ASTRONAUTICS

No. 23 DAVID LASSER, *Editor* October, 1932

TABLE OF CONTENTS

ASTRONAUTICS is the official organ of the American Interplanetary Society and is published monthly for its members.

Associate Membership in the Society at $3.00 per year may be obtained by sending the first year's dues to the Secretary, C. P. Mason at 302 W. 22 St., New York. Information on other classes of membership may be obtained by writing the Secretary. Meetings of the Society are held monthly at the American Museum of Natural History, 77th St. and Central Park West, New York.

ARTIFICIAL GRAVITY FOR THE SPACE SHIP

By Noel Deisch

Member of the American Interplanetary Society

Robert Esnault-Pelterie, the French aeronautic expert, well known for his theoretical work on the space rocket, has suggested that a false "weight" might be produced within the interior of the vessel while on its journey through space, by the expedient of keeping the rocket in action continuously, so that the ship would be given a certain acceleration throughout its journey. But he balked at the enormous expenditure of energy that would be required to put the idea into effect.

Herman Ganswindt, a pioneer German speculator on this subject, long ago suggested the alternative of rotating the ship, so that all objects in its interior would press to the outer walls. They would hence possess a kind of weight produced by centripetal acceleration, which weight could be maintained indefinitely without any continuous expenditure of work.

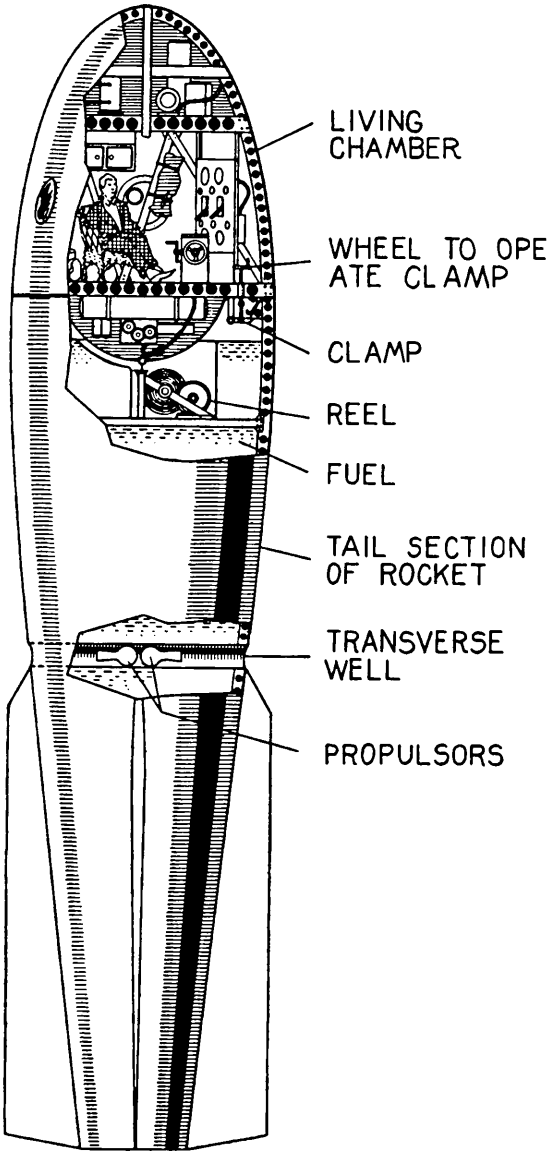
This method is unsuited for application to an ordinary rocket because of the rocket's small diameter, for in this case the necessary high speed of rotation combined with the rapid variation in intensity of the inertial field at different distances from the axis of rotation, would undoubtedly discomfit the most hardy sailor of the ether.

The German engineer Noordung, in a very suggestive book on rocket travel, shows a great doughnut-shaped vessel designed with the purpose of reducing the above trouble. The objection in this case is that such a shape is totally unsuited for the purposes of rocket propulsion, where, due to the tremendous speeds developed while the rocket is still in the atmosphere, it is necessary to keep the air resistance down to the very minimum.

As a contestant in the first Rep-Hirsch international competition for studies on the subject of astronautics, the present writer made a suggestion toward the practical application of the rotation method to a rocket ship, which, in combination with other work described in his essay, was thought by the judges of sufficient merit to warrant extending to him honorable mention. Since that time he has often been asked as to just how the suggestion might be applied in a practical way, and though it does not appear likely from the present state of development of rocket travel that there will be an early call for shop drawings, a few preliminary sketches are evidently already in demand.

The idea is this: the rocket is shaped just like any other cosmic rocket, that is, it has a streamlined form to give it a low resistance while penetrating the atmosphere. However it is made up of two divisible sections which at the beginning of the flight are securely locked together. When the ship has climbed up entirely above the atmosphere and is merely coasting through empty space, it is split in two and the two sections are moved apart, being secured to each other by means of a cable. They are, moreover, given a

gradually increasing motion of relative revolution by rocket apparatus contained in one of the sections, so that they swing about each other something like the opposite blades of a windmill. Due to the large radius of the circle described and the resulting small gradient of the inertial field produced, the likelihood of the pilot being troubled with dizziness or ether sickness becomes extremely remote.



Showing the details of the author's rocket which will automatically provide gravitation for occupants in interplanetary space.

A Ceiling for a Floor

The figure gives an idea of such a rocket. The general shape as here drawn is entirely conventional, but this is immaterial, for the principle is of course adaptable to any form of rocket.

It will be seen that the upper part of the rocket ship comprises the living compartment, which is really a somewhat egg-shaped hermetically-sealed shell, within which will be noted the intrepid pilot, complacently seated in a wicker chair. It also contains the air-conditioning apparatus and other paraphernalia necessary to the health of the voyager. This section fits into the lower or propelling portion of the rocket, the mating edges being flush with each other to form a continuous smooth outer surface. There are several screw-operated clamps that lock the two sections firmly together near the point where they make contact.

Attached to the lower compartment is a windlass apparatus including a winding drum and its driving motor. The drum carries a considerable length of cable, the free end of which is attached to the upper section at its lowermost point, as clearly shown in the drawing. In the tail portion of the ship two oppositely directed propulsors or rocket jet apparatus are fitted. The winding motor and the propulsors are controlled by electrical impulses sent down the attaching cable, which impulses operate relays of the harmonic vibration type. The relays are of the electrostatic variety, thus dispensing with the use of a separate controlling cable in addition to the attaching cable.

We are now prepared to follow our apparatus in operation. The ship has attained a position high above the atmosphere, and is rushing out through space toward its destination. But the power has been shut off and the pilot is or soon will be in distress due to want of weight. He unclamps the two sections. He also sets into operation one of the transverse propulsors. This causes the ship to turn about in an end-over-end direction, no doubt with some discomfort to the pilot. But not for long, for the centrifugal force thus developed drives the two sections away from each other, and at the same time draws out the cable from the reel.

The motor clutch is, of course, disconnected so that the drum can turn freely, but a friction gear is provided to prevent too rapid unwinding of the cable. As the action of the propulsor continues, the two sections turn about each other in wider and wider circles, until at last the entire length of cable is unwound. However, the propulsor is allowed to continue in operation for some time longer.

Meanwhile the pilot has become aware of a steadily increasing force which tends to push him up toward the ceiling. When the force has attained the desired value, as indicated by the gravimeter on the instrument board, the propulsor is

shut off. The pilot rearranges his chair and thereafter uses the ceiling as a floor.

Suppose we use some figures, which of course in the nature of the case must be somewhat arbitrary, but which will enable us to get a certain idea of the quantities involved. Assume, then, that the head section of the ship weighs one ton and the tail portion three tons. Suppose also that the cable is 500 feet long. The head section revolves about a point in the cable located 375 feet from the point of attachment, that is, it describes a circle having a diameter of 750 feet. Under these conditions the speed of revolution will be 2.8 turns per minute to reproduce an apparent weight within the living chamber equal to that which exists at the surface of the earth.

Landing on the Moon

But in all probability half of this weight would be sufficient for entire comfort: this would call for a rate of revolution of only 2 turns per minute, or twice as fast as the second-hand of a watch. In the latter case the cable would be subject to a stress of 1,000 pounds, and if we assume it to be made of the best steel rope, and allow it a factor of safety of six, its weight (on the earth) would amount to about 50 pounds. To this must be added the weight of the drum and other accessory apparatus.

There are of course some subsidiary details that will require attention. For example, the axis of force exerted by the transverse propulsors must theoretically pass through the inertial axis of the tail section if the spinning of the latter when the propulsor is in action is to be avoided. This condition is hard to meet in practice, but is approached by placing the propulsors near the axis of the ship, as shown.

Better, the propulsors could be arranged to be shifted from one end of the cylindrical transverse well or tube to the other, according to the direction of operation: by this means the centre of tractive effort could be brought in advance of the center of inertia,—an excellent relation to minimize rotational forces.

An accessory method of preventing rotation, either by an automatic apparatus to slightly shift the axis of the propulsor to correct rotation or by a gyrostatic stabilizer, or both, must however also be provided. A ball-bearing sheave would be fitted at the point of attachment of the cable to the living chamber, to prevent rotation of the latter due to the twist of the wire rope. It would be essential to provide stabilizing apparatus for the living chamber, just as for the tail section.

Now imagine the expedition to have arrived in the vicinity of its destination. Before landing, the ship would of course be brought back into its original or integral form. To effect this, the pilot would start his winding motor, and the windlass would gradually reel in the two sections of the ship. At the same time the propulsor would again be set into operation, but this time its jet would be directed counter to the direction of rotation, so as to slow down the turning motion. When the two sections had finally been drawn together, and while tension was still maintained on the cable, the two parts would be secured by the clamping bolts. These would merely engage under the flanged edge of the stiffening ring, so that it would not be necessary to locate the clamps with respect to any particular fitting.

The pilot would orient his ship base-on, and the chair would again be reversed. He would then turn on his main rocket for the great landing. If his destination happened to be the moon, he would find on coming to rest that gravity there was only a sixth of what it is on the surface of the earth. To make it easier to accommodate himself to the new conditions he might choose to decrease the rate of revolution from time to time, as the trip progressed across space toward the moon, though this maneuver would probably prove an unnecessary refinement.

DEVICE IS BUILT TO FIND IF STARS HAVE PLANETS

Gustaf Stomberg, astronomer, has made an interferometer which he believes will enable him to discover whether there are planets other than those about our sun.

"If we should find they have planets revolving about them it would be evident that there are possibilities of life on many bodies throughout the universe."

Dr. Stromberg has taken an interferometer, and adapted and improved it until he is able to measure angles corresponding to that subtended one-thirty-second of an inch at a distance of 100 miles or more. The instrument will be used at the Carnegie Institution's Mount Wilson observatory with the 100-inch telescope and a microscope which together can magnify a star 1,000,000 times.

Dr. Stomberg said he hopes to measure the distance between binaries, or double stars, which are close together and revolve about each other. Where formerly years were required to obtain approximately the orbits of the double stars, he now expects to measure them accurately within a comparatively short time.

"It has long been known that the sun moves in a minute orbit because of the pull of the planets which revolve about it," said Dr. Stromberg. "Thus, if we find similar oscillations in the orbital motions of binaries, we will know that planets are causing the disturbances."

NEWS OF THE MONTH

NEW GROUPS BEGIN ROCKET EXPERIMENTAION

A new group of rocket experimenters has been formed at Tri-State College, Agnola, Indiana. Mr. Burnham, aeronautical instructor; Professor Rousch, dean of the Mechanical Department; and John W. Herrick, aeronautical engineer are members of the group. They have already begun work on a spherical combustion chamber with a nozzle of circular section; and will try out the reaction of various hydrocarbons and nitroglycerin. The group has been in close communication with member Harry W. Bull, formerly of Syracuse University have followed closely Bull's experimental experience.

In Glendale, California, Maurice Poirier has constructed several small rockets as well as a model of a larger 8-foot rocket. The projected rocket will have four combustion chambers circling the rocket's nose, supported about a foot away from the nose. The news account of Poirier's rocket states that "he expects to derive power from a gas manufactured from a German weed." No further information as to the mysterious substance has been vouchsafed.

LIQUID FUEL ROCKET EXPLODES 50 FEET UP IN GERMAN TEST

Johannes Winkler, inventor of a liquid fuel rocket that he calls a "space ship," tried out the device recently. According to a dispatch, it rose about fifty feet from the ground, exploded with a deafening roar and fell back in pieces.

Herr Winkler had hoped to send the rocket up to a record altitude. The cause of the explosion was not determined.

The first successful flight by a rocket propelled by liquid fuel, said the despatch, occurred near Dessau, Germany, March 15, 1931, when the device of Herr Winkler, a former Junkers engineer, rose vertically for about 1,000 feet and landed about 600 feet away as planned. The rocket, ignited electrically from a distance of 150 feet, was driven by a mixture of liquid oxygen and gasoline, said to provide greater efficiency and economy than the solid fuel used in previous experiments.

(The shot of a liquid propelled rocket by Dr. R. H. Goddard near Worcester, Mass., preceded that of Herr Winkler by one year.—*Editor.*)

NEW ROCKET AUTOMATICALLY RELEASES WINGS AT AN ALTITUDE OF 8,000 FEET

Reinhold Tiling the celebrated aeronautic engineer has just perfected his latest type flying rocket with detachable wings. The rocket itself is 11 feet long and has a wing spread of 13 feet. The rocket is released through electric mechanism and when it reaches an altitude of 8,000 feet, its wings automatically are released so that they fold back toward the tail of the rocket. Like a boomerang, it will return to within a few feet of the position from which it has been released, landing as do all planes perfectly controlled, to the equivalent of a three point landing. Tiling's assistant is Miss Angela Buddenbohner, said by the inventor to be the only woman in Europe or for that matter in the world who is engaged in rocket construction and research.

(Miss Lee Gregory, Librarian of the American Interplanetary Society should be added to the list of feminine rocketeers—*Editor*).

NEW THEORY OF ORIGIN OF PLANETS DISCUSSED IN EUROPE

A new nebular hypothesis of planetary origins is being discussed here as a substitute for the theory that the planets are fragments torn from the sun by the enormous tidal forces generated when another huge star passed too close to the sun.

The new evidence against the "tidal forces" theory is based on observations and calculations made and reported by H. P. Berlage, Jr., of the Meteorological Observatory in Batavia, Java. His paper was communicated to the Royal Academy of Sciences by Prof. H. A. Kramers.

Berlage's theory is that the planets had their origin in a nebula surrounding the sun and having the shape of a thin, flat disc. From what is known of the way in which the present planets differ in their respective densities it follows that if there actually was such a nebula it must have had this disk shape at least as far out from the sun as Neptune. Moreover, the densities for each planet, calculated on the assumption that the new theory is correct, agree remarkably well with the actual known densities. For example, according to the theory the greatest density should be along a circle which is nearly the same as the earth's orbit. The earth is actually the most dense of the planets.

Additional supporting evidence is found in the distances of the planets from the sun. Careful examination of the known facts about these distances reveals that the figures agree much better than has ever been believed with the positions which the planets should occupy, according to this theory, with respect to the sun.

If the planets did originate from a great disk-

shaped nebula, it is easy to understand the presence of the great bulk of planetoids between Mars and Jupiter; they arose from an unstable and highly turbulent zone in the gaseous disk. Even the puzzling arrangement of these planetoids can be simply explained on the proposed basis.

If the theory is correct, there should have been another, lesser zone of turbulence, and so there should be another family of planetoids. It is considered probable that the recent discovery of Pluto brought to light the first known member of such a group of planetoids, thus giving the theory added confirmation; and it suggested that if these planetoids are discovered, they might appropriately be called plutoids.

RYNIN COMPLETES NEW ROCKET INDEX

A new and wonderfully complete index of all material published in recent years on rockets, has been received from Professor Nicolas Rynin of Petrograd, Russia. The index forms a large part of a new book on astronautics written by the Professor. Professor Rynin who is a member of the Society and a technical expert in the Soviet Union, has accumulated from international sources all rocket data available and has collated and arranged the material in this book, which is now in the possession of the Society.

Unfortunately, however, the book is in Russian. But this has not detracted from the feeling of those who have examined it that the book should be a valuable aid to future historians digging into the beliefs of men of the early 20th century with regard to new methods of transportation on earth and into space.

THIRD MOST SPEEDY TINY PLANET DISCOVERED

A tiny planet, probably not over ten miles in diameter, that makes a trip in its orbit around the sun in 2.023 years, has been discovered independently by American and Russian astronomers. Of the 1,500 or more of these bodies, called asteroids, that revolve in the space between the orbits of Mars and Jupiter, only two encircle the sun in shorter periods, according to calculations made here by Dr. A. Kahrstedt, of the staff of the Astronomisches Rocheninstitut at Berlin-Dahlem. Long ago astronomers stopped naming these bodies, so the newly identified member of the solar system is designated only by a number, 1932 PB.

Though the first observation of the asteroid to reach the Recheninstitut was made on August 4 by Dr. G. Neujmin, at the branch of the Russian Central Observatory at Simeis, in the Crimea, it was found previously by Dr. George Biesbroeck, of the Yerkes Observatory in Wisconsin, who first recorded it on July 30. Dr. Kahrstedt's computation of the orbit was made with the aid of four observations by Dr. Van Biesbroeck. At present the planet is in the constellation of Capricornus, in the southern evening sky, but is of the 12.7 magnitude, too faint to be seen except with a big telescope. Because of its rapid motion, astronomers have been asked to keep it under observation as long as possible.

THE CHRONOLOGICAL HISTORY OF THE ROCKET

by Willy Ley

(Continued from last month)

1888. Engineer Ciarcu drives on the Seine a motor boat with repulsion. An explosion kills his assistant.

1891. Hermann Ganswindt discusses in evening lectures, among other inventions, his idea of reaching Mars with an interstellar vehicle propelled by dynamite explosions. This is really the first comprehensive and earnest plan of a space ship.

1892. An engineer residing in Mexico by the name of Nikolaus Petersen obtains a patent on an airship which was to be propelled by rockets stored in large revolving drums.

1893. On June 3, E. Lavarenne in Paris secures DRP No. 68783 (German Patent) "A working mechanism for airships utilizing the reaction of a means of propulsion coming forth through a tube system, the characteristic of which is that in the tubes one axle-tree each, provided with screw-wings for regulating the exhaust.

1893. On July 3, August Klumpp in Muenchen and Conrad Haussner in Ingolstadt secure DRP (German Patent) No. 69520, dealing with an airplane kept suspended by diverting and commutating air currents.

1894. On January 15, the firm of Huettner, Walter & Co. in Hamburg obtains DRP (German Patent) No. 79446 for a captive flying machine, kept suspended by the reaction of air. The machinery is kept on the ground. Additional patents of the same inventor regarding this invention are: No. 82257, 82904, 86738.

1895. DRP No. 89890 is issued to Karl Reiter in Muenchen for a reaction motor for airplanes. This motor is a cone-shaped receptacle without a tip, with various openings at the edge of the bottom. The receptacle is rotated around its perpendicular axis whereby the air in the cone is pressed downward through centrifugal force, and then blows out through the openings. Through the hole on top new air is sucked in, so as to have a steady reaction pressure. A number of these apparatus are supposed to keep an airplane without carrier surfaces up in the air.

1895. The Frenchman Denisse is the first one to use a camera-equipped rocket for the taking of birds-eye pictures.

1895. Pedro E. Paulet, a Peruvian chemical engineer is experimenting with Dauerrueckstossduesen (Duration repulse containers (?)) made of the then novel vanadium steel. At the rate of about 300 explosions a minute, he obtained around 90 kilos (about 198 lbs.) repulsion over a supposedly long period. More recent research men doubt this result, which was only made public in 1927, and which apparently is justified.

1900-1910. Experimenting with the air torpedoes invented by the Swedish Lieut. Col. Baron von Unge, which are being propelled by rocket power. These were undertaken in Stockholm in 1901. The accuracy of the aim in spite of the discharge cannon was too small, so that Unge in 1908 propagated his air torpedoes as means of warfare for airplanes also. Krupp in Essen bought the patents and worked on them until 1910; then the plan was dropped. In the opinion of Frenchmen, similar air torpedoes are supposed to have been used by German zeppelins during the World War, but there do not exist any German reports on the subject.

1902. On September 20, Paul Wappler in Spandau obtained DRP (German Patent) No. 134182 for a reaction airship, activated by the suction and repulsion of air which is being moved through ventilators placed in tubes.

1904. Engineer Maul who had been working on the photo rocket, shot off in this year for the first time a rocket equipped with a camera, picture size 4 x 4 (1½" x 1½") to a height of 300 meters (990 feet). (Seon is written as though it were a name, but apparently a typing error and should read 'sein' which means 'his'). His largest model in 1912 at that time had a plate size of 20 x 25 (8" x 10") and was lifted by two 8 centimeter (3¼") rockets of the laboratory in Spandau, to an altitude of 800 meters (that is 2640 feet) and had a total weight of 42 kilos (that is 93 lbs).

In the same category, as regards application, belongs DRP (German Patent) 64209 of Ludwig Rohrmann of Krauschwitz near Muskau. It deals with a rocket with photo-apparatus for the taking of one or several panorama views and with an automatic parachute opener.

1905. On May 26 Gustav Knaepper of Dortmund secures Patent DRP No. 160742 for a reaction motor for airplanes; expansion of compressed air.

1905. The Swedish astronomer Birkenland is said to have worked between 1905 and 1907 on a project of a rocket airship.

1906. On the 78th Natural Scientists' Day in Stuttgart, R. Bauer reports on fighting hail with explosion rockets. The process has been refined and successfully improved in more recent times; on that same day also a lecture on photo rockets was given.

1910. On November 14, DRP (German Patent) No. 228654 was given to Christopher Antoonovics in St. Petersburg (Leningrad). Refers to the raising of airplanes by an explosion to be as continuous as possible, at the lower side of the metallic carrier surfaces by means of liquid combustible material which are being discharged through the many pores.

1911. René Lorin in the "Aerophile" proposes a repulsion rocket plane to which he devotes a whole series of articles in this publication. Compiled in book form, these works appeared in Paris in 1919 under the title "L'air et la vitesse". (Air and Speed).

1911. Aleksandr Gorochoff publishes in "Wosduschnij put" (Air way) his project on an all-metal-airplane operating on the repulsion principle. Gorochoff thought of using alcohol, benzin or gasoline as fuel. The start of the airplane was supposed to take place by sliding down a steep slope, and the landing in a big sand port. (!)

1911. Dr. André Bing on June 10 receives the Belgian patent No. 236377 for the Stufenprinzip (step, scale, gradation principle) in the construction of rockets.

1911. Engineer Crassus (Pseudonym for Wilhelm Gaedicke) publishes in a treatise entitled "Der gefahrlose Menschenflug" (Human flight free from danger) the plans of a Hubschrauber (stroke screwer) which is run by the repulsion of combustible lighting gas.

1912. In the fall of this year, Prof. Piccard, who later became a stratosphere aviator, conducted his first experiments with rocket-propelled airplane models, inasmuch as he thought at first that to get into the stratosphere he would have to proceed in this way.

1916. In England a rocket with a howling mechanism for fog signals is brought on the market.

1916. On July 13, the Sachsenwerk A.-G. in

Niedersedlitz near Dresden, secured DRP (German Patent) No. 301270 on a rocket apparatus with parachute.

1919. (May) In the publication of the Smithsonian Institution appears Prof. Robert H. Goddard's work "A method of reaching extreme high altitudes" (Miscellaneous Collections No. 2540). It is the first of modern books dealing with rockets.

1920. Dimitri P. Rjabuschinsky (Riabouchinski) publishes in "Bulletin de l'Institut Aerodynamique de Kaoutkhino" a remarkable "Théorie des fusées" (Rocket theory).

1921. (March) In Paris, in "La Science et la Vie" the repulsion motor is published for the first time by Henri F. Melot. It deals with a horizontal double cylinder, in which the piston moves with a Pleuelstange (some kind of a rod) and crankshaft. The system works in -one-two-time with the customary fuels, the gases puff out through a Duese (exhaust) around which a number of Venturiduesen are arranged that by the sucking in of air the mass of the gas current is enlarged, but its speed reduced, in order to obtain for slow vehicles (airplanes) a better ratio of action. (The experiments date back as far as 1918.)

1923. Prof. H. Oberth publishes "Die Rakete zu den Planetenraeumen" (The rocket to the interstellar spaces).

1924. (Summer) Founding of the "Interplanetary Section" in Moscow. The society came to an end before the task could be undertaken. The publication "PAKETA" which had been announced, did not come out.

1924. (Fall) "First International Exhibition for World Space Navigation" in Moscow. Almost nothing but astronomical material and fantasy; hardly any serious work.

1924. (Nov. 14) In Kaluga appears the new print of Konstantin Eduardowitsch Ziolkowsky's "Rocket in cosmic space" (Paketa B Kosmn Yeckoe Iipoctpahctbo). First published in 1903 in Hay Ihoe 0b03-Pehne. The great inquiry which in 1911-1913 first appeared in BECTHNK BO3AYXOIISI ABAIINe entitled "NCCAEAOBAIINE MNPOBbIX IIPOCTPAHCTB PEAKTKBHbIMN IIPNbOPAMN" (Exploration of the world spaces by reaction apparatus) were republished in Kaluga in 1926. In the meantime, Ziolkowsky has come out with several smaller books.

1925. Dr. engineer Walter Hohmann publishes "Die Erreichbarkeit der Himmelskoerper. Wichtige rechnerische Studien ohne Konstruktionsvorschlaege) (The attainability of the heavenly bodies. Important mathematical studies without proposals for construction).

1926. On November 24, Heinrich Schreiner in Graz is granted DRP (German Patent) No. 484064 on a gas rocket operated by liquid fuel. The liquid or liquefied fuel is pushed by piston or other pumps into the combustion chamber.

1927. In June, in Breslau was founded by Max Valier and Johannes Winkler the "Verein fuer Raumschiffahrt e.v." (Society for Space Navigation" whose monthly publication, "Die Rakete" (The Rocket) appeared until the end of 1929. In 1930 the society was moved to Berlin.

1927. (May) Geheimrat (a German title) Lorenz in Danzig tried in the VDI-News to theoretically prove the impossibility of space navigation. The press controversy that ensued between him and Prof. Oberth led to a mutual conference at the WGL meeting in Zoppot in Spring (Pentecost) 1928.

1927. (June 8) Robert Esnault-Pelterie speaking before the main assembly of the Société Astronomique de France concerning "L'Exploration de la très haute atmosphère par fusées et la possibilité des voyages interplanétaires" (The exploration of the very high atmospheric regions by rockets and the possibility of interplanetary travel). In 1928 the speech appeared in book form, and in 1930 considerably enlarged in its second edition under the title of "L'Astronautique".

1928. March 12. First start of Opel's rocket car in Ruesselsheim. The first public demonstration took place at the same racing ground on April 11. The next car (during these tests Volckhart was in the steering seat), Fritz von Opel demonstrated it himself on the Avus near Berlin on May 23rd.

1928. May. The first comprehensive work on space navigation "Die Moeglichkeit der Weltraumfahrt" (The possibility of space navigation) appears, by Willy Ley, with contributions by Prof. Hermann Oberth, Dr. engineer W. Hohmann, Dr. Franz von Hoefft, Dr. Karl Debus, Engineer Fr. W. Sander, engineer Guido von Pirquet and from the publisher.

1928. June 11; the first witnessed human rocket flight with an duck airplane from the water top. Starting point from a rope of rubber; reached a distance of some 1500 meters (that is slightly less than a mile) with pilot, Fr. Sthamer by means of two rockets.

1928. June 23. On the track Burgwedel-Celle, Fritz von Opel let the first (unmanned, the same as all rail-rocket-vehicles) rail-car run. Destroyed through an explosion when it skipped the rail.

Valier's first rail-wagon ran on July 26; the one following on October 3 at Blankenburg on the

Harz. Each and every rail wagon met with accidents.

1928. Autumn. In Leningrad appears the first volume of a rocket encyclopedia of 12 volumes by Prof. Nikolai Aleksejewitsch Rynin. The work is entitled: "Interplanetary Communication", Thus far 7 volumes have appeared, among them the sole biography of Ziolkowsky.

1929. Max Valier demonstrating on February 3 on the Eibsee (a small lake), on February 9 on the Starnbergersee a rocket sled for powder propulsion, both manned and unmanned. Maximum speed unmanned, about 395 kilometers (that is about 246 miles) an hour.

1929. April 10. Engineer Fr. W. Sander is shooting off a rocket which is propelled by a liquid fuel. It is not, however, a genuine liquid fuel rocket, under which name are comprised rockets using a liquid fuel and liquid oxygen, but a sort of pyrotechnical rocket using liquid constituents.

1929. June. The International Prize for World Space Travel Science (REP-Hirsch Prize; of Robert Esnault-Pelterie and André Hirsch in Paris) is being distributed for the first time. The winner is Prof. Hermann Oberth with the book "Ways to Space Travel" (Wege zur Raumschiffahrt), the third edition of "Rakete zu den Planetenraeumen" (Rockets to interstellar spaces) which just then came out. Because of the value of the work, the prize is doubled (10,000 francs).

1929. July 18. Prof. Goddard is shooting off at Worcester (Mass.) U. S. A. a rocket 3 meters (that is 10 feet) long and 70 centimeters (that is 24") in diameter. After making its start as scheduled, it explodes at 300 meters (that is 990 feet) altitude.

1929. August. At the Junkers plants experiments are undertaken in Dessau, to facilitate by means of rockets the start of overloaded hydroplanes. The results are satisfactory. Details and further developments are kept secret.

1929. Sept. 30. Max Valier demonstrating a repulsion car which is operated by evaporated liquid carbonic acid.

1929. Sept. 30. Fritz von Opel in Frankfurt is successful in his first rocket flight, in which the plane starts out of its own power. (powder being the motive power).

1929. October 15. At the UFA-Palace at the Zoo in Berlin World Premier of the Space Navigation Film "Frau im Mond" (Woman in the Moon), Direction by Fritz Lang, Manuscript by Thea V. Harbou, Scientific Advisor Prof. H. Oberth. The film had a few forerunners in the "Aelita" of Tolstoj and the "Himmelsschiff" (Ship of Heaven) after a novel by Sophus Michaelis, but it was the first that was produced under expert scientific advice. "Frau im Mond" (Woman in the Moon) was the last silent film which in 1931 was still running in the large cities of America.

1929. November. A union of parties interested in space navigation is founded at the State Hochschule (University?) in Leningrad. Directors, Dr. Rynin and Dr. Perlmann.

1930. March. Founding of the American Interplanetary Society in New York, which immediately gets in touch with the German Society of Space Navigation (Verein fur Raumschiffahrt). A visit of the Vice-President G. Edward Pendray in April 1931 on the rocket flying field in Berlin leads to a close union.

1930. April 19. The first car constructed at the Heyland Works in cooperation with Valier, and operated with liquid fuel rockets, undertakes its first trip.

1930. May. Through the Verein fur Raumschiffahrt e. v. (Society for Space Ship Travel) for two weeks the first liquid fuel rockets and experimental apparatus are exhibited at the Potsdamer Place and the adjacent Wertheim Department Store.

1930. May 17. Max Valier is killed by an exploding liquid fuel rocket.

1930. September 27. The "Rocket Airport Berlin" is founded.

1931. March. Engineer Karl Poggensee discharges near Bremen a powder rocket which reaches an altitude of about 800 meters (that is about 2660 feet). It safely lands by a parachute.

1931. March 14. Engineer John Winkler shooting off at Dessau a rocket using methane and oxygen. It reached an altitude of around 600 meters (that is around 1980 feet).

1931. April 11. Chief engineer Pietsch of the Heylandt Works demonstrating at the Central Airport in Berlin the improved wagon of Valier. Operation: by alcohol and oxygen.

1931. April 15. Engineer R. Tiling demonstrating at Osnabrueck newly invented powder rockets with an altitude of 2000 meters (6600 feet) altitude. The rockets have a sail-mechanism for the landing. The tests are perfectly successful.

1931. May 23. At the Rocket Airport in Berlin, for the first time a repulsor using oxygen and benzin, after completion and test of the Duesen at the examination stand, is flying over a stretch of over 600 meters (1980 feet). Two weeks earlier this same apparatus had already risen to 100 meters (330 feet) up in the air. In the meantime, improved repulsors of same size have attained a distance of 5 kilometers (3 miles) and an altitude of about one and a half kilometers (slightly below 1 mile. Hence the technical development of the liquid fuel rocket has been initiated.