LOVE JOINS WITH SCIENCE IN PERFECTING ROCKET WHICH MAY BRIDGE SPACE FROM EARTH TO MOON

Professor Robert H. Goddard, Inventor of Giant Lunar Projectile, Is Aided in Experiment and Research by College Girl Whom He Will Marry

FIANCEE WRITES PLAYS AS SAVANT STUDIES WAY TO CHART REALMS OF SKIES

May Revolutionize Accepted Theories of Earth's Atmospheric Conditions by Recording Accurate Data of Regions Miles Above the Clouds

THE rose-tinted glow of romance and the cold, steady light of science, usually as far asunder as the poles, have been united in remarkable tests that may revolutionize man's knowledge of the atmosphere.

Prof. Robert H. Goddard, originator of the idea of the "moon rocket," has fallen in love with a charming young college girl.

Miss Esther Christine Kisk, of Worcester, Mass., the professor's fiancee, has become absorbed in the experiments her future husband is making at Clark University, Worcester, where he is head of the Department of Physics.

The moon and lovers have been associated since the earliest ages. Poets have rhapsodized over the spell of romance cast by its silver flood of light.

But to Dr. Goddard and his bride-to-be the moon has become the symbol of a scientific goal. The super-rocket which he is planning, if successful, will add one more victory to man's conquest of nature.

Dr. Goddard became renowned overnight several years ago when the world learned of the great rocket he was planning to shoot into infinite space.

The public fancy was caught with the suggestion that eventually the Goddard super-rocket might carry a man to the moon. Numerous men and some women offered to attempt the trip.

But the professor is not interested primarily in any attempts to reach the moon. What he wants to do is to solve the mysteries of the spaces beyond the earth's atmospheric envelope.

He wants to learn the density, the chemical composition and the temperature at various planes of elevation.

He hopes that his invention will enable aviators to chart the sky and gain reliable information as to flying conditions at great heights.

He wants to learn more of "geocoronium," a gas not found at the surface of the earth, which is said to comprise the fourth region of the atmosphere.

In two years Dr. Goddard expects to reach his scientific goal. Scientists in this country, in Europe and even in Africa are in touch with his experiments.

Initial Steps in Love and Research in 1917

It is a coincidence that the first step that brought exceptional progress with the model rocket was made by Dr. Goddard in 1917, the year he met Miss Kisk. She graduated from the South High School in Worcester in that year and became secretary to Dr. Edmund P. Sanford, then president of Clark University.

Miss Kisk's scholastic attainments are indicative, friends say, of the assistance that she will give Prof. Goddard in working out perplexing problems and lending sympathetic and intelligent encouragement.

She served as secretary to Dr. Sanford for two years before entering Bates College. In her first year there she attained the highest grade of scholarship, not only in her own class, but in the entire student body. This year she won sophomore honors for the highest rank in her class. She has also the distinction of being a half holder of the Bancroft Scholarship in Worcester, an honor going only to those who have mental ability far above the average.

Miss Kisk's verse and prose frequently appeared in magazines, and her play, "Now and Then," won the competition of the sophomores at Bates this year and was presented at the Little Theatre at the college. Miss Kisk also held an assistantship in economics as a part of her student activities. Next year she will have a similar position in Greek and English. When she was graduated from the high school she had the highest school scholarship.

In 1915 and 1916 the actual experimental investigation was undertaken. Tests concerning ordinary rockets, steel chambers, and nozzles were made at Clark University. The original calculations were then repeated, using the data from these experiments, and both the theoretical and experimental results were submitted to the Smithsonian Institution.

It costs money to carry on scientific experiments, and especially those that involve such immense possibilities as a moon-going rocket, but it came from an unexpected source after Prof. Goddard, in his confidence in his theory, had dug deep into his own pocket to advance the idea.

A grant of $5000 from the Hodgkins Fund at the Smithsonian Institution gave impetus to the development of a reloading or multiple charge rocket. The work was begun at the Worcester Polytechnic Institute in 1917, and later was undertaken as a war proposition. It was continued at the Mount Wilson Observatory in California from June, 1918, up to very nearly the time of signing the armistice.

Gets Financial Help From Unexpected Source

Since then the work has not progressed as rapidly owing to a lack of funds, but again financial assistance has come from an unexpected quarter. The source has been especially gratifying to Dr. Goddard, in that it is indicative of the confidence which the trustees of his university have in his theories, despite the fact that the experiment has not advanced beyond the model stage.

Dr. Goddard was in his laboratory at Worcester when he consented to tell of his experiments. Before him was a model of the rocket over which he has worked for seven years.

"I have faith in the possibilities of the rocket," he said, "not only as an aid to science in determining the density, chemical composition and temperature of the atmosphere, but also as a means of exploration."

"Do you really believe that eventually you will be able to send a human being to the moon?"

Prof. Goddard's smile gave way to a look of seriousness.

"I think the suggestion of such an achievement came from my original paper to the Smithsonian Institution," he answered.

"But," the questioner continued, "there have been reports from time to time that your rocket theory did not anticipate more than sending a rocket to an unexplored region of the air to determine scientific facts concerning the atmosphere and the nature of the aurora."

"The possibilities of the rocket which I have outlined in theory and have brought to a degree of perfection in model form can readily be recognized," Dr. Goddard replied.

"I must make it clear, however, that as the financial assistance to carry on my work came from Clark University, it becomes essential that I keep silent until such time as the institution is prepared to announce any definite developments.

"I can say, however, that I believe the sum which Clark University has put at my disposal will be sufficient to enable me to make rapid progress in the future development of the rocket. It will enable me to make more experiments with my model and pave the way for the larger rocket. Beyond that I can say nothing."

Many Have Offered to Take Lunar Trip

That many people throughout the world have taken serious cognizance of Dr. Goddard's experiments is evinced by the large number of letters he has received from persons eager to take a trip to the moon.

"When my theory was first made public," said Dr. Goddard, "I received letters from men who desired to ride to the moon. They are still coming. Only recently I got a letter from a woman in Kansas City, Mo., who appealed for the opportunity to take the rocket trip.

"The majority of the writers, however, reveal in their letters that they are animated by the desire for publicity. Their offers are not to be taken seriously as an effort to give scientific assistance."

Dr. Goddard has received countless letters from scientists who have offered their services. Some of them propose journeying to Worcester to aid the professor in the Clark laboratory.

Perhaps the most interesting of these missives has come from Khartum, Africa, where a scientist who has spent his life in research work details how he gleaned the knowledge from a newspaper which reached there almost two years after the subject gained prominence in scientific discussions. Offers of help have come from a German student at Heidelberg and still another from a Danish engineer.

"There is only one person, to my knowledge, beside myself who is at work on a rocket theory," said Dr. Goddard. "He is a French engineer, but his experiments are not being conducted with the idea of exploring extreme altitudes."

The amount of money which Clark University trustees have placed at the disposal of Dr. Goddard to further his experiments has not been made public. Dr. Goddard contents himself with the statement that it is a modest amount, but entirely adequate for the work in hand. The trustees are likewise uncommunicative, but they say the appropriation was made because they had faith in the practicability of the project.

It is not the sensational idea of shooting a human being to the moon that has attracted the attention of scientists and impressed the university trustees, but rather the possibilities for scientific information which has long been desired.

Dr. Goddard says that while his theory is not being worked out with the idea of getting data on weather conditions for forecast, the rocket plan would be an immeasurable aid to the weather man.

Observations May Aid Science of Aviation

"The observations that could be made with rockets and proper instruments fired only a few miles into the air would be valuable to aviators also," he said. "I think the time is not so very far distant when such methods will be employed to ascertain flying conditions.

"This is one of the immense possibilities in the development of the rocket theory. While my rocket would be employed to reach extreme altitudes, it would not be difficult to utilize it on a smaller scale for just such purposes.

"Speculations have been made as to the nature of the upper atmosphere—those by Wegner being perhaps the most plausible.

"By estimating the temperature and percentage composition of the gases present in the atmosphere, Wegner calculates the partial pressure of the constituent gases, and concludes that there are four regions or spheres of the atmosphere in which certain gases predominate: the troposphere, in which are the clouds; the stratosphere, predominatingly nitrogen; the hydrogen sphere, and the geocoronium sphere.

"This highest sphere appears to consist essentially of an element of 'geocoronium,' a gas not present at the surface of the earth. The existence of such a gas is in agreement with Nicholson's theory of the atom, and its investigation, would, of course, be a matter of considerable importance to astronomy and physics, as well as meteorology.

"The greatest altitude at which soundings of the atmosphere have been made by balloons, namely, about twenty miles, is but a small fraction of the height to which the atmosphere is supposed to extend.

"Simultaneous daily observations at a large number of stations of the various planes of pressure, temperature and wind velocity would doubtless be of great value in weather forecasting. The theory, which I have worked out, is well suited for such a purpose, in that the time and rise of such a fall would be short, so that the apparatus would readily be found on its return. The expanse would be slight, being simply that of a fresh magazine of cartridges for each day."

Nitrocellulose smokeless powder is the propelling force of the rocket which Dr. Goddard has worked out in theory and through patient experiment. The gases are ejected from the rocket at a high velocity, most of the projectile consisting of propellent material.

Successive charges are fired in the same chamber, as in a rapid-fire gun. Such reloading mechanisms, together with what is termed a "primary and secondary" rocket principle, have been patented by Dr. Goddard under four patents.

There are three principles involved. The first concerns thermo-dynamic efficiency through the use of a smooth nozzle of proper length and taper, through which the gaseous products of combustion are discharged.

"By this means the expansion of the gases is obtained as kinetic energy, and complete combustion is ensued.

A reloading device embodies the second principle, whereby a large mass of explosive material is used, a little at a time, in a small, strong, combustion chamber. This enables high chamber pressures to be employed, impossible in an ordinary paper rocket, and also permits the mass of the rocket to consist of propellent material.

The employment of a primary and secondary rocket apparatus is dealt with in the third principle. The secondary, a minature of the primary, is fired when the primary has reached the upper limit of its flight. By this means the large ratio of propellent material to total mass is kept virtually the same during the entire flight. A parachute device provides for the return of the discarded casings to the ground without damage.

Rocket Striking Moon Visible by Its Flash

The calculations of Prof. Goddard reveal that with an initial mass charge weighing 6346 pounds he could cause an explosion on the surface of the moon sufficient to make a flash visible on the earth through a telescope of one foot aperture. With 33,278 pounds he could produce a flash visible to the naked eye.

Through the employment of a larger telescope these amounts could, of course, be much reduced. With an aperture of two feet the masses would be reduced one-fourth of those given, but the use of such telescopes would greatly limit the number of observers.

Dr. Goddard has already made tests with tubes containing Victor flash powder in Auburn, Mass., just outside of the city limits of Worcester. The flashes fired on a fairly clear night were observed in Worcester. It was found that one-twentieth of a grain of Victor flash powder fired in vacuum could be seen at a distance of two and one-quarter miles.

Prof. Goddard has taken into consideration every condition that it is possible to anticipate in the flight of the rocket toward the moon. He has even given deep study to the possibility of a collision between the rocket and meteors. He says the danger of such an accident is negligible, especially as the rocket would be discharged so as to avoid meteor swarms, the direction of motion chosen being that of the swarms.

Dr. Goddard gave a careful summary of the situation as it is today after years of experiment and study.

Briefly, the facts that stand out are these: The rocket in principle is ideally adapted to reaching high altitudes, in that it carries apparatus without jar, and does not depend upon the pressure of air for propulsion.

A theoretical treatment of the rocket principle shows that if the velocity of expulsion of the gases were considerably increased and the ratio of propellent material to the entire rocket were also increased, a tremendous increase in range would result.

Experiments with ordinary rockets show that the efficiency of such rockets is 2 per cent and the velocity of ejection of gases 1000 feet per second. For small rockets the ratios are slightly less. With a special type of steel chamber and nozzle, an efficiency has been obtained with smokeless powder of over 64 per cent (higher than that of any heat engine ever before tested), together with a velocity of nearly 8000 feet per second, which is the highest velocity so far obtained in any way except in electrical discharge work.

Experiments repeated with the same chambers in a vacuum demonstrated that the high velocity of the ejected gases was a real velocity, and not merely an effect of reaction against the air. In fact, experiments performed at pressures such as probably exist at an altitude of thirty miles gave velocities even higher than those obtained in air at atmospheric pressures, the increase in velocity probably being due to a difference in ignition. Results of the experiments also indicated that this velocity could be exceeded with a modified form of apparatus.

When a large chamber was used in experiments it was demonstrated that not only are large chambers operative, but that the velocities and efficiencies are higher than for small chambers.

A calculation based upon the theory, involving data that is partly theoretical and partly empirical, indicates that only a moderately large initial mass is required to raise recording instruments weighing a pound, even to the extreme upper atmosphere.

The initial mass necessary is likewise not excessive even if the effective velocity is reduced by one-half. Calculations show, however, that any apparatus in which ordinary rockets are used would be impractical, because of the large initial masses that would be required.

Could Recover Rocket by Means of Parachute

The recovery of appartus on its return, Dr. Goddard says, need not be a difficult matter, inasmuch as the time of ascent even to great altitudes in the atmosphere will be comparatively short, due to the high speed of the rocket throughout its entire course.

The time of descent will also be short, but a free fall can be prevented satisfactorily by a suitable parachute. A parachute will be operative, he says, for the reason that high velocities and small atmospheric densities are essentially the same as low velocities and ordinary density.

Even if a mass of one pound were propelled by the apparatus until it possessed sufficient momentum to escape the earth's attraction, the propelling mass need not be unreasonably large, for a high velocity of ejection would be attainable.

Dr. Goddard has not been unmindful of the popular discussions that have ensued concerning the merits of his theory and the possibilities it presents. He has given careful consideration to all questions that have been raised and has not failed to convince his critics of the faith he has in the principle and the ultimate success of his project.

Dr. Goddard says that to many people the operation of a jet in a vacuum is still a mystery. However, he says the phenomenon is easily understood if one thinks of the ejected gas as a charge of fine shot, moving with a very high velocity. The chamber will react or kick when the charge is fired, exactly as a shotgun kicks when firing a charge of ordinary shot.

An objection which Dr. Goddard has answered is that if a rocket were to be projected to an infinite distance, the apparatus would engender great friction while passing through the air, and if it moved with a speed as great as one and one-half miles per second outside the atmosphere, it would catch fire by friction or fly to pieces, because of the excessive speed.

He declares that the initial speed does not exceed two thousand feet per second over the first twenty-five miles, beyond which the density of the atmosphere is negligible. He says the idea of a body flying to pieces is unfounded, and points out there is good evidence to believe that the earth, together with the entire remaining solar system is traveling through space at a speed of fifteen miles per second, but this does not cause any one noticeable inconvenience.

To Steer Projectile by Silenium Cells

Concerning the possibilty of hitting the moon with a rocket, Dr. Goddard says it has been argued, granting that the projection to such a distance can be made, there will be so many disturbing influences affecting its course that it will be very unlikely to continue in the proper direction to make a hit.

He declares the photo-sensitive cell will be the means of automatically guiding the apparatus toward or near a luminous object, in this case the crescent of the moon. The steering, he says, must be accomplished by jets, which work laterally just as the main jet works perpendicularly.

Dr. Goddard is of average size but inclined to slimness. A pair of penetrating eyes accentuates the intelligence of his face and forehead. He is only forty years old. His scientific researches and his perseverance in the perfection of a rocket to explore extreme altitudes has not diminished in the slightest degree his humor, or his appreciation of the companionship of those whose minds do not deal with scientific problems. No professor at Clark University is more loved and respected than Dr. Goddard, and the students have frequently demonstrated their deep affection for the man.

Illustrative of his knowledge of the human interest element in his rocket experiment is the following incident he told students of the Worcester Polytechnic Institute, for which institution he has a deep affection born of his student days, and because many of his most important experiments were performed there:

"It is probable that the points which the average person would desire most to have discussed are shooting the moon and allied problems.

"After the announcement of my theory by the Smithsonian Institution the popular impression was so much in evidence that a moon-shooting device was under way, and that all the public needed to do was to sit still and watch it, that I believed it necessary to correct the impression. But I wanted at the same time to hint that further experiments would lead to even more interesting results.

"My statement was taken more conservatively than I had anticipated, but in the light of subsequent events I was very glad that this was so. In the first place, I am not a sensationalist, even though I realize I am dealing with a sensational subject. I almost wish I were, for I could certainly start something.

"To discuss details before one has checked up matters completely by experiment is unwise, for to do so merely precipitates a flood of useless argument, discussion and comment, to which reply must be made. The ideal method, when possible, is to solve a problem completely, as was done with the tests of the jet in vacuum, and then to state results. Thus the discussion dies before it starts.

Has Unalterable Faith in Principles and Theory

"But while I prefer to avoid sensations, I will not back down when I am convinced of the soundness of a physical principle—and not only is the moon-shooting proposition based upon sound physical principles, but there are other principles just as fundamental which are bound not only to lead to certain refinements, but also to results of still greater interest."

And while the discussions continue, Dr Goddard works unceasingly on the model, which he is confident will soon be brought to such perfection as to permit work to begin on the rocket which he believes will justify his beliefs and theories.

The people of Dr. Goddard's native city (he was born in Worcester on October 5, 1882) have great respect for his scientific ability. They know his struggles and hardships in bringing the model to the advanced stage it has already reached.

They have likened his experiences to those of other inventors who have made notable contributions to the world's progress; they know of the success of experiments he has carried on in the past, and they are confident that the financial assistance from Clark University will result within the next two years in an announcement that will startle the scientific world and bring even greater honor and fame to Prof. Goddard and the institution with which he is connected.

Supporters of Dr. Goddard's project believe that the first real test of the equipment will not long be delayed, with a small rocket mounting about two miles in the air, to be followed later by the sending of a projectile to the moon. And then the supreme achievement—the sending of a human being to that planet.

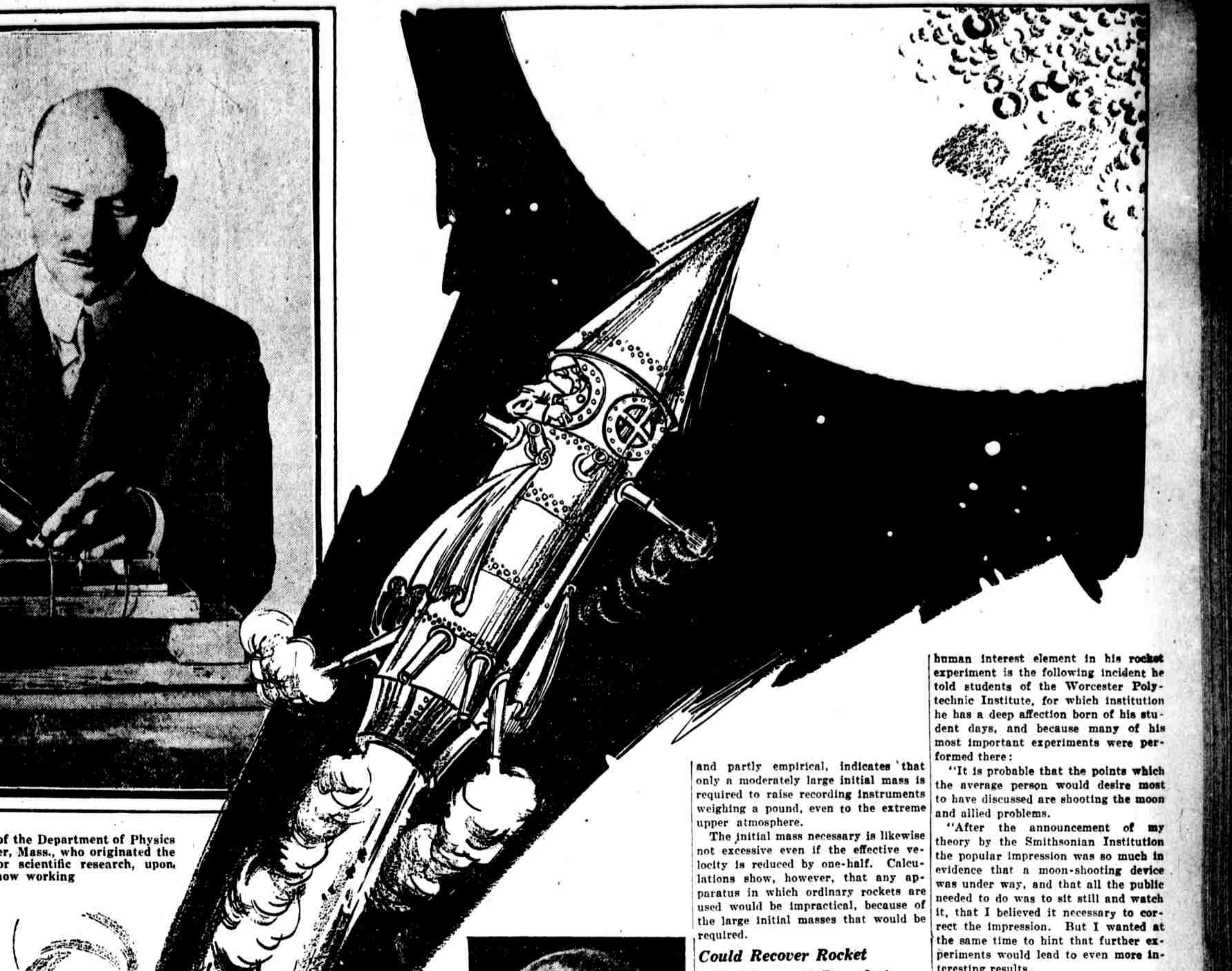
Even before two years have elapsed his associates believe the long-awaited announcement will come. The close acquaintances of Dr. Goddard are fully aware of his modesty and his dislike for making statements before there is just reason, but they believe the faith of the trustees of Clark University will be rewarded with results which the professor's modesty may now forbid announcing.

Dr. Goddard's family is widely known in Worcester for its philanthropy. When the professor was a child the family moved temporarily to Boston and he graduated from the Hugh O'Brien Grammar School and went for a year to the English High School. Then the home was moved again to Worcester.

He was graduated from the South High School in Worcester with the class of 1904 as an honor man, and then attended Worcester Polytechnic Institute, from which he was also graduated with high honors.

Then came degrees from Clark University. He was made honorary Fellow in Physics. The following year he went to Princeton University as a research instructor in the same subject, but was speedily recalled to Clark, first as instructor, then assistant professor, then associate professor and later head of the department.

Dr. Robert H. Goddard, head of the Department of Physics at Clark University, Worcester, Mass., who originated the idea of a "moon rocket" for scientific research, upon which he is now working



Miss Esther Christine Kisk, Bates College girl and fiancee of Dr. Goddard, whom she is expected to assist in his experiments by her profound knowledge of physics and meteorology