of our former conceptions of what a space flyer should be and should do, and the highly suprising results which he gets are no more astonishing than the machines themselves.

There remains the problem of transporting the space flyer into outer space. This, however, can no longer be considered as impossible. If we are willing to spend the money to construct the rocket that Captain Noordung thinks is necessary, it would even today be possible to achieve the results he mentions.

In a series of later articles, we will publish the latest scientific achievements of rocket flyers which are no longer of a theoretical nature, but as is well-known, have already been demonstrated in Germany during the past year.

While it is true that so far we have only seen a rocket-propelled automobile, yet even as this is written, special airplanes are to have an auxiliary source of power developed by the application of the rocket principle and aeronautical authorities have stated recently that the future development of the airplane will be along the lines of the rocket-propulsion. By these planes it is hoped to rise to heights of our atmosphere which have not been explored before.

As is well-known, present day airplane propellers are no longer capable of functioning 10 miles above sea level. A rocket plane will have no such difficulties and may rise to any height, even beyond the atmosphere, where, as a matter of fact, it will function better than in the atmosphere.

PART II

CHAPTER V

The Arrangement of the Spatial Observatory In Three Divisions

ACCORDING to what has previously been said, it may be agreed that technical provisions can be made to enable one to remain in space in spite of the absence of all external matter. And, as has been shown, even the absence of weight would prove no decisive hindrance to living (at least physically, though doubtless it would otherwise), if the various details of life were arranged for in the manner already described.

But since the weightless condition in any case would involve serious inconveniences and, perhaps, might prove injurious to health in cases of long duration, the observatory in space is provided with an artificial substitute for gravity.

According to our previous explanation, the force of gravity being itself a force of the attraction of mass for mass, it can only be influenced, neutralized, or replaced by some other force of mass. In this case it can be replaced only by centrifugal force, if a lasting and stable condition is to result. Centrifugal force serves, in fact, to keep the observatory at its dizzy height; as it were, to hold it up. Centrifugal force is called upon also, though applied in a different manner, to produce anew the sensation of weight.

To effect this would, fundamentally, be very simple: it is only necessary to revolve the parts of the structure, whereby the sensation of weight should be produced about their centre of gravity at proper speed. This would produce the necessary centrifugal force on any object in the observatory and hence a sensation of being pulled toward the rim. It is, however, more difficult to create at the same time the conditions necessary to allow one to enter and leave these rotating parts of the structure simply and safely; to attach electric wires and great concave mirrors, and besides be able to adjust the position of the whole with regard not only to the sun's rays but also to the momentary making of distant observations.

The recognition of these difficulties leads to a division of the entire observatory system into three separate objects: the "rotary house," in which an artificial condition of weight is constantly preserved by rotation (accordingly creating the same condition for life as on earth). This house would then be used normally for occupancy. Second, there would be the observatory proper; and last, the engine house—the last two retaining the weightless condition and being equipped only for their special purposes. They would serve merely for temporary occupancy by the workers during the performance of their duties.

To be sure, this division of the observatory renders it necessary to take special measures to neutralize the mutual attraction of the separate masses. For even though the attraction may be very slight, on account of the relative smallness of the attracting masses, in the course of considerable time (in weeks or months, perhaps) it would draw them perceptibly nearer together and finally would even make the separate objects meet. They must, therefore, either be kept as far as possible from each other (100 or 1000 meters, perhaps), to make the mutual attraction as slight as possible, (while the inevitable approaching together would be counterbalanced from time to time by recoil action), or else they must be placed as near together as possible and be held apart mechanically, by some sort of props. After consideration the former method seems the most feasible.

The "Rotary House"

It is a well known fact that the rotary speed and centrifugal force of various points of a revolving body are proportionate to the distances from their centre of revolution, the axis. The further the point in question lies from the axis the greater the centrifugal force, the nearer it is, the smaller the force. In the theoretical axis the force is zero.

Accordingly, the rotary part of the observatory must be so constructed that the air-locks and cable connections lie on the axis of rotation, because there is the least centrifugal force there. Those parts, however, in which the effect of weight is to be produced by centrifugal force must be on the circumference, because there the centrifugal force is greatest.

To meet these conditions it is best to arrange the structure in the form of a great wheel, the rim being composed of cells and having the form of a ring fastened to the axis by wire spokes. The rim is divided by partitions into separate rooms, all being accessible from a wide corridor going all the way around, and thoroughly enclosed. There are single rooms, good sized sleeping-rooms, rooms for work and study, dining room, laboratories, workshops, dark room; besides the usual kitchen, bathroom, laundry, etc. Everything is furnished in modern comfort; there is even hot and cold water. In general the rooms are like those on a ship. They can be furnished just as on earth; since approximately the normal terrestrial conditions of weight prevail in them.

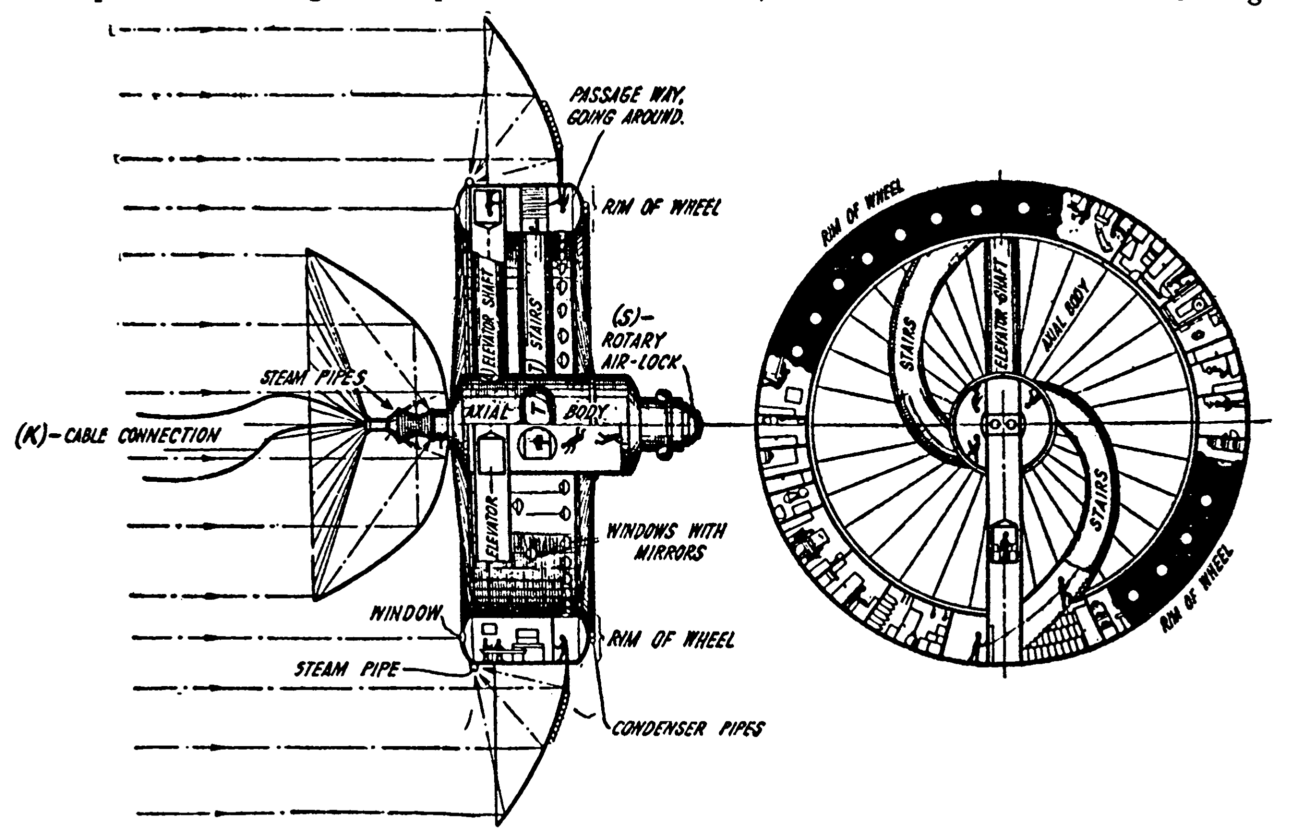

Fig. 24—Two cross-section views of the rotary house in space. At the left is an end view showing the concave mirror and the rotary house proper. The living quarters are near the outer edge of the building, the rooms being built along the rim. A stairway and elevator connect with the axial body and the air lock which one uses to go out into space or return to the building. At the right is a view of the side that faces the sun.

To attain a centrifugal force on the rim equivalent to the force of gravity on the earth, the wheel must make a revolution in about 8 seconds for a wheel with a diameter of 30 meters (about 100 feet).

But whereas gravity operates toward the centre of mass, centrifugal force operates away from the centre. Therefore in the rotary house "up" means the opposite to what it does on earth; that is, "up" means toward the axis and "down" is outward from the centre (the axis of rotation). Accordingly "down" indicates the direction of the circumference or "lowest" part, and "up" signifies toward the axis or "highest" part of this artificial world. In view of the small size of our world, all lines (all walls, etc.), must have their prolonged lines meet at the axis. All "vertical" things (such as persons standing up, the partition walls, etc.) are oblique instead of parallel to each other, and everything "horizontal" (for instance, the surface of the water in the bathtub) appears curved instead of flat.

A further peculiarity consists in the fact that, inasmuch as the speed of revolution and the centrifugal force decrease as one approaches the centre of rotation, these quantities are somewhat less for the head than for the feet of a person standing in the rotary house. (With a diameter of 30 meters this change between the head and feet would be about 1/9). The resulting difference in centrifugal force could hardly be perceptible, but the difference in speed of revolution might be rather apparent, especially in the making of up and down movements (following the radial course), such as raising the hand, sitting down, etc.

All these phenomena become less significant, however, as the diameter of the wheel becomes greater. In the selected instance, with a diameter of 30 meters, the effect of the change would be trifling.

Since the arrangements for connection with the outside (the "air lock" and cables) are placed in the vicinity of the axis, the axial body forms a sort of vestibule for the entire structure. It is cylindrical in form. At its ends, the points where the theo-

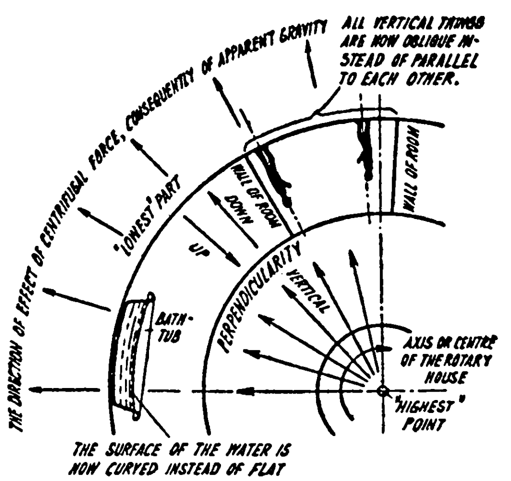

Fig. 25—Diagram showing the new conception of directions in the rotary house. Since the focal point of the house is at the axis, directions are considered in their relation to the axis. Thus the figure of the man standing on the floor of his room has his head toward the axis. Therefore the axis is up. Directions away from the axis radially are down.

retical axis of rotation passes, the air-lock is placed on one side and the cable connection on the other.

The air-lock in this case is rotary, to make easier the passage from conditions existing on the wheel to the motionless condition of space. During the process of "locking out" the "air-lock" rotates at the same speed as the wheel. A person can therefore go directly into the lock. Now it is slowly turned by electrical means, in the opposite direction to the rotation of the wheel, until it reaches the same speed. Thus it becomes motionless so far as space is concerned and the man leaves it ex-

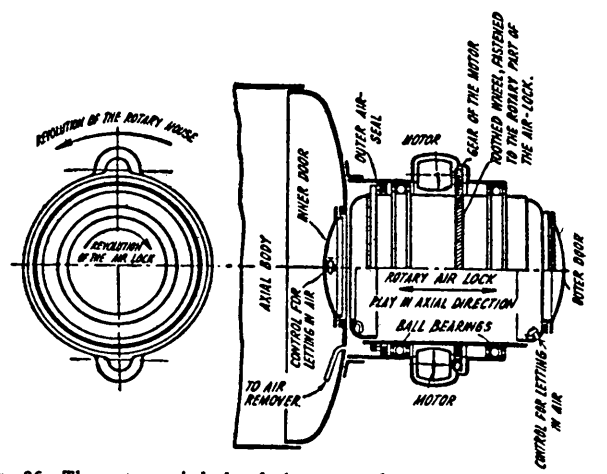

Fig. 26—The rotary air-lock of the rotary house, viewed on the left from above and on the right in axial cross-section. (Compare cross-section of the entire rotary house as well as the text referring to the use of the air-lock). The ball bearings are so arranged that they allow play in the axial direction, making possible the closing or opening of the outer air-seal which joins the air-lock to the inside of the rotary house in air-tight fashion, when the inner door is open.

actly as though the wheel were not revolving at all. For "locking in" the process is reversed.

With some practice the turning of the air-lock can be eliminated, since the rotary house revolves rather slowly (one complete revolution in about 8 seconds, in the case of a diameter of 30 meters).

The cable connection at the other end of the axial body is arranged in a fundamentally similar manner, to prevent the twisting of the cable by the revolving of the wheel. The cable accordingly runs from the end of a shaft, which is arranged in the theoretical axis of rotation and is constantly operated by an electric motor in such a way that it turns at the same speed as the wheel but in the opposite direction. Consequently, the shaft is always motionless with respect to space. As a result, the cable cannot be affected by the rotation of the wheel.

The axial body and the rim are joined by stairs and electric elevators, placed in separate tubular shafts. The elevator shafts run vertically (that is to say, radially). The stairways, however, which have to be inclined, are bent in spirals, in view of the diverging of the perpendicular, becoming steeper toward the "top" (the axis), proportionate to the constantly decreasing effect of weight (centrifugal force) in that direction. By making the progress toward the centre slow either by the stairs or elevators, the transition from the condition of weight prevailing in the rim of the rotary house to the weightlessness of space may be made as gradual as is desired.

Equipment of the rotary house with light, heat, air, and water takes place in the manner previously indicated for the spatial observatory, using the devices described there. There is this difference, that in heating it, the side of the rim which is always turned toward the sun is painted dull black. The other external surfaces of the structure have an absolutely mirror-like polish. Of course, the heat for the rotary house could be entirely provided by heating the air to be used in the rooms. In that

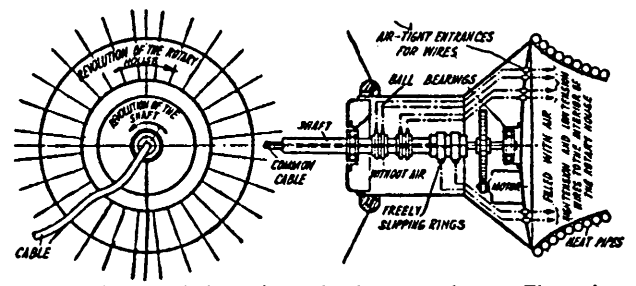

Fig. 28—Diagram of the stairway in the rotary house. The stairway end view; on the right an axial cross-section. Compare the cross-section of the rotary house, with the text, to understand the cable connection.

case the entire rim would have to be polished. There is also a small sun-power plant sufficient for any needs of the rotary house.

The Observatory Proper and the Engine House

THE guiding thought in the construction of the rotary house is the maintenance of the most favorable living conditions possible. But in the case of the observatory proper and the engine house this must yield to the necessity of making them, first of all, suited to their special work. For this reason, as was already mentioned, no attempt is

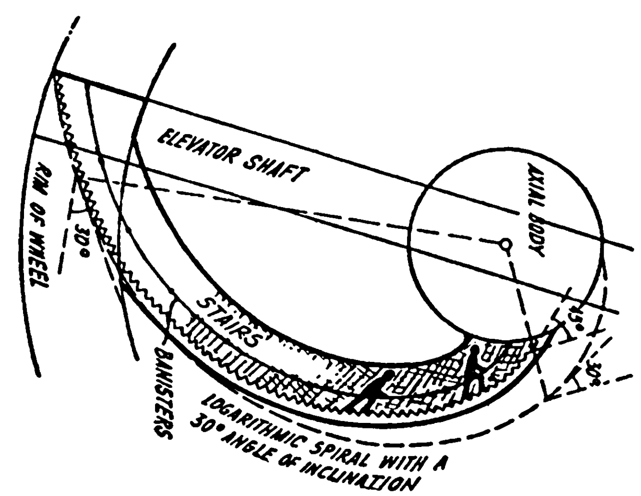

Fig. 28—Diagram of the stairway in the rotary house. The stairway must be built in a spiral (a logarithmic spiral) in order to make ascent possible. This is because as one ascends or descends the centrifugal force acting on him is changing, and the manner of his ascent or descent must correct for that.

made to eliminate in them the condition of weightlessness.

For the observatory, it is principally important that any desired position in space, which may be demanded by the observations to be made, may be given it, therefore, it must be entirely independent of the position of the sun and must have none of the previously described devices operated by the sun's rays. The air and heat for the observatory, therefore, as well as its supply of electricity must depend on the engine house. Accordingly, the two are connected not only with a cable but also with a flexible pipe-line Provision is made, however, that in case of an emergency, the airing of the observatory may be managed independently by using purifying cartridges in much the same way as is customary in modern diving suits.

In the observatory, there are, first of all, in keeping with its chief purpose, the devices for distant observation. There are, likewise, all the controls, the operation of which depends on distant observation, such as the controls of the spatial mirror (for this, see later sections dealing with "A Giant Floating Mirror" and "The Most Frightful of Weapons"). Lastly, there is also a laboratory for investigations in a weightless condition.

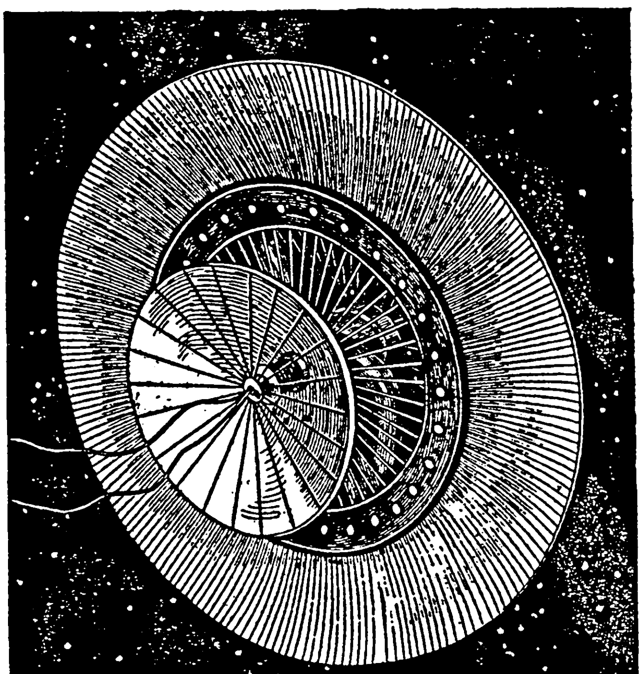

Fig. 29—View of the sunny side of the entire rotary house in space. In the center is seen the concave mirror in the center of which are the steam pipes. Back of the mirror is the rotary house proper, showing the axial body and the living quarters in the rim. (The small white dots represent port-holes). Along the outermost rim is a secondary mirror for heating other steampipes. The electric cables are seen leading from the axis of the house.

The engine house is intended to contain the more important mechanical systems common to the entire observatory, particularly those utilizing the sun's rays on a grand scale. Accordingly, it contains, first of all, the chief sun-power plant with its storage battery. There is also the entire apparatus of the great radio station, as well as an aeration-plant serving, at the same time, for the observatory proper.

The access of solar energy is due to an immense concave mirror solidly connected with the building. Within the focus of the mirror are the vaporizing and heating pipes, while the condensing and cooling pipes are behind the mirror.

The position of the engine house is therefore predetermined: it must always be kept so that the sun's rays strike squarely on the front of the concave mirror.

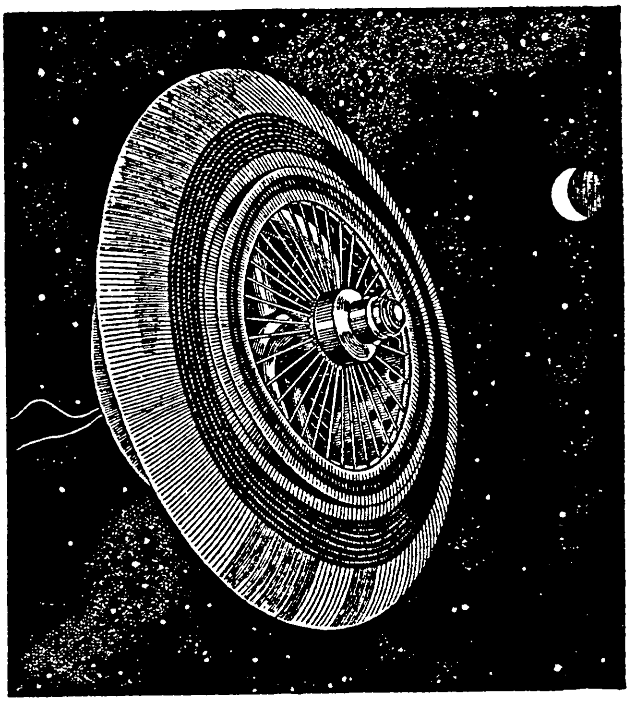

Fig. 30—View of the shady side of the rotary house, the moon being seen in the distance. At the right side of the axis of the house is the air-lock which one uses to go into the open or to return to the house.

Both the observatory proper and the engine house are illuminated in the manner already generally described for the entire establishment in space. The outer surfaces of the structures are kept absolutely mirror-like to lessen the cooling by radiation. Finally, both structures are equipped with rotary motors and recoil devices.

Kitchens, water purifiers, and equipment for washing, etc., are not provided in them in view of the very inconvenient behavior of liquids in a weightless condition. For eating and care of the body, the rotary house is available. Whatever is needed in the observatory and engine house in the way of food and drink must be taken there by each man from the rotary house, already prepared in a manner suited to the weightless situation.

CHAPTER VI

Provision for Distant Communication and For Safety

COMMUNICATION between the separate objects of the system takes place either by light signals or radio or simply by communication over wires. Accordingly all three parts of the space flyer are provided with their own local radio stations and are connected by a cable, which serves also to carry the high tension wires.

Finally, each of the three buildings is provided with reserve supplies of food, oxygen, water, heating material, and electricity (in storage batteries), so that the entire force of men in any building can exist for some time, if by chance the two other structures should become unserviceable at one time. In this way, the division of the system into three parts, favored on technical grounds, contributes materially to safety. To increase the safety still more, provision is made so that each building can communicate with the earth, not only by means of the main radio station, but independently by means of its own blinkers.

The Arrangement of the Spatial Observatory In Two Divisions

THE observatory could be arranged in only two instead of three parts, merely by combining the rotary house and the engine house. Basically this would be possible, because the position of both these objects in space is determined in the same way, by the direction of the sun's rays.

If it is desirable to keep the mirror of the engine house from revolving with the rotary house (for the speed would be comparatively rapid for its size) both the rotary house and the engine house (along with the mirror) could be revolved on a common axis—but in opposite directions. Or the rotary house and the engine house could be completely joined in one structure, on the axis of which the great mirror of the engine house alone revolved in the opposite direction.

The advantages of this arrangement would be as follows: first, the travelling about within the system would be reduced; next, there would be no need of the mechanism necessary in the separate arrangement to neutralize the mutual mass attraction of

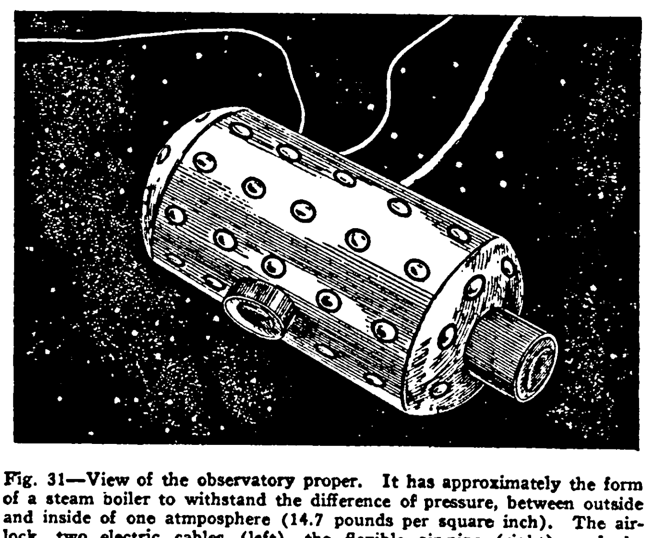

Fig. 31—View of the observatory proper. It has approximately the form of a steam boiler to withstand the difference of pressure, between outside and inside of one atmposphere (14.7 pounds per square inch). The air-lock, two electric cables (left), the flexible air-pipe (right), and the windows are shown here.

the rotary house and the engine house; finally, the rate of revolution of the rotary house could be changed in any way by motor power; that is, without using any operating material. For this purpose either the entire engine house or the great mirror, according to the arrangement, would be available as a counterweight. This explains the reason for the opposite direction of rotation.

Against these advantages must, however, be placed the disadvantage that this method presents

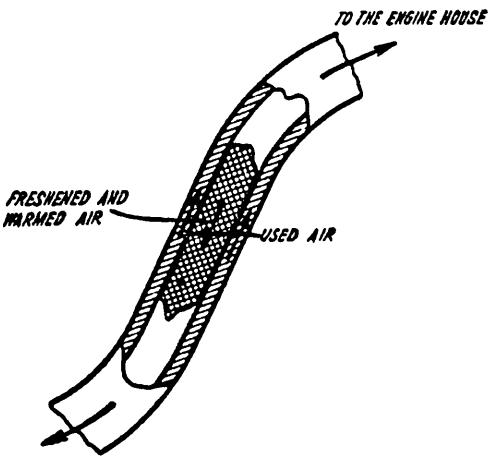

Fig. 32—The flexible pipe line that will connect the observatory with the engine house proper. It has two concentric parts. In the inside pure air is sent to the observatory to provide oxygen for the workers there. The outside pipe is for the return of used air to the engine house.

considerable, though perhaps solvable, difficulties of construction. We shall not give a more detailed account of this arrangement of the observatory system, in order not to confuse the picture already presented.

The Space Suit

NOT only for constructing the spatial observatory system, but also for operating it (for travel between the separate objects, to and from the space ships, for doing various work, etc.) there is need of being able to remain in them (outside of the closed rooms). Since this is possible only with the aid of the "space suits" already mentioned, we must now consider these more in detail.

They are, as was remarked, similar to the modern suits used for diving, or for protection against gas. The covering, however, must be something more than those used in the case of diving suits and the like. For whereas the former must be airtight, resistant to outside influences, and so made that they allow the freest possible movement, in the case of space suits they must also possess great tensile strength. For it must be remembered that within the suits there is a pressure of air of an entire atmosphere. Furthermore, the material of the covering must not be sensitive to extremely low temperatures, such as may result from radiation into space. It must accordingly, under such conditions, not become brittle or otherwise lose its solidity. There is no doubt that very considerable problems are presented in the solution of a material for the covering of such a space suit.

Certainly the greatest difficulty is offered by the problem of keeping the loss of heat by radiation within endurable limits. It is therefore necessary to try to limit the power of radiation of the covering to a minimum. This purpose could most easily be attained by making the entire outside of the suit mirror-like. In that case it would certainly have to consist entirely of metal or at least be coated with it. Perhaps, however, a properly prepared flexible material, insensitive to extreme cold, would serve as a covering, if colored an absolute white and made as smooth as possible.

To be sure, the advantages of such a suit in the matter of freedom of movement might not be very great. Even if the covering used is naturally flexible, it would become stiff, since the suit when inflated by the internal pressure becomes taut. Sufficient freedom of motion would be prevented. The effect would be literally the same as though the covering consisted of a solid material, such as a metal. Since we already have much experience, from modern diving armor, about the making of such rigid suits (so that they might perhaps be given in part a similar texture to that of flexible metal tubes), the most logical method clearly appears to be the entire metal construction.

We shall assume that the space suits are made in that way. Their cooling through radiation is prevented so far as possible by the polished condition of their entire outside surfaces. A special padding of the entire suits also assists considerably the insulation of heat. In the case of a very long stay

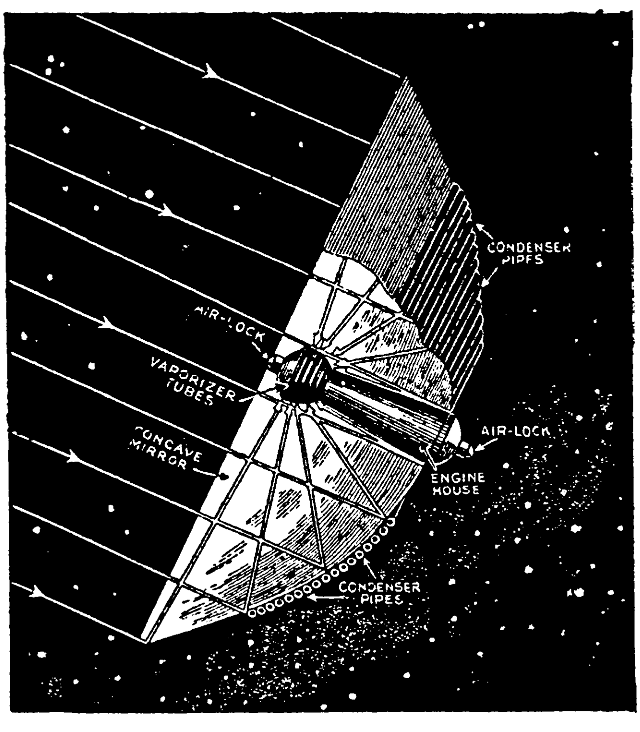

Fig. 33—Cross-section of the engine house. The white lines show the sun's rays striking the mirror and being reflected to the steam pipes (vaporizer tubes) where they converge to produce the necessary heat. The condenser pipes are located on the shady side where they can radiate off the heat of the vapor. The body of the engine house is shown as well as the air lock on the right hand and left hand ends of the axis.

in the open, if the cooling off becomes noticeable, it is counteracted by the radiation of mirrors placed on the side of the suit away from the sun. The air supply is provided as in modern diving armor. The necessary oxygen cylinders and cartridges to purify the air are contained in a metal knapsack on the back.

Since oral conversation through airless space is only possible by telephone and a wire-connection would be impractical, the space suits are provided with radio equipment. A small tube set, operated by batteries, and serving as sender and receiver, is also contained in the knapsack. The microphone and telephone receiver are built solidly into the helmet. As antenna, there serves either a properly attached wire or the metal of the suit. Since each individual building of the observatory is equipped for local radio communication, persons floating in the open can converse not only together but also with the interior of the observatory, just as in a room filled with air, though not by air waves, to be sure.

For special security against one already mentioned danger which always threatens when one remains in the open, that of floating off into space, the local radio stations are also provided with a very sensitive alarm apparatus, suitable for chance calls for help from persons in space suits even at great distances.

To avoid mutual interference, different wavelengths are, of course, fixed for the various types of local communication, the radio sets of the space suits being readily tuned to these.

To confer the ability to move, there are small recoil devices operated by hand. The containers of the operating material are in the knapsack along with the previously mentioned articles.

CHAPTER VII

The Trip to the Spatial Observatory

TRAVEL between the earth and the observatory takes place by means of rocket space ships. It may complete the picture to go through a trip in full detail.

The space ship is ready on the earth. We enter the passenger compartment, a small room built inside the hull, serving to hold the operator and the passengers. The door is shut from within and made airtight. We have to lie down in hammocks.

A few levers touched by the operator, a slight trembling of the ship, and in the next moment we feel as heavy as lead. The cords of the hammocks press almost painfully into our bodies, breathing is an exertion, lifting an arm is a real test of strength—the ascent has begun. The motive force is working and lifting us with an acceleration of thirty meters a second, which we feel as a fourfold increase of our weight. To stand erect under this load would be impossible.

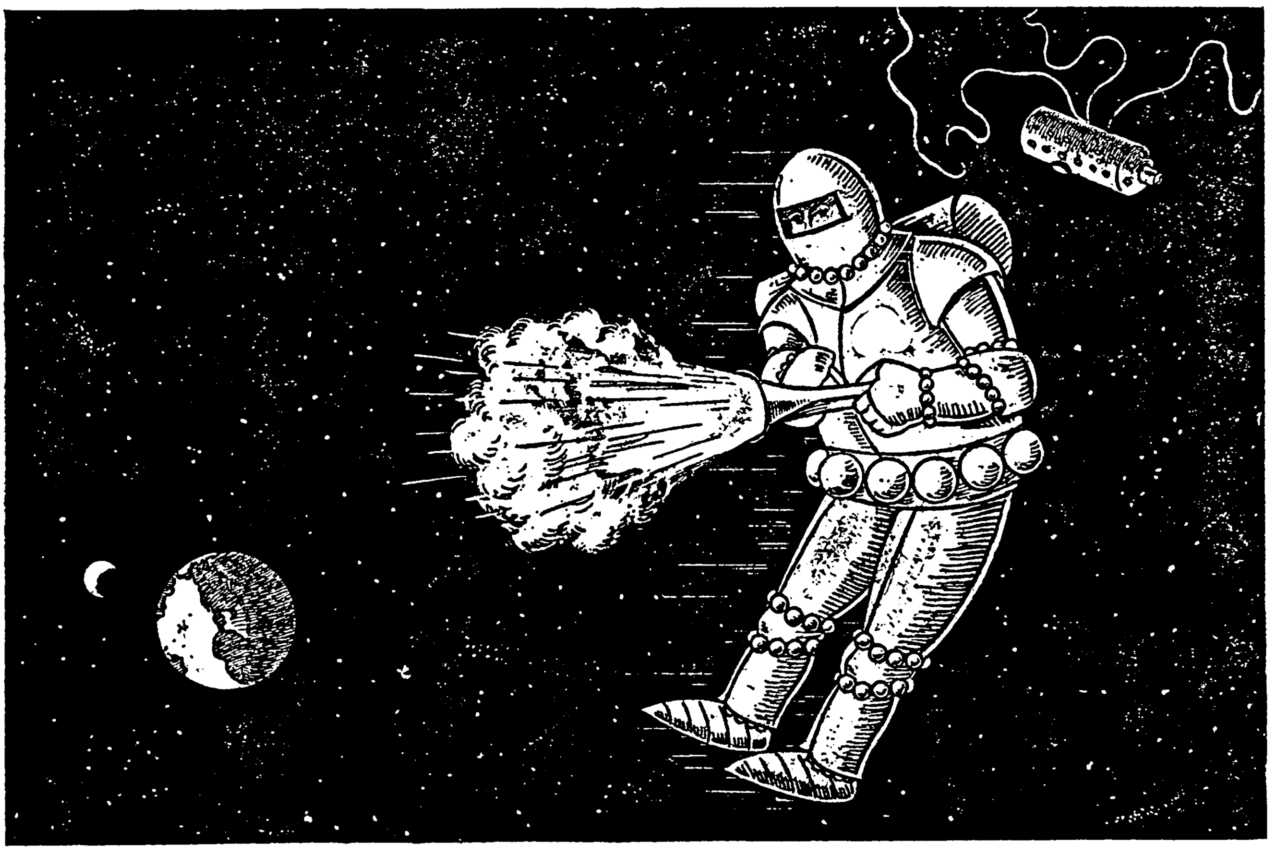

Fig. 34—A man traveling through space to the observatory proper. He is clad in a metal suit with a knapsack on his back holding the oxygen and radio set and other equipment necessary. He is propelled by the reaction from the force of the discharge of the gun in his hands. The observatory is seen in the upper right, while on the left are the moon and earth.

Before long the increased feeling of weight ceases for a moment, to be renewed again immediately. The operator explains that he has just uncoupled the first section of the rocket, where power was used up, and has started the action of the second.

Soon the operator touches the lever again. We have, as he explains, already attained the highest necessary climbing speed; therefore the ship was turned ninety degrees so that the impulse now operates horizontally, to bring us to the necessary speed of revolution.

We have already reached this, too. Only a few minutes have passed since the start, but it seems to us that we have had to endure endlessly the oppressive condition of increased weight. Now the pressure weighing upon us is gradually diminished. At first we feel welcome relief, but afterward comes oppressive fear: we think we are falling, plunging without a stop into the depths. The brave operator strives to calm us: he says that he has slowly decreased the power; our motion is now due only to our own kinetic energy. What we feel as falling is nothing but the feeling of weightlessness, to which we must accustom ourselves. *Easier said than done!* But since we must endure it, we finally succeed in making our mental readjustments.

Meanwhile, the operator has closely watched his instruments and heeded his tables and curves of flight. Several times the driving power must be started anew for a short time, to correct the slight errors in our course.

But now the goal is reached. We have put on the space suits, the air is released from the compartment, and the door is opened. Before us, at some distance, we see a very strange thing, a thing that contrasts with the jet-black sky all sprinkled with stars. It is a thing with a metallic gleam in the dazzling sunlight—the spatial observatory.

We are given little time to stare. Already our operator is pushing off from the rocket and floating to the observatory. We see him a lonely little figure in immeasurable space. We follow him, though not with very pleasant feelings. Between us and the earth yawns an abyss of nearly 36,000 kilometers!

For the return trip to earth we find our rocket ship provided with wings. During the ascent these were carried in sections and were now mounted, a task of no difficulty in view of the absence of weight.

Again we enter the passenger compartment of the space ship. The door is shut and air is admitted. At first the impulse begins to operate very slowly. A slight feeling of weight commences. Again we have to lie down in the hammocks. Then, gradually, the operator connects more exhaust pipes, so that the feeling of weight increases. This time we feel it much more oppressive than before, after we have been accustomed for some time to an absence of weight. Now the impulse is working to capacity, horizontally indeed, but in the opposite direction to that taken before. It is a question of so greatly diminishing our speed of revolution and at the same time the centrifugal force which carried us in our visit to the observatory, so we may freely fall to the earth in an elliptical path. During this part of the return trip the weightless condition again prevails.

Meanwhile we have already come sensibly nearer the earth. Gradually we also enter its coating of air; already the air resistance is noticeable, and now begins the hardest part of the journey, the landing. For now it is necessary to slacken our speed, so gradually during our fall to the earth that there will be no melting of our ship through the heat generated by friction of the air. For the speed acquired may reach twelve times that of the velocity of a bullet.

As a precautionary measure we are all fastened in. The operator is fully occupied in guiding the wings and parachutes, in determining the position of the ship, in measuring the air pressure and the external temperature, etc. For hours we thus madly circle about our planet. First there is a straight flight at a height of about 75 kilometers; later, with a constant decrease in speed, we come in a long spiral nearer and nearer to the earth and thus enter lower and denser layers of air; gradually

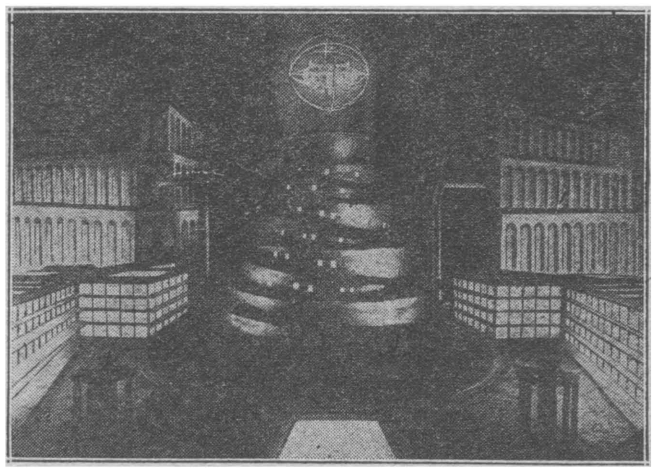

Fig. 35—That the Germans are taking space flying perhaps more seriously than the rest of the world is best shown by some of the science fiction films which they are now turning out. This illustration shows the departure of the space flyer, it being filmed at the instant it is hurled into space. It is of course, propelled by electricity. The film pictures a scene two thousand years hence. (See also Figure 36, showing the inside of the space car).

the terrestrial feeling of weight sets in, and our flight changes into a normal glide. As in a mad race, the surface of the earth speeds by below us; in mere half hours we cross entire oceans and traverse continents.

Yet the flight becomes slower and slower, we come nearer to the earth, until at length we descend upon the sea near a harbor.

CHAPTER VIII

Special Physical Investigations

AND now for the important question, of what use to us is the spatial observatory we have discussed? Oberth has given many interesting suggestions concerning this, and much of what follows is due to his hints.

For example, special chemical and physical experiments could be undertaken, those that demand large and absolutely airless spaces or require the absence of gravity; such investigations in short as are impossible to carry out under earthly conditions.

It would also be possible to produce not only extremely low temperatures more easily than on earth, but also to come at the same time much nearer the absolute zero than can be done in our chilling laboratories. So far we have come within about one degree of absolute zero, that is to —272 degrees Centigrade. In the observatory in space, besides the usual process of helium liquefaction, there would be available the possibility of most extensive chilling by radiation into space.

We could also test the behavior of bodies in a condition of almost absolute absence of heat. This might lead to extremely valuable conclusions regarding the structure of matter as well as the nature of electricity and heat, conclusions that similar experiments undertaken in our chilling laboratories are unable to furnish. From these experiments might result, for instance, the solution of the problem of finding a process for using the tremendous amounts of energy bound up in matter.

Finally, in view of the special possibilities offered by a spatial observatory, the question of the Northern Lights might be definitely answered, likewise that of certain rays in distant space, as well as of many other still unexplained natural phenomena.

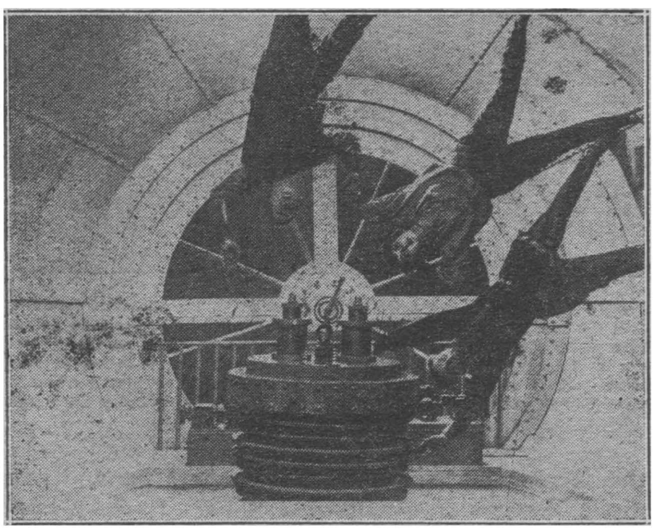

Fig. 36—Here we see the interior of the space flyer as depicted in the latest German science fiction film. (See also Figure 35, showing the outside of the space flyer). In this illustration we see graphically what is happening when the space flyer arrives at a point where weight no longer exists. In this German film, the actors actually were made to float about space—as now they have no weight—in a most entrancing manner.

Telescopes of Immense Size

AS previously explained, there is, in space, because of the absence of air, no optical hindrance to prevent the use of any size at all of devices for distant vision. But also from the structural standpoint the conditions are very favorable, in view of the prevailing absence of weight. Likewise the electrical energy needed to operate the devices or their parts is available in the spatial observatory.

Thus, it would be possible, for instance, to make reflecting telescopes kilometers in length very simply by placing, at proper distances from the observer, parabolic mirrors (adjustable by electricity) merely floating in space. Such devices for distant vision, and similar types as well, would be vastly superior to the very best ones existing on earth today. One may even say that there would be almost no limit at all to their efficiency and therefore to the possibilities of distant observation.

Observation and Study of the Surface of the Earth

WITH such powerful telescopes everything on the surface of the earth, down to the smallest objects, could be recognized from the spatial observatory. Thus it would be possible to perceive optical signals sent from the earth by the simplest means, thus keeping exploring expeditions in touch with their native lands at all times. Unexplored lands could also be investigated, their terrain determined, general conclusions reached about their population and their accessibility. Valuable preliminary work therefore could be done for expeditions planned, and even photographic detail maps could be furnished for new lands to be visited.

This indicates that *cartography* would rest on an absolutely new basis; for by means of *telephotography* not only could entire countries and even continents be mapped from the observatory (a task requiring otherwise many years and corresponding amounts of money), but also detail maps on any scale could be made, not surpassed in exactness even by the most scientific work of surveyors and mappers. To the latter would remain only the task of putting in contours. Above all, the still little-known regions of the earth, such as Central Africa, Tibet, Northern Siberia, the Polar regions, etc., could be mapped very exactly without much trouble.

Furthermore, important sailing routes could be kept under observation (at least by day, cloud conditions permitting), to be able to warn the ships in time about dangers such as floating icebergs, approaching storms, etc., or to announce immediately shipwrecks which had already taken place.

Since, from the observatory, the cloud movements of more than a third of the earth can be seen at one time, while cosmic observations not possible from the earth can be undertaken at the same time, entirely new bases for weather prediction might result.

By no means, of least importance, is the strategic value of such possibilities of distant observation. Spread out like the map of a war game, there would lie before the eyes of the observer in the spatial station the entire battlefield and its approaches. Even with most careful avoiding of any movement by day the enemy would hardly succeed in hiding his plans from such "Argus eyes".

(*To be concluded*)