# ASTRONAUTICS

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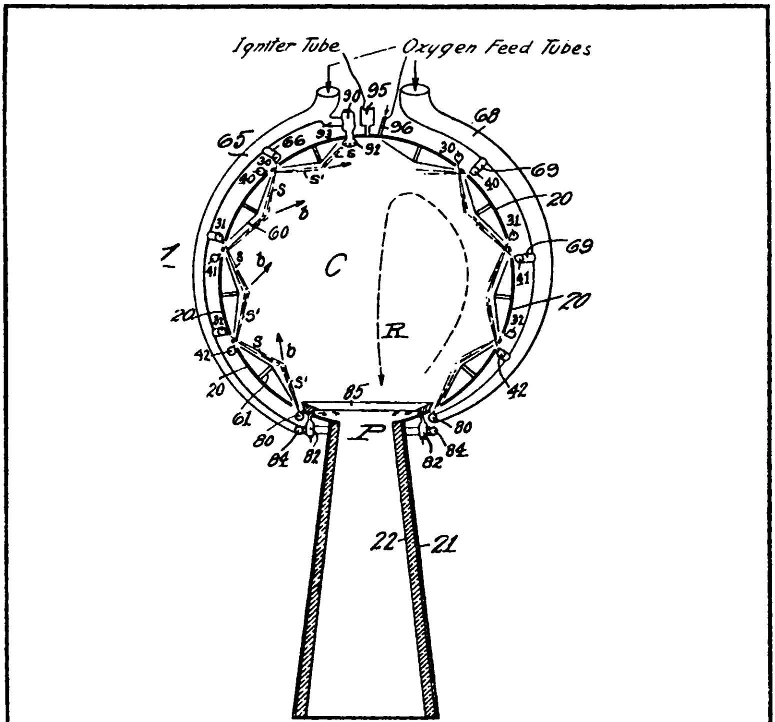


**LATEST GODDARD MOTOR** — An internally cooled rocket motor is the most recently patented design (2,217,649) of America's leading rocketeer—Dr. R. H. Goddard. Multiple flat sprays of propellants are utilized as a protective lining for the thin sheet metal walls. Loxygen is led through manifolds **65** and **68** to the injection nozzles **30-31-32.** Emerging from the slot-like orifice as a thin spray of tiny droplets each stream is directed to intercept and intermingle with a similar spray of fuel. Vented angular deflector plates **60** are used to protect the chamber walls from stray portions of mixed gas. The upper portion of the refractory lined nozzle is further protected by a film of liquid fuel injected through inlets 82.

**THE AMERICAN ROCKET SOCIETY**

was founded to aid in the scientific and engineering development of jet propulsion and its application to communication and transportation. Three types of membership are offered: **Active,** for experimenters and others with suitable training; **Associate,** for those wishing to aid in research and publication of results, and **Junior,** for High School Students and others under 18. For information regarding membership, write to the Secretary, American Rocket Society, 50 Church Street, New York City.

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## NOTES AND NEWS

SEPTEMBER MEETING: Featured at the first fall meeting of the A. R. S. was the completely overhauled test stand, now ready for use. Chairman of the Experimental Committee John Shesta gave an illuminating talk in question and answer form pointing out each detail of the stand and its function. The regenerative motor of James Wyld was used to illustrate mounting and firing procedure. This motor, slightly modified from its original form, is one of several scheduled to be tested during the next few months.

Mr. Shesta also revealed that work is underway on a small liquid-fuel rocket to be powered by the Wyld motor, should it repeat its previous excellent performance. Intended as a trial horse for preliminary aerial shots, this rocket will limit its flights to a mile or so. Data garnered from its use will be utilized in the design of a much more ambitious rocket being planned by the Experimental Committee.

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In this issue we are pleased to print reports from two out-of-town members on their experimental work. Mr. Heyer, long a rocket enthusiast, is concerned with improving efficiency by eliminating the need for carrying an oxidizer. It is interesting to compare the apparatus used in his last test with the Melot design illustrated in Mr. Ananoff's article.

(Continued on Page 16)

# Rocketry In France

## Summarizing The Work Of Several Experimenters

By A. ANANOFF

**This is the last report of French research received before that land succumbed to the Nazi blitzkrieg. Intended as the first of a series dealing with world-wide rocket work, it appeared under the title "Les recherces sur les fusees en France" in the April, 1940 issue of "l'Aerophile". Translation by Dr. Harald Schutz.**

### Work by Robert Esnault-Pelterie

Since the year 1907 Robert Esnault-Pelterie, famous inventor of the airplane control stick, and member of the Academy of Sciences, foresaw the possibility of using rockets for interplanetary communication. In 1912 he presented the results of his computations to the Societe Francaise de Physique.

On June 8, 1927 he disclosed further developments of his theoretical research to the Societe Astronomique de France. Robert Esnault-Pelterie announced on this occasion creation of a Prix International d'Astronautique and constitution of a committee composed of Messrs. J. Perrin, E. Esclangon, J. Baillaud, C. Maurain, Rosny, etc., charged to award 5000 French francs for the best paper presented during the year. The intiative came from his friend Andre Hirsch.

In 1930 appeared an important book by Robert Esnault-Pelterie entitled "l'Astronautique". Later on he contributed a supplementary paper, read at a conference of the Society of French Civil Engineers on May 25, 1934. Parallel to these purely theoretical studies the author also worked to build a stratosphere rocket. This was to be driven by the regular combustion of liquid fuel, and provided with initial ignition for starting.

Robert Esnault-Pelterie bases his work on the theoretical studies in his book. He points out the possibility of rockets driven by liquid oxygen and liquid tetranitromethane, both at ordinary temperatures.

In the first days of October, 1931, Esnault-Pelterie lost four fingers of his left hand in consequence of an accident with tetranitromethane, due to insufficient equipment. He then resumed experiments with liquid oxygen and hoped in the first tests to obtain exact fuel measureemnts by injecting it with a pump. The pump's design proving too frail, Esnault-Pelterie planned to use a vibrating injector. A simple model worked according to plans from the start.

Simultaneously he also computed charts showing zenithal trajectories and calculated general characteristics of a rocket designed to climb to heights of 60 miles.

Apparently Robert Esnault-Pelterie has abandoned practical research after having completed his methodical studies with so much success. He still is one of the champions of astronautics and is deeply interested in the development of experiments abroad.

### Work of Henry Melot

The engineer Henry Melot has worked on the subject since 1916. He first became interested in gas turbines, later in an auto-generator of combustion gases, then in a system of compression by air jet. He then developed a trumpet-shaped propelling unit powered by naphtha and using liquids exclusively in its working cycle. This system includes a boiler for building up pressures to 2200 lbs./sq. in., heated by the "Autoprogressive Burner Melot" for which the inventor had received a prize award from the Office National des Inventions and also the Prix J. and S. Bares in 1936.

In this system steam forces air under about 300 lbs./sq. in. into the oil burning chamber, which leads into the propelling orifice. The gases are ejected at speeds of over 4900 feet per second into a Venturi-shaped tunnel with several stages. These are built to suck in a considerable air volume which then is thrown back by a diffusor to help propell the rocket.

These experiments were made in the Institut des Arts et Metiers. The motor developed about 30 horsepower at 165 feet per second. This corresponds to a traction of about 77 lbs.

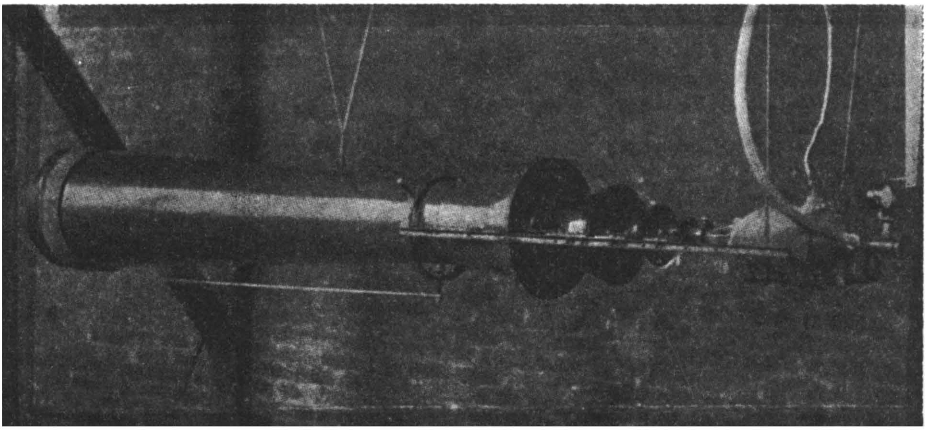
We have to note the following features: No moving parts, air being compressed by steam, the pre-heating chamber, the high thermo-dynamic overall efficiency of more than 30% of the fuel energy as compared to airplane motors.

Henry Melot hopes to reach altitudes of 85,000 to 100,000 feet by adapting his motor to flying machines. Usually rocket vehicles have to carry fuel and liquid oxygen with them, but the motor of Melot breathes the air and does not have to transport its oxidizer. Motors of this sort might be used for auxiliary power to start space rockets, the main power only having to work after having left the range of terrestrial oxygen.

**The reaction motor of Lepinte**

During the year 1924 Capt. Fr. Albert Lepinte planned to increase the safety of aircraft by a reaction motor.

He intended to create, by means of several rockets mounted on the airplane in different positions to obtain



**Melot Motor and Thrust Augmentors**

various effects, a certain amount of gas at very high pressures (about 15,000 to 30,000 lbs./sq. in.) and to permit this gas to escape by a nozzle of small cross-section. It is evident that by simple reaction the gas produces a force which, according to the direction of the rocket, can be used for retarding if the plane falls, or accelerating in case of loss of speed.

Captain Lepinte chose powder to produce the gas. This project was submitted to the Section Technique de l'Aeronautique militaire and was found theoretically and practically feasible. All the same nothing seems to have been done about it.

**The Astronautical group**

The efforts to further the astronautical science, made during several years by eminent engineers, and referred to above, have only awakened the interest of a few specialists. This new science of transportation became an obscure, Utopian and usually misunderstood pursuit.

Ten years ago we, in France, did not even know the elements of the astronautical problems. Even less did we know of research completed abroad. Nevertheless in Germany, at that time, research by Valier, Hohmann, Oberth, Hoefft, Pirquet, etc., had progressed far. The same applies to the Russian research of Ziolkowsky, Rinin, Perelmann, etc., and in the U. S. A. Goddard had begun seriously to plan rocket propulsion.

To change this state of affairs, since 1930 I have been working to complete the data given three years before by Robert Esnault-Pelterie on his experiences abroad . In 1932 we arranged a series of lectures on different aspects of the problem in the French Astronomical Society, and in the Sorbonne. We also tried to divulge basic notions of the astronautical problems by the technical press.

At the International Exposition in 1937, aided by Mr. Jean Perrin, we created an astronautical section in the Palais des Inventions and gave more than 150 lectures on the subject.

On May 9, 1938 we founded an astronautical group, the first created in France. Its aim is to unite persons working in astronautics or persons able to contribute by theoretical or practical work towards the perfection of rocket motors and rockets. Since then this group has held regular meetings twice a month and leading specialists on the subject were given a chance to speak on the topic.

Public interest encourages us to persue our work and to bring it to a good end in face of all efforts made by retarding or malevolent elements.

**Louis Damblanc's powder rockets**

Louis Damblanc, in March 1932 in the Institut Aerotechnique de Saint Cyr, persued a series of experiments with rockets containing charges of from 13.2 ounces to 8.8 lbs. of powder. This in contradiction to the majority of scientists who definitely preferred liquid fuel and oxidizer. His aim was to build, try out and perfect explosive-driven rockets designed either to reach great heights or span long distances.

Differential calculus proving insufficient to solve the ballistic problems of rocket projectiles, he had to resort to direct observation. Placed on a test stand, the rockets could be observed with accuracy as to time and intensity of combustion and ballistic constants could be determined experimentally. Most of the experiments were recorded on sound film.

Louis Damblanc plans to build postal rockets and hopes to obtain precision of aim by a rocket catapult, data and design of which are available. Unfortunately the Damblanc rockets, even in their most perfect state, will never be able to fly further than 15 miles or so. This seems to be the limit of powder driven rockets, as proven by our earliest studies.

**Thermo-propulsive jet of Leduc**

The first thermo-propulsive jet of Leduc was shown by the Air Ministry at the Salon Aeronautique of 1936. This apparatus is characterized by the dynamic compressor in which the air is compressed by its energy of motion. There is further a combustion chamber and an expansion jet to eject the gases . The compression ratio is lower than 2, even at 600 miles per hour, giving a very low thermo-dynamic efficiency and a considerable fuel consumption per horse-power. But the weight per horse-power of the power plant equals only several grams. This is extremely low, compared to the best motors, where this ratio is usually more than 2 lbs./hp.

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Experiments on a reduced scale permitted Leduc to check his figures and to get data on the combustion of gasoline in air currents of great velocity.

Simultaneously with these experiments Leduc finished building a turbine combined with a centrifugal compressor to force the air into a circular chamber. The fuel is then injected and ignited. This apparatus was to weigh 70 lbs. and should develop about 200 horse-power. Its specific data was: 0.352 lbs./hp and consumption of 0.38 lbs./hp/hr. These figures would permit utilization in pursuit planes.

Leduc plans soon to build a plane powered by his thermo-propulsive jet, hoping to attain the following characteristics:

| | |
|---|---|
| Total weight | 4400 lbs. |
| Fuel weight | 1980 lbs. |
| Wing area | 172 sq. ft. |
| High speed | 612 M. P. H. |

The distance this plane could travel is a function of the height and at 65,500 feet would be 2445 miles.

**G. Millet's Turbo-Rocket**

On June 10, 1937 G. Millet demonstrated to the press a rocket-driven car. His system is characterized by a type of fan directly coupled to the motor (was 8¾ horse-power in this instance) to force an air stream under high pressure. In the velodrome of Buffalo this car reached about 18 miles per hour after having been started downhill on one of the banked curves.

Ed. Note: It is hoped to present further articles by this distinguished author in future issues, as the French periodicals in which he wrote have in all likelihood suspended publication

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Considerable interest has been aroused by newspaper reports of secret rocket experiments being carried on by J. Robert Fish of Springfield, Mass. Mr. Fish has publicly announced he is working on a sonic-guided anti-aircraft bomb. We have been in communication with Mr. Fish. When and if something of this nature is developed **ASTRONAUTICS** will endeavor to present full details.

# Experiments In Outside Burning

## Reaction Motors Without Combustion Chambers?

By WILLIAM T. HEYER

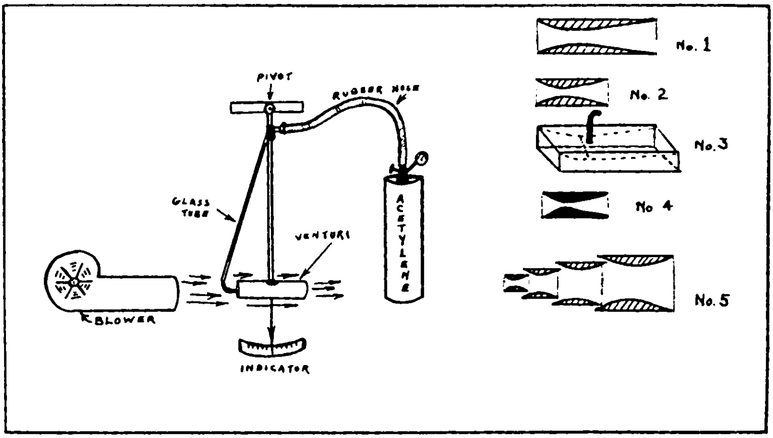
**Recently the radical theory of outside burning was expounded in these pages by Cedric Giles. Here is a first account of some unique tests along this line, conducted by a Connecticut member. Though the results may seem negative, judgment must be withheld until Mr. Heyer concludes his research.**

Primary objective of these tests was to direct the energy from the expansion of a burning gas, as it moved through the air, into a propulsive force. This differs from the ordinary rocket principle in that the fuel combines with the air through which it passes, thereby eliminating the necessity of carrying a stored charge of oxygen for combustion of the fuels.

The testing apparatus consisted of a supply of acetylene gas, fed through a regulator valve and rubber tubing to a glass tube one end of which formed the nozzle. The burning gas issuing from this nozzle passes through a Venturi shaped tunnel. Both nozzle and Venturi were rigidly connected and suspended in an airstream, from an impeller, in the manner shown in the drawing.

Glass was used because it could be bent to a rigid shape and could be drawn to make any size orifice, in most cases 1/64" or less in diameter. The Venturi tunnels were turned from solid stock of brass, copper and aluminum rod.

The air stream was supplied through a pipe from a 7" centrifugal impeller driven by a high speed electric motor, having rheostat control. It should be noted that unless test specimen advanced into the airstream, beyond the point of rest when the air stream was zero, there would be no indication of useful traction.




**Sketch of Apparatus Used in Tests**

**First Test**

The gas was ignited and wind velocity steadily increased by impeller. As gas and flame increased the model moved gradually forward into the air stream. At full speed the flame blew out; at no time did the apparatus move beyond neutral position. Extinguishing of the flame seemed to indicate the inside diameter of the Venturi was too large, so that air entering tunnel was not compressed suffiicently, also the flame burned considerably in the air outside the tunnel mouth. (The tunnel must be considered a secondary nozzle).

**Second Test**

This tube had smaller diameter than No. 1 and operated more successfully since the flame burned at full air stream velocity. A high pitch sound was emitted at full throttle, combustion was again visible outside the mouth of tunnel.

**Third Test**

Next attempt was to confine flame more within secondary nozzle yet have it function at full air stream velocity. Since the making of tapered tubes on the lathe requires considerable time for a smooth finish a different type ot tunnel was attempted.

As shown No. 3 was made up of welded copper and did give a mixture of fuel and air that enabled the combustion to take place wholly within the nozzle box. The flame was nearly noiseless and there was little carbon deposit in the better models. Several shapes and sizes were tested and most efficient position of fuel entry holes was determined.

**Fourth Test**

This model produced better forward thrust than any previously tested, yet it failed to move beyond neutral position. The flame burned well at all speeds but was too much on the carbonizing side, lacking enough air for proper mixture. If more air could be forced to mix with the gas nearer the surface inside the tunnel the result would be better combustion and cooler nozzles. Some models showed effects of burning.

**Fifth Test**

Several of the No. 5 type were made and tried. Each section is about 1/32" smaller than the successive one. This allows air to enter at numerous points making for complete combustion before the gases leave the series of Venturies, also making for cooler burning. After some adjustments the flame operated completely within the apparatus at all velocities of air stream. There was little noise and no carbon deposit. Although this model produced best results of all it would not pass the neutral point on the indicator, thereby showing no positive tractive force as a useful engine.

**Conclusions**

Combustion is a combination of molecules which cause their expansion in all directions, as is well known. The tested nozzles made use of this expansion in only one direction, i. e. laterally with the air stream. The vertical or other forces in such a case produce no useful effect.

Another series of experiments is now underway on the same primary objective but with a different approach.

# Rocket Flights Of Fancy

## No. 1 _ _ _ Edwin Pynchon's Albatross

Nearly half a century ago the use of explosives for aerial propulsion was seriously considered, even if in so quaint a manner as depicted below. This (to our eyes) aeronautical monstrosity earned patent No. 508,753 for its inventor, Edwin Pynchon of Chicago, back in November of 1893.

The general idea was an airship, supported by both static and dynamic lift of hydrogen gas and wings, to be propelled by successively exploded cartridges. As auxiliary power air was to be sucked in through duct E by electric fans and blown out through the rear openings. While this may seem inside out it is a system still being advocated by some amateur inventors.

One can only gain an insight into the brain labor expended on the ship by a complete reading of the patent. Inside staterooms, dining room with elevated chandelier, and railed stairways between decks were provided. Easily discernable on the outside of the vessel, is a lounging balcony, while forward is the promanade deck (hold your hats, boys!) with round house and captain's deck. Atop it all Old Glory flutters in the breeze.

High explosive cartridges were to be placed in a conduit and blown by compressed air down to their firing position in a detonating plate. When snugly locked in place a contact would ring a bell in the engineer's office. If he thought another blast necessary a mere closing of a switch fired the cartridge, as shown by puff of smoke in the drawing. To clear the tube for the next shot a more powerful blast of air was sent through the conduit, blowing the exhausted cartridge out the rear.

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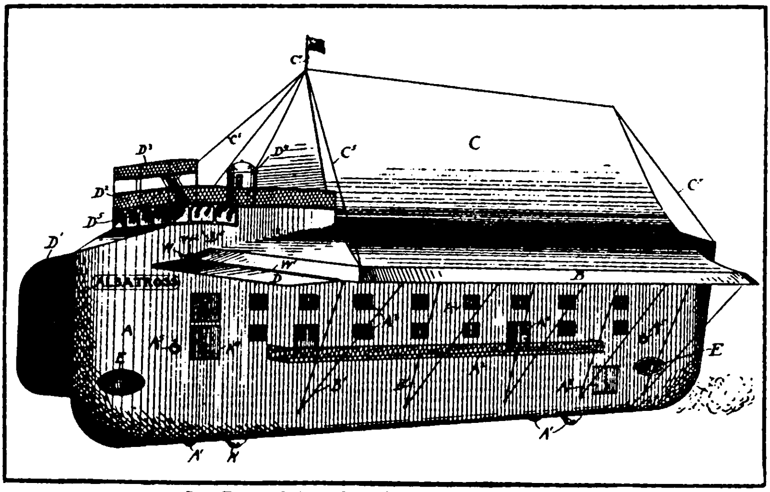



**Jet Propulsion for Aerial Houseboats**

# Liquid Cooling For Rocket Motors

## West Coast Group Initiates Research Program

**By BERNARD SMITH**

The formation of the California Rocket Society has now made it possible for those in the southwest to join in further attacks on rocket problems. Already one of the first tackled; an investigation into the practicability of liquid cooled motors,—has resulted in definitely indicating a wide range of possibilities for this type.

Early preliminary experiments were made in which water running through tubing of copper, aluminum and iron was subjected to externally applied heat. These tests served to show that the only way to gain the required information was to duplicate the conditions of a real rocket motor, that is with heat applied internally and coolant applied externally.

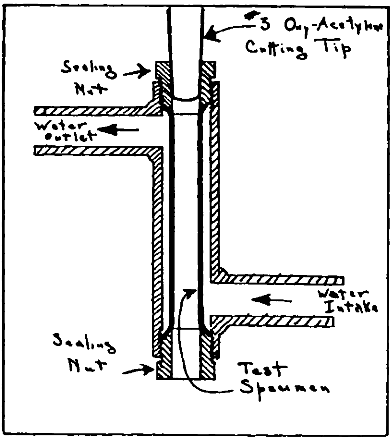
To attain this end the device finally used in the experiments was constructed to resemble a chemical condenser, but modified in such a manner as to permit easy removal and replacement of the samples tested. These sample tubes, comprising 8 different metals and alloys, were 3¾" long and ½" O. D. and ranged in wall thickness from .028" to .065". They were so held inside the device that a concentric column of water, ⅛" deep, could flow spirally around the tube from bottom to top. The flame from a #3 oxy-acetylene cutting tip, with a temperature of 3600° C, passed down the interior of the tubing. This was managed as shown in the accompanying drawing.

**Conditions of Tests**

All the factors in the tests were kept constant except the terminal water temperature and the temperature lag. These two figures therefore are critical ones. Because it obviously was the surface effects between metal and water being observed the external areas of the tubes were used for B. t. u. calculation even though the internal ones varied After making corrections for certain portions not in contact with the collant this area came to 5½ square inches. The initial water temperature was constant for all tests at 66° F. Other constants for the series were; water speed 10" per second, water pressure .4 lbs./sq. in., running time per sample 1 minute and 48 seconds, water accumulation for same 1 gallon or 8 lbs.

**Method of Procedure**

Tests were conducted in the following manner. Water speed through the system was adjusted to 10" per second. Even at this speed steam pockets




**Method of Testing**

would occasionally form at the upper ends of the tubes. This fact introduced an error in some of the tests, being greatest in reducing terminal water temperature for those metals of poorest conductivity. However this error was estimated at less than 5%. Another slight error was introduced by an occasional change in water pressure from the city supply line.

After water speed adjustment the torch with flame set was inserted through one of the hollow nuts machined to receive it and the time lapsed from this moment, until the temperature of the emitted water ceased to increase, was measured. Because of a slow-acting thermometer and the actual difficulties of judging just when the moment of stability had been reached a large amount of error was involved here, but what had been recorded conformed so well with our other data that these figures can safely be used for comparative purposes. Water from the test motor was then collected in a gallon container and its temperature taken along with a check on the running time.

**Effects of high temperature**

Samples were afterward examined for any marks of deterioration. Nearly all of them displayed for about 1/8" at their upper ends the effects of high temperature, in the form of oxide films, indicating the existence of a steam or air pocket. This could have been avoided by better design for it was later realized the water passages were so arranged as to accidentally create a pocket at this point from which no gas could escape if present or once formed. Allowances were made for this fact in the calculations.

Some of the tubes expanded under fire and forced their ends into the threads cut for the sealing nuts, so that only by driving could they be re-

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| Metal | Wall Thick. Inches | Temp. Lag Seconds | Terminal Water Temp °Fahr. | Temp. Increase °Fahr. | B. T. U. per Sec. per Sq. In. |
|---|---|---|---|---|---|
| Al 2S½H | .028 | 2 | 96 | 30 | 23.9 |
| * " | " | 2 | 94 | 28 | 22.6 |
| " | .065 | 3 | 92 | 26 | 21.0 |
| * " | " | 3 | 88 | 22 | 17.8 |
| Al 52SO | .035 | 4 | 89 | 23 | 18.6 |
| * " | " | 4 | 88 | 22 | 17.8 |
| Al 17St | " | 4 | 87 | 21 | 16.9 |
| * " | " | 4 | 87 | 21 | 16.9 |
| Copper | " | 4 | 86 | 20 | 16 |
| † " | " | 5 | 86 | 20 | 16 |
| Brass | " | 5 | 86 | 20 | 16 |
| † " | " | 5 | 84 | 18 | 14.6 |
| Stainless Steel | " | 5 | 85 | 19 | 15.2 |
| Cro Mo Steel | .065 | 6 | 84 | 18 | 14.6 |
| Inconst | .065 | 6 | 85 | 19 | 15.2 |

*Aluminized †Oxidized

# Fuel Injection

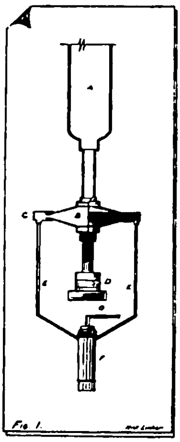
**Two Interesting New Methods Suggested.**

## Centrifugal Feed Pump

Among the earliest difficulties encountered by rocket designers, the problem of forcing fuel under pressure into the blast chamber was considered of major importance. Although many years have elapsed since the days of the first German experiments, when the importance of the problem became apparent, a satisfactory method of pressure feed has yet to be developed.

Suggested by the centrifugal pump the writer has conceived a device that will undoubtedly offer experimenters a field for justified research with this type of pump.

It is a known fact that pressure can be imparted to a liquid enclosed in a rotating reservoir and that this pressure can be increased by increasing the velocity at which the container revolves. Is it therefore improbable to conclude that if sufficient speed is attained by the container the liquid within can be forced into a motor under high pressure?



**Centrifugal Pump**

Undoubtedly several factors such as weight, etc., must be considered in designing a pump for rocket work but with sufficient experimentation such a pump may become practical. Basic design for a pump of this type is shown in the drawing.

Fuel is allowed to flow from tank "A" into reservoir "B" which is revolving at a high speed. Small motor "D" may be used for this purpose, or possibly some other simple means. Centrifugal force imparted to the fuel within the reservoir causes it to flow through outlets into a collar "C" and thence through tubing to the motor "F". The pressure of the fuel will depend upon the speed at which the reservoir is revolved and its diameter. A similar method may be used to force the loxygen to the motor through tubing "G" if it is desirable.

As the weight factor is of tremendous importance it is advised that experimenters consider Dowmetal as a possible medium of fabrication and that a turbine operated from pressure within the loxygen tank be used to rotate the reservoir.

Louis Goodman

## Quick Pressure Generator

IT IS INDISPUTABLE that high pressures are necessary for efficient operation of rocket motors. Present sources of pressure are either self-generated as by oxygen pressure build-up or feeding from outside the fuel tanks from a supplementary source. Most obvious drawbacks of these methods are time consumption and additional weight, but just as important are their lack of regulation during flight. It is usually necessary to provide extra space above the fuel and oxygen for gas pressures feeding of the usual type, this extra space means more parasitic weight.

A practical and simple solution has come to mind which might be applied to any design of rocket. Powder cartridges of the slow-burning, shock-proof type are serially fired, in a small chamber connected to the tanks, until the desired pressure is reached. The apparatus could be similar to a machine gun in design, action being automatic. Pressure could be controlled by some limiting method to stop or start the firing to maintain the desired pressure. During flight additional cartridges would be fired to keep the fuel feed constant.

Powder generates a large volume of gas compared with its volume as a solid. As the gases cool there will be a slight pressure drop, this can be taken care of by additional shots.

The total apparatus may consist of a series of cartridges, a pressure limiting method, the firing apparatus and a small, light chamber adjacent to the tanks. It is believed that the total weight of such a quick pressure generator would be less than present methods of fuel feeding.

**Nathan Carver**

## FLIGHTS OF FANCY

(Continued from Page 9)

While all this may seem rather inadequate for safe flight, Mr. Pynchon must be credited with some ideas in advance of his time, as a reading of the patent will disclose.

For controlling the ship a rudder was positioned at the nose, the elevators in front of the wings. The airfoils curved concavely upward to blend into the triangular buoyancy chamber in which was confined the hydrogen gas. Landing gear was provided in the form of four rollers. Mooring rings were attached to the sides. As this was ten years before the Wright brothers Kittyhawk flight the designer may be excused for the nautical appearance of his dream ship.

A NEW NOMENCLATURE breaking up the troposphere into three levels was urged, at the Summer session of the Institute of the Aeronautical Sciences, by Dr. Arnold Tuttle, medical director of United Air Lines.

Dr. Tuttle suggested the following sub-divisions:

Paleosphere—up to 9,000 feet. Man's natural region, in which he breathes without effort. Here most of today's flying is done.

Mesosphere—9,000 to 18,000 feet. Representing man's limit without external oxygen supply in the form of masks, etc.

Neosphere—18,000 to 36,000 feet. Now called the sub-strateophere. In this zone the new transport planes with pressurized cabins operate. Above most weather, clear of all terrain hazards and with reduced air resistance this is the ideal level for flying.

## LETTERS TO THE EDITOR

ALWAYS PERPLEXING to the newcomer to rocketry is the comparison of power developed by rockets to more familiar types of engines. Here is a typical inquiry from a military-minded reader:

**In reading Mr. Africano's article in the last issue of ASTRONAUTICS I find there is one question which bothers the amateur very much and that is this:**

**We know from reading reports of rocket performance that a motor weighing 15 lbs may develope about 245 horse-power. (A German experimenter reports that in some book I picked up at a local library.) But is this 245 horse-power in such form that it will propel a heavy rocket-bomb weighing say 1000 lbs? And if it will, what velocity could one expect? If the 245 horse-power could be delivered as by a turbine turning up a propeller then all would be well, but isn't it a fact that jet propulsion is different in that the efficiency of the motor is pretty low, and the 245 horse-power is so dissipated that nothing much happens to a heavy body like a 1000 lb. rocket-bomb when directed upward against gravity?**

**George Mills**

Horsepower calculations are confusing when applied to rockets, and it would perhaps be wiser if this unit of measurement were not used when speaking of rocket motors.

In the ordinary internal combustion engine the horse-power rating is derived from torque readings taken from a revolving shaft. As a rocket motor has no moving parts such methods cannot be used, therefore its power is measured by the amount of thrust, or reaction produced. For example the American Rocket Society test stand has a hydraulic cylinder, connected to a gauge calibrated in lbs., to give power measurements.

Regarding the German motor we have found that such figures are to be taken sceptically, the more authentic reports from that country speak in kilograms thrust, not horse-power. Present trends indicate that large rocket motors will give at least 50 lbs. thrust per lb of motor, contrasted with the airplane engine's 2½ to 3 lbs per lb of powerplant.

Airplanes are not pulled into the air by their engines, they are lifted by the dynamic reaction of their wings. If you stood the most powerful plane in the world on its tail, nose straight up, and opened its engines wide the plane would not rise an inch. Nor would a 245 horse-power engine and propeller lift a 1000 lb bomb off the ground. Yet a rocket zooms skyward under like circumstances, blasted upward by power alone.

To shoot a 1000 lb rocket-bomb into the air would obviously necessitate more than 1000 lbs thrust, how much more would depend on the speed desired. If the motor gave 2000 lbs thrust the bomb would rise under an acceleration of 1 "G", or 32 feet per second per second less air resistance. This acceleration rate would increase as the fuel was consumed and the weight dropped, if the power remained constant. It will be no easy task to develope a 2000 lb thrust motor. A unit of this power would consume something like 10 lbs of fuel per second, making the tanks, fuel and motor a considerable part of the total weight of the rocket-bomb.

## LIQUID COOLING

(Continued from Page 11)

moved. This is mentioned to indicate that even in liquid cooled motor design expansion effects must be considered.

Half the aluminum alloys had their surfaces anodized in the belief such surfaces would remain cleaner, but the only effect noticed was a reduction in conductive properties. In fact all the specimens were found to be as clean after removal as before firing. The oxidized copper tube lost some of its scale while being tested.

**Points for motor designers**

From these results several conclusions of importance can be drawn:

1. All metals and alloys begin to display closer heat transmitting properties as the wall section involved becomes thinner.

2. Water speeds as low as 10" per second, 1/8" depth over the surface being cooled, with temperature increase allowances of 10° F. per inch of travel are sufficient for cooling any thin metallic wall providing its opposite wall is heated by nothing hotter than the oxy-acetylene flame.

3. Great care must be taken in the design of liquid cooled motors to avoid an occurrance of pockets, especially where low coolant speeds are contemplated.

In appreciation for having made the success of these tests possible thanks must be extended to George Putnam, Gavin Galceron, Robert Gordon and Al. Stuart.

## 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 experimenters and enthusiasts.

ROCKETS THROUGH SPACE, by P. E. Cleator (277 pages); a popular treatment of rockets, their history, how they work and what they promise. Price to members $2; to non-members $2.50.

STRATOSPHERE AND ROCKET FLIGHT, by C. G. Philp. Possibilities of jet propulsion for high altitude and space flights. Price $1.25

DAS NEUEFAHRZEUG May 1937 issue
Publication of the German Rocket Society. Price 25¢

JOURNAL OF THE BRITISH INTERPLANETARY SOCIETY
December 1937 issue Price 25¢

ROCKET BIBLIOGRAPHY
Contains a comprehensive listing of books and articles on the subject of rockets Price 50¢

MISCELLANEOUS DRAWINGS, useful in suggesting experimental design. Price, per set of 6, 50¢; each 10¢. Subjects: (1) Rocket No. 2/1932, (2) Cross section of motor of Rocket No. 2/1932, (3) Cross section of motor used in 1935 tests, (4) Schematic drawing of proving stand used in 1935 tests, (5) Result of motor tests, Series 3, No. 1, (6) Results of motor tests, Series 3, No. 2.

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Copies of the current year 75¢; numbers 18 to 44 inclusive $1; numbers 11 to 17 inclusive $2; numbers previous to 11 $5.

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## NOTES AND NEWS

(Continued from Page 2)

Bernard Smith, pioneer member of the A. R. S. and recent founder of the California Rocket Society, forwards the results of their tests on cooling, an outstanding problem in design.

Officers of the California group are:

President—Bernard Smith
Vice-President—George Putnam
Secretary—Miss Grace Huntington
Treasurer—Gavin Galceron
Custodian—Robert Gordon

The C. R. S. is indeed fortunate in its choice of Secretary, for Miss Huntington has recently set a new altitude record for light planes. Soaring to a height of 22,750 feet over the Union Air Terminal, Burbank, California on September 11, 1940, Miss Huntington captured the American record for both sexes in Category 3. The A. R. S. is proud of this record for its owner is an Active member in our group.

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"A Rocket Trip To The Moon" was recently presented by the Fels Planetarium of Philadelphia. As the year was supposedly 2033 puny liquid fuels were dispensed with and several hundred imaginations were blasted skyward by atomic power in the lunar flight. President H. F. Pierce of the A. R. S., guest speaker at the opening performance, reports the show widely publicized in the Quaker City. Hotel bars featured the "Rocket Ship Special", so potent that one drink was guaranteed to put your head in the clouds.

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