BULLETIN

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David Lasser, President C. W. Van Devander, Editor.

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INTERPLANETARY COMMUNICATION

by

Clyde J. Fitch.

(This article is a slightly abbreviated form of a paper read by Mr. Fitch before the Society on October 3 at the American Museum of Natural History, New York, It elicited an interesting editorial from the New York Times of October 6, 1930.)

Whether life exists on any of the planets of our solar system or not is a question that our huge telescopes have been unable to answer. Consequently man has turned his attention to other methods of finding out more about the inhabitants, if any, of our planetary neighbors. Various methods of signaling the planets have been proposed; some of them worthless, and some scientifically sound. All of the methods presuppose the existance of beings of the same order of evolution as are found on Earth in order that we may get an answer to our signals. For, if they are of a lower grade of evolution we should not expect a return signal; and if of higher evolution their mode of thinking and living will be beyond our imagination and either we cannot signal them or they will not be interested in our signals. While a negative result from signaling tests, should we transmit some form of signals, would not deny the existance of other inhabitants, a positive result would definitely prove their existance and the experiment would be of inestimable value to science. In addition to this, should man ever leave this earth and travel through space in a space flier, he would want to be in constant communication with the Earth; and whether such communication can be maintained between the space flier and Earth or between some distant planet and Earth, with apparatus now available, seems to be a subject of scientific interest. Suppose we assume, then, that whatever instruments we now have available on Earth, will be carried on the space flier or will be in use and the messages they send will be understood by the inhabitants of some other planet. And with these instruments, let us see what can be done in the way of transmitting simple code signals, speech, music, or television images through space.

Ether Vibration Spectrum

Every possible method of communication known depends upon the transmission of material or energy, whether we drop a letter in the mail or wave our hand. In the latter case the signal is transmitted by light energy. To signal through empty space the only means known, aside from actually shooting a rocket to the distant point, is by the transmission of energy by means of ether vibrations. With its infinite flexibility, the ether offers us a medium for the transmission of vibrations ranging from a few thousand a second as used in the longest radio waves, through the whole spectrum of heat, light, ultra violet, X-rays, gamma rays to the billions of vibrations per second found in the cosmic rays.

The Radio Region

Beginning at what we might call the lower end of the spectrum, the radio region, we have the Heaviside layer to contend with. This is a layer of ionized gas in the upper atmosphere some 50 to 100 miles thick and ranging from 50 to 300 miles above the Earth, depending upon the time of day and season of the year. This ionization is caused by the powerful radiations of the sun. This strata is a partial conductor of electricity, causing a reflection of radio waves, as light is reflected from a mirror, and is also a medium of lower dielectric constant than the air below it, causing a refraction of radio waves. In either case, the waves are projected down to Earth again after leaving the transmitting antenna, and apparently are prevented from leaving the Earth and traveling out through interplanetary space. While the actual existance of the Heaviside layer is still theoretical, all observations conclusively point to its existance. But fortunately, its effect on radio waves varies with the frequency of vibration, or wave length; and this gives us a possible loophole through which the waves can penetrate into outer space.

Some hold that the long radio waves do penetrate the Heaviside layer. This is not definitely known, but if they do, it would be impractical to use them for interplanetary communication as they would spread out through all space and be attenuated so greatly that they would be of infinitestimal strength by the time they reached our nearest planet. And to focus these waves into a beam would require reflectors of colossal proportions. The short wave radio band offers much more interesting possibilities.

The Short Wave Radio Band

If we gradually increase the frequency of our radio oscillator and thereby radiate shorter and shorter waves, we find that the Heaviside layer plays an important part in their behavior after they leave the transmitting antenna. Waves ranging from 100 meters in length down to 10 meters, or vibration frequencies ranging from three million up to thirty million per second behave very differently from the longer, lower frequency vibrations. Observations made at different points of the globe show how they skip around the Earth by bouncing from the Heaviside layer down to the Earth's surface, up to the Heaviside layer and down again, and so on; as light would be reflected if the Earth and the sky were mirrors.

Just how deeply the waves penetrate the Heaviside layer, we do not know. Some of the energy may pass through and travel on into outer space. We do know that the waves penetrate the earth to some extent. Located 400 feet underground in Carlsbad Cavern, New Mexico, Eric Palmer, Jr., a short wave enthusiast, succeeded in receiving G5SW, England, and PCJ, Holland, as well as transmitting to several distant amateur stations.

By setting up suitable reflectors at the transmitter, the short waves can be directed into a beam and projected in any desired direction. With this beam of radio waves, the sky can be scanned and the direction and location of the reflected beam determined by receiving stations equipped with direction finding aerials. In this manner it has been found that a beam directed straight up, perpendicular to the Earth's surface, or above the critical angle, is not reflected back to Earth again. Whether the energy in this wave passes on through the Heaviside layer and travels out into space, or is entirely absorbed in the ionized layer, we do not know.

However, since we haven't yet come to an ether vibration frequency that we definitely know will penetrate the atmosphere, let us tune our transmitter to even shorter, higher frequency waves. We will go down into the region of the ultra-short radio waves, of which little is known but about which much is daily being learned. This region includes all waves from 10 meters in length down to the shortest possible radio waves produced -- waves a few centimeters in length. Waves one meter long can be produced with sufficient power for our purpose. In this region, tests have shown that waves below 8 meters in length, say from 8 meters down to 1 meter, or vibration frequencies from 37,500,000 up to 300,000,000 cycles

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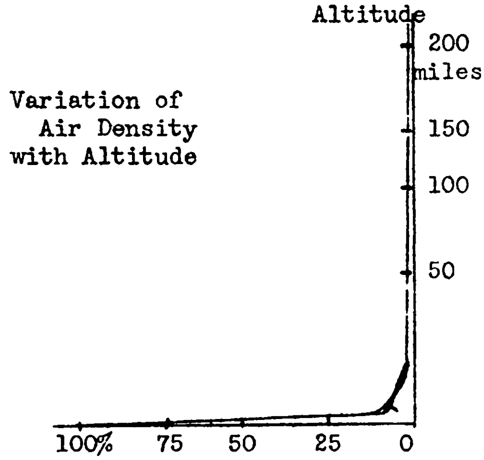
SOME SPECULATIONS UPON THE PROBLEM OF LANDING A SPACE SHIP
By L. E. Manning.

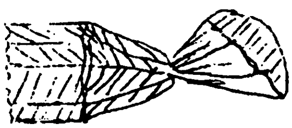
The first question an interplanetary travel prospect would ask is "Can we return to Earth and land safely? "The answer is yes. Without any increase in fuel tonnage a safe landing on the earth is possible by several landing manoeuvre. All of them take into account the extreme rarity of the atmosphere at a distance of fifty or more miles up. The rocket, returning from space, approaches Earth at 6 miles per second. At this speed it can come within 50 or 60 miles of the earth without air friction heating the rocket to the danger point.(According to Noordung) By the'braking eclipse'manoeuvre, a parachute is towed through the air and the rocket is slowed from 6 to say, $5\frac{1}{2}$ miles per second, at which speed of course, it cannot remain in the attraction of the earth, but proceeds into space again, returning in an eclipse to the atmosphere. The parachute is again towed and a still further reduction of speed obtained, and so on until 4 miles a second is reached. Now the rocket does not leave the atmosphere, but circles the earth in a free orbit until the parachute slows it down to landing speed. Estimated time 23 hours.



Air density(o/o of sea level)

Dr. Hohman, inventor of the above, also has a manoeuvre called the "forced curve". Here the rocket has airplane wings and once it enters the atmosphere, remains there until it lands. At 6 miles a second it tends to leave the atmosphere and the wings are depressed to hold it in at the fifty mile distance from earth. Air friction slows it down and the wings level out in proportion. At four miles per second and fifty miles height, the wings are nearly level. As it slows still further, the wings are used to keep the rocket up in the air and after a period of perhaps 5 to 10 hours, a normal glide brings the spatial airplane to land.

The Parachute with shortened string at the tail of rocket



Oberth's Parachute--

It would be desirable to build a rocket without wings if possible. Dr. Oberth suggests using the braking eclipse manoeuvre, at the same time retaining some of the advantages of the forced curve. His parachute, after speed is reduced to 4 miles per second, has one rope shortened. Then it acts not only as a brake, but as an airplane also. It tends to lift. As it is important to remain well up until the speed is materially lessened, this is a valuable adjunct to the braking eclipse manoeuvre.

Obviously, we are dealing with theory, If at 6 miles per second, the atmosphere 50 miles up were a little denser than current theory indicates, then the heat of air friction would probably be fatal. The proposed experimental rockets of Goddard and Oberth may soon settle this question.

<u>Landing on other planets</u>

A landing on Mars would not be successful, perhaps, with this manoeuvre. The atmosphere would not support an airplane nor permit parachute landing with safety. Perhaps one more step in the step-rocket principle would be required. On Venus the manoeuvre should be successful, altered to allow for the denser atmosphere.

But once on another planet, you must get off again to return to Earth. This means three more steps in the step-rocket, and as each step is equivalent to multiplying total tonnage by eight, the figures would be something like this:-

To take only ten tons of men and instruments and food to another planet and return, starting weight must be in the order of 2,500,000 tons. Even at $100. per ton we are in the realm of the fantastic.

* Synopsis of paper read at a meeting of the Society on September 19, 1930

If we can get volunteers for a colony on Venus, we can land ten tons payload there with a starting weight of only 5120 tons. No provision made for a return trip. Or, with approximately one more step (40,000 tons) we can circle another planet at a few hundred miles distance and return to Earth.

Perhaps the most sensible trip might be to circle Venus carrying a small one-man auxiliary rocket-plane. This plane makes a trip to the surface of Venus and returns to the main rocket, which then returns to Earth. Keeping in touch by radio, the lone explorer in the auxiliary rocket would hardly come to grief without being able to report the cause, and while it would be taking desperate chances, the possible results are sufficiently great to make it worth while.

To make a rough estimate of the weights involved, let us allow five men and supplies a weight of thirty tons, and an additional thirty tons for the auxiliary rocket. Three steps would be required to attain the necessary 7½ miles per second to reach Mars, and one additional step to break away from the free orbit set up about that planet for the return to Earth. The total pay-load, therefore is sixty tons and the starting weight upon leaving the Earth would be in the neighborhood of 120,000 tons. At $100. per ton, supposing the rocket could be built for that figure, the cost would be twelve million dollars.

The figures are mere speculation, in that they are based entirely upon theory. If they indicate the proportionate values and give a general picture of the problem in concrete form, they have served their purpose. Further research and refinement of present designs should, however, not increase, but decrease them, as they are conservatively estimated.

SURFACE OF THE MOON AND PLANETS

Interesting data concerning the probable nature of the surface of the moon and several of the planets has been gathered by Dr. B. Lyot, of the Paris Observatory, from a study of the polarization of light reflected from them. His investigations are based on the fact that polarized light vibrates in a single plane instead of in all directions and is reflected at different angles by different substances. Consequently light reflected to the Earth from the moon or planets bears its own testimony as to the nature of the surface from which it is reflected. The polarized light reflected from the heavenly bodies has been compared by Dr. Lyot with light reflected from various terrestrial substances.

The moon is covered with a volcanic ash, Dr. Lyot concludes, thus lending weight to the theory that the craters observed on our satellite are extinct volcanoes. Mercury, the nearest of the planets to the sun, shows a very similar condition, and Dr. Lyot also believes from his studies that if Mercury has an atmosphere anything like ours it cannot be more than about one-fifth as dense.

Venus was found hard to study because it seems to be enveloped in clouds, and it was difficult to compare the reflected light from terrestrial clouds of sufficient thickness. However, the results seemed to indicate that the light from Venus is reflected from tiny droplets of water possibly.

Mars gave results closely similar to the moon, with variations caused by clouds or mist in the atmosphere, which Dr. Lyot believes is not more than one-third as dense as that of the Earth. Jupiter and Saturn were difficult to study because both are so far from Earth that the angle of reflection changes little. Indications were found, however, that the inner ring of Saturn may consist of something analagous to pieces of mineral, lava and granite particularly.

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per second, are radiated in straight lines, like light, and do not come back to Earth again by reflection from the Heaviside layer. Consequently they cannot be used for transoceanic communication. The receiving station must be in sight of the sending station in order to receive these ultra-short waves. Objects within their path produce radio shadows. They behave according to all the laws of optics and act like the monachromatic light. It is interesting to note that Hertz made his classic discoveries in this field. For his oscillator he was limited to the use of a simple spark gap; but now we have means of generating powerful undamped waves of this order. And if they do penetrate the Heaviside layer, we would have no difficulty in projecting them in the form of a beam to our neighboring planets. In order to be sure that our aim is good and that we can hit the planet, it will be necessary to let the beam diverge slightly -- so that it will cover an area of about a billion square miles by the time it reaches the planet. Since there is virtually no loss in transmission in vacant space, it would not take a great amount of power to transmit a signal that could be detected at this distance. With a few kilowats, our present short wave stations can encircle the globe three times, including losses in reflection, and still have sufficient energy to be detected; and in doing this they cover an area of over 603,000,000 square miles, or three times the area of the Earth's surface. Therefore, if these ultra short waves do penetrate the Heaviside layer without great absorption losses, they offer an easy means of transmitting signals, sound or pictures to the planets.

Ultra-Short Waves

It is interesting to note that considerable experimenting is now being done down in the still shorter wave lengths of less than one meter. At these extremely high frequencies, the ordinary vacuum tube oscillatory circuits do not work--because of the comparatively great physical size of the apparatus and its connections, which place a definite limit on the shortest wave length possible that can be produced. Barkhausen and Kurz, some years ago, however, observed an unusual phenomenon within the vacuum tube, by which the generation of powerful waves as short as 4 inches were possible. In this generator the grid of the tube is held at a positive potential and the plate, negative. Some of the electrons, attracted to the positively charged grid at high velocity, strike the grid and some pass through it, and come within the repulsive field of the negatively charged plate, and are consequently repelled back to the grid. It is these electrons, oscillating back and forth around the grid in small orbits, like planets around the sun, that generate the ultra short waves. Whether radio waves of this frequency, some 2½ billion cycles per second, will ever be of any practical value in space communication or not we do not know. Only short distances have been covered on Earth with them.

The Infra-Red Region

Passing on down to waves of still shorter length, we come to a gap in our vibration spectrum in which we have no practical means of generating waves of any great strength. Beyond this gap, we find the band of heat and infra-red radiations, the so-called invisible light, located on the border line of the visible spectrum. The infra-red band ranges in wave lengths from 2.4 microns to .7 microns; or 1/10,000 to less than 3/100,000 of an inch.

In this region of vibrations and beyond, we no longer have the Heaviside layer to contend with; our difficulties now lie in the possible interference from the powerful radiations of the sun -- and the absorption and scattering of the rays by the atmospheres of the two planets between which communication is to be established.

(Mr. Fitch then states that water vapor in the atmosphere is the chief obstacle to the passage of infra-red rays, and points out that if the atmosphere of Venus contains large amounts of water vapor their use in communicating with that planet might not be possible, The infra-red beam might be transmitted, he says, by a group of huge search lights. At the receiving end one or more telescopes would focus the faint ray on a substance sensitive to infra-red light, such as selenium, which has the property of varying its resistance to an electric current in proportion to the square root of the illumination falling on it. Its action, however, is sluggish, like that of the human eye. As an illustration of the extreme sensitivity of selenium, Mr. Fitch states that "if you struck a match on the moon, without a reflector and without a telescope, its light would be indicated by a selenium cell on Earth all in one second's time." E D.)

But selenium is sluggish--like the pupil of the human eye. The problem then is how are we going to transmit messages over this infra-red ray? The sending of simple code signals like the Morse code would be easy. There would be plenty of time. But once communication is established, we would like to transmit speech and television images. With the proper apparatus at the receiving end, and plenty of time to work, this is easily accomplished. We first record our speech or television vibrations photographically, on a strip of film -- by a process similar to that used in talking pictures. Then we make an enlarged fire-proof film that can be passed slowly over our infra-red searchlight. This will slowly modulate the intensity of the ray emitted.

At the receiving end the infra-red rays are collected by one or more telescopes and concentrated on a selenium cell. The rays modulate the electric current through the cell in exact accordance with the modulations of the beam at the transmitter. The electric current modulations are amplified by suitable vacuum tube amplifiers--the output of which lights a lamp, which also varies in brilliancy. In front of this lamp is slowly passed a sensitized film and a photographic record made of the light fluctuations. All that remains to do now is to run the film through the proper sound apparatus at the correct or faster original speed and the speech is reproduced. For television; a televisor is used in place of the loud speaker. Such a system could easily be managed if beings on the other planet had the proper equipment. The chances that such conditions will ever exist are very remote. Should life exist on some of the other planets it is likely that they have eyes to see with, similar to ours, and the obvious method of attracting their attention would seem to be with visible light.

Visible Light Rays

In a recent article in the Scientific American, Prof. Thompson of the University of Reading, England, ruled out the possibility of signaling the planets either with visible light or infra-red rays. The reason given was that the powerful light and heat radiations of the sun would interfere with any signals we might send over. All interference from sunlight seems to be due to the scattering of the rays by particles in the atmosphere. But since we found that infra-red rays from the sun are not scattered by our atmosphere -- on a clear day -- this objection does not appear logical.

When Mars is in "opposition" or nearest the Earth, a spot five miles in diameter on its surface will be visible using the 200-inch telescope now under construction. Should any inhabitants of Mars choose to set up huge geometrical figures we should be able to see them. Huge mirrors, reflecting the sunlight, as in a heliograph, would easily attract our attention. But to see us, Mars would be looking towards the sun, and any light flashes that we may send would be lost in the brilliancy of the sun. But suppose we wait until Mars has traveled a little farther from us, and analyze the conditions. In this case Mars does not look directly into the sun to see us; and since the atmosphere on Mars is very rare, it is quite likely that inhabitants up there could see stars in the day time and also see our planet. Should this be the case, we could easily signal by means of visible light beams.

With new supersensitive photoelectric cells and amplifiers, which unlike selenium is instantaneous in action -- telephonic communication could be established directly with inhabitants on Mars, and television images transmitted over a beam of light. And one way to offset any interference from the sun's radiations is to interrupt our light beam at a high super-audible frequency, say 100,000 cycles per second, on top of which is superimposed our telephonic currents. Nowhere in the universe would the Martians find a light source interrupted at this particular frequency and with proper tuning circuits they could tune in the light of this frequency in spite of light received from other sources -- provided such interfering light was not strong enough to paralyze the photoelectric cell.

In conclusion, it is safe to say that communication can be established with inhabitants on Mars if they had the proper equipment, by means of radio waves under 8 meters in length, infra-red rays, and visible light rays. The latter, being the most primitive and easiest method of signalling, would probably be the quickest to attract attention. With Venus, the conditions are not as favorable. Radio communication is no doubt possible, although there must be an enormous Heaviside layer around Venus and many electric storms which would cause considerable static, although here static does not interfere with short wave reception on waves shorter than 30 meters. Infra-red ray communication with Venus may be impossible on account of the fog in her atmosphere -- unless the high mountain tops on that planet project through it. And light beam communication seems impossible for similar reasons. Unfortunately, Venus seems to be the planet most likely to be inhabited. Mercury is very hot, 800 degrees Farenheit, and life as we know it is impossible there. Venus is covered with clouds and the surface temperature cannot be easily determined. It is about 9 degrees below zero there at night and very hot in the day. On Mars the temperatures vary greatly between day and night, and are comparable with temperatures here on high mountains. The outer planets are very cold -- the temperature on Jupiter being about 216 degrees below zero.

Recent Articles on Interplanetary Travel

The past month showed a very high level for general interest in interplanetary travel, judging by the number of articles appearing in current magazines. The following list is offered:

1. "New Worlds to Conquer" by Philip M. Barr- October 8 Outlook, a summary of the interplanetary question, and an Utopian vision of the future space flight.
2. "A trip to Mars" by Waldemar Kampffert, October Forum, a picturesque description of a rocket flight to the "red planet"
3. "The Mechanics of the Space Flight" by Hugo Gernsback, November Everyday Mechanics. A popular yet authoritative account of some of the conditions that explorers must face in cosmic space.
4. "Why Rockets Propel" by David Lasser, Nov-Dec. Aviation Mechancis. A description of how the rocket works, and how to build small models.
5. "Will the Rocket Displace Artillery" by Gawain Edwards, November Science and Invention. An analysis of the use of the rocket in warfare.

RESEARCH PROGRAM BEGUN

A program of research on the rocket and its possibilities has been started by the Society under the direction of G. Edward Pendray, vice-president. The research will probably be carried on during the next two years - reports to be issued from time to time on its findings. The Society is inviting cooperation from scientists and scientific institutions, in promoting its work, by a series of questionnaires to be issued shortly.

COSMIC RAYS.

Some conclusions as to the nature and origin of Cosmic Rays have recently been announced by Dr. R. A. Millikan, who first discovered them in 1925 through an investigation of leakage of electric charges from tightly sealed electroscopes. The Cosmic Rays, because of their great penetrating power (some being able to go through 18 feet of lead) may prove of great importance when man undertakes to leave the protection of Earth's atmospheric blanket and venture out into space.

By comparing the intensity of the rays in California and at a point on Hudson Bay comparatively near the magnetic pole, Dr. Millikan found experimental proof of his belief that the rays are ether vibrations and not high-speed electrons, as some scientists had believed. No massing of the rays was observed in the neighborhood of the magnetic pole as had been calculated would be the case if they were electrons from the sun. Dr. Millikan believes that the rays originate from the formation of heavier atoms from lighter ones in interstellar space.

OBERTH ROCKET READY.

Professor Hermann Oberth, German experimenter, has completed an eight-foot rocket which he expects to try out soon on the Baltic seacoast. Constructed of metal, it will carry an hour's supply of fuel, and Professor Oberth expects it to reach an altitude of about 13 miles, higher than any projectile built by man has ever risen, and to bring back valuable scientific data. It will be launched from a tower resembling an oil well derrick. The rocket will carry a red tail light, and observers will follow its flight by the use of telescopes.

"ROCKETEERING".

Readers of the New York Evening Post recently enjoyed an interesting controversy on "Rocketeering" in the "Letters to the Editor" department. It began when David Lasser, President of the Society, wrote to the Post congratulating the editor on the open mindedness shown in an editorial on the possibility of rocket travel in interplanetary space. Shortly afterward a reader signing himself "Earthbound," contributed the statement that a rocket would not work in the interplanetary vacuum since it would have nothing to push against. Mr. Lasser, in reply, gave a clear explanation of the principle on which a rocket operates, showing that its efficiency is greater in a vacuum than in the atmosphere. "Earthbound" retorted that he was a graduate of Massachusetts Institute of Technology and that he had not been taught anything like that. The controversy was ended after two neutrals entered the fray and completely routed "Earthbound." One of them, also an alumnus of M.I.T., declared that Earthbound's "lack of fundamental knowledge is a most unfortunate reflection on his school."

Meetings of the New York members of the American Interplanetary Society are held on the first and third Fridays of each month at the American Museum of Natural History, 77th Street and Central Park West. Persons interested in the aims of the Society are invited to attend and to write to the secretary, C. P. Mason, 302 West 22nd Street, New York City, for information about the various classes of membership, including active, associate and special, which are open to men and women who possess the necessary qualifications.