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TECHNICAL REPORT No. 465-45

CERAMIC FUZES

September 1945

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TECHNICAL REPORT No. 465-45

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CERAMIC FUZES

SUMMARY

This report contains information on development of ceramic materials for use in fuzes.

September 1945

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CERAMIC FUZES

1. Introduction:

Late in 1944 the German Navy instigated a program to develop a projectile fuze made of porcelain or some other ceramic material. Experiments were carried out with glass too but abandoned almost immediately. The experiments with ceramic materials were being carried out right up to the time of surrender.

The firm Rosenthal Isolatoren G.m.b.H. in Berlin-Charlottenburg was given the contract for the technical work. All firing tests were to be carried out on the Rheinmetall-Borsig proving grounds at Unterluss.

2. Purpose:

The main purpose behind this program for ceramic fuzes was to try and eliminate some of the fuze problems that faced the Navy late in 1944.

A fuze constructed entirely of ceramic materials would be impervious to storage problems. There would be no deterioration of parts and the length of storage would be indefinite. Also a serious shortage of materials for all metal fuzes was beginning to develop about the same time and it was thought that if they turned to the field of ceramics, this shortage problem could be solved.

When the actual work started it wasn't long before they realized that an all-ceramic fuze was impossible. Manufacturing tolerances necessary for the moveable parts in the fuze were out of the question. Molds for such parts could be made to the correct tolerances but when heat treated, the high temperatures required caused considerable and irregular expansion.

The ceramic fuze program finally ended up taking the metal working parts from already proven fuzes and constructing a body suitable for housing the works. The working parts for the following fuzes were used in this program: KZ 27, 28, 29 and BdZ 36 and 38.

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3. Materials:

Two ceramic materials were experimented with in addition to glass. The glass idea was dropped immediately after the first tests were made. Static tests proved that glass did not have sufficient tensile strength to withstand the requisite stresses.

Far more extensive tests were made with two ceramic materials, serosalt and steatite. Serosalt consisted of 65% serozit, 17% soapstone, and 18% clay. Steatite was made up of the same constituent materials except that there was approximately 50% less soapstone and clay used for the purpose of increasing the hardness of the finished product.

The procedure for forming the fuze body is the same for both types of ceramics. When the constituent materials were properly mixed, they were put under a pressure of 120 Kg/cm² and baked at a temperature of 1200° C for a period of two to three hours.

4. Fuze Body:

Designing a body for this type of fuze created a real problem. The main difficulty to overcome was to obtain a satisfactory method of securing the fuze in the shell. The ceramic material has the property of being quite brittle and if the fuze is not properly secured, it will break up when the shell is fired from the gun.

The ballistic figures for the equipment in which the ceramic fuzes were to be used are as follows:

Gun	10.5 cm Sk C/33	8.8 cm. SkC/30
Shell	10.5 cm. Spr. L/4.6	8.8 cm. Spr. L/4.6
Muzzle velocity	900 m/sec	790 m/sec
Gas pressure	3175 Kg/cm ²	3300 Kg/cm ²
Acceleration	13800 g in m/sec	14500g in m/sec

In order for a ceramic fuze body to withstand such stresses it was necessary to include a source of elasticity which would absorb some of the initial shock of firing. On the original design the idea of a shock absorber was left out completely. The fuze was threaded directly into the shell and on all firing tests the threads ruptured, and the fuzes failed to function.

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4. Fuze Body, (Cont'd.)

When the idea of using threads to secure the fuze failed, two other methods were tried. See figs. 2 and 7. The design as shown in fig. 2 proved to be the most satisfactory. The fuze was secured by means of two keep rings and a metal ring collar (fig. 5) which threaded into the shell. This method allowed sufficient flexibility to eliminate the tendency for rupture on firing. See fig. 6 for the position of collar and keep ring.

The closing piece for the fuze body had to be treated in the same manner. See figs. 3 and 4 for the two designs. A kneading material was used to hold the closing piece in fig. 3 but again the problem of insufficient elasticity developed. To solve this, the original design was cut down as seen in fig. 4 and held in place with a split keep-ring.

5. Test Results:

The original tests made with ceramic fuze showed extremely poor results, due to the shock of firing. The last few tests made early in 1945 were carried out with a cardboard washer placed between the fuze body and the fuze seat. See figs. 6 and 7. The washer absorbed most of the hammer effect and considerably reduced the number of malfunctions caused by fuzes breaking up. Under this new set-up the fuzes were many times found to be badly chipped but not to the extent that the fuze could not function properly.

The condition of the ceramic fuzes after the latest test firing is shown in figs. 8 and 9. The firing tests of the fuzes shown were made early in 1945:

<u>Fuze No.</u>	<u>Results</u>
3	The fuze started to fire. The body above the circular cut away section was totally splintered. The closing piece located in the circular groove with the metal keep-ring was broken loose and badly distorted.

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5. Test Results, (Cont'd.)

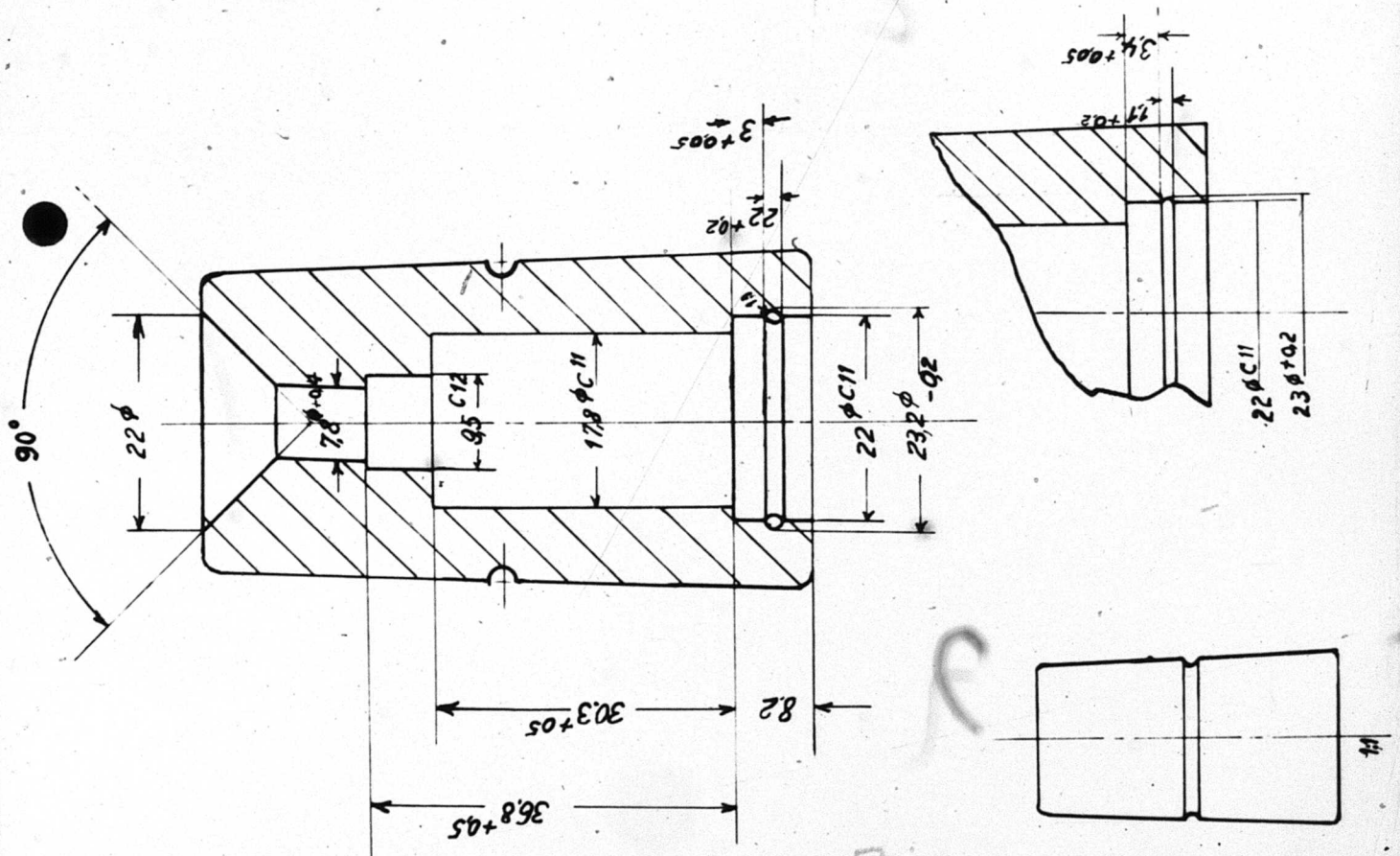
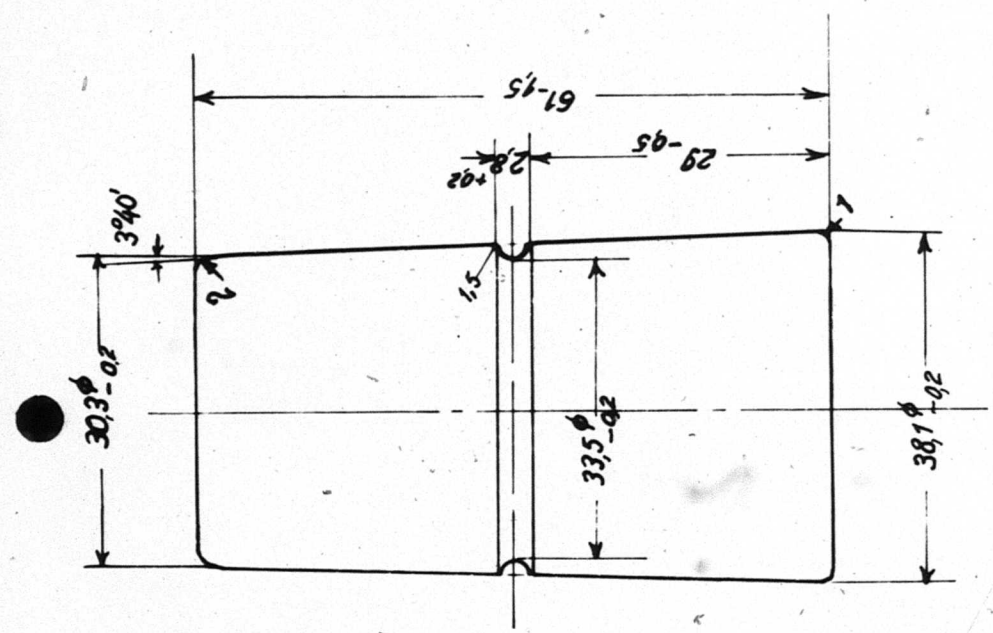
<u>Fuze No.</u>	<u>Results</u>
15	Better results were shown with this fuze. Only the lower flat seating surface of the fuze body in and around the circular groove was damaged. This section was about $3/4$ splintered. The closing piece was slightly distorted.
20	The fuze body in this case remained intact up to the external groove at which point a large chip broke out. In the closing piece only the middle part broke loose.
22	In this case the fuze body remained intact except for a slight chip at the forward end of the body. The closing piece was cracked but still held together with the metal keep-ring.
23	The portion of the fuze body above the circular groove was totally destroyed. The closing piece was also completely splintered.
30	The fuze body above the circular groove was completely destroyed. The closing piece which had been secured in place with the kneeding material was in order. All connections were free of defects.

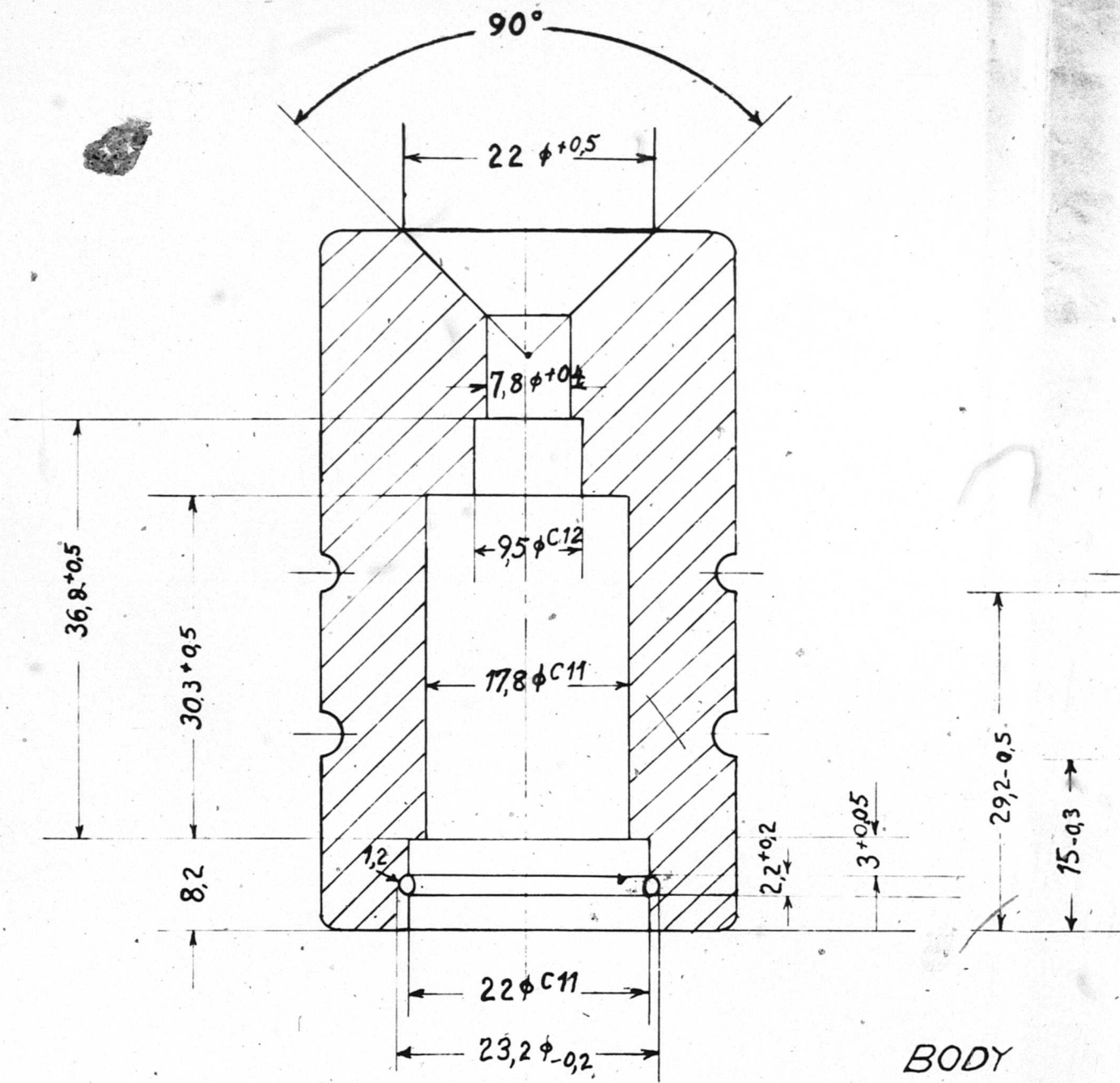
6. Conclusions:

The last recorded tests on this type of fuze construction were by no means entirely satisfactory. Considerable progress had been made since the project was first undertaken and it was still regarded as a feasible one.

Prepared by:
R. L. GELLEIN
Lieut., USNR.

FIG 1





BODY

1:1

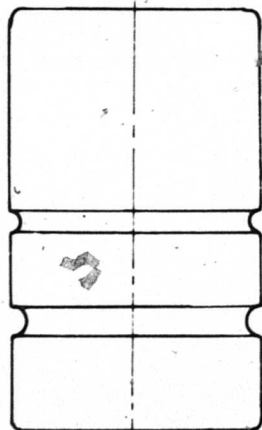
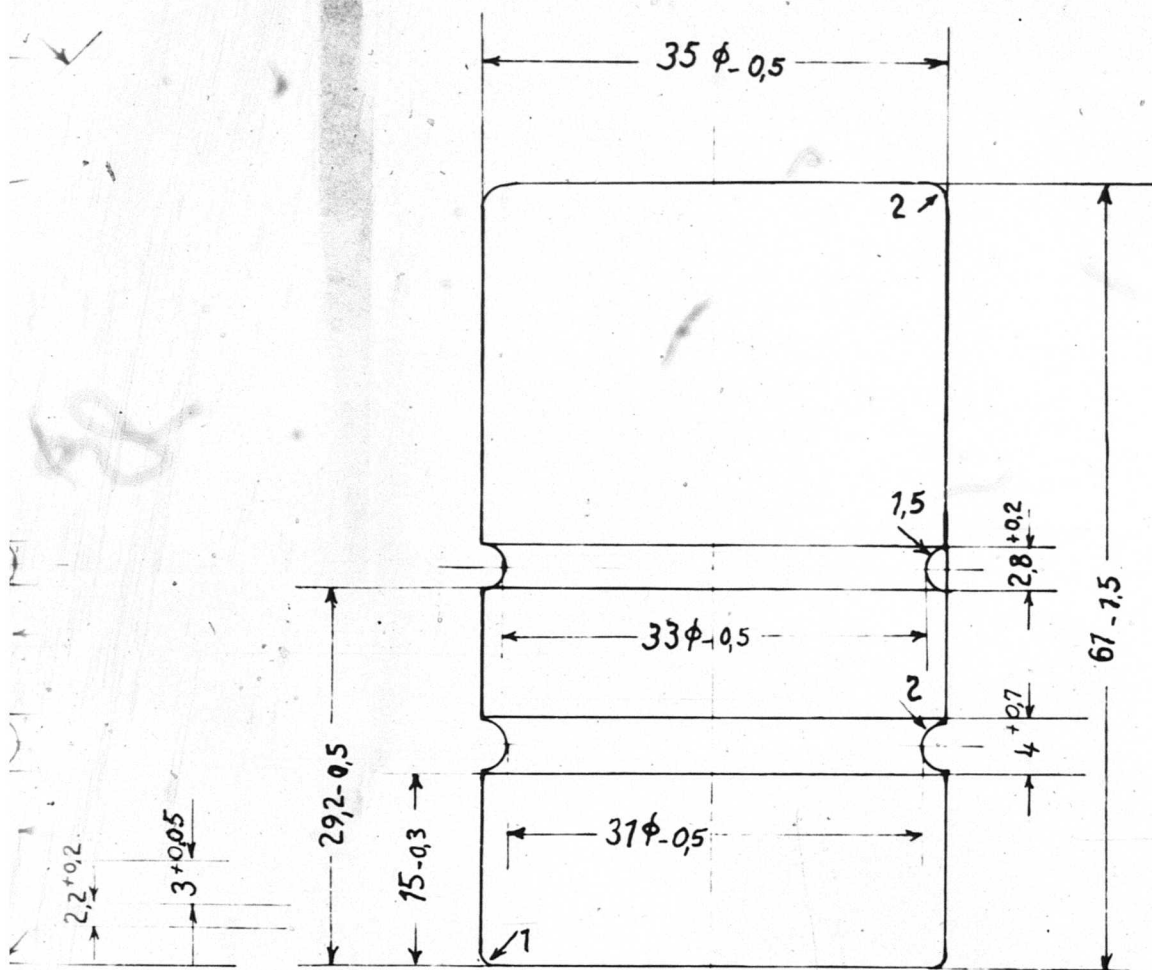


FIG. 2



BODY

FIG. 2

2

Scale: 2:1

KZ 127K

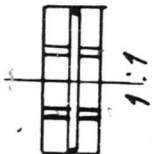
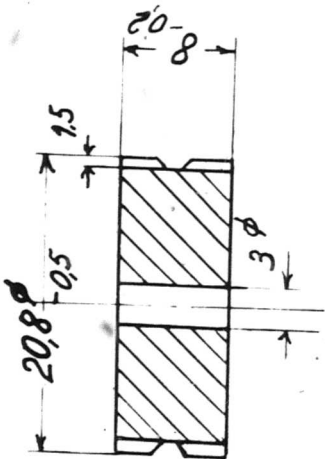


FIG 3

CLOSING PIECE
TYPE 1

SCALE 2:1

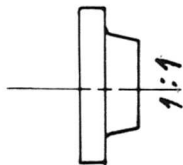
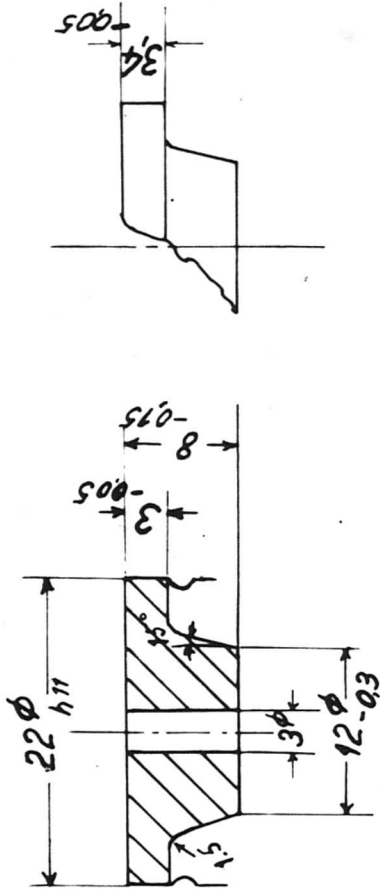
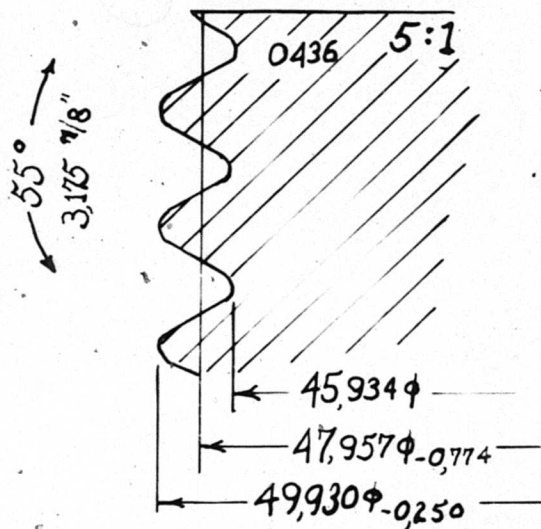
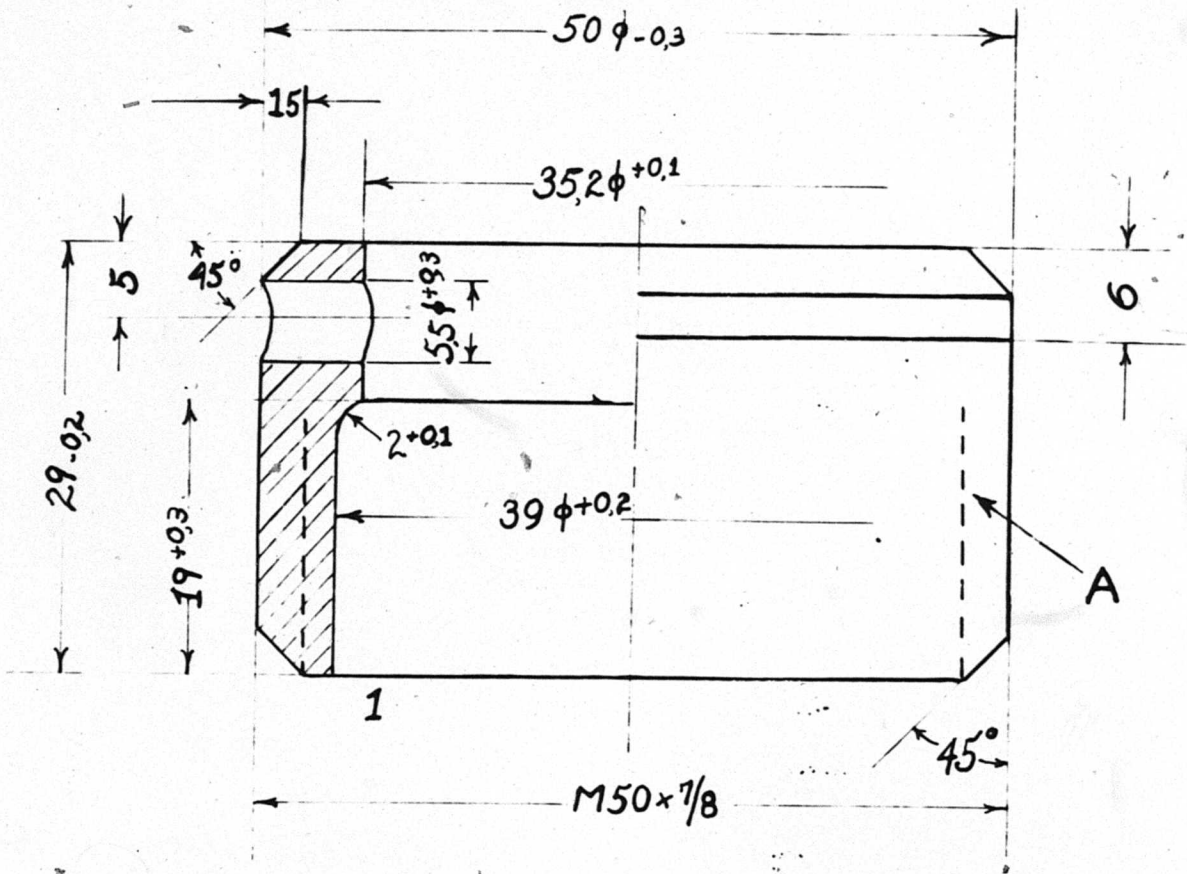


FIG. 4

Scale: 2:1

CLOSING PIECE

TYPE 2



THREADS IN SEC. A
 SEE ABOVE

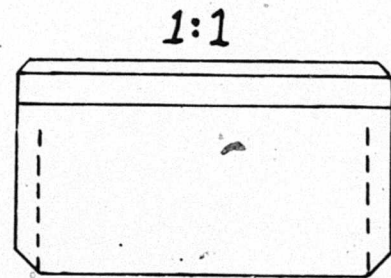


FIG. 5

SCALE
 2:1

THREADED
 KEEP RING

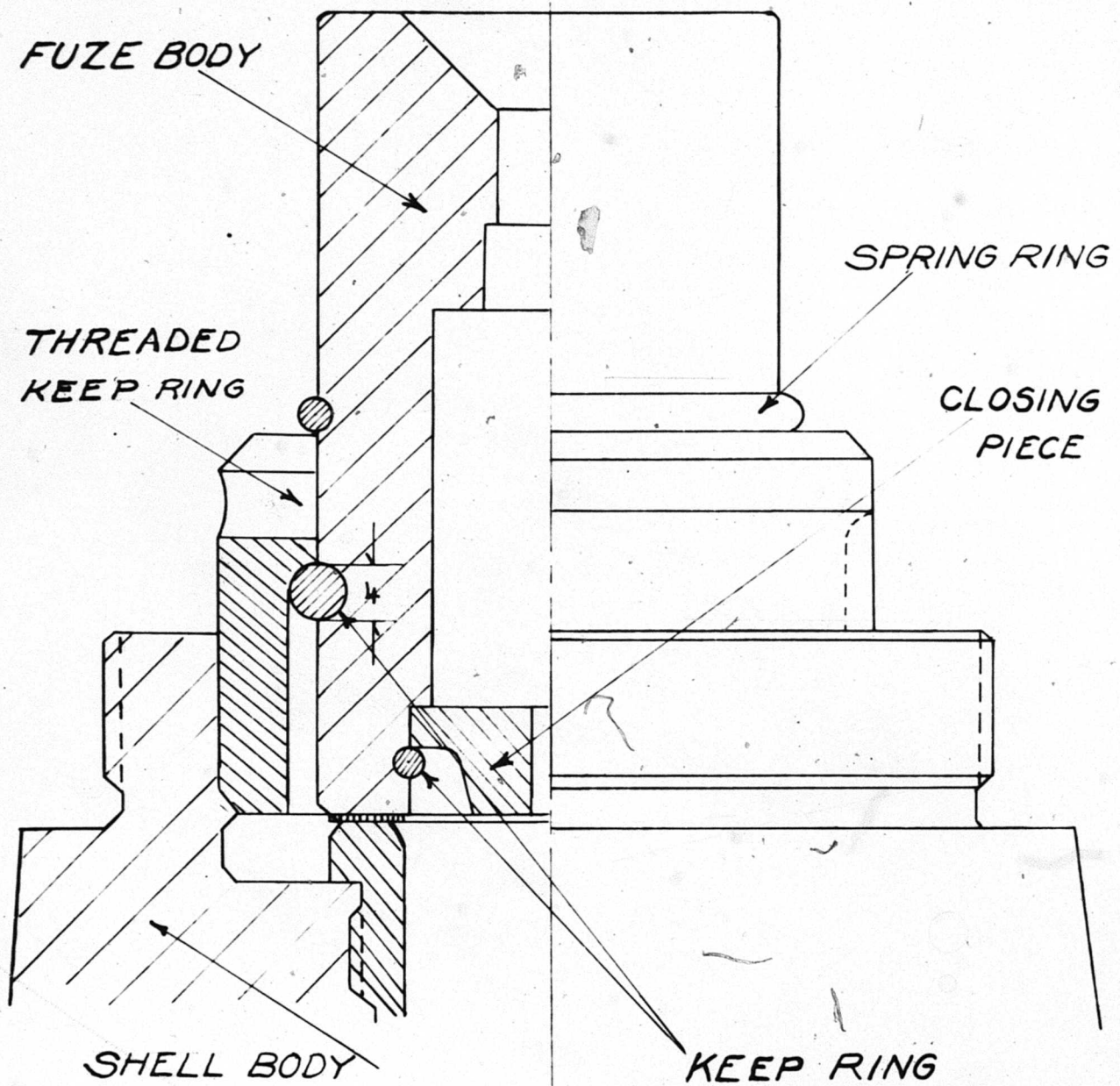
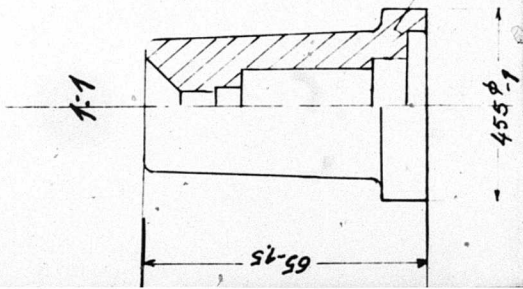
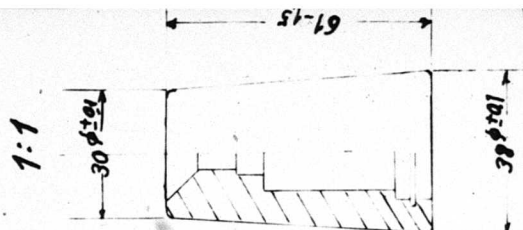
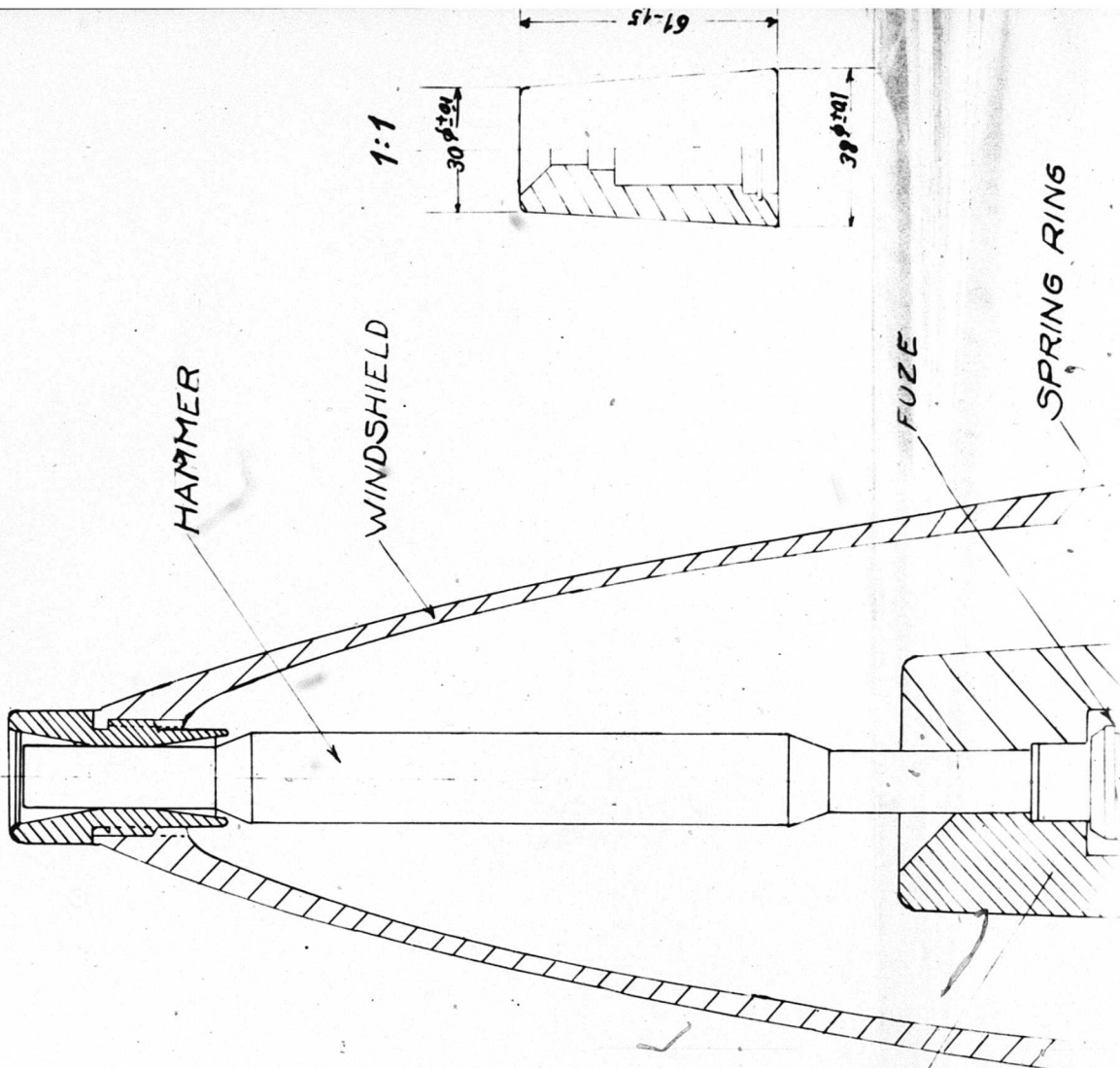
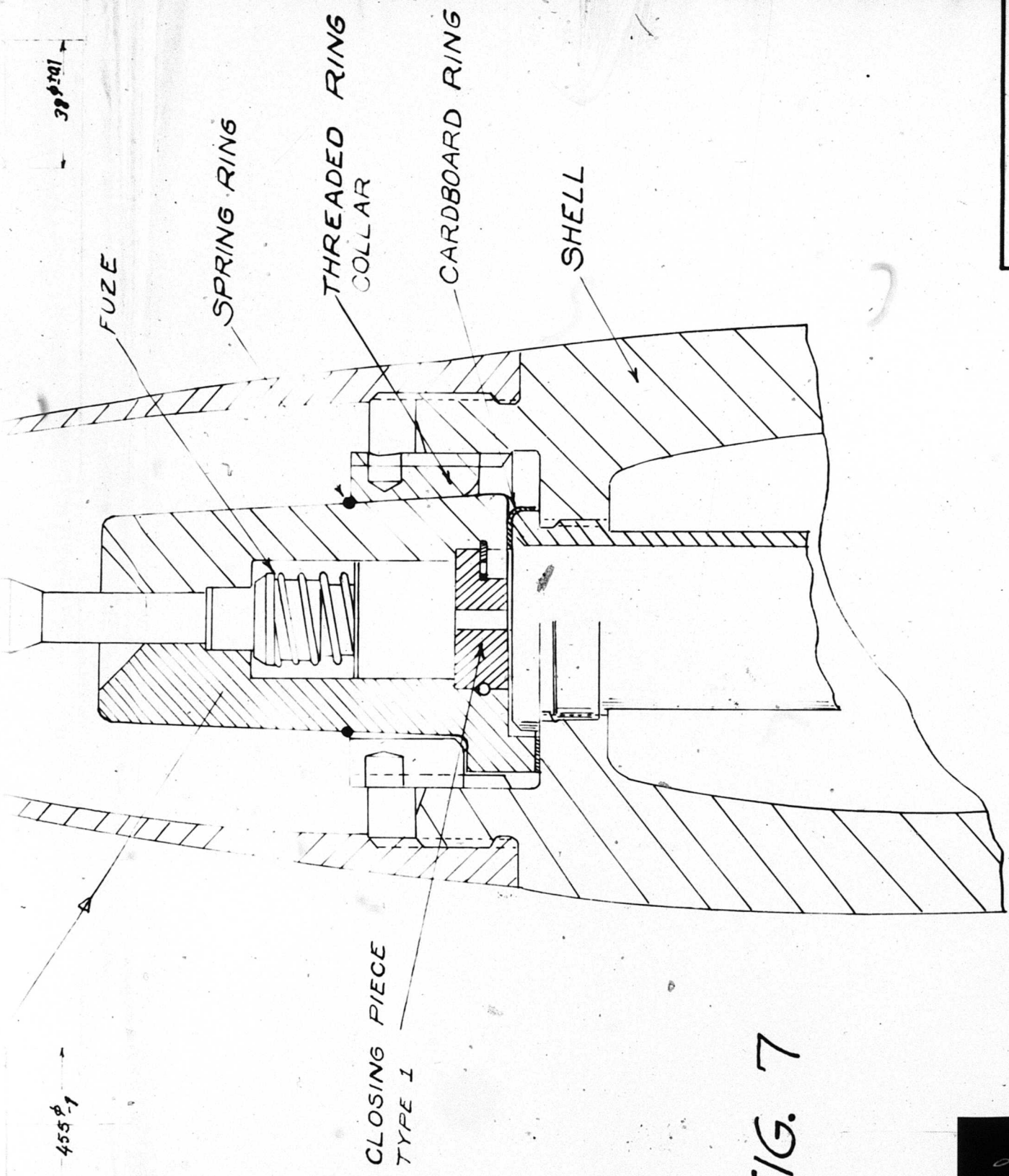


FIG. 6





38.701

FUZE

SPRING RING

THREADED COLLAR

CARDBOARD RING

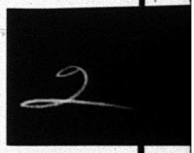
SHELL

CLOSING PIECE
TYPE 1

45.5

FIG. 7

KZ127K



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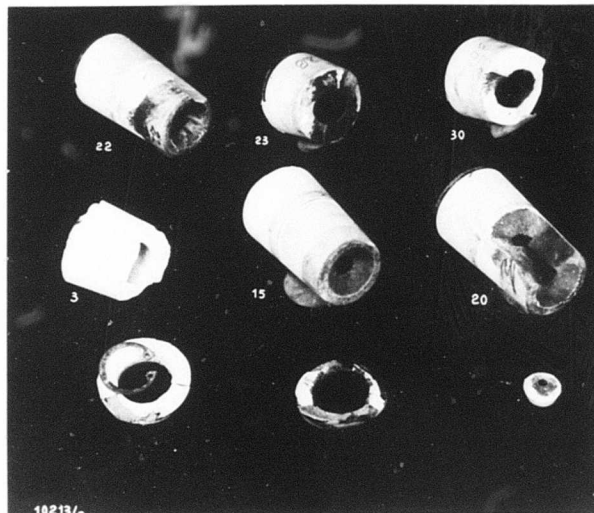


Figure 8

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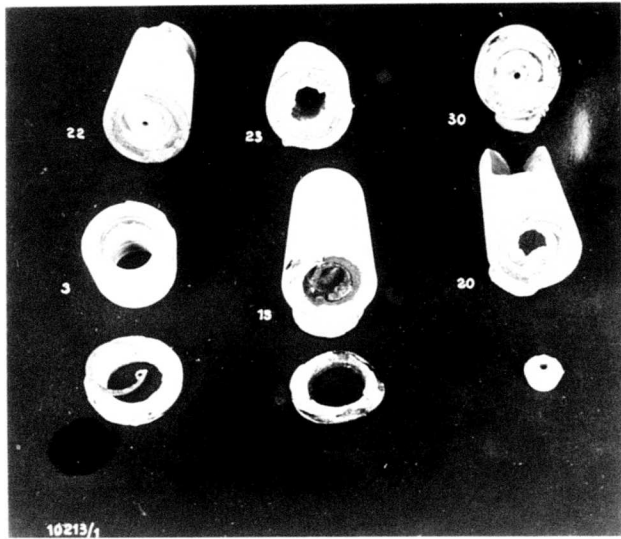


Figure 9