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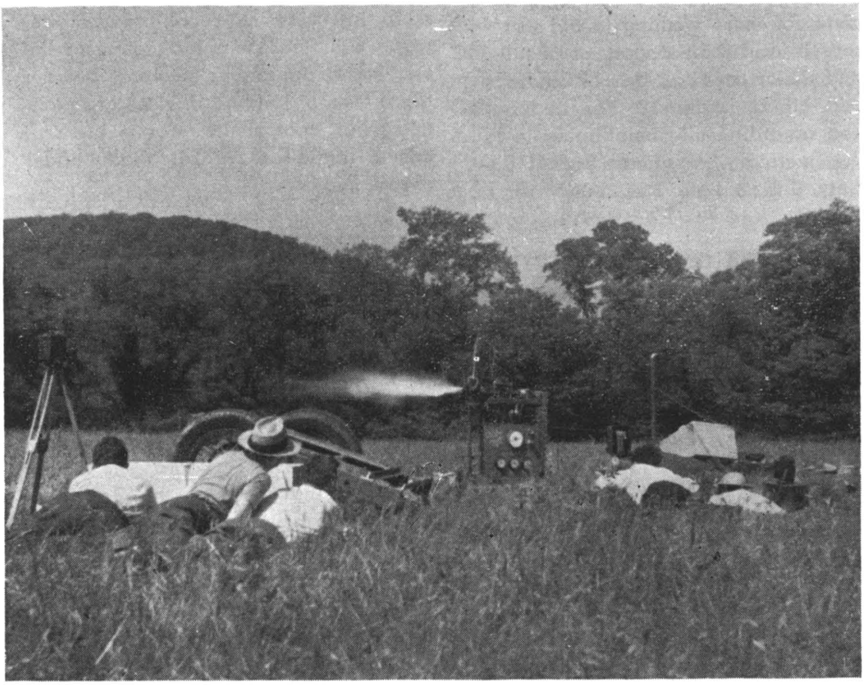

BAUM

ROCKET MOTOR FIRING—Experimenters view a jet propulsor in action at recent test runs. Note cameras for permanent recording of data.

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, 1 East 42nd Street, New York City.

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NOTES AND NEWS

THE NUMBER OF MOTORS to be tested during the present experimental program may exceed the total number tested during the last five years of research. Larger motors with new injection and cooling methods and more intensive study of previous designs will be the main points of the test stand operations. Several powder flight tests of landing devices are planned. High spot of the year is the proposed liquid-fuel rocket flight under gyroscopic control.

OFFICERS FOR 1941 as elected during a Summer Board of Directors meeting are listed in the box at left. The Board is very happy to announce the return to active duty of Mr. G. E. Pendray who takes over the newly augmented duties of Vive-President. Mr. J R. Glazebrook was appointed Chairman of the Advisory Board. The steadily increasing work of the Secretary has been transferred to the able shoulders of Mr. Lovell Lawrence, Jr. The Directors have recently approved the removal of the Society's office from nts Church Street address to the more convenient location at 1 East 42nd Street, New York City.

The Society tends its sincere condolences to Mr. Philip Cleator, President of the British Interplanetary Society. His entire family was killed in an air raid which demolished their home. Mr. Cleator's home was bombed the same night resulting in the destruction of his laboratory, library and

(Continued on Page 16)

Report On Motor Tests

Of June 8, 1941 At Midvale

The deep roar of a rocket motor vibrating through a secluded valley outside Midvale, N. J., inauguarted the 1941 experimental program of the American Rocket Society. The day was June 8, 1941, a sweltering hot Sunday. Two motors were tested during the course of the day. These were the regenerative motor of J. H. Wyld and a concentric feed design constructed by N. Carver and C. Piecewiez.

Preparatory Work

The Experimental Committee arrived early in the morning and set up the test stand. A trench for the camermen was dug some 15 feet from the stand. Since this series of tests was the first of the season, after a long period of inaction, some anxiety was felt concerning the possibility of mechanical failure of some part of the apparatus. However a complete check revealed nothing amiss. During the experiments all parts functioned satisfactorily.

Practice Run

A practice test was conducted to thoroughly familiarize all active personnel with their duties. The task of keeping the spectators, members of the society and their guests, at a safe distance was handled by G. E. Pendray. After simulating filling the tanks H. F. Pierce gave the signal that all was ready. Controlman J. Shesta called, "Nitrogen" to R. Healy who opened the pressure feed valve. Almost immediately the tank pressure rose to the desired figure. Shesta cried,—"Fire" to L. Lawrence, Jr. who threw the switch that would ignite the fusee and start the electric clock. An instant later the fuel and oxygen release valves were jerked open by the control cord—in this case letting the nitrogen pour out of the motor. In the trench just forward of the stand were camermen A. Africano, N. Carver, H. F. Pierce and P. Teillon. Also ready to catch the action in snapshots was W. Hecht while C. Giles and J. J. Pesqueira stood by to make observations of the flame and sound. Due to this practice run each man performed his assigned duty without fault during the tests which followed.

GREENE

James Wyld and his Fuel-Cooled Motor

Liquid Air Used

The first motor to be run was the fuel-cooled design of J. H. Wyld. Except for a few minor changes, mainly the substitution of an inner sleeve of higher melting point, this motor was the same as when tested previously. The fuel charge consisted of a gallon of alcohol and about 8 lbs. of liquid air. The use of liquid air instead of liquid oxygen was due to a misunderstanding which made it impossible to obtain the customary oxygen when needed. Furthermore the Dewar flask appeared to be defective so that only about 8 lbs. of the mixture remained at the time of the tests, the rest having boiled off overnight. In view of the good results which were achieved, however, it may be assumed the remaining liquid air had a very high oxygen content as the nitrogen will boil off first.

Wyld Motor Test

When the tanks had been filled and capped and all participants were at "battle stations" the controlman gave the signals. The motor, ignited by an internal gunpowder fusee, fired with the intense roar peculiar to rocket motors. The air in the valley vibrated, as did the spectators for these tests are exciting to witness. About the middle of the run there occurred a series of chugging sounds and fluctuations were visible in the exhaust flame. This seemed to have little effect on the thrust intensity which hovered between 80 and 85 lbs. for the better part of the 26 second run.

Examination of the motor after firing revealed no damage to its internal parts. The outer sleeve was hot to the touch.

BAUM

Relaxation While Tanks Are Filled

Conclusions

Jet velocity was calculated at about 5000 ft/sec. This is somewhat below the figure of previous tests of the motor. Since the motor was operating on liquid air, the fuel ports designed for liquid oxygen did not provide the proper ratio. The run therefore cannot be regarded as conclusive and will be repeated in the near future with oxygen. Disclosed was the fact that liquid air can be used in an emergency with fair results. Also worthy of note was that the motor did not come up to full efficiency until it had been heated for several seconds by the initial combustion.

Recess For Refueling

After the post-firing discussion had cooled off a bit the Refreshment Committee—Miss R. Greene and Mrs. G. E. Pendray—set about the task of refueling the experimenters and spectators. Despite the heat and poison ivy all made themselves at ease and went to with great gusto. A nearby stream of cool water aided greatly in reviving the drooping energy of the more active participants.

A Nozzle-less Motor

Numerous local inhabitants were drawn to the scene by the roar of the first motor. They were fearful that an airplane had crashed in the valley. After satisfying their curiosity most of them departed. The Piecewiez-Carver motor was clamped to the stand. Most of the features of this motor are similar to the latter's Greenwood Lake design. Oxygen was fed into the small chamber through an axial opening in the head, around it in an annular spray was fed the alcohol. After mixing in the chamber to some degree it passes out through a length of straight-walled monel tubing. This exit was 8" long by ½" diameter. Thus this motor had no nozzle in the conventional sense of the word. It had been constructed to prove the contention that the conventional tapering nozzle was unnecessary.

Metering The Fuel

Fortunately Mr. Carver had brought along a 5 liter flask of liuqid oxygen. The method of controlling the fuel ratios was rather unique. Two lengths of copper tubing were used to convey the liquids from the valves of the test-stand to the motor. It was assumed by the designers that the differences in the bore of these tubes would provide just the proper fuel ratios needed. Beyond bore variation there were no other orifices or constrictions on the inlet ports, the inlets being so proportioned as to provide a full tube-bore area.

There was no means provided for tapping the chamber pressure, nor was it possible to use an internal fusee. Ignition was by external fusee, supplemented by an alcohol-soaked asbestos strip. The regulaotor was set to 300 lbs/sq/in pressure before the run, but during the run pressure dropped to 260 lbs. and remained constant. This was caused by pressure drop in the lines and regulating valve, allowances not having been made for the effects of the rapid flow.

Pieceweiz Motor Test

Upon ignition an enormous brush like flame appeared at the end of the tubular exit. It was apparent that most of the combustion was taking place after the mixture left the motor. The loud hissing noise was distinctly different from the deeper roar of the motor previously run. Combustion lasted for 8 seconds on the charge of 5.5 lbs. oxygen and 9.8 lbs. of alcohol. The reaction was spasmodic at first but settled down during the last half of the run to some 42 lbs.

Conclusions

At the end of the run, the motor and lines were found to be frosted, showing that no combustion took place inside, the motor merely acting as a mixing jet. This, no doubt, accounts for the low efficiency of the motor. Jet velocity was about 650 ft/sec.

This run does show that a rocket motor with purely external combustion, although prodigious in its waste of fuel, will give a slight amount of reaction. It would be interesting to see what thrusts could be achieved if the motor had been run without igniting the fuel.

More Tests Coming

The experimental season promises to be a busy one. Of the motors to be tested in the future we shall see designs using ceramic lining, using oxygen for cooling and a large air-cooled design.

J. Shesta
R. Healy
for the Experimental Committee

Report On Flame and Sound

Observations On The June 8th Tests

Test No. 1 —Motor Submitted by Mr. Wyld

Test No. 2 —Motor submitted by Mr. Piecewiez

TEST No. 1

Observation of flame colors was rendered difficult by much bright sunlight that prevailed during the tests. Flame lengths were estimated by means of a 3.5 ft. scale, graduated in feet and inches, placed behind the jet. This scale proved to be too short, as the total lengths of the flames exceeded it, but its presence nevertheless facilitated a fairly close estimate of such lengths.

FLAME. Soon after ignition, the flame settled down to a remarkably steady state (stationary flow) which remained throughout perhaps 80 per cent of the total test time. During this steady state, the total flame length slightly exceeded 4 ft. There was a distinct red-white concentric inner zone extending about 2.5 ft. from the nozzle. The remaining or enveloping zone of the flame appeared to be of a greyish color, and had a well defined external boundary. This boundary, however, seemed to be more evident because of refraction than because of coloring. There appeared next to the nozzle a train of 4 or 5 staitonary bright bands alternating with dark ones (standing waves). This train seemed to lie within a concentric cylinder of about 1 in. in diameter and 1.5 ft. in length.

The distance between adjacent bright bands (wave length?) was estimated against the graduated scale to be of the order of 1.5 in. Close to the end of the run, the above train of bright and dark bands was disturbed, at one time appearing to move towards the nozzle, and at other time appearing to move away from it. A lengthening of the dark bands then resulted, and this time was followed by a vigorous turbulence and discontinuity in the jet stream.

HECHT

Rocket roars alarm natives. Midvale police chief investigates strange sounds among Jersey hills. Note cameraman protector in right foreground.

SOUND. After a loud hiss following igniton, the sound soon became a uniform roar until the end of the run, when this roar increased somewhat in intensity and was disrupted in its regularity. The steady roar was mainly characterized by its staccato quality, which resembled closely the sound of an airplane engine.

TEST No. 2

FLAME. The flame was considerably erratic during the whole test, and it was not possible to ascertain what portion of the test period corresponded to what might have been the steady state of the flame, had this had an opportunity to settle down. It was conspicuous for its yellow-red color, presence of some smoke, and unmistakable evidence of much external burning. It reached at one time an estimated length of 6 ft. There was much but weak turbulence, and levitation was perceptible at the end of the flame. Towards the end of the run, much free oxygen escaped through the nozzle, as manifested by the presence of clouds of condensation in the jet.

SOUND. The sound consisted mainly of a very loud hiss.

J. J. PESQUEIRA
CEDRIC GILES
Observers

BOOKS

For the air-minded rocketor who would be informed as to the procedure necessary to become a licensed pilot we recommend "Introduction to Aviaiton" by J. P. Eames ($3.50 Chemical Publishing Co.). After covering flight training quite thoroughly Mr. Eames devotes a large section to Aeronautical Meteorology, of interest to all rocket enthusiasts. A very complete Glossary of Aeronautical Terms is appended, including a table of pressure and temperature drop with altitude.

THE ROCKETOR'S LIBRARY

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. Philip. Possibilities of jet propulsion for high altitude and space flights. Price $1.25

Journal of the British Interplanetary Society. December 1937 issue Price 25¢.

Index To Astronautics

Contains a complete and segregated list of important articles on rocketry published in past issues.
Free on request

The following items are in German and there are only a few copies of each.

GESCHICHTE DER ROKETE, by Willy Ley. Price $1

RAKETE ZUR HOEHENFORSCHUNG, by Mandl. Price $1

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DAS NEUFAHRZEUG May 1937
Price 25¢

The Nozzle-less Motor

Explaining The Piecewiez-Carver Design

By CEDRIC GILES

Based on misconception of theory nozzles have been used on rocket motors. This misconception has led to complicating of one of the simplest heat engines known, as well as the addition of new difficulties of design to overcome. By the absence of a nozzle many problems now obstructing the achievement of higher efficiencies would be surmounted. A nozzle-less motor when considered in relation to the conventional liquid fueled rocket motor, comprised of a combustion chamber and a nozzle, appears to have great promise of becoming the ultimate design.

Heretofore the nozzle has been deemed indispensable for the proper operation of a motor. Such a belief is generally shown by pointing to various types of flow devices requiring nozzles, where in all examples the air, water or steam is expanded. A brief examination of the characteristics of a rocket motor will demonstrate the difference when compared with low pressure flow contrivances.

The main function of a rocket motor is, by thermodynamic action, to obtain the greatest possible thrust or reaction from the propellants. This function is conceived by converting the available heat energy of the propellants, into a jet of kinetic energy. The jet reaction, for any given amount of fuels, will be dependent upon the final velocity of the jet. Other things being equal, the greater the velocity the greater the reaction.

The greatest jet velocity is attained only when the following qualifications

GREENE

The nozzle-less Carver-Piecewiez motor and its designers.

are fulfilled:

1. The completest possible combustion is obtained.
2. The jet flows in a straight path in the exhaust direction.
3. The jet flows in a compact, cylindrical form.
4. The surface friction of the jet is negligible against the walls.
5. Heat of combustion is used in expansion.

IDEAL DESIGN

A motor designed to accomplish these five qualifications would be a better motor from a design standpoint. Taking each requirement in turn for the correctly designed motor:

1. The propellants should be of correct proportional mixture, having equalized feed pressure, and feed lines and inlets of correct metering proportion.

2. The motor wall design should have no bends or curves, and be constructed in an axial straight line.

3. The motor should support, shape, surround and guide the jet.

4. There should be no unnecessary boundary friction, and no constrictions in the motor.

5. Higher input pressure will propagate more expansion, and higher heat makes more expansion possible.

From the foregoing discourse the final correctly designed motor will necessarily be of an elongated tubular shape without a nozzle. Or if preferable, a linear combustion chamber less a nozzle.

Function of Nozzle

The theoretical functions of a nozzle are as follows: to provide a guided passageway for the exhaust gases to outer space; to constrict the jet (at the throat) in order to obtain a greater area of pressure from the same initial pressure; and to increase area of pressure difference for same output by using divergent nozzle walls.

The nozzle throat, which fundamentally controls the area of pressure output when used in low pressure flow devices, will be of greater hindrance through frictional losses and turbulence in motors having high chamber pressures. In expanding by an isentropic process from an initial high pressure to a final low pressure area, the exhaust gases will develop increased pressure area against the expansion nozzle walls, which in turn is translated into added forward thrust to the motor.

An ideal nozzle-less motor is where the exhausting gases yield all their thermal energy to the motor. The higher the chamber pressure the greater the exhaust velocity resulting in the need of longer chambers with narrower flares, until a straight wall design is reached. If the expansion ratio (ratio between the chamber's narrowest cross-sectional area and the chamber mouth) is larger than the correct motor head and chamber mouth ratios, the result will be a lowering of the motor efficiency. This erroneous expansion ratio causes the overexpansion of the gas. Underexpansion can occur when too low pressure is used with a too straight wall or nozzle.

Proper Expansion

If the expansion angle is too small, the gases will be underexpanded resulting in a series of shock waves, commonly known as "standing waves," and if the flare angle is too great, the jet will attempt to flow along one side or the other of the chamber walls, due to overexpansion of the gases. Overexpansion of the gases will cause a larger loss of efficiency, than in underexpansion.

The motor length is determined by the needed length of the chamber to guide the jet gases in correct form and shape, until the combustion is far enough advanced. Too long a chamber will decrease the jet velocity through frictional drag of the chamber walls, while too short a chamber deprives the motor of obtaining the maximum available energy of the gases. Due to the velocity of the exhaust gases a phantom tubular form, continuing on from the aperture of the effective chamber, will hold the gaseous jet in a flowing compact mass until dissipated into space, otherwise known as outside reaction. With jet velocities in excess of a mile a second, the jet will have little outward expansion the greater part of its travel.

Motor Length

Employing the usual present-day fuel feed pressures, the nozzle-less motor should be at least ten inches from point of start of combustion to mouth of effective metal combustion chamber for alcohol and liquid oxygen, and slightly longer for gasoline and loxygen.

The American Rocket Society's Experimental Rocket No. 5 designed by Messrs. Nathan Carver and H. Franklin Pierce, was one of the first drawings of a motor without the established nozzle. The motor described in **Astronautics** No. 27, October 1933, "consisted of a cone instead of the conventional chamber and nozzle." Unfortunately this motor was never built.

A motor tested by Mr. Nathan Carver, as reported in **Astronautics** No. 38, had the reaction pressure jump from 40 to 50 lbs. when the nozzle fell off during the last few seconds of firing. This sudden increase in reaction pounds, as the motor became fully tubular, would probably have been much higher if the motor had retained its original length, in lieu of the loss of 4 inches (nozzle).

In view of the many versions of the correct motor design, this paper is presented as a means of aiding experimenters in reaching a more defininte conclusion. It is also hoped the results arrived at may serve as a guide to future development of a type of thrust motor which has hithertofore been neglected in the approach to the ultimate type of design.

Cedric Giles.
March 29, 1941.

MR. CARVER EXPLAINS

In regard to the test of the nozzleless motor June 8th, it may be said that this design was a very slightly modified version of my motor used at Greenwood Lake. Since this type was well tested and investigated it should have delivered better performance. Due to unbalanced fuel pressures which varied during the run I consider it proved that a pressure equalising cross-connection of the type I employed during 1936 is necessary. (Ed. Note: Our photographic record shows the pressures of both tanks were balanced at 260 lbs./sq./in. during the last 6 seconds of the 8 second run. A cross-connection with a check valve is provided).

In addition to delivering all the alcohol first and afterwards all of the oxygen the test stand had another fault. (Ed. Note: Our films show the oxygen tank was empty at the end of the run while about 1½ lbs of alcohol remained in the fuel tank.) Due to the large mass of metal in the oxygen line from the tank to the motor there is a period when only gaseous oxygen is delivered and this further aggrevates the difficulty with spring operated check valves in the cross-connection.

Further the route of flow from tanks to motor was full of sharp turns and various sized fittings that the motor on the test stand, if designed for this condition will not act the same when installed in a rocket, as is supposed to be our intention.

I claim that with the use of proportional feed lines (where the inside area of the cross section is proportional to the volume ratio) of the same length, and with the use of valves and fittings that are the equivalent of a continua-

(continued on page 14)

The Rocketor's Workshop

A Department Devoted To Shop-Talk, Ideas, Devices

PLASTIC ROCKET SHELLS FOR THE EXPERIMENTOR

By George C. Putnam

The method herein proposed describes a process for making rocket shells which involves a minimum expenditure of money and very little equipment. It can be applied to any rocket design and produces a product having excellent qualities of hardness, tensile strength, elasticity, and density. The fabrication of complicated shapes involving under-cuts and inconvenient fineness ratios is relatively simple with this method.

The Material

There may be several plastics adaptable to this process, but the one chosen was methyl methacrylate polymer, which is a form of "Lucite." This material was purchased in the form known as "Clear Methacrylate," a liquid sold by du Pont at about $2.60 a gallon. Two quarts were needed to build the first shell for the California Rocket Society, which measures eleven inches long by three inches in diameter. Two quarts of solvent, ethyl acetate (at about $1.60 a gallon), were used to thin the ethacrylate. Although there are other and cheaper solvents, ethyl acetate is excellent because of its fast drying quality.

The Shape

The first step in the construction of a shell is to determine its dimensions from the size and position of the apparatus which it is to house. From these a model is made of any suitable material (wood, wax, clay, plaster, etc.) and of any shape the designer wishes to apply. Because of a shrinkage of 3/4" to the foot in this process, the design should be correspondingly larger. The models for the C. R. S. were made in the following simple manner:

The Template

A metal template is made of half the shape along its longitudinal axis, including a flare at the base to serve in the model as a handle. The template attached to a forming device is fastened horizontally to the edge of a bench so that excess plaster, shaved from the model while being turned against the template, will drop away cleanly.

The Plaster Model

A batch of plaster is mixed with water to a thick consistency, and in this are dipped quantities of manila fibre, or rags torn into strips. These are wound about the tube in the template to fill out the shape roughly. To this, as the plaster thickens, the rest of the batch is added until the shape of the rocket is defined as the tube is rotated. Grease smeared on the template wil keep the plaster from sticking to it. The rod is withdrawn when the plaster is set, and the model removed to dry thoroughly. After drying, it is shellacked and greased for making the plaster mold.

The Plaster Mold

A two piece mold cut by a plane through the longitudinal axis will be satisfactory. The model is set in clay, or modelling wax on its side, and buried up to the cutting plane. A wall of clay, or modelling wax, is built around the model to prevent the wet plaster from flowing away. A batch of plaster and water is mixed and used to cover the exposed half of the plaster model to a depth of at least one inch. This half of the mold, when set, is inverted and the clay or modelling wax removed. The sides of the mold along the cutting plane are notched and the mold left to dry. When dry the exposed sides of the mold and model are greased, a new wall of clay or modelling wax added, and a fresh mix of plaster and water poured. The mold is left to set, and when set grooves are cut for tying strings. The mold is tied around the model and set aside to dry slowly. This will take about two days (an oven at low heat may be used to hasten this part of the process). The model is now removed from the mold, irregularities

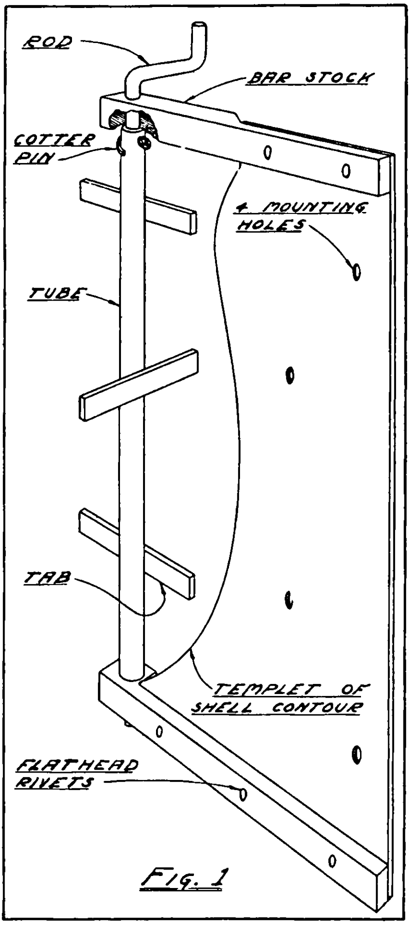


FIG. 1

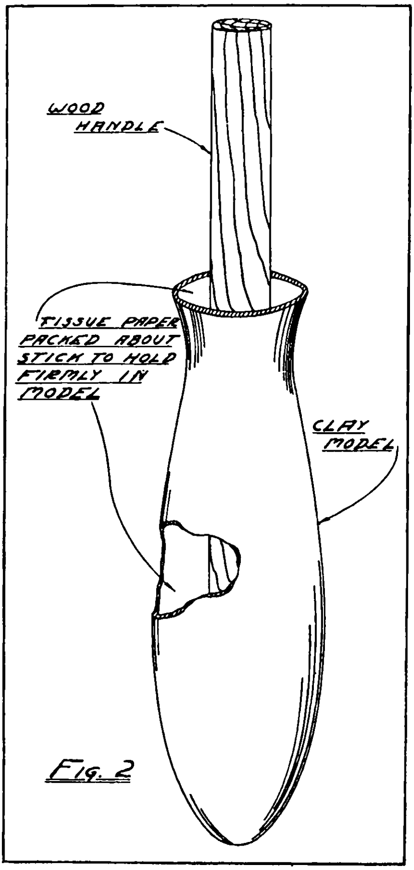


FIG. 2

scraped off, and air holes filled with plaster (which is then allowed to set).

The Clay Model

Obtain a quantity (several pounds) of modelling clay, dry powdered or moist, and mix with water to the consistency of thick cream. About three quarts will be needed. Strain this clay mixture through a 70 mesh brass wire screen.

At this point the inside of the mold may be wet slightly. Then hold the mold upright with its open end up, and pour the clay mixture, tilting the mold in different directions to allow the clay to wet the sides and to prevent the clay mixture from splashing. Pour until the mold is filled to the top and stand the mold on end. Keep adding the mixture as its water is absorbed by the mold. From time to time check the wall thickness of the dense clay next to the plaster by scraping away the excess on top of the mold. When this thickness attains from 3-16" to 1-4" (this will vary with model size) pour out the rest of the mixture and leave the clay treated mold to dry in its upright position. This drying process may be speeded up by inserting a small tubular electric lamp after the clay has stood for at least an hour.

When the clay model is dry it may be removed from the mold. Exercise care in handling because this model is fragile. Use sandpaper to remove seam lines, and fill in air holes with the clay mixture.

Equipment for Dipping

Obtain a piece of wood about ¾" square, or round, and about six inches longer than the model. Drill a hole in one end, drive a nail through the wood at about three inches from this hole, push in several thumb tacks along the length of the stick and insert the other end in the clay model after a wad of tissue paper to protect the clay. Pack more tissue paper around the stick and thumb tacks in the model until the stick feels secure.

Drill a hole big enough to receive the stick in another piece of wood, and mount this in a vise or other convenient fixture. Drive a nail into the edge of a work bench. The wood is to hold the clay model in an upright position, and the nail to suspend it in an inverted position.

Make a container big enough to dip the clay model completely without danger of touching the sides. This may be done by rolling a cylinder from sheet stock and soldering on a bottom, or by soldering a used food can, with top and bottom cut out, to another such can, having only its top cut out. Fill this container half full of a mixture of one part methacrylate to one part ethyl acetate. From here on use precaution against fire hazard.

The Dipping Process

Stand the clay model on the wood in its upright position and paint with a mixture of one part methacrylate to two parts ethyl acetate. Allow about five minutes for this to dry, paint again and allow it to dry a second time. The model is now ready for dipping.

Remove the model from the wooden support and dip, inverted, into the can, until the liquid rises to the flare. Remove the model from the can and hang it, still inverted from the nail. The excess liquid may be caught in the container or in another can as it drips off. Wipe away the last two or three drops from the apex before they dry. Allow about ten minutes for this coat to dry, or enough time until it feels dry to the touch. Remove the model from the nail and dip again. This time allow the excess liquid to drip back into the can for only two seconds, and then invert the model to upright position, and mount it on the wooden support. The excess liquid on the model should be ample to permit it to run off evenly without leaving drops or streaks on the surface. Again allow about ten minutes for drying. Continue dipping and drying alternately in upright and inverted positions until twenty coats are applied. Once the application of the plastic has been started it should be continued until completed without interruption to avoid cracking. Add more liquid to the can as needed. Work away from all fire to avoid accidents. Bubbles may be removed when dry by applying ethyl acetate. Handle the clay model by its wooden handle only to avoid breakage. Avoid touching the insides of the can with the model during the dipping process. Allow the dipped model to dry two days after the last dip before removing the clay.

The Completed Shell

Fill the model with water after removing the stick and tissue paper, and allow it to stand overnight. Wash out the clay the next day.

The shell form is now finished, except for trimming and needs no polishing. It may be cut, sawed or drilled whenever necessary. The liquid methacrylate may be used as a cement to secure any attachments.

Additional shells will require about a pint of methacrylate and a pint of ethyl acetate each, added to the mixture in the dipping can. These amounts apply only to the rocket sizes herein considered. Larger models would naturally require more.

I wish to acknowledge the assistance given me by the California Rocket Society in the development and publication of this process, and to thank in particular, A. S. Turner, Bernard Smith, and G. Steelberg for their cooperation.

MR. CARVER EXPLAINS

(Continued From Page 10)

tion of the line when open, and with thermally insulated loxygen lines most of the difficulties can be overcome.

If a safety precaution is felt necessary in the cross-connection why not shut off valves until the tank is loaded, rather than check valves, and fully open them when ready to test.

The other two alternatives are as follows:

1 Two bags in a pressure tank, each bag being connected to one of the propellant tanks. Pressure variation would be transmitted from one bag to the other keeping the feeds equalized. An additional advantage is storage of reserve pressure, it being noticed that sometimes the pressure regulator can not keep up with the rate of flow.

2 Use a liquid flow regulator. Recently I have developed a device of this kind. It consists of a diaphragm on either side which flow the liquid fuels. When the pressure on one exceeds the other the movement of the diaphragm operates a gate in the flow path of the higher pressured liquid beyond the diaphragm. If so desired springs may be used to change and hold almost any ratio of flow.

3 Use a manually operated gate valve and adjust the mixture by direct observation of the exhaust while firing the motor. This accomplished by remote control, of course. This can further be facilitated by adjusting until the flame reaches the proper predetermined length.

Nathan Carver

Army Men Design AA Rocket

Includes Radio Or Light Beam Control

The Society has had some interesting correspondence with Technical Sergeant W. F. Pont regarding anti-aircraft rockets. Below is a recent letter typical in its description of the difficulties encountered by rocket-minded men.

My partner, George E. Sharp, of Fort Bliss, Texas, and myself are intensely interested in the development of rockets for defense and for commercial use. We are also aware of the numerous possibilities of rockets; but being soldiers on active duty we are at a tremendous disadvantage as regards finances, time, and suitable workshops.

Perhaps I can give you a brief summary of our work so far. It began about a year ago. Mr. Sharp is a mechanical engineer and is well acquainted with aerodynamics. I am qualified as an electrician in the Coast Artillery and radio and television theories are familiar to me.

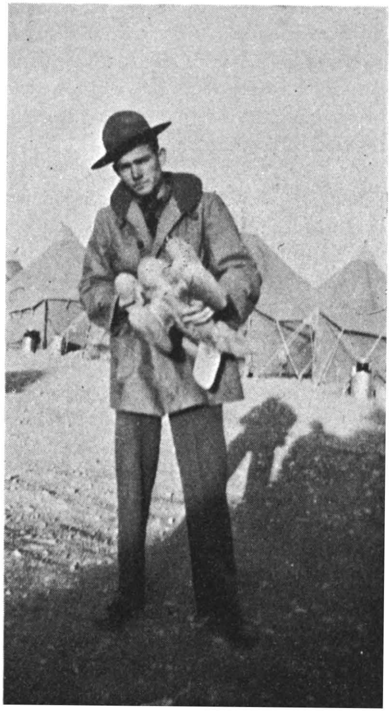
A complete description and detailed drawings of our proposed rocket were forwarded to the War Department at their request. Previously our proposed methods of control were approved by the faculty of the Radio Institute of California of Pacific States University in Los Angeles. An endorsed request that Mr. Sharp and myself be given a special duty assignment for construction and development of the rocket was also forwarded to the War Dept. Failure to have action taken on this request has been one of our big disappointments.

At the present complete details of our rocket are in the custody of the government and are filed at the National Inventors Council, Washington, D. C. This body has notified us that a technical inspection of our device was approved. In this case an instantaneous radio control is used. I feel that details of the radio control method would be of assistance to the Society. I see no reason why the War Dept. would not forward such details to you at your request. Conditions being as they are, I, personally could not give you such information even though I so desire. Complete construction of radio controlled rocket was estimated at $1000, half of which was to be allowed for contingencies.

Failure to have favorable action taken on our request for a special duty assignment caused us to conceive of another very practical control method which is effected by means of either a visible or an invisible light beam. Local commanders at Fort Bliss gave us their fullest cooperation in connection with our construction and purchasing equipment for a demonstration of the light control features. It was hoped that a successful demonstration would incite the War Dept. to take favorable action on our request. But before the construction could be completed I was ordered to Fort Eustis, Va., my partner remaining in Fort Bliss, Texas.

This is the condition at present and all work has practically ceased since we are not together. It is all very discouraging and our enthusiasm forces us to seek some means that will bring us together again so that under favorable conditions we may be able to continue our work."

W. F. Pont
Tech. Sgt. CAC



Sergeant Pont and model

NOTES AND NEWS

all his records of the work of the British rocket group.

The A. R. S. can not stress too heavily the dangers involved when boys engage in experiments with home-made or otherwise obtained powder rockets Any work of this sort should be under the direct supervision of an experienced adult. Two news items recently exemplified this unwise but understandable urge on the part of boys to dabble with explosives. A youth in New York City was seriously injured by an explosion of the chemical mixture which he had prepared to propel a "rocket ship". Another boy in Connecticut aroused a commotion and involved himself with the authorities by firing off a large distress signal rocket he had stolen from a ship.

Mr. William Heyer suggests the setting up of awards of recognition for the leading designs in the different phases of rocketry. For motors awards might be given for the most efficient design, that of the greatest thrust, that of the greatest duration of firing and largest power to weight ratio. For liquid or dry fuel rockets maximum performances in both vertical or horizontal flight are suggested. Further news of the Society's action on these proposals will be carried in the next issue.

ANOTHER RADIO CONTROL

During the questioning interlude at a recent meeting of the A. R. S. I had occasion to call attention to a physical fact that would make one form of remote control quite simple.

The method would not need either tubes, batteries or other amplifying apparatus. Remote control would be accomplished by having a resonant ultra short wave system resonate at different points along the coil or inductors for different wave lengths.

In practice a beam antenna of high power and high beam radiates considerable power directed at the rocket in flight. The power source for the ultra short waves may be a Klystron Oscillator. This directed beam intensely radiates to the aerial and counterpoise of the rocket.

The tuned circuit is so adjusted that the current nodes for each preselected wavelength passes through a very fine wire which will get hot enough at resonance to ignite a cartridge which, by firing rapidly or slowly according to the powder mixture, will be a motor for remote control. According to the wavelength used, separately or simultaneously, it will be its own power source and, what is more, will consume itself while discharging its function.

Such a simple and low weight remote control system can also be utilized at longer ranges by using radio amplification to increase incoming signals without changing their wavelength.

Nathan Carver

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