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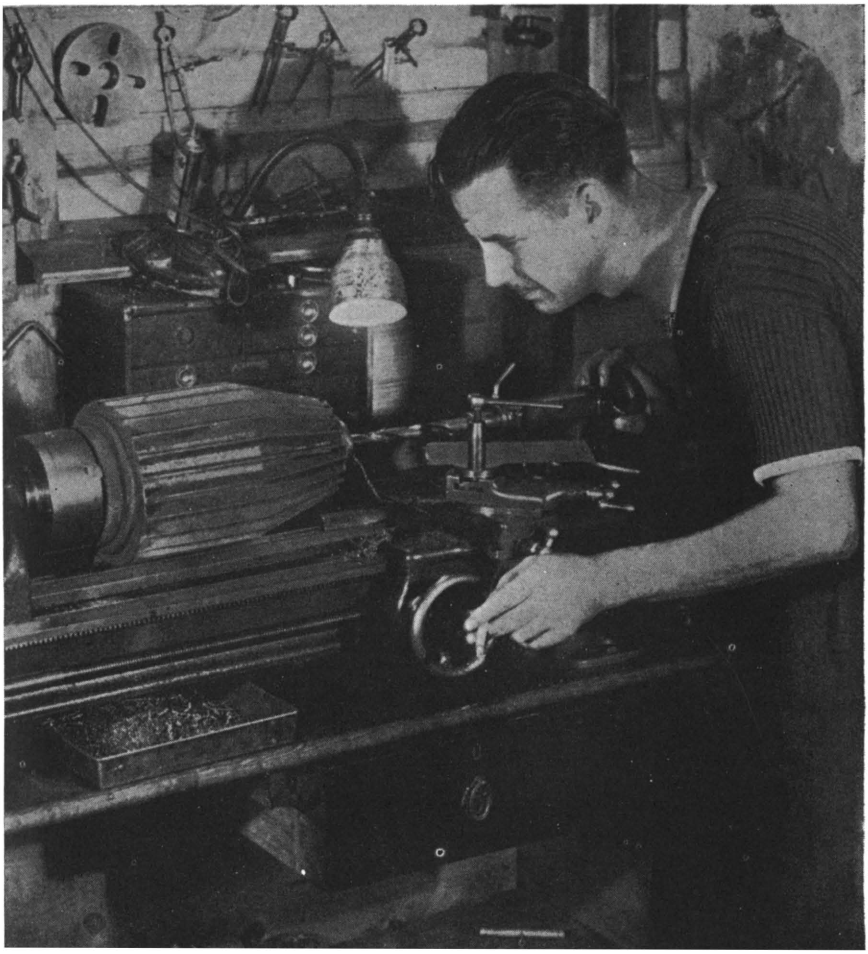


A ROCKETOR'S WORKSHOP—H. F. Pierce hard at work on one of the new motors under construction. Summer test stand runs are expected to reveal important information on rocket problems.

NOTES AND NEWS

THE THREATENED ALL-OUT Spring offensive of the warring powers may bring out new and startling weapons. There can be no doubt that the laboratories and experimental grounds of all nations are scenes of hurried research on many sensational devices. Some application of rocket power may yet be unleashed by the gods of destruction. as yet, however, jet propulsion has only appeared in the form of rumor on the battle fronts.

FROM ROME reports have eminated of an "all metal fighting plane moved only by internal reaction." It is claimed the "motorless, propellerless craft shot through the air by gas" has been successfully tested by Col. Mario de Bernardi. Col. Bernardi is fairly well known in aviation circles and his name lends some weight to the story. From the meager details available it is certain that the plane referred to, whether flown or not, is none other than the design of Secundo Campini which was described and depicted in the November 1939 issue of **ASTRONAUTICS.**

CONSIDERABLE NEWSPAPER PUBLICITY has been given to the "blast engine" of Elman B. Myers, for which a great future is forseen by feature writers. Back in October 1938 this motor, or its predecessor, was exhibited to members of the A. R. S. at one of our meetings. A write-up of the meeting appearing in the A. R. S. Bulletin

(Continued on Page 16)

Aerial Cannon and Rocket Shells

Can The Rocket Projectile Replace Present Airplane Armament?

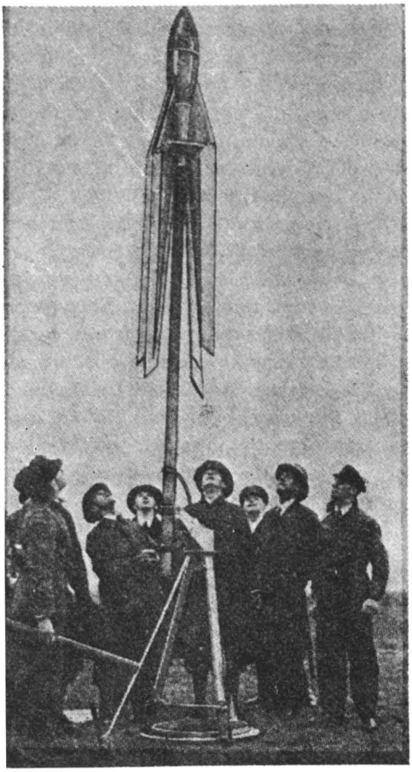
By ROY HEALY

It is a sad commentary on human nature that the rocket, only recently thought of as a means of scientific exploration of the atmosphere and even other worlds, should now mainly be considered as a potential weapon of destruction.

The sincereity of those proposing its use as a means of national defense cannot be questioned, but they must realize that it has been repeatedly demonstrated in this current war that so-called defensive weapons can easily be adopted to offensive. German Panzer columns in the Battles of Flanders and France used anti-aircraft guns to shoot down defending bombers; pursuit planes developed for defense are being used as bomber escorts and light bombers; commercial planes carry parachute troops and defensive rockets would soon be adapted to the offensive.

A number of active military uses for rocket power have been suggested among them being:

1. Huge rocket-projectiles to outdistance present artillery.
2. Anti-aircraft shells to be shot from the ground and attracted to the bomber by sonic or electrical effects.
3. Rocket powered bombs shot downward at ground objectives, improving accuracy.
4. Military meteorological rockets to check weather conditions preceeding mass bombing flights, gas attacks, etc.
5. As a means of assisting bomber take-off or interceptor climb.
6. Rocket shells for aerial combat.



—Keystone

Bomber Destroyer? Prewar German rocket of a type which made many successful high flights.

Rocket projectiles are far from new. Back in 1806 the Emperor Napolean had gathered his legions at Boulougne for an attempt to invade England. The newly invented Congreve rocket played a large part in the smashing of his flatboat armada. Their use in that war, as well as in the War of 1812 and our

Civil War have been well-covered in past issues of **Astronautics.** Enough to point out that rocket-projectiles were made obsolete by the development of cannon artillery which proved immeasurably superior in range and accuracy.

In recent years, with the advent of the liquid-fuel rocket motor, innumerable prophecies have been written of the coming use of rocket shells raining death on cities 500 miles distant. But the "next war" is here and nothing of the sort has occured.

The anti-aircraft ground launched rocket, with sonic-hunting control, has also been much talked about for the last 20 years, but little has been done to realize it. Every so often one reads in the newspapers of some obscure inventor having developed something along this line, but these do not appear to ever get beyond the wooden model stage.

World War I

Now the emphasis appears to be on the rocket-shell fired from defending planes at bombers, the idea being to project a shell larger than is now possible from existing aerial weapons.

During the early days of World War I many planes went aloft armed with rockets. These were rather crude powder weapons, attached to struts and nacelles, meant to be used against observation balloons and Zepplins. Many of the smaller gas bags went down in flames after being pierced by a hissing rocket, but no Zepplin is known to have fallen to this weapon. Before long the more efficient incendiary machine gun bullets replaced the often erratic rockets.

Since the termination of the last slaughter enormous quantities of mathematics, much thought and some serious experimental research have been devoted to advancing the science of jet propulsion. It is only natural that this type power, really efficient only at high velocity, should be called into use, in the new terrific speeds of aerial warfare.

Sky battles have undergone quite a change since the days of the Aces. The speed of the machines has tripled and the complicated combat maneuvers have vanished with the Spads and Fokkers. Physiological strains rule out violent aerobatics at today's speeds. The only method of attack possible is a quick dash at the enemy, a wide turn and another dash. With the range of the best modern weapons limited to 500 yards with accuracy, and the velocity of planes now well over 350 m. p. h., the opponent can only be kept in the sights for 3 or 4 seconds at most. During this short time as much destruction as possible must be launched in his direction. Before we can consider the potentialities of the rocket-shell in this game of tag it will be necessary to evaluate current methods.

Spitfire vs. Messerschmidt

To suit these new conditions Britian went in for quantity of armament. The sleek Spitfires and Hurricanes that threw back the Nazi onslaught of last September were each armed with 8 rifle-caliber machine guns. These .303 caliber Brownings each fire 20 rounds per second, mass production in death. A raiding Heinkel or Dornier can be blasted with over 500 slugs (each over an inch long by 5/16" in diameter) in one brief volley. Limited by the ammunition load of 600 rounds per gun, the British fighters can only make a dozen or less attacks before descending to reload.

German fighters escorting the bombers are armed with 20 and 23 mm aerial cannon as well as numerous machine guns for closer work. The Nazis have gone in heavily for quality of fire power and all the swastikered swarm, from single seater fighters to heaviest bomber, bristle with these miniature artillery. One hit by their high-explosive shells on the wing or fuselage of a British fighter means another statistic in the report of the battle.

The Oerlikon Cannon

While airplane cannon saw limited use in World War I, notably by the French Ace Georges Guynemer, it was at that time an awkward, heavy and cumberson weapon to use. In recent years the Swiss Oerlikon Machine Tool Co. has successfully revived the aerial cannon, and various models of their gun are in wide use today.

Originally developed as a 20 mm weapon for flexible use in the nose of bombers, they showed so much promise that they were soon adapted to fighter installations. In some cases they are wing mounted, in pursuits with liquid cooled engines they fire through the hollow propeller shaft, which is geared off the engine. The famed Messerschmidt 109 has this instllation in some models, in others two are wing mounted and machine guns fire through the whirling propeller blades.

It is considered too hazardous to attempt synchronizing these shell guns with the propeller for should a shell hit a blade it would easily blow it off whereas a machine gun bullet will cause only minor damage. Thus, as will be the case with rocket shells, all aerial cannon either fire through the prop hub or outside the propeller disc.

Below are a few figures on their performance, all guns firing the same 20 mm shell.

Model	Muzzle Vel.	Rounds/min.	W
F	1968 Ft/Sec	520	51 lb
L	2460	450	66
S	2952	400	86
FF	1968	550	51
FFS	2952	—	—
FFL	2460	—	—
OHS	2723	400	105

In Germany they are manufactured by the Werkzeugmaschinenfabrik Oerlikon Buhrle.

Hispano-Suiza Cannon

Many of the French fighting planes were equipped with a version of the FF Oerlikon gun, manufactured by the Hispano-Suiza Works under license. This famed engine firm took the original design of the FF and modified it to suit their engine, building it as part of the powerplant and so arranged as to fire through a hollow propeller shaft.

The figures above of the OHS are some specifications of this gun. It has a horizontal range of 16,000 feet with the standard .55 ib shell fired from these weapons. The overall length of the gun is 6′ 9″ and its breech mechanism is in the cockpit with the pilot. It is interesting to note the maximum gas pressure in the chamber is over 47,000 lbs/sq/in. Mounted integrally as part of the engine a great deal of the recoil was absorbed by the mass of the powerplant. Rate of fire is 60 to 105 rounds per minute. The recoil load on the plane is held to 231.5 lbs by clever utilization of most of the thrust into the automatic mechanism of the gun.

The Madson Cannon

The Danish Madson air cannon, manufactured by the Danski Industrial Syndicate of Copenhagen, was used by the short-lived air forces of Belgium and the Netherlands. This weapon comes in a number of sizes, the 20 and 23 mm models being of the same weight and general dimensions. The 23 mm gun weighs approximately 115 lbs, fires 20 shells in 3 seconds or 360 to 400 per minute, and has a muzle velocity of 2394 ft/sec. With a four foot barrel this gun is aircooled and works similar to a Browning machine gun. When belt fed a supply of 100 rounds weighs 80 lbs with links. Interesting is the total recoil of the gun, with a single shot it is about 3000 lbs, during automatic firing it may reach 3600 lbs. Very little of this is transmitted to the plane's frame for it is absorbed by a muzzle buffer and the recoil arm and spring which feed in the next shot and fire it. By an ironic quirk of fate many of the planes armed with these guns which rose to battle the Luftwaffe were creations of the late Anthony Fokker.

Other Guns

The deadliness of the aerial cannon has aroused the British and all late models of their fighters, including those bought from the U. S., are being armed with cannon as well as machine guns. The Vickers-Armstrong cannon is said to be mounted in the Spitfire III, the Hawker Tornado (new version of the Hurricane), Boulton Paul Defiant, Westland Whirlwind and Fairey Fulmar.

America Follows The Trend

In these United States the war in the air is being closely watched and the aerial cannon's place in combat is one of the lessons learned. Recently a very large order for airplane shell guns was issued to the Munitions Manufacturing Corp. Practically all new military planes are being made to carry one or more of these weapons. Specifications are not yet available.

The American Armament Co. has been hard at work for some years on a 37 mm cannon, but it seems that all the "bugs" have not been worked out of this gun and few if any planes have it installed.

Much larger than the European guns this throws a 1.1 lb explosive shell. Details are available on 2 barrel lengths, the 20 caliber and 50 caliber, the former for defensive use has a range limited to 1800 feet and a muzzle velocity of only 1250 ft/sec. This weapon has a weight, mounted, of 250 lbs. This high weight and short range are a disadvantage. To overcome this the offensive gun, with a 6'8½" barrel, has been designed with velocity of 2700 feet and range of 3500 feet. But this gun weighs 440 lbs. without a mount and being so cumbersome can only be lugged along by heavy bombers.

The 37 mm shells are fed in clips of 5 weighing 8 lbs., and can be fired in 30 seconds. They come in high explosive, armour piercing, super high explosive and cannister for use against troops. Like the Oerlikon the shell is bore safe, an offset detonating pin does not come into line until clear of the barrel under centrifugal force of rotation. If 200 shells are carried this will add 350 lbs more to the weight of armament, which is rather high. While this gun has many disadvantages yet to be worked out, it is a very powerful weapon.

Heavy Caliber Machine Guns

While the much vaunted British 8 gun fighters have received a great amount of publicity, it is apparent that they were not found the ultimate solution in armament. For the English are switching over to the Nazi bag of tricks and installing aerial cannon and the larger .50 caliber machine guns in their newest planes. These .50 caliber and its cousin the 13.2 mm gun spew forth 600 slugs pr/min (each 2⅜" long by ½" diameter, weighing about 1¾ oz.) of several varieties. Not merely pieces of lead, as the layman thinks, but of armour piercing steel, incendiary (tracer to the polite), explosive and mere ordinary service death-dealing. Range with accuracy of this size gun is about 200 yards, the muzzle velocity is around 2500 feet per second, chamber pressures of 50,000 lb/sq/in. are reached. This type machine gun is favored by American fighting planes.

What Next

That the present weapons are quite deadly daily claims and counter-claims attest. But man has never been satisfied with his toys of destruction and the thought of a rocket-projectile offers his curiosity a new plaything.

Though the recoil load of the heaviest guns now used can be borne by a small fighter, by clever absorbtion of the reaction, it seems that guns firing shells of say 75 mm size will be borne only by heavy bombers or big destroyers of the air. The problem is to increase the effectiveness of the small fighter seeking to destroy these big bombers, to improve the efficiency of the defensive air force.

As has been pointed out the reaction from a rocket shell launched from a plane would be practicably negligable, so that even small pursuits could fire shells of 3" or more. Unfortunately there are many difficulties connected with utilizing jet propulsion in this manner.

Stream or Single Shots

The machine guns fire a stream of bullets, we try to spray our opponent with this stream. With the 20 mm cannon we are still using a stream, not as solid as the machine gun's, but of much greater power. The 37 mm gun must be thought of as firing single shots even if comparatively closely spaced. But with a rocket-firing plane, as proposed, the shells are going to be few and far between, each shot will be an individual attempt to destroy the enemy. We are "putting all our eggs in one basket" and depending on accuracy of aim.

If our target the bomber is loafing along at 250 m/p/hr, this is 367 ft/per/sec. Even if he is 75 feet long, the enemy will completely pass any given spot, where we might aim our shell, in less than ¼ second. Multiply this by the fact that we ourselves are traveling at 450 to 500 ft/per/sec, are some distance away and firing a shell which will start slowly, as rockets do in comparison to bullets. The disadvantages which will have to be overcome become obvious with a little thought.

Are Rocket-shells Practical?

For any conceivable use in aerial war the liquid-fuel rocket motor, fed through an intricate induction system, with attendant difficulties of fueling etc., is out of the question as powerplant for a shell of the type considered. Therefore we must backslide to the use of the now scorned power fuels, thus losing all the benefits gained in the last 10 years of experimental research. True, there are many powerful dry fuels which might be used, but none as powerful as the liquids currently used in experimental work.

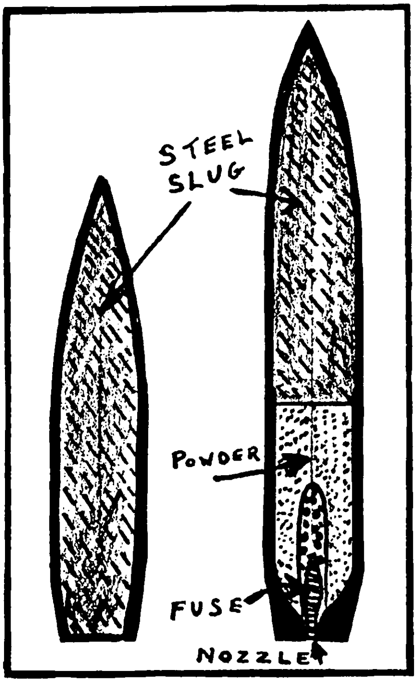
Assuming we did develop a 3" rocket shell which seemed satisfactory in ground tests how are we going to install them in planes? For single-engined fighters we might load them in wing tubes, perhaps 6 in each wing, and fire them electrically from the cockpit. Or by enlarging the hollow propeller shaft of the cannon equipped engines we might fire them through this. But it seems that rocket-shells, if they are made, will be better suited to multi-engined destroyers or even to the bomber itself, thus defeating the original purpose. Feeding of the shells into the firing tube would probably require the effort of a gunner, for belt feeding or even clips of 5 would probably be out of the question. Remember the rocket-shell is necessarily much longer than would be a cannon shell of the same caliber. To expect the pilot of a interceptor to load individual shots during the heat of a battle would be asking too much.

Starting Difficulties

The breech mechanism and firing method involved would not present much of a problem, a simple spark is all that is needed. But firing at the right moment is something else again. An ordinary bullet leaves the gun a tiny fraction of a second after firing, but the rocket-shell would have to gather power before moving. Again if fired in an open tube the thrust will have to build up to overcome the considerable air resistance to the plane's speed of 300 or so m/p/hr before it leaves the tube. If the tube has a temporary cover the shell move slowly until this is pierced or opened, then hit by the sudden outside resistance will slow up or even temporarily stop before going on its journey. Once gone the 3" opening in the tube will present considerable resistance for the plane to overcome, particularly if there are a number wing-mounted. Some covering mechanism would need be developed.

Compromise

What does seem to offer more immediate promise is a compromise, a shell fired from a gun with rocket propulsion to give it a constant velocity and longer accurate range. Thus the initial velocity could be kept comparatively low, say 1500 ft/sec., over a long distance this would be made up for by constant or even increasing velocity. With such a low initial velocity we could fire a much larger shell with no more recoil than is now given by smaller shells with higher muzzle velicity.



Problems Of The Reaction Engine

How A Liquid Fuel Rocket Motor Functions

By A. ANANOFF

Translation by Dr. Harold Schutz. Reprinted from "l'aerophile" of Sept. 1939.

Mixing

RAPIDITY OF BURNING as well as completeness of combustion in the rocket motor depends to a large extent on the homogeniety of the fuel and its oxidizer. It may be stated that the more complete the mixing of fuels the smaller and more efficient the combustion chamber.

This statement shows us two possible solutions to our problem: (a) To mix fuel and oxidizer outside the chamber or (b) to mix them inside the chamber. Ideally the mixing process should take place in a separate space or mixing chamber before being injected into the combustion chamber and ignited. The space devoted to burning would then be considerably smaller than necessary with the present methods.

It is, however, rather difficult to use this principle in practice because the mixture of liquid fuels usually constitute a violent explosive and on being introduced into the chamber might detonate rather than burn evenly. In this case it would also be necessary to feed in the liquid mixture as quickly as the exploded mixture was expelled from the nozzle.

Chamber Mixing

It is also possible to mix directly in the combustion chamber and so evade the above mentioned difficulties. By this method one can inject the two liquids separately in correct proportions. Combustion will be regular. The liquid fuels are fed in at a low speed in comparison to the high jet velocities. This method was favored by Oberth. He planned to locate the combustion chamber in the head of the rocket and allow the jet gases to stream out on both sides.

A third possibility, and a very important one, is to introduce into the combustion chamber part of the mixture in a proportion insufficient for combustion. A supplementary amount is then fed into the chamber bringing the mixture to its correct proportions and burning takes place. This method increases homegeniety of mixture and power output of the motor.

Of course this method cannot be used if oxidizer and fuel react chemically or if they undergo changes at high temperatures. If, for example, a mixture of oxidizer and carbohydrate of high melting point is planned the result would be an irregular output owing to solidification of the fuel.

Mixing Methods

The liquids can be mixed inside the chamber by atomization or more or less solid jet. The first method is used in Diesel engines where the fuel is ignited upon injection by the temperature of the compressed air in the cylinder. More than 30 years were spent in perfecting atomization of this type at high pressures used in the Diesel which often run over 10,000 lbs/sq/in. The power consumed by the injecting apparatus is usually from 3% to 5%

of the motor efficiency.

To use this method in rocket motors one would need atomize the oxidizer as well as the fuel thus vastly increasing the problem. As the mixture then takes place between two liquids the results would probably be inferior to that achieved in the Diesel.

Jet Mixing

Mixing by jets has been considered by many including Oberth. His combustion chamber is elongated and ends in a conical shape. The ports were so placed that fuel and oxidizer met in the extreme tip of the cone. Another method used the same principle but utilizes only one jet for the premixed fuels.

Neither method can be seriously considered. It is difficult to visualize the jet, coming from a opening of only a few millimeters diameter, crossing the length of the chamber and still remaining liquid under the high pressure and temperatures existing therein. It is certain that part of the liquid would be vaporized and dispersed before reaching the target, and the regularity of output would be seriously jeopardized.

These drawbacks may be eliminated by having the liquids meet at the entrance to the chamber where they mix before ignition. Improvements on the straight jet system would be easy. The liquids could be broken up by various means such as turbulence produced by using little vanes inside the chamber. These would need be cooled.

- II -

Inside the Chamber

One of the most important moments in the working cycle of a reaction motor is the inflamation of the fuels entering the combusion chamber so as to keep up constant and unvarying combustion. This ignition should take place immediately upon entry, even if one of the oxidizers enters somewhat later or if the ratio is not perfect.

The ignition system depends somewhat on the nature of the fuel and its oxidizer. If the liquids are admitted continuously to the chamber initial ignition will suffice as combustion will be maintained by the heated walls and the continuously present hot gases.

Ignition

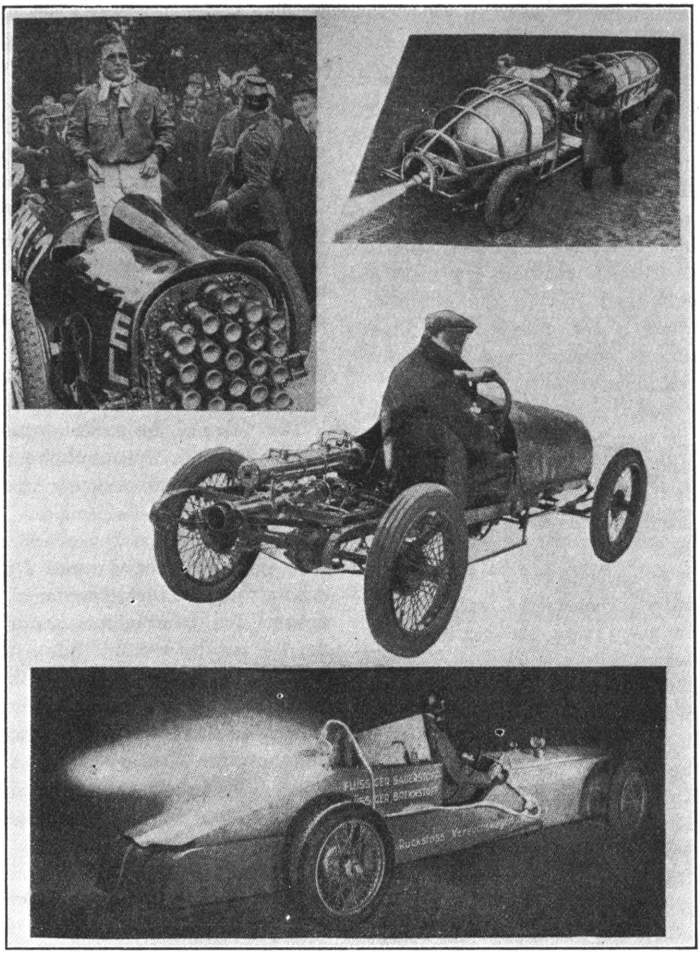
According to the design of the rocket motor two different methods of ignition can be used:

1) Continuous feed in which the motor uses the fuel in continuous combustion. Particularly suited to rocket bombs and torpedoes.

2) Intermittent feed. Suitable for airplanes or astronautical needs. It is obvious that the mechanism needed to regulate a motor of the intermittent type is going to be much more complicated that that used where combusion is continuous.

The parts of the igniting device located inside the chamber have to withstand extreme heat. In the intermittent type it must be capable of furnishing regular ignition when needed.

Immediately after introduction of the fuels into the chamber ignition must take place. If this is not done an accumulation of liquids will take place which upon igniting will cause a serious explosion. After starting ignition should be kept up until the motor has reached its normal working cycle, viz, until any danger of choking or explosion is past. This is of great importance for on it depends the proper functioning of the motor at a critical moment. Yet despite its importance this



ROCKET CARS:—More sensational but less informative than proving stand tests were these cars tested by European rocketors in the early 1930's. Top left; Fritz von Opel's 24 rocket powered car, Top right; Alfons Pietsh testing a powerful motor, last experiment heard of from Germany. Center; Karl Cermy, Viennese inventor, in rocket-motored car of which details are lacking. Bottom; Max Valier in the car in which he later met his death.

part of the problem has not been studied deeply. Perhaps its importance has not yet been realized.

Experimental Ignition Devices

During his experiments Oberth started ignition by a rag dipped into gasoline and tied to a stick. This crude device was ignited and thrust into the combustion chamber through the nozzle. This method can be used only in a laboratory because of its risk. Oberth used still another method; He put the gasoline soaked rag in the chamber and ignited it by means of a fuse. This means is possibly less dangerous but just as inconvenient.

It has been proposed to ignite the mixture by locating a hot spot near the jet, igniting the fuel after it leaves the jet and letting the flame work back into the chamber. This is also a dangerous method which might easily cause the motor to explode.

Frequently a standard spark plug has been suggested for starting the motor. Unfortunately this can only be done where continuous combustion and a well-chosen fuel are used in the motor. The plug would probably fill up with carbon.

Slow combustion of a powder charge, introduced into the chamber and electrically fired was proposed in a French patent, No. 502562.

A very convenient method would be one in which the atomized fuel, upon injection, would ignite at contact with the oxidizer.

Keeping Temperature Down

Inside the combustion chamber temperatures may reach more than 3500°C. No known metal can resist such extreme heat without melting. The nozzle, even more than the chamber, is imperilled. It is not only subject to great heat but also to continuous and intense friction, caused by the gas escaping under pressure. We have also to consider that the combustion products are some times of a corrosive nature.

One consideration alone can console us: Rocket motors usually work during short periods only, sometimes only a few seconds, as would be the case with certain projectiles for long range. In ordinary rockets, the temperature inside the combustion chamber might be lowered by introduction of a thin stream of air, or by atomizing water. Both methods have the following drawbacks:

1. The mass of the rocket would be increased by the weight of the container of compressed air or water, thus lowering the range.
2. Power of the rocket would diminish with lowered temperatures. Nor would it help much to install water circulation around the combustion chamber and the jet, for the reason given above.

These short remarks prove that methods, used profitably to other ends, cannot be applied to rocket motors.

Regenerative Cooling

It might be thought that one could use metals of high heat conductivity to lower the temperature in the chamber and nozzle. These metal walls would be bathed by the liquid fuel and oxidizer. Thus, the heat taken from the walls would not be lost because the liquids would be heated before entering the cumbustion chamber, thereby rendering the mixture more homogenous, less viscous and more easier to atomize. Burning would be acellerated as well as initial inflamation of the mixture. Care must be taken not to overheat and vaporize the liquids before their injection into the chamber, as this would jeojardize the regularity of combustion. Certain experiments show that one would do just the opposite and build the nozzle and chamber of a metal of low themal conductivity.

Red copper used by Oberth to line his combustion chamber has proven a perfect insulant, though it begins to melt between 300° and 400°C, much below that of steel. It worked particularly well with mixtures of oxygen with certain carbohydrates, which give a considerable temperature.

Owing to its chemical nature and its high melting temperature (about 1,-700°C.) cromium can also be used profitably, while neither aluminum or magnesium (melting at about 650° C) are of real value. (Ed. note: The successful regenerative cooled Wyld motor was constructed of thin walled aluminum tubing.

Several other materials have a sufficiently high melting temperature, and some of their carbides melt at temperatures over 4000°C. Graphite, which is pure carbon, melts at between 3600° and 3700°C. It is doubtful if graphite is practical as the liquids and gases may after some time carry off these insulants, as Oberth found.

CiO_2 with a melting temperature of 2950°C. and MgO with 2800°C, may prove more interesting. Unfortunately much experience will be needed to solve the complex problem of producing a thin, perfect insulating surface to keep weight down, and to offer no roughness which would be subject to the erosive effect of the gas flow.

Materials of Construction

The metals to be used for other parts of the rocket motor's auxiliary equipment have to be chosen according to their tasks. For containers, water jackets, tubes, etc., aluminum is indicated being well adapted to standing low temperatures as those of liquid oxygen. For parts subject to the influence of acids and water containing oxygen, one might use stainless steel. Aluminum might also be used for parts not subject to high temperatures. It might be cromium plated for corrosion resistance.

To conclude this paper we wart to point out once more that perfection of rocket motors raises a great number of technical questions which have yet to be solved. Experimenters and inventors can find countless problems arising and on their collective effort depends the final result.

A. Ananoff
Secretary General, founder of the Astronautical Section of the French Astronomic Society, Laureate of the Prize Rep-Hirsch.

BOOKS

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¢

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Tank Pressure and Motor Efficiency

Unconsidered Efficiency Formula Factors

By CEDRIC GILES

In calculating the thermal efficiency of the rocket motor and in comparing the efficiency values between motors certain standard formulas and equations are made use of. Most of these equations, due to a failure to employ all essential associating data, develop a flaw tending to lead to false efficiency result.

Present Formula Incomplete

Probably the best known and most widely used efficiency formula is the one stating that the thermal efficiency is obtained by the heat efficiency of the fuel converted into the kinetic energy of the jet. (Output/input). The greatest fallacy of this formula is the need of taking into consideration the tank pressures of the propellants. In the testing of a motor, the greater the tank pressures the greater the possible combustion chamber pressure which in turn results in a better motor reaction.

An example of the usage of the above formula is shown by a theoretical rocket motor using a perfect ratio mixture of 1 lb of alcohol and proportional amount of liquid oxygen. With the tank pressures building up a chamber pressure great enough to deliver a reaction of 1417 lbs. per sec. the motor would have an efficiency of 100%. The same motor upon using a gasoline-loxygen combination would show a 100% efficiency when the chamber pressure was supplying a thrust of 2046 lbs. per sec.

These examples show the necessity of utilizing the pressure of the propellant tanks into the efficiency formulas. A motor having an extremely high efficiency due to great tank pressures would probably be unable to propell its rocket proper owing to the weight of the tanks and fuel compressing apparatus needed for obtaining the high motor efficiency. On the other hand a proving stand motor test having a mediocre efficiency, with a low tank pressure, could in all probability propel its rocket body.

One method of comparing motors could be by making use of various tank pressure divisions. Motors employing a certain tank pressure could be allotted to their corresponding divisions.

Fuel Ratio

Another characteristic efficiency factor involves the ratio of propellants used. The fuel, either gasoline or alcohol as the case may be, is considered in both parts of the thermal efficiency formula. The oxidizer, liquid oxygen ,is applied in the Kinetic energy portion only. Such treatment of the loxygen factor defeats the usage of correct proportional ratio of the propellants.

For illustration: using an unbalanced propellant compound where the least amount of fuel is used to insure combustion. The netted result would reveal a high thermal efficiency per cent to present formulas.

LETTERS TO THE EDITOR

OUTSIDE BURNING as a possibility for future development in rockets has become a subject of debate, some holding the idea without merit others claiming further experimental work is war ranted. The report of Mr. William T Heyer in the last issue provokes some reminiscenses.

Note with interest experiments described by Mr. Heyer investigating the possibilty of using air as a rocket fuel oxidizer.

Several years back I attempted the same but used gasoline instead of acetylene which added the complication of preheating. This was arranged by wrapping a few turns of gasoline line around the venturi which ran red hot in operation.

I solved the problem of thrust measurement and air blast simultaneously by mounting the device on a pivot so it could turn freely, thereby creating its own draft. Its acceleration was easily measured. Originally the device required a push to get it going. However by changing my method of approach, which originally was encumbered with thoughts of "thrust augmentors", "venturi effects", "outside burning", etc., to a simple conception of opposing pressures on each side of the narrowest part of the motor throat, I was finally able to make it accelerate of its own from a dead start.

I constructed a more ambitious model containing a gasoline tank, preheater and motor in one unit but, unfortunately, at its first test the device exploded. This incident was instrumental in persuading me to leave it alone,—made necessary in fact, because of my original description of it as a "safe device" with which to experiment. I hope Mr. Heyer will find these reminiscenses helpful.

Bernard Smith

MR. NATHAN CARVER forwards a similar report of his recollections of the Smith device and gives the additional information that it was demonstrated in the garage of Mr. G. E. Pendray during 1932 or 1933. He recalls it rotated up to 88 R. P. M. at which point the flame blew out. The original apparatus is now in his possession.

From another member comes an almost identical report:

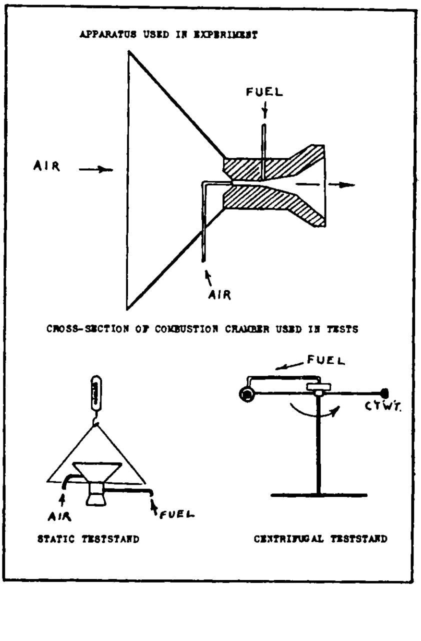
Last February I conceived the idea of constructing a tubular combustion chamber, open at both ends. The front aperture would be small, the rear flared out in nozzle form. Air was to be injected into the front and mixed and burned with fuel in the nozzle section. Gasoline was used as fuel. It was my belief that, since the nozzle would direct the force of the exploding gases to the rear, some thrust could be expected.

I have enclosed a sketch of the chamber. An airscoop was provided on the front end to produce the necessary pressure, but an airjet was included for use on the static teststand. The fuel was introduced in such a way that the air blast vaporized and mixed with it thoroughly. Combustion took place in the nozzle.

Results of the experiment were unsatisfactory. Combustion was not confined to the nozzle. In some cases flame extended for two feet beyond the end of the chamber. No thrust was recorded.

However, I do not consider these results conclusive. If the nozzle were to be lengthened more of the combustion would be completed in the chamber which might result in entirely different results. However I have made no further tests, due to lack of equipment.

E. G. Lill



Notes and News

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said, "Claiming for reasons of a military nature and because of current patent proceedings that he could not disclose complete details or performance data on this startling device, Mr. Myers in his talk nevertheless did manage to convey its essential features and enough data to provoke a storm of discussion as to the feasibility of its operation in accordance with accepted scientific knowledge in this field."

At several subsequent meetings, since that time, Mr. Myers has reported progress. The tremendous power of the motor was explained by its inventor, who described tests in which the station wagon, in which it was mounted, rose several feet off the ground when the motor exploded. A 1/4" steel plate between driver and motor was said to have been bent considerably by the detonation. However Mr. Myers has not seen fit to divulge any particulars of successful tests either to the A. R. S. or any technical publication.

Recently the inventor has been free to release further details to the newspapers. We learn the secret fuel is "Myrite" and consists of nitrous oxide and carbon disulphide. It is claimed the device will increase plane speeds as much as 200 m. p. h. and pay loads as much of 100%. The American Rocket Society is particularly anxious to have an official observer present when the motor is next tested.

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