ASTRONAUTICS

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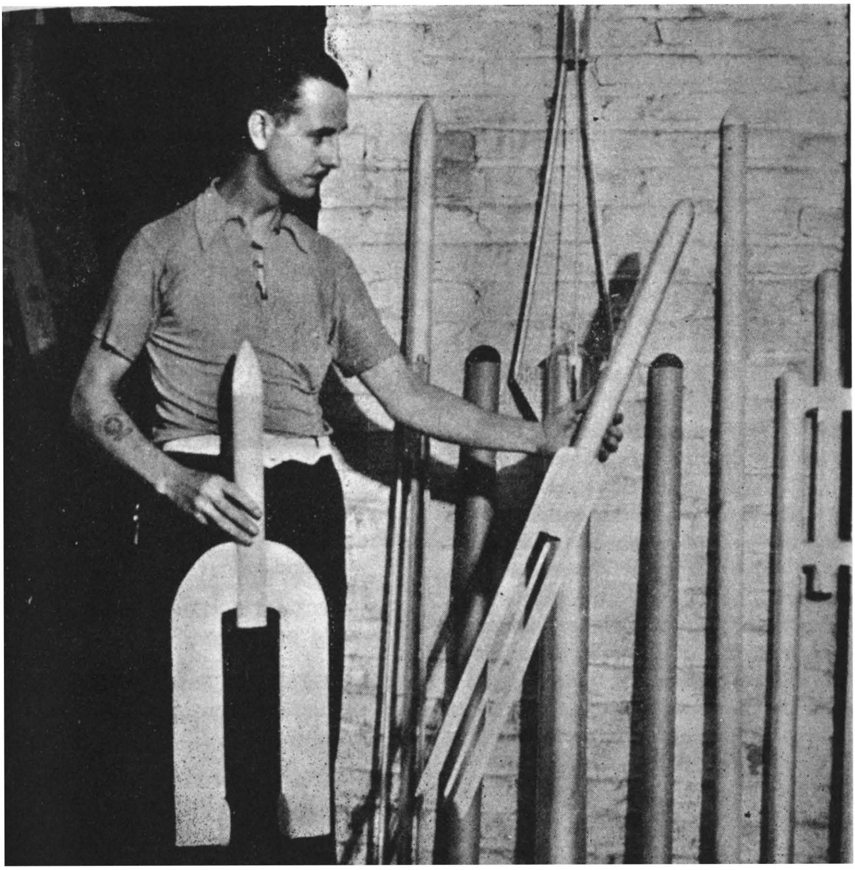

Africano photo

Rocket Tests at Pawling — Beginning a new series of flight stability studies. **Specifications For A Rocket**—Outlining a "practical" rocket. **The Rocketor's Workshop**—Shop talk for practical men. **Rocket Records**

ASTRONAUTICS Journal of the American Rocket Society

Devoted to the scientific and engineering development of the rocket and its application to problems of research and technology. Published quarterly by the American Rocket Society, 420 Lexington Avenue, New York City. Subscriptions with associate membership, $3 per year. **Editor, G. Edward Pendray.**

Notes and News

AFTER THE EXPERIMENT comes the post-mortem, the discussion, the better and bigger plans for next season, the clash and intermingling of fertile minds. To foster such activities the American Rocket Society was formed; it promotes them partly through its publications, and partly through its meetings.

Those yet to come are as follows; write them in your date-book now:

November 17	March 18
December 17	April 15
January 21	May 20
February 18	

In general, meetings are held the third Friday of each month, at 8 p. m. at the Engineering Societies Building, 33 West 39th Street, New York City, Room 603. **An exception to this will be the November 17 meeting,** which will be held on Wednesday, in Roosevelt Hall at the American Museum of Natural History, Central Park West and 77th Street. This meeting will be held jointly with the Amateur Astronomers Association. Mr. Alfred Africano, President of the American Rocket Society, will be the principal speaker.

President Africano opened the first meeting of the year, on September 17, with a talk on the results of the September 12 flight tests at Pawling, N. Y. (see page 9). He showed fifty feet of 8 mm. motion picture film of the flights.

The second meeting was held at the Engineering Societies Building on October 15. Mr. James Wyld, active member of the Society, provided an interesting talk on the properties and handling of liquid oxygen, with special attention to production and use.

(Continued on Page 16)

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A PRACTICAL WEATHER-ROCKET MUST

1. Reach an altitude of at least three miles
2. Carry a payload of approximately two pounds
3. Be simple and safe in operation; capable of being racked, fueled and fired by one, or not more than two men
4. Consume not more than $20 in fuel and repairs at each shot
5. Be capable of vertical shot with not more than 10 degrees deviation
6. Be capable of announcing its whereabouts automatically and continually, at least while on ground at end of shot
7. Descend with an impact velocity on coming to earth of not more than 750 to 1000 feet a minute
8. Be so little damaged upon landing that rocket and instruments could be successfully refired upon refueling
9. Land within half a mile of the launching rack.

SPECIFICATIONS FOR A ROCKET

What Should A Practical Rocket Be Able To Do?

ROCKET men for years have been dreaming of the day when rockets would become "practical" — that is, useful instruments for upper air exploration, transport of mail or express, or able otherwise to serve some purpose beside the experimental.

How near we now stand to that moment depends upon the definition of a "practical" rocket.

The replacement of airplanes in upper-air meteorological investigation is the least difficult task a practical rocket could perform. At present, the Weather Bureau, in cooperation with Army, Navy and private flyers, sends up airplanes daily from various points, carrying instruments to measure the temperature, pressure and relative humidity of the upper air. This information is used in the new technique of "air mass analysis".

For such work the airplane presents certain unsatisfactory aspects. The cost of ascents is sufficiently great to discourage much use of them. They are more or less dependent on the weather, and the exploration of the upper atmosphere is difficult if not impossible under certain conditions, such as severe thunderstorms, clouds in which icing occurs on aircraft, etc. The time required for plane flights precludes frequent ascents for data.

Airplanes are supplemented by sounding balloons; but these, too, have many drawbacks. They do not rise vertically except in perfectly calm weather; they drift miles. Frequently the instruments they carry are not found. This means complete loss when the instruments are self-recording. Since the balloon rises until it bursts, a new balloon is required for each ascent.

Rocket experimenters have been saying that the rocket could overcome all these difficulties. Instrument-bearing rockets could be sent up hourly from hundreds or thousands of points; could rise vertically to the required distance, penetrate any weather formation, complete a flight in a few minutes, and land safely with self-recording instruments intact.

I recently interviewed several authorities in this field with a view to jotting down some weather - rocket specifications which would satisfy meteorologists. They were practically unanimous in their opinion of what a weather-rocket should be able to do.

Specifications

The basic requirements are stated in a box at the beginning of this article.

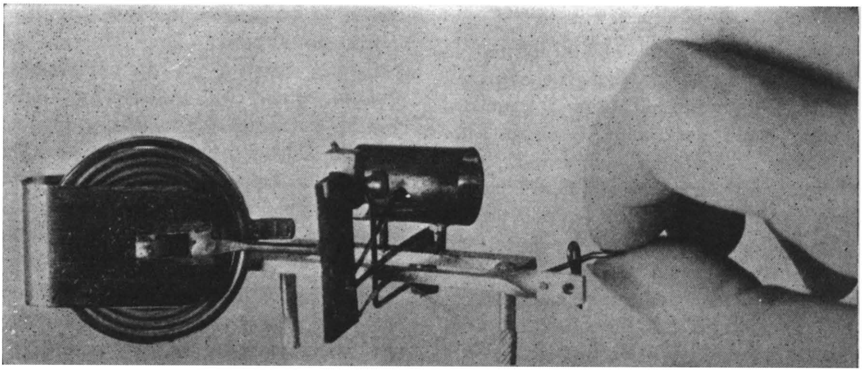
Most of these specifications explain themselves. Three miles is the minimum altitude now reached by airplanes for meteorological work. Radio-meteorographs used by the Weather Bureau on sounding balloons, making a continuous report back to earth by means of radio signals, weigh about two pounds.

The question of cost of each shot is important, for if rockets are to replace airplanes and sounding balloons, they will not only have to perform the work better, but at an outlay near or under that of present equipment, shot for shot. The cost of an average plane flight for meterological data is estimated at $20 to $25. The average sounding balloon, used only once, costs approximately $2.25. In order for the rocket to compete, the fuel cost of each shot and also the depreciation on the rocket must be counted. For example, if the rocket is capable of only twenty shots before it wears out or requires extensive repair, 5 per cent of the total cost of the rocket must be added to the fuel and minor repair costs arising from each shot.

The rocket must go nearly straight up to reach its objective in the least possible time, with the smallest expenditure of fuel. The setting of permissible deviation at 10 degrees from the course is somewhat arbitrary, but is deemed sufficient to permit the "hunting" that might attend the use of gyro or other stabilizing devices.

Even in the best light, a rocket will probably not be visible at three miles; consequently some simple, sure and easy method of keeping track of it, particularly until discovery on the ground, must be provided. The simplest, probably, would be the emission of a single radio tone, tuned to suitable ground instruments.

Much help in the preparation of these specifications was obtained



U. S. Weather Bureau photo

Jaumotte micro-meteorograph: weighs 45 grams complete in case; gives record of temperature and relative humidity against pressure on small smoked glass plate slightly larger than a postage stamp.

from the Weather Bureau; particularly from Dr. C. C. Clark, Acting Chief of the Bureau, who sent detailed information in response to a questionnaire referred to him by Dr. James H. Kimball, Chief of the New York Weather Bureau and member of the American Rocket Society's Advisory Board.

Dr. Clark's replies to specific queries were as follows:

"1. The minimum altitude required of a rocket for use in meterological work depends upon the use to which the data obtained thereby are to be put. For example, if the rockets are intended to replace airplane weather observations, the minimum altitude required would be set at five kilometers (about 16,520 feet). If the rockets are intended to reach the stratosphere in these latitudes, the minimum altitude required would be usually from about twelve to eighteen kilometers. If they are intended to replace sounding balloons and to reach altitudes beyond the base of the stratosphere, a suitable minimum might be set at twenty-five kilometers.

Pay-load Requirements

"2. The 'pay-load' which a meteorological sounding rocket would need to carry depends upon the requirements made of the records obtained from the instrument associated with the rocket. For example, if it were desired that the instrument record pressure, temperature and humidity as functions of time, a clock would have to be included in the mechanism and this would add an appreciable weight. If no clock were required, the mechanism could be much simplified and this would save some weight. As examples of the weight of self-recording instruments which meteorologists employ with sounding balloons, it may be stated that one instrument with a clock, used by the Weather Bureau, weighs about two hundred grams (about 7 ounces avoirdupois) while another instrument without a clock weighs about forty-five grams, but presumably, for use in connection with rocket investigations, an instrument of perhaps one hundred or more grams would be more desirable than the lighter ones just specified. It is not practicable to give an accurate upper limit for the weight of the instrument to be carried in rockets, since various questions of design are involved which cannot be foreseen until actual experience is gained by the development and experimental use of the proposed instrument. It is probable that more rugged parts would be necessary in connection with rockets than are employed in the instruments carried aloft on sounding balloons at the present time. - - -

Present Rocket Records

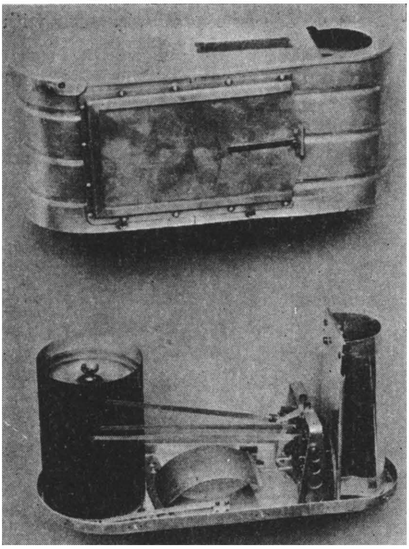
Altitude: 7,500 feet (Goddard, May 31, 1935) Six-mile shot claimed by Reinhold Tiling is now generally discredited

Distance: 11,000 feet (Goddard, early in 1935) Longer shots have been claimed for dry-fuel rockets, but no data are available

Speed: 700 miles an hour (Shesta, September 9, 1934) Eqalled later by Goddard, early in 1935

Payload: Unknown. Fritz Schmiedl is reported to have sent "several pounds" of mail from Schockel to Radegund, Austria, in 1935. Goddard sent up a small camera and barometer, weight unreported, at Auburn, Mass., July 17, 1929.

Motor Efficiency: Around 10 per cent (Various experimenters)



U. S. Weather Bureau photo

Sounding balloon meteorograph (Fergusson pattern); weighs 200 grams (0.44 pound); gives continuous record of barometer pressure, temperature and relative humidity. Instrument proper is shown below; upper item is aluminum protective cover.

"3. Radiometeorographs, which are instruments of the type used by the Weather Bureau on sounding balloons making a continuous report back to earth by means of radio signals, now weigh from one to two pounds. In this connection, the considerations regarding actual weight in an instrument especially designed for use on rockets, are essentially the same as indicated in question 2 above. It appears probable that the delicate parts of the radio transmitter employed in such an instrument would require special shock absorbing mountings, which would add appreciably to the weight of the instrument if adapted to use on rockets.

"4. It appears probable that meteorological instruments for application to rockets can be designed to withstand an acceleration as great as three times that of gravity.

"5. The sounding balloons carrying meterographs released by the Weather Bureau all have parachutes which retard the fall of instruments after the balloons burst. From observations at hand, it appears that an impact velocity on coming to earth of from 750 to 1,000 feet per minute would be satisfactory. Impact velocities greater than the larger figure just given would probably lead to an appreciable damage of the apparatus and consequently, it is probable that a parachute would be necessary if the instrument must be salvaged."

If we are in substantial agreement that the specifications outlined in this survey are indeed the minimum ones for a practical meteorological rocket, the question remains: could such a rocket be made?

Where We Stand

Various considerations lead to the conclusion that it could. Experimental motors recently used, though by no means perfect, are nevertheless efficient enough to give an altitude in excess of three miles. The two-pound pay-load does not seem an insuperable obstacle. Providing the rocket with a means of signalling its position would require little more than the invention of a gadget, of which several types have already been suggested by members of the Society.

Points 7, 8 and 9 are really all part of the same problem. It must be confessed that landing devices are still susceptible of considerable improvement. A carefully planned series of tests with dry fuel rockets ought, however, to yield a satisfactory method of releasing the parachute at the right moment, or lead to the development of rotating wings which could land the rocket and its fragile cargo surely and lightly, and within the required half mile of the point of ascent.

The question of flight cost is at present a totally unknown factor. Liquid oxygen, assuming the rocket were fueled with liquids, is still expensive, but if demand were to develop, it could surely be brought well below the present general price of $1.50 a quart. It would be important to provide a motor that does not burn out, or at least one in which the nozzle, or its liner, could be quickly, simply and cheaply replaced after each shot. There are so few other working parts on the rocket, exclusive of the guiding mechanism, that a well-constructed one should outlast many flights, provided the landing apparatus worked according to specifications.

Chief doubt about our present ability to produce a suitable weather rocket revolves, finally, around three quite dissimilar points: (a) the rocket must make a nearly vertical flight, (b) it must be safe and simple to operate, and (c) suitable instruments must be devised to gather weather data under the peculiar conditions of rocket flight.

Flight Control

As to the first, many are convinced that we must provide a steering mechanism, which inevitably will add to the weight and complication of the rocket. Some believe that the question of vertical flight can be managed by proper aerodynamic design alone, by rapid accelleration or other such means. The sensible course, obviously, would be to take full advantage of aerodynamics, acceleration and inherent stability; yet make doubly sure of vertical flight with auxiliary apparatus.

The question of safety and simplicity; if indeed this be only one question, and not two; has yet to be tackled adequately. It ought to be possible to assure the operator that the fuels could not become accidentally mixed under any condition; that the motor or tanks simply could not explode, any more than they do in a modern automobile, and that the rocket will go straight up when launched, not run amok and threaten the operator and bystanders.

Rocket Must Be Simple

As to simplicity: the rocket ought to be so easily fueled, through such accessible ports, that no Houdini is needed for the job. No waiting period should be necessary after fueling, but if a wait should occur, adequate safety valves should relieve all dangerous pressure. The launching rack ought to be so devised that one man could place the rocket in firing position without help. The firing should be accomplished, from fusee to valve release, with the pressing of a single key, the lighting of a single fuse, or the pulling of a single, easily-operated cord.

The problem of developing rocket-borne weather instruments has been so inadequately studied that little can yet be said on this point. Dr. Clark says:

"It is desired to point out that when the rocket passes through the air at high speed, the meterological measuring elements do not respond quickly enough and, therefore, do not record accurately the condition of the air being traversed.

"This involves several problems, the solution of which may require considerable investigation".

—G. E. P.

Letters to the Editor

A CALL FOR HELP: Wendell Zimmerman, of the Department of Physics, University of California, wants experimenters to aid him in testing out some new fuels. He writes:

Quite a while ago I attempted to discover what combination of substances produce the most powerful explosive, of all combinations practical and theoretically producible, using as a criterion an "index number" directly proportional to the amount of energy liberated and the volume increase, and inversely proportional to the specific volumes of the constituents.

I tested a very large number of known and possible explosives by this criterion (which agrees with experimental data) . . . Out of all this came several possible new fuels for rockets.

I am writing to see if any rocket experimenters would be interested enough to work out experimental details of some of these. There is, for example, my "M-1", which, for producing a large quantity of heat in a small space, is certainly a more powerful fuel than any rocket fuel used today. "M-1" is simply very fine dry Mg powder plus liquid oxygen. The burning of "M-1" is much like a dust explosion, but more vigorous.

The practical use of Mg plus oxygen would involve some carrier for the powder —such as benzene. A slush of Mg and benzene fed through a nozzle under pressure and mixed with oxygen might work . . . I foresee some real difficulties in getting controllable power from the stuff, maximum power and still have the combustion chamber stand up . . ."

Adventurous experimenters can get in touch with Mr. Zimmerman at Le Conte Hall, University of California, Berkeley.

SAFETY FIRST: To the precautions suggested by Morris Berman, of the New York Department of Buildings and a member of the Society, the Editor wishes to add a word of commendation. Writes Mr. Berman:

When the first rocket was successfully launched from the Staten Island shore in 1933, practically every member of the Society's Experimental Committee pitched in to dig trenches that would presumably protect the experimenters against the erratic ways of a rocket in flight.

But even the finest trench is no protection from missiles flying overhead.

Experimenters must emphatically realize the problem of safety confronting them in a field that has already claimed the lives of a number of scientists.

Mr. James H. Wyld has suggested a dugout shielded by wooden beams covered with sand ballast. It is believed by the writer that this scheme is practical, and should be tried. A dugout roofed by one or more layers of metal mesh somewhat lighter than the type used for blasting is another method which would lend itself to transportation. Crevices in a pitched roof might serve as eyeholes, or periscopes may be provided.

At any rate, some means of protecting the lives of experimenters should be found.

A good rule for rocket experimenters to follow is this: always assume that it will explode.

EXPERIMENTAL FUNDS

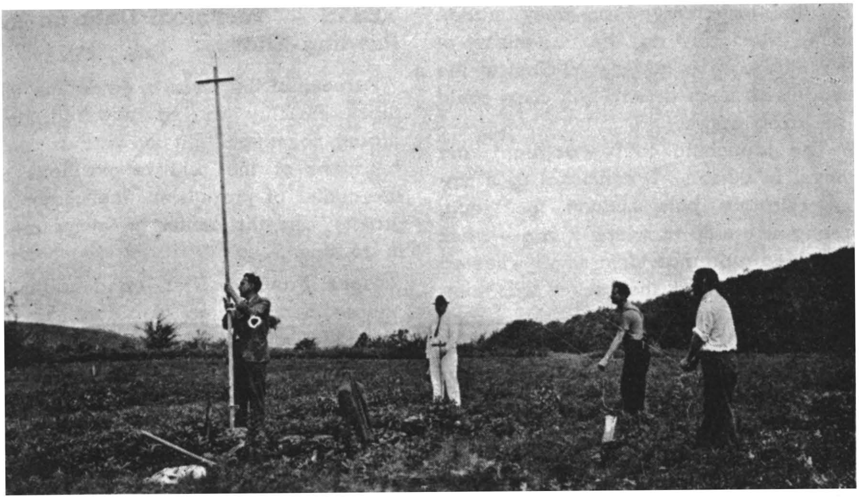
Many experimenters have written to inquire about the policy of the Society with regard to experimental funds.

While the Society would like to help everyone, it has available only a limited amount of money, and this must be devoted to aiding those experiments likely to contribute most to the work of all experimenters.

Members wishing financial aid from the Society for experimental work must submit to the Experimental Committee a complete plan and estimate of costs. If the plan is approved by the Committee it will be so certified by the Board of Directors, who will in turn make a study of the matter. The Board may in its discretion allot such funds as it may deem advisable.

The amount of money for this important function of the Society is unfortunately small. The Society gets its funds solely from membership dues, from contributions, and from the sale of books and materials.

Any person interested in furthering the development of rockets may make contributions to the Experimental Fund. Such contributions can be earmarked to be used for a specific purpose, or may be given for aiding the general work of the Society.



Gregory photo

Raising the launching rack; a view of the field at Pawling, N. Y., where flight stabilization tests were made.

ROCKET TESTS AT PAWLING

Dry Fuel Shots Raise New Questions of Stability

SOMETIMES it takes much,discussed problems a long time to reach the experiment stage. The question of relative stability in flight of rockets powered from the nose, center-of-gravity or tail, for example, has been argued at almost every meeting of experimenters. Last month (September 12) the first series of comprehensive tests of these flight questions began at Pawling, N. Y., under the direction of John Shesta, the Society's Experimental Committee chairman, and H. F. Pierce, a member of the Committee.

The results were by no means conclusive, but the experimenters expect to push on with their tests this autumn and next spring, until definite data is provided for the guidance of rocket designers.

Seven different models of rockets were constructed for the first series of tests, each to be powered by dry-fuel cartridges. The designs proposed by Mr. Pierce, Mr. Africano, Mr. Goodman, Mr. Wyld and Mr. Shesta for altitude work were imitated in the models, especially as to outer design and point of application of the thrust. In addition, a model "two-step" rocket and a design similar to that of the German "Repulsors" were used.

The field at Pawling was made available through the generosity of Philip M. Smith, writer for the Scientific American and other magazines. The location, though somewhat distant from New York, is ideal for rocket experiment.

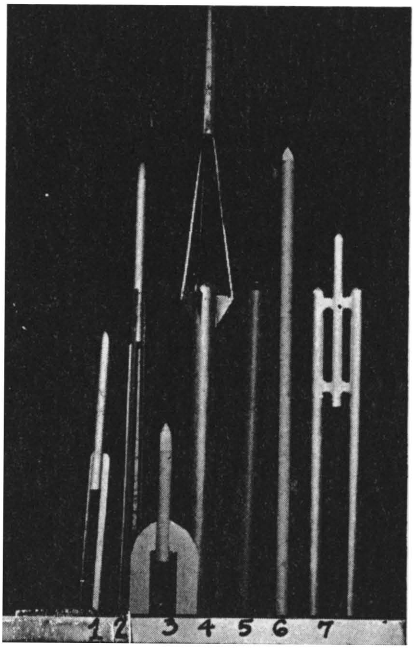
The field itself is a flat about fifteen acres in extent, surrounded by woods. There are no nearby neighbors; the location is isolated and no curiosity-seekers appeared to hinder the tests.

Transporting the materials necessary for the tests proved an easy matte. due principally to the ingenuity ot Mr. Pierce, who had made most of the models in such a way that they could be taken apart.

The launching rack was light and novel in design. It consisted of a single straight pole sixteen feet long, along one side of which a brass track provided guidance for a small wheeled car. To this car the rocket was fastened by string. At the top of the rack a small blade cut the string, releasing the rocket as the car reached the end of its run.

The pole and its track were transported readily in an automobile. At the field, it was held upright by four guy wires. A flat rock served as foundation. The device worked admirably,

—G. E. P.



Africano photo

Fig. 1. Seven test models, numbered as in table of results, Page 11.

REPORT ON MODEL FLIGHT TESTS — Technical Data on the Pawling Shots.

Purpose of the tests: to determine the flight stability during powered and during coasting flight for various combinations of the relative positions of the center of propulsion, the center of gravity, and the center of lateral area in rockets.

Place: Pawling, N. Y. on a half-mile square cleared area of a farm kindly placed at our disposal by Mr. Philip M. Smith.

Time: Sunday afternoon, September 12, 1937.

Present at the Tests: Pierce, Pendray, Africano, Manning, Gregory, Berman, White, Goodman, Hecht.

Description of Test Procedure: The models shown in the photograph, Fig. 1, were constructed of balsa wood and cardboard tubing by H. F. Pierce to simulate various rocket designs proposed by members of the society. The principal feature to be tested was the effect of the position of the center of propulsion on stability, that is, whether a "nose-driven" rocket performed better than a "tail-driven" rocket or not.

The cartridges used in the type of gunpowder skyrocket designated commercially as the "4 lb. rocket" were utilized for the propulsion of these models. These cartridges cost about half a dollar each and are very convenient for this purpose. The 12 inch long cardboard encased cartridge was pushed into a hollow tube and fastened into position with a few tacks. The rocket model was then attached to a small "truck" by slender strings which would be cut with a sharp knife blade fixed to the top of the launching rack. When everything was ready the fuse was ignited, (electrically in some cases, manually in others), the rocket and the carrying truck slid up the monorail of the launching rack, and

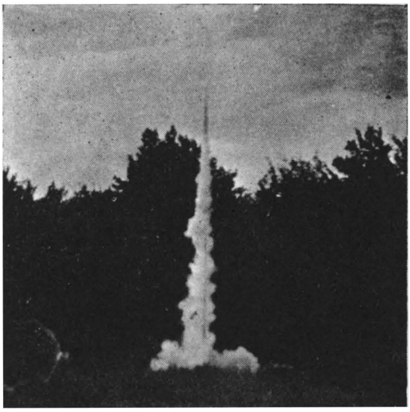
RESULTS OF MODEL FLIGHT TESTS

MODELS	1	2	3	4	5	6	7
After prototype design of	Pierce	"2-step"	Africano	Goodman	Wyld	Shesta	"Repulsor"
1 Distance from nose of rocket to:							
a. Center of propulsion	15 in.	28 in.	8 in.	14 in.	39 in.	59 in.	14 in.
b. Center of gravity	19 in.	28 in.	15 in.	39 in.	33 in.	43 in.	24 in.
c. Center of area	22 in.	28 in.	19 in.	59 in.	25 in.	35 in.	22 in.
d. Bottom of rocket	44 in.	68 in.	33 in.	94 in.	49 in.	68 in.	48 in.
2 Weight of rocket at start	1.19 lb.	2.27 lb.	1.19 lb.	2.16 lb.	1.85 lb.	1.72 lb.	2.28 lb.
3 Est. max altitude of flight	1500 ft.	600 ft.	1500 ft.	400 ft.	200 ft.	300 ft.	100 ft.
4 Time of ascent	7 secs.	5 secs.	5 secs.	4 secs.	4 secs.	4 secs.	3 secs.
5 Time of descent	3 secs.	4 secs.	3 secs.	4 secs.	4 secs.	3 secs.	2 secs.

Motion pictures were taken of the the strings were cut, freeing the rocket. flights for subsequent study of the relative stability of the various designs. Two of the models which gave the highest and most stable flight are shown on the cover (held by Mr. Pierce). It is my opinion that these successful flights were due to two fundamental features of their design, namely: First, these models were the lightest of the group, making the impulse of the cartridge more effective by producting a higher acceleration and velocity, and, Second, the center of propulsion in each case was ahead of both the center of gravity and the center of lateral area. More tests will be required with a series of similar models to check these conclusions. These will be undertaken in the near future The measured data and the results of the tests are shown in summarized form in the table.

The weight of the "4 lb. rocket" cartridge loaded was 12 oz. Each cartridge contained 6 oz. of gunpowder. The average reaction was about 20 pounds for one second. The times of ascent and descent were obtained by timing the motion pictures.

—Alfred Africano.



Hecht photo
Start of the shot of rocket No. 3.

THE ROCKETOR'S LIBRARY

FOR THE CONVENIENCE of members, the Society's library now has available at cost the following items of interest to rocket experimenter and student:

Rockets Through Space, by P. E. Cleator (227 pages); Popular book on rockets, their history, how they work, what they promise; price to members, $2.00; to non-members, $2.50.

Liquid Propellant Rocket Development, by Robert H. Goddard (10 pages & illustrations); Dr. Goddard's recent report of his work; price, 25 cents.

The Design of a Stratosphere Rocket, by Alfred Africano; reprint, with drawings, of Mr. Africano's Rep-Hirsch Prize paper; price, 10 cents.

Supplement to L'Astronautique, by Robert Esnault-Pelterie (93 pages, ap pendix & tables); the famous French engineer amplifies his **L'Astronautique,** Few copies on hand autographed; price, members $2, non-members, $3.

Miscellaneous Drawings, useful in suggesting experimental designs; price, per set of 6, 50 cents; each, 10 cents. Subjects: (1) Rocket No. 2/1932, (2) Cross section of motor of Rocket No. 2/1932, (3) Cross section of motor used in 1935 proving stand tests, (4) Schematic drawing of proving stand used in 1935 tests, (5) Results of motor tests, Series 3, No. 1, (6) Results of motor tests, Series 3, No. 2.

All the above items are sent postpaid; cash must accompany order.

The Society's librarian will obtain available books, pamphlets or reports on rockets and allied subjects for members, on a cost basis. Address requests to the Secretary, 420 Lexington Avenue, New York City.

THE ROCKETOR'S WORKSHOP

A Department Devoted to Shop-talk, Ideas, Devices

Practical experimenters are invited to contribute to this new department. Articles should be kept brief, to the point, non-theoretical. They should be accompanied by suitable drawing or photograph.—Ed.

HANDLING LIQUID OXYGEN— It Requires Forethought, Special Equipment

Those who have not personally experienced the handling of liquid oxygen are not likely to foresee the difficulties that will be encountered, for under field conditions, without the proper equipment, it can sometimes be quite annoying and very uncomfortable. But if the experimenter provides himself with the simple pieces of apparatus described here, it will become an easy operation to charge a rocket tank with liquid oxygen.

It may be well before proceeding with description of the apparatus to mention a few "don'ts" that should be remembered. Don't attempt to tip a Dewar flask of 20 liters or larger, for this will result in damage to the flask. Don't try to transfer liquid oxygen from the flask to the rocket tank with a thermos bottle, for the extreme temperature will shatter the lining of the thermos. Don't forget to remove your wrist watch and rings. If gloves are worn be sure that they are of a size that can be quickly removed. Liquid oxygen held in close contact with the skin by gloves or rings will cause bad burns.

Dewar Flask and Syphon

The ordinary commercial Dewar flask consists of an outer case and two spherical containers, one within the other. The center chamber is suspended by a long slender neck, being secured near the top to the outer case. The space between the concentric spheres has a fairly high vacuum while the outer space is at atmospheric pressure. The two spheres are usually made of spun copper.

Noting the suspension of the centre chamber one can readily understand why the larger flasks should not be tipped. The liquid should be dispensed with the use of a syphon such as the one illustrated in Fig. 1, using a small hand pump to supply the necessary pressure. This can be constructed very simply by soldering onto a length of half-inch copper tubing a sleeve of the same diameter as the neck opening, providing an inlet for

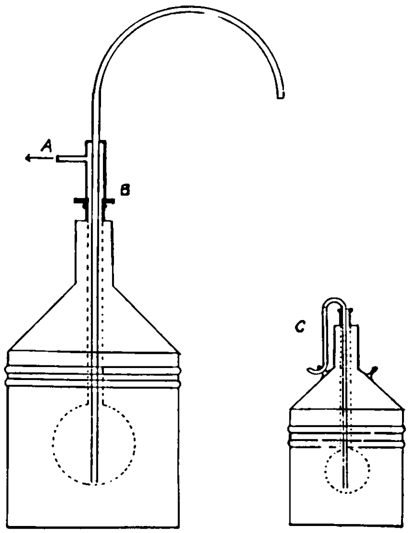
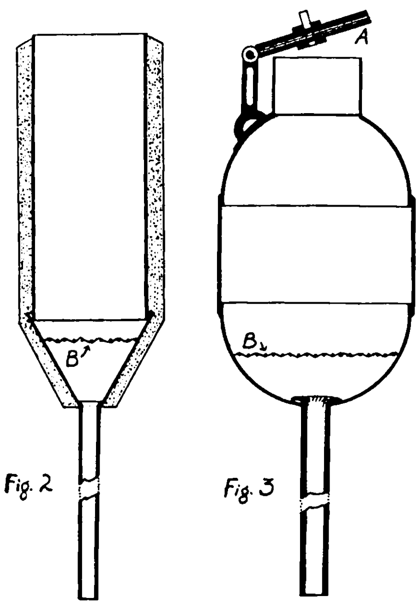


Fig. 1. Methods of syphoning liquid oxygen. (A) lead to air supply; (B) rubber gasket; (C) air inlet for small Dewar flask.



Figs. 2 and 3. Two types of oxygen funnels. (A) hinged rubber cover; (B) fine copper wire mesh.

air pressure. A rubber gasket is used as a seal when held in place over the opening. The tubing then being bent to a goose neck shape.

Smaller flasks can be tipped without fear of damage but due to the long slender opening the inner chamber will soon develop a vacuum preventing rapid flow. This can be overcome by inserting a small tube into the neck to the bottom of the flask, bending it down along the outside and fastening it to one of the handles. This will form a sufficient vent to keep the liquid free-flowing into a funnel of the type shown in Fig. 2.

Oxygen Funnels

The cone and cylinder (Fig. 2) are light gauge sheet copper with soldering seams. Near the junction of cone and cylinder there should be placed a disc of fine copper wire mesh to prevent condensation ice particles from entering the tank. The tubing at the bottom may be made from a length of copper tubing flared at one end and soldered to the cone with the flare on the inside. The size of this tubing should be not less than 3/8" inside diamter and not less than 12" in length. The outer walls of the cone and cylinder are covered with 1/2" of asbestos or spun glass held in place with canvass or other suitable material.

With a funnel of this simple design, experiments requiring one to four liters can be handled with a minimum loss of the liquid.

When experiments require larger quantities the funnel illustrated in Fig. 3 will be found to be more efficient. The body of the funnel, formed from two hemispheres, makes for reducing surface area. The addition of a rubber lid sealing against knife edges and using air pressure to force the li- liquid from the funnel, makes insulation of the outer surface unnecessary since the liquid will remain for only short periods of time.

—**H. F. Pierce**

AN ALTITUDE INSTRUMENT — It Measures Height, Temperature

Seventeen years ago, in the June, 1920, issue of Monthly Weather Review, Dr. S. P. Fergusson, now research associate of the Blue Hill Observatory at Hyde Park, Mass., published a design for a meterological instrument suitable for use in a rocket. The instrument, intended for use in high altitude shots, was designed to measure altitude and temperature, these data appearing as lines engraved on a metal plate.

A part of Dr. Fergusson's article is reproduced here, for the interest of rocket experimenters engaged in the development of instruments:

"The Goddard exploring rocket has been suggested as a means for obtaining meteorological data of heights greatly exceeding those accessible by balloons. Propelled by charges of explosives fired at frequent intervals, its velocity is very high, and the ascent to and the descent from the height of 100 kilometers requires only about 10 minutes.

"Under such circumstances the best methods of measurement now available are not likely to yied data of more than approximate value at first . . . The development of recording apparatus adapted to these conditions is well worth while, for there are projects . . . in which a simple instrument without clock will be useful.

"The conditions under which such an instrument must function are very trying. The shock of the frequent explosions (Some early rocket designs contemplated repeated explosions instead of continuous firing—Ed.) and the strain caused by the high velocity are very likely to destroy an instrument with delicate mobiles, consequently time-clocks and mechanisms ordinarily employed in measuring temperature and pressure need not be considered at present. The range of movement required and freedom from vibration must be secured by the use of strong elements well supported.

"The apparatus described herein is suggested as a basis for further experimental study. It has not been constructed, but the principal of Mr. Dines's successful engraving instrument has been followed, and essential parts already have been used to a limited extent in instruments produced by Richard and other manufacturers.

Referring to figures 14, 15 and 16, the pressure-element (B) is composed of two helical Bourdon tubes secured in a light frame (A), so that their free ends move in opposite directions when there is a change of pressure. A single tube could be used, but the double-tube element is preferred for the reason that thereby may be secured greater compactness and rigidity.

"One tube carries the record-plate (C), and the other the temperature-element. The latter consists of two or more strips of very thin bronze (T,T), connected by spring hinges and mounted in a light invar frame (D), in

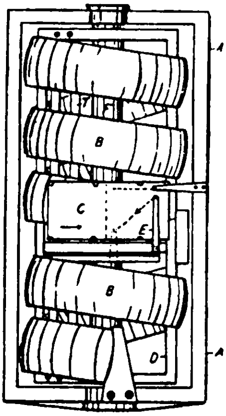


FIG. 14

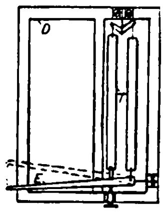


FIG. 15

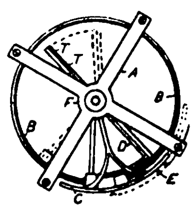


FIG 16

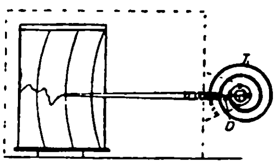


FIG 17

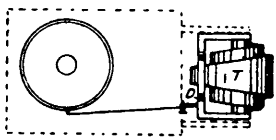


FIG. 18

Dr. Fergusson's weather rocket instrument.

such a manner than changes of length corresponding to changes of temperature are engraved upon the record plate by the style (E). The strips (T, T) are insulated from their support.

The inner ends or edges of the plate-carrier (C), and the frame (D), are secured, under tension, to spring hinges in the center of the tube (F), and therefore restrict the motions of the pressure tubes to an arc whose axis is the center of the tube (F). By this means longitudinal movements of the pressure tubes are prevented and there are no pivots with the variable friction inevitable when Bourdon tubes of this kind are mounted in the usual way.

"Another application of this device, in the construction of a simple thermograph without pivots, is shown in Figures 17 and 18. Here, circular motion about the center of the coiled element (T), is obtained by securing its free end to the frame (D). Adjustment for range is accomplished by changing the position of (D) as shown by the dotted lines."

News and Notes

(Continued from Page 2)

BACK NUMBERS of **Astronautics** are valuable; especially scarce are all numbers earlier than No. 19 (May 1932). Members who have these early numbers and wish to part with them for $1 each or less should notify the Society. State the numbers you have and the price. Occasional requests come from collectors for complete sets, and only with the help of members can such complete, or nearly complete sets be made up. **Please note** that the Society does not want to buy back numbers; information as to your back numbers for sale will be put on file in case a request comes in.

CONTROVERSY over various aspects of the Greenwood Lake flights, which many hoped was settled for good, rose up to smite us again as a result of July **Astronautics'** report on Mr. H. F. Pierce's tubular rocket motor experiments.

Mr. Nathan Carver, long a member of the Society and one of the original Greenwood Lake experimenters, wrote to assure us that concentric-fed tubular motors were by no means new with Mr. Pierce; that they had, indeed, been used on the Greenwood Lake rocket planes.

Astronautics hastily disclaims any intention of robbing Mr. Carver or any other experimenter of credit.

In any case, **nihil nisi bonum;** Mr. Carver sends the results of a Greenwood Lake motor test that should be entered on the record. This particular motor was a tubular one with concentric feed:

Firing time—37¼ seconds
Fuel—Alcohol (denatured) 10 cups (3 lbs., 11½ ounces)
Loxygen—23 cups, less 3 cups lost by evaporation (8.32 pounds)
Motor—overall length 15½ inches; from point fuels mix to nozzle, 11½ inches; weight 2½ pounds; material, brass and monel
Nozzle—½ inch diameter at throat, ¾ at orifice; length 4 inches; material, monel
Reaction—40 pounds during 34¾ seconds of the run; 50 pounds during last 2½ seconds (nozzle fell off)
Pressure in tanks (air) about 150 pounds throughout, made possible by large capacity
Fuel not used owing to tank bottom construction—one cup each

From these data, for which, of course, the Society cannot vouch because the test was not made in the presence of official witnesses, Mr. Carver calculates an efficiency of 11 per cent.