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REPORT NO. 12-8-50G-1

MONTHLY PROGRESS REPORT

ENGINEERING PROGRAM FOR THE

DEVELOPMENT OF A LIGHTWEIGHT

ANTI-TANK ROCKET

FOR THE PERIOD

MONTH OF DECEMBER 1958

CONTRACT NO. RD-142

~~ORDNANCE PROJECT XXXX~~

~~DEPT XX OF ARMY PROJECT XXXX~~

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FLIGHTEX FABRICS, INC.

PROGRESS REPORT # 16

ENGINEERING PROGRAM FOR THE DEVELOPMENT OF A LIGHTWEIGHT ANTI-TANK ROCKET

DECEMBER 1958

CONTRACT NO. RD-142

PREPARED BY _____ APPROVED BY _____

Thomas Forman
Project Engineer

Charles B. Weeks
General Manager

SUBMITTED BY: HESSE-EASTERN DIVISION
FLIGHTEX FABRICS, INC.
EVERETT, MASSACHUSETTS

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WORK DONE DURING THE MONTH OF DECEMBER 1958

SYSTEM EVALUATION PROGRAM

Seven systems for a demonstration for your agency have been assembled and picked up. Accuracy tests, ignition tests, and functioning tests with Model No. 3 fuze have been conducted. Assembly tools are in the process of being made, and methods of assembling the system are being devised.

MOTOR DEVELOPMENT PROGRAM

Accuracy and Ignition

An accuracy test at 50 yards was conducted 4 December 1958. Photograph No. 144 shows the results. The following is a tabulation of this test. A target was placed at 50 meters from the launcher. The launcher elevation was not changed throughout the test. The sights were used and aimed at the center of the group on the target as shown on Photograph No. 144. Modified igniters (see Photograph No. 145) with polyethylene wrapped around were used on all rounds:

Round No.	Temperature	Vel. F/S	Type Motor	Comments
392	-20		Extruded	Very long ignition delay (more than one second caused probably by throat contour in motor)
393	-20	286	Machined	No comments
394	-20	285	Machined	No comments
395	-20	286	Machined	No comments
396	-20	286	Machined	No comments
397	+120	308	Machined	No comments
398	+120	290	Extruded	No comments
399	+120	No camera	Machined	No comments
400	+120	No camera	Machined	No comments
401	+120	No camera	Machined	No comments
403	Amb.	305	Machined	Round assembled with Lorne before firing

With the exception of Round No. 392, this test confirms previous tests as far as interior and exterior ballistics of the round when used at a range of 50 meters are concerned.

Extruded motors had been received from the Harvey Aluminum Company only one day before the test. Two motors were pressure tested at 10,000 psi and used in this test. When inspecting the motors, some discrepancies in the throat configuration were found. This results in some difficulties with the igniter properly clicking into place. See Photograph Nos. 146 and 147. It is possible that this condition caused the long ignition delay for the following reason:

If the igniter assembly is not properly held near the throat, the impact of the firing pin may push it forward into the motor body, and this may result in a very severe loss of pressure before the burning gases in the motor body push the igniter back into position and close off the end of the motor, thus allowing the necessary pressure build-up to spit the igniter out and start propulsion of the rocket. This initial pressure loss would result in a long time delay and in lack of thrust, i.e., the low flight of the rocket (Round No. 392).

Since insufficient information was available on the Harvey motors, machined motors were supplied your agency for the demonstration. Eighteen more rounds were fired with extruded motors in fuze tests, and it was found that all the rockets operated satisfactorily except Round No. 413 which was fired at ambient temperature and also experienced a long ignition delay.

The discrepancies between the drawings and the throat configuration were pointed out to Harvey Aluminum Company who have made a change in their tooling and have since produced motors with a better throat configuration.

Two shipments of 29 and 20 motor bodies have been received. The second shipment contained the corrected throat configuration and improved physical characteristics. The burst strength of the latest motors received from Harvey Aluminum is 15,000 psi. The motors yield at about 14,800 psi. A permanent set at 11,000 psi is experienced with the first batch of the 29 motors. Changes in the extrusion process have resulted in an improvement of the physical characteristics so that no permanent set is experienced with any motors up to 11,000 psi. However, two batches of motors

will be delivered by Harvey Aluminum, one marked "A" and the other marked "B". Batch "A" will take a permanent set of .0005" at a hydrostatic pressure of 12,000 psi. Batch "B" will not take a permanent set at this pressure.

It is planned to conduct tests with loose propellant and broken-up propellant in order to determine the safety of the motor bodies under dynamic conditions. As soon as these tests are evaluated and sufficient numbers of rockets fired without failures, shoulder firing will be conducted.

Since ignition on the test with Round Nos. 392 through 403 has been satisfactory at high and low temperatures, it was decided to conduct one more test and try out the same igniter configuration except for the method of closing off the open end of the igniter. The igniter closure with the snap-in ring will be used. See Photograph No. 145. This would facilitate assembly of the igniters and therefore reduce the cost of the systems by an appreciable amount. It would also improve the water tightness. It is felt that the igniter configuration is not going to cause any problems in actual shoulder firing as long as only small portions of igniter (or no igniter parts) are left in the motor.

Propellant

The extruded propellant was received late in December, and the time-pressure curves will be obtained the first part of January and flight tests conducted to check out the characteristics of the extruded propellant versus the propellant machined on the O. D. as used until now.

WARHEAD DEVELOPMENT PROGRAM

Ten warheads from Eastern Tool & Mfg. Company were poured at the Hesse-Eastern Division Range in order to supply heads for the demonstration. Three of these heads were used in a dynamic penetration test conducted on 11 December 1958. Two rounds penetrated the 6" target, and one did not penetrate the 6" target. The heads from Universal Match Corporation were received later in December. In examining the densities achieved in our pouring and in theirs, there appears to be some question as to the accuracy of the measurements taken at Universal Match Corporation and the method in which the measurements are obtained. However, the discrepancy in densities between our pouring and theirs is extremely small. The booster and fuze cavity configuration in the heads loaded by Universal Match Corporation is extremely unsatisfactory. The booster cavity is oversize and is as much as 1/8" off center. The level of the charge measured from the rear of the head is too high. This means that it would be impossible to assemble fuzes without machining the heads.

The remaining heads from Eastern Tool & Mfg. Company have been shipped to the Universal Match Corporation and a letter sent to them requesting an improvement in the pouring configuration. A copy of this letter is enclosed in the appendix.

Preparations are under way to conduct a dynamic penetration test in which photographs of the rocket hitting the target will be obtained so that the actual crush-up can be determined. It is expected that these tests will be conducted in January. Some difficulties have arisen in this

regard because of availability of fuze parts. This will be discussed in the fuze section. It is also planned to conduct dynamic penetration tests against stacks of 1 1/2" thick armor in order to get an accurate indication of penetration. Arrangements are being made with Mr. Kesler at Aberdeen Proving Ground to obtain some plate for this purpose.

FUZE DEVELOPMENT PROGRAM

Due to unavailability of parts, no static or dynamic fuze testing with fuze Model No. 4 was conducted in December. A drop fixture has been designed and placed in manufacture. This fixture will make it possible to drop the fuze in a number of different orientations and determine the minimum angle of incidence at which the fuze will function. It must be borne in mind that such a fixture does not completely simulate dynamic conditions but that it gives merely an indication of the expected functioning of the fuze in this respect.

At a conference late in November it was decided to shift the emphasis from fuze Model No. 4 to fuze Model No. 3. This shift was further stressed in a letter received from your agency on 23 December 1958. The 20 sets of components for fuze Model No. 4 will be assembled and tested, and a decision was reached not to order large quantities of fuze Model No. 3 until this test has been conducted and evaluated. Eleven Model No. 3 fuzes were assembled and checked out for functioning dynamically partly at our Range and partly at the demonstration conducted by your agency. All fuzes tested at our Range functioned upon impact. We understand that one fuze

supplied with the HEAT rounds for the demonstration did not function. It is possible that the configuration of the Comp B load in the head allowed the fuze too much play, and this induced malfunction of the safety mechanism.

In addition, two fuze tests were conducted on 22 December and 23 December with fuze Model No. 3 for functioning under graze conditions and for functioning at -20°F:

FUZE TEST - 22 December 1958

Round Nos. 413 through 420
Ambient Temperature
No camera records taken

Round No.	Fuze Function	Comments
413	OK on second impact	Long ignition delay
414	OK on first impact	
415	OK on second impact	
416	OK on first impact	
417	OK on third impact	
418	OK on second impact	
419	OK on second impact	
420	OK on second impact	

The rounds are fired in such a way as to hit the ground at a distance of approximately 70 yards from the launcher. In the case of this test the surface contacted by the round was hard snow, and the angle of obliquity as evidenced by the marks on ogive and head body was between 1° and 0°.

In evaluating this test, it may be stated that properly functioning Model No. 3 fuzes show indications of being reasonably graze sensitive, but that further tests to determine the actual minimum angle of obliquity required will have to be conducted. Another fuze test was conducted on 23 December 1958:

FUZE TEST - 23 December 1958

Round Nos. 421 through 430
-20 Temperature
No camera records taken

Round No.	Vel. F/S	Fuze Function
421	300 (?)	Partly armed
422	---	Did not function on graze which was very light. Was dropped 6" - functioned.
423	---	OK
424	290	OK
425	---	OK
426	---	OK
427	304 (?)	OK
428	295	OK
429	286	Did not set back. Did not latch.
430	290	OK

In evaluating the results of this test, it appears that some

functioning problems still exist at the cold temperature. In examining the rotor spring of Round No. 421, it was found that due to the method of anchoring the rotor spring in the rotor shaft a certain amount of torque may be lost if the two ends of the spring are not quite in line. In examining the spring in question, this seems to have been the case. The spring drawing was therefore changed, and the orientation of the hole which is used to anchor the torque spring in the rotor shaft was moved so as to produce more stored-up energy in the torque spring under all tolerance conditions. Tests were conducted statically with fuzes at temperatures varying from -10° to -40°. It was found that if the torque spring is wound up properly no functioning troubles exist at those temperature extremes.

Round No. 422 did not function on graze. This round hit the ground at an extremely flat angle of obliquity, and it is entirely possible that the only type of surface contacted by the round was snow. However, more tests at the cold temperature will have to be conducted in order to test whether any differences exist in functioning between hot, cold, and ambient temperatures. This can be done statically using the new drop fixture which is being made.

Round No. 429 failed to set back. The cause for this is being investigated, and no conclusion has been reached at the present time. A new firing pin spring has been ordered which will require a slightly smaller force to compress when setting back. An investigation was conducted to test the clearances between the fuze housing and the inertia element change under cold conditions. The decrease in clearance turned out to be less than .0002" at -40°F. No differences could be found at -20°. The

remaining seven complete sets of fuze parts will be used to conduct a test to establish the angle of incidence required in order to function fuze Model No. 3. As soon as the test with Model No. 4 has been conducted, additional components will be ordered for fuze Model No. 3. Complete sets of prints on Model No. 3 have been sent out to a number of suppliers for pricing on quantities of 300, 500 and 1,000.

The lock spring has been redesigned in order to achieve smoother operation and to reduce the possibility of malfunctions. The lock springs are being cadmium plated and heat treated after plating in order to prevent any possibility of embrittlement. Until now, lock springs have been protected by a phosphate rust preventing treatment. Some rust is evident on lock springs which have been in storage for over half a year. The cadmium should eliminate this problem. The cadmium plate will also give a soapy and smoother surface which should reduce the friction between the lock spring and the fuze housing.

LAUNCHER DEVELOPMENT PROGRAM

Eighty per cent of the final components of the launcher have been received, and a program of tooling up for assembly has been started. A number of assembly tools have been made, and a preliminary assembly procedure has been established. Photograph Nos. 149 through 155 show the tooling and the steps used in assembling the launcher. All launchers tested at our Range during November have continued to work satisfactory. We understand that one assembly used during the demonstration did not fire. Different

possibilities which might have caused this malfunction have been investigated without any result, and since sufficiently detailed information about this malfunction is not available, it appears that nothing more can be done about it. More work was done on igniters, and the following is a tabulation of Round Nos. 421 through 430 which used the igniter configuration shown in Photograph No.145, right side:

Round No.	Operation of Igniter
421	Heavy erosion. Small part of igniter in motor.
422	Small amount of erosion.
423	Small amount of erosion.
424	Small amount of erosion.
425	Heavy erosion. No igniter parts.
426	Light erosion. No igniter parts.
427	Heavy erosion. Small particles of igniter in motor.
428	Light erosion. No igniter parts.
429	Light erosion. No igniter parts.
430	Light erosion. No igniter parts.

In evaluating these results, the following has to be stated:

The velocities of the round seem consistent. Round Nos. 421 and 427 show faint timing marks on the motion picture record, and the velocities are not quite conclusive on those rounds. The motors used were Harvey extrusions and not hard anodized which explains most of the erosion. It does not appear that the small particles of igniter have any particular effect on

the behavior of the round nor can it be expected that any of the parts could hurt the gunner since all igniter parts are expelled long before the round reaches the launcher. Further tests will provide additional data on this subject. If necessary, it would be possible to revert to the wrap-around polyethylene method of loading the igniter. A small amount of trouble in round performance would, however, be preferable to this since it is not as good and clear an assembly as the assembly with the cap.

Evaluated vs. Costs Expended for the Month:

December: $11,580.56

Charles B. Weeks
General Manager

Thomas Forman
Project Engineer

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31 December 1958
Ref: 50G

Universal Match Corporation
Crab Orchard Plant
P. O. Box 130
Marion, Illinois

Attention: Mr. Wilbur Cox
Assistant Manager

Gentlemen:

This is to advise you that the remaining heads from Eastern Tool Mfg. Company are on their way to you for loading. We wish to make the following comments:

The cavity for the fuze and booster as shown on our loading Drawing No. B8428 was not to print in the heads which we received from you. It will be necessary to stick closely to this drawing and may therefore be advisable to cut down on the size of the funnel considerably to allow for additional explosive to be poured in the cavity and to subsequently ream out the cavity in order to conform to the drawing. Please advise if you cannot do this, in which case we will have to change the procedure and will have to ask you to load higher than indicated on the drawing. This would necessitate the reaming operation to be performed at our Range. We would prefer if you could do the complete job.

Hoping to hear from you very soon and wishing you a Happy New Year.

Yours very truly,

HESSE-EASTERN DIVISION
FLIGHTEX FABRICS, INC.

Thomas Forman
Project Engineer

TF/mml

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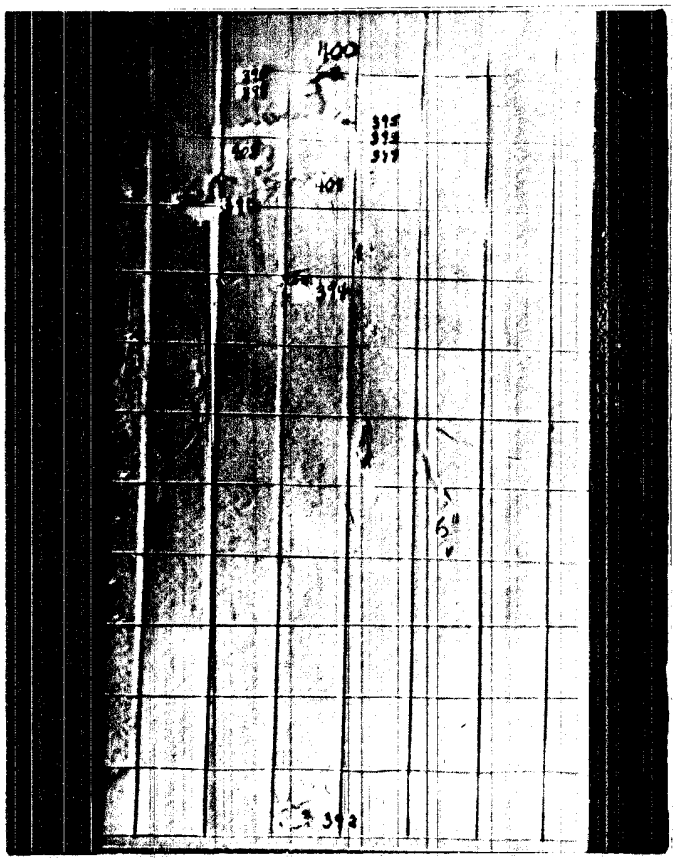
PHOTOGRAPHS



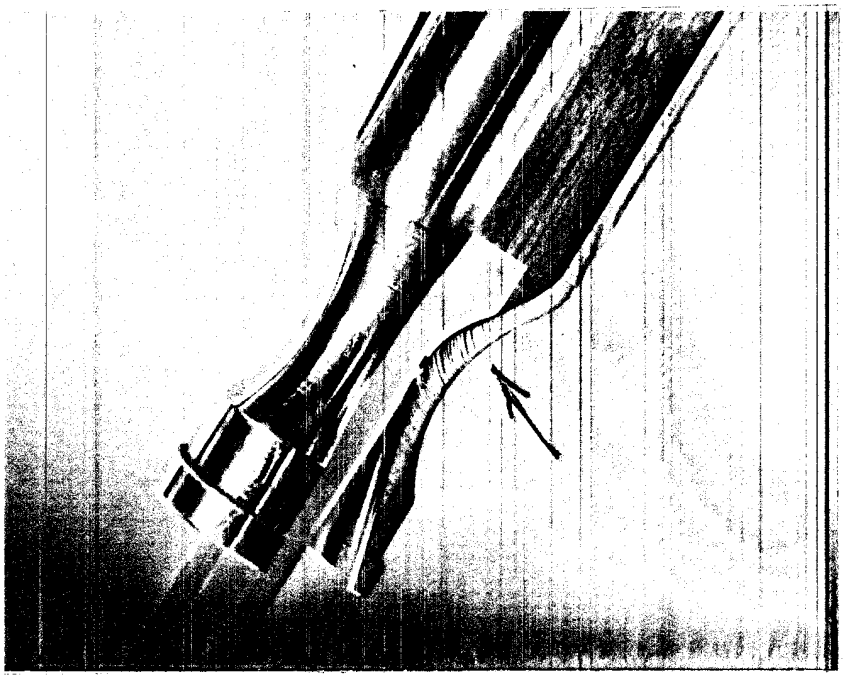
Photograph No. 144
Accuracy Test December 4, 1958

Photograph No. 145
Igniters Left Modified Igniter Right Igniter as Molded

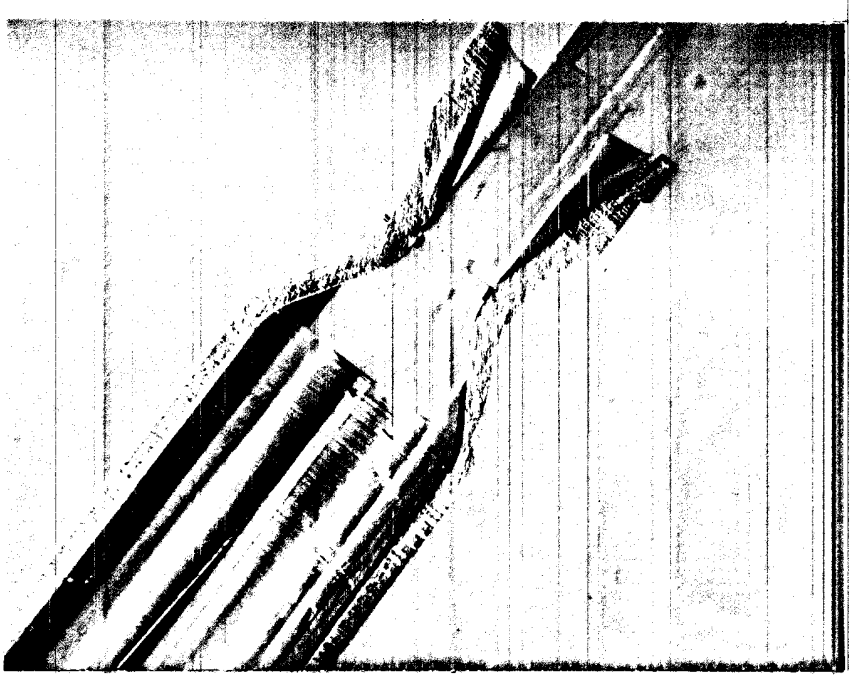
Glass - after impact of one .38 Special Hi-Way Master - Metal Piercing 110 - Grain - Remington stopped.

Test Set-up

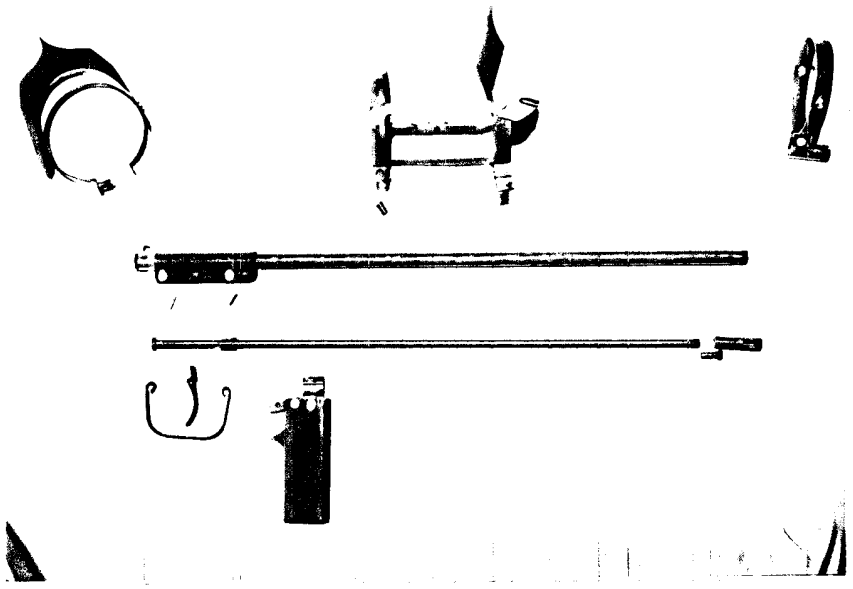
.45 Auto in Vise 6' from face of Target - Silex Bullet-Resisting Glass



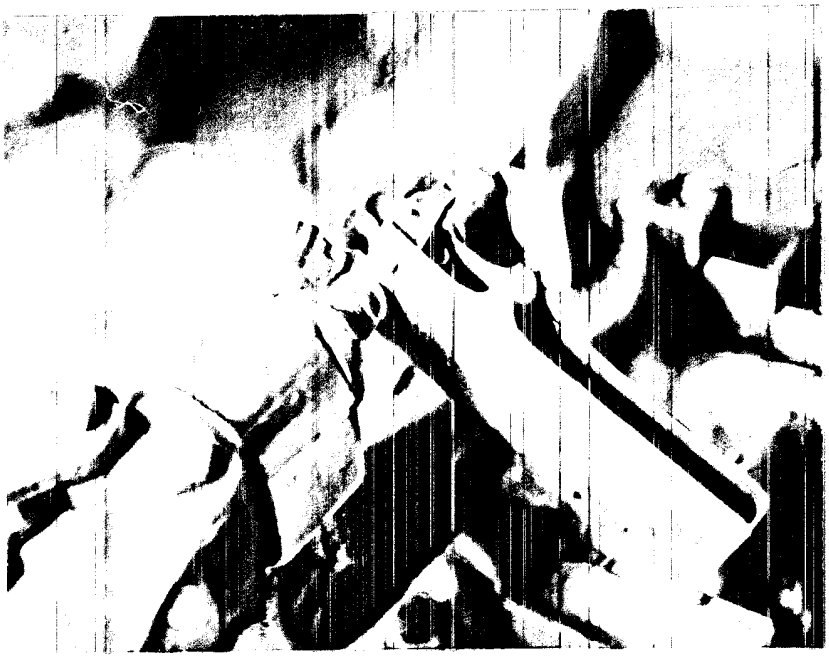
Photograph No. 146
Harvey extruded motor showing unsatisfactory fit of igniter. Incorrectly machined angle of expansion cone produces too great a land in transition area between throat and expansion cone.



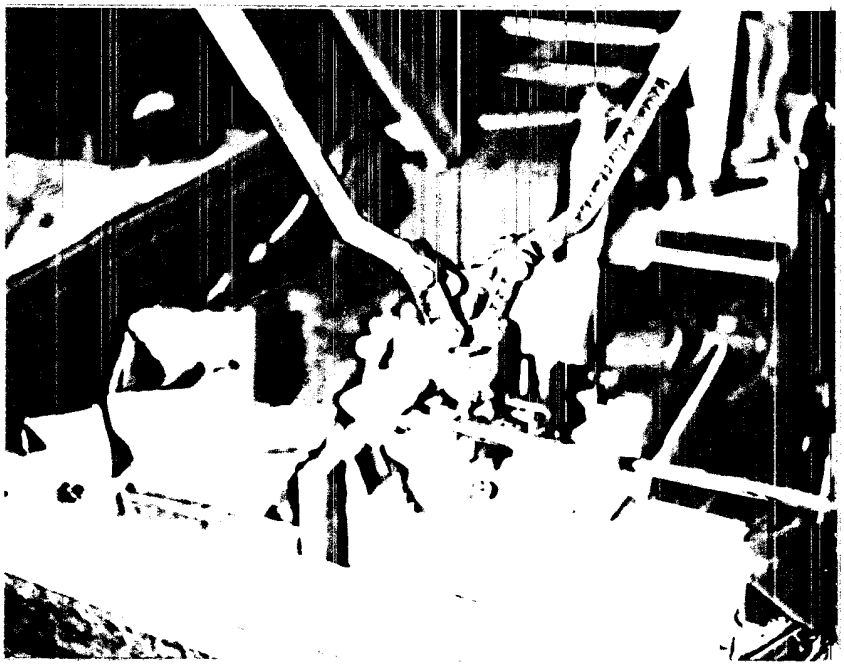
Photograph No. 147
Cross-section Through Correctly Machined
Motor Showing Satisfactory Fit of Igniter

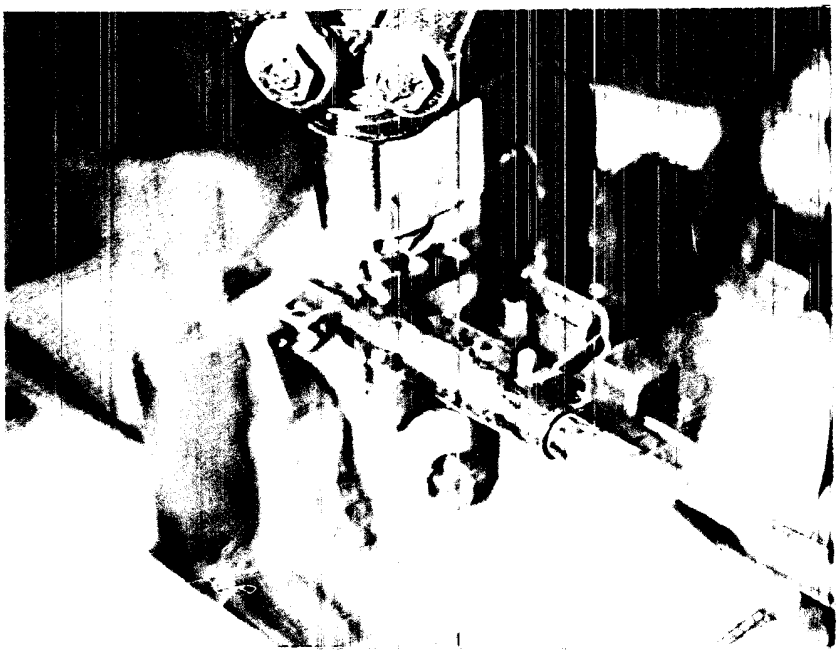


Photograph No. 148
Launcher Components Before Final Assembly

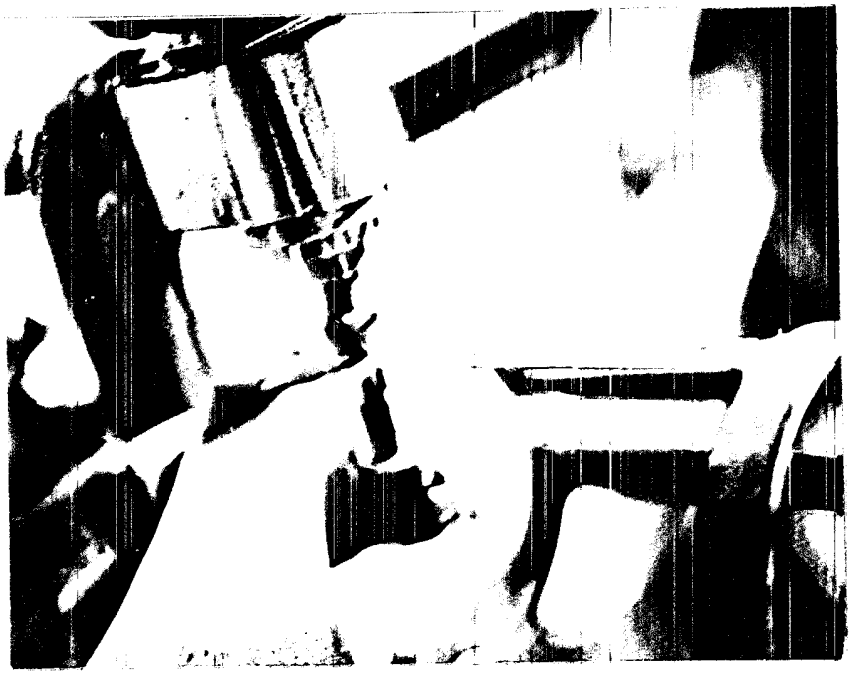


Photograph No. 149
Rivet Squeezer Assembling Trigger Handle





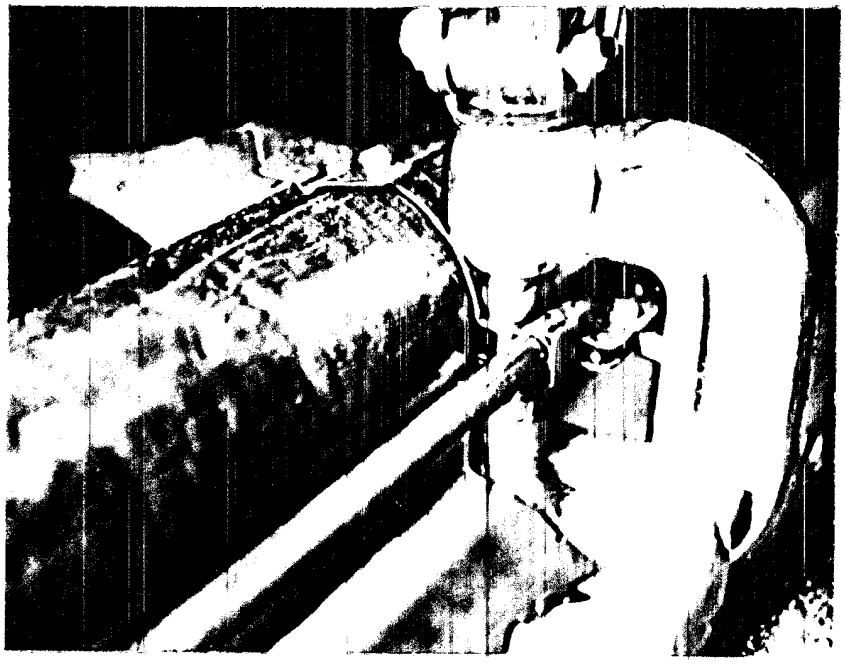
Photograph Nos. 150, 151
Trigger Housing Being Assembled to Linkage



Photograph No. 152
Assembling Rear Sight and Fastener

Photograph No. 153
Locating Trigger Linkage on Launcher Tube

Photograph No. 154
Over-all View of Final Assembly Jig



Photograph No. 155
Rivet Clinching on Final Assembly. Three sets of anvils in rivet clincher are used to assemble complete system.