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ARMAMENTS DESIGN DEPARTMENT

Technical Report No.6/46.

GERMAN NON GUIDED FLAK ROCKET-TAIFUN

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Abstract

This report deals with the experimental development, service design, and projected improvements relating to the German liquid fuelled flak rocket, Taifun.

The information has been obtained from interrogations and the examination of a nearly complete selection of components for the model F.

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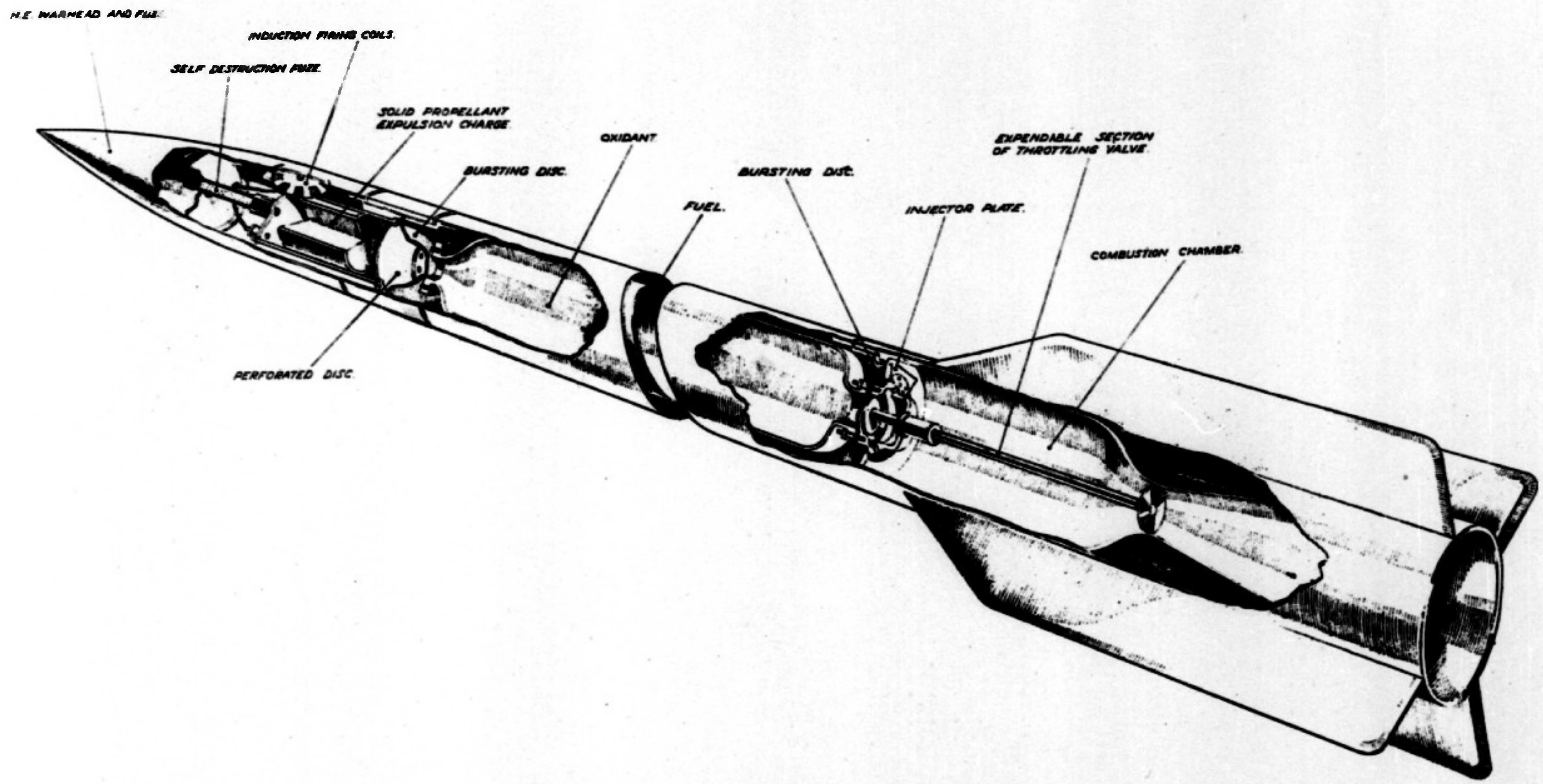

TAIFUN

LIQUID FUELLED ANTI-AIRCRAFT ROCKET.

(1)

GERMAN NON GUIDED FLAK ROCKET-TAIFUN

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SECTION 1 - INTRODUCTION

1.1 Scope of the report

This report is intended to deal fully with the German liquid fuelled non-guided flak rocket-Taifun, by collecting together all the data brought back by various investigators from Germany, and combining this with an examination of parts of actual rounds at Fort Halstead. It should be a final assessment of this weapon.

The solid fuelled "Taifun" which was being developed under Ing.Wilhelm Burkhardt, who is now believed to be in the Russian zone of Occupied Germany, is not treated here in any detail.

1.2 Sources of Information

A great deal of the information contained in this report was obtained from Dipl.Ing.Scheufelen, who was in charge of the development of the rocket, and from some of his associated workers. Those interrogated were:-

Dr. Weidler	(Chemistry)	)Warhead and
Streeker	(Int.Ballistics)	)self destruction
Wiemhoff		)fuze only.
Tschinkel	(Chemistry)	
Brasselmann	(Engineering)	
Ing Pohajac	(Foreman)	
Schuler	(Measuring Instruments)	

Wherever possible, facts and figures obtained in this manner have been corroborated by measurements made on components of a Taifun rocket at Fort Halstead. In some cases, however, notably due to the variations from the manufactured type, this has not been possible.

1.3 Acknowledgements

Acknowledgements are due to the following for providing interrogation reports and drawings:-

S/Ldr. Robinson	(A.D.D.)	
Mr. I.C. Hutcheon	(A.D.D.)	
Dr. Merrington	(A.R.D.)	
Dr. Sumner	(P.D.E.)	
Dr. R.J. Rosser	(P.D.E.)	
Mr. J.H. Whittaker	(R.A.E.)	)of C.I.O.S. team
Capt. J.W. Giles	(U.S. Army)	)367 June '45.

SECTION 2. HISTORY AND PRODUCTION OF TAIFUN

2.1 General

Taifun came into being towards the end of 1944, at a time when Germany was putting every effort into the development and design of anti aircraft weapons. The rate of development, according to the progress dates given, was very high.

According to Scheufelen, he was initially working as a range officer and concerned with the firing trials of Wasserfall, but became more and more dissatisfied with the project, considering it far too large and uneconomical. It also lacked a homing device which was essentail to its use; and much trouble was experienced in the initial firings.

2.2 Initiation of Taifun Project. Cordite Expulsion.

Scheufelen accordingly started work himself, to design a small cheap unguided flak rocket using the same fuels, and incorporating the new method of fuel expulsion using gas produced by burning cordite. It is not clear whether this was a development of attempts to use cordite expulsion for Wasserfall, or whether this method was being tried out for Taifun and Wasserfall simultaneously. It is known, however, that while little success was achieved with the long burning times (45 seconds) required by the large projectile, owing to the burning out of pipes etc., completely satisfactory firings were obtained with the short burning times (2½ secs. and 1 sec.) used in Taifun. It seems probable that this followed attempts with Wasserfall.

2.3 Submission of designs

Designs were submitted to the Reichsluftfahrt Ministerium in September 1944, and accepted and frozen in October. Scheufelen was made the 'sachbearbeiter', or administrative officer in charge of development at Peenemunde.

2.4 Production.

Actual production of finished rounds began in January 1945 and it is certain that over 600 out of the first projected batch of 10,000 were completed before the capitulation.

2.5 Intended quantities

It was expected to have 400 batteries of 12 projectors each, in action by 1st September, 1945, each projector consisting of a converted "88 mm." gun carrying 30 rockets in a projector, instead of a barrel. This conversion was very simple and took under 1 day to effect.

SECTION 3. BASIS OF DESIGN

3.1 Theory of Contact Fuzing

Due to the increasing size of our bomber aircraft and the formations, the Germans had decided on a policy of using contact fuzing instead of time fuzing, in AA weapons. The theory of this is given briefly in Appendix 2, where it is shown that, as the aircraft size increases, there comes a point where contact fuzing is more efficient. With this method there is a fixed size of warhead required to destroy an aircraft this size having an explosive charge weight of about 1.1 lb.

3.2 Choice of Rocket Weapon

The problem then became one of carrying this 1.1 lb. of explosive as near as possible to high flying formations in a suitably lethal density. The cheapest and most accurate way, leaving out of account guided weapons, was seen to be by the use of the small liquid fuelled rocket with very short burning time and very high velocity. The dispersion of this weapon was reputed to be so small that the barrels on one projector had to be splayed to give the necessary spread.

As a rough comparison with the AA gun, the time of flight of the Taifun to 6 miles is 14 seconds compared with the 28 seconds taken by an 88 mm. shell to reach somewhat under this height.

3.3 Most economical design

It was considered, on the basis of experiments done with the 10 cm. (3.94 inches) Taifun, that the most economical size for carrying the necessary warhead would be of 7 cm. (2.75 inches) calibre and somewhat longer than the 10 cm. model, with a greatly lowered drag, and a reduction in the weight of Salbei from 16.5 to 8.8 lb. and of visol from 7.7 to 4.1 lb.

3.4 Fixation of production design

It was not possible to change to this size, however, since it would have involved carrying out new large scale firing trials to determine trajectories at different elevations; these being required for the range finder and predictor devices.

3.5 Sub calibre size

A smaller and cheaper variation of the same type to be used for vertical ranges up to 3 miles was also designed, and had reached the stage of being tested statically. This was of 5 cm. (1.97 in.) calibre and total weight 17.6 lb.

3.6 Future development

Scheufelen stated, that if he were carrying out future development of this type of rocket, he would have 10,000 rounds made of the 7 cm. size. After complete trials and tests on these, during which he would become thoroughly conversant with their properties and peculiarities, he would proceed to the designing of other types.

SECTION 4. LIQUID FUELLED TAIFUN ROCKET - DESCRIPTION AND OPERATION.

(Full details of the various parts are given separately under section 6).

4.1 General description of rocket

The liquid fuelled Taifun (in English "Typhoon") is a small non-guided, fin-stabilised AA rocket, with slow rotation, running on Salbei and Visol as propellant and having a high all-burnt velocity.

Having an initial all-up weight of some 46 lb. it carries a contact fuzed warhead with 1.1 lb. of H.E. filling to an operational height of 9 miles and has an all-burnt velocity of over 3000 ft./sec. It was intended for ripple firing in large numbers from multiple projectors. The cost of manufacture of a filled round was about 25 marks or 12/6d.

A section view of this rocket is shown in Fig.1 and the reference numbers in the following paragraphs refer to this drawing.

4.2 Propellants tankage

The motor burns the self igniting propellants "Salbei" and "Visol" which are contained respectively in the inner tank (1) and in the annular space (2) between the inner tank and outer tube, and sealed at either end with a bursting disc (3,15). The tanks are simply two long tubes of different diameter, one within the other, the outer forming the body of the rocket. Visol is a mixture of various hydro-carbons, while Salbei (the oxidant) is composed chiefly of nitric acid.

4.3 Propellant expulsion

The propellants are expelled to the combustion chamber by gas at 900 or 1800 lb./sq.in. (depending on the model), produced by the burning of a cartridge of solid propellant (12) contained in a steel breech (11) forward of the tankage. This cartridge is ignited electrically by induction and burns, producing gas at a pressure of 2250 lb./sq.in., the gas being throttled through a steel choke (13) before it passes through a perforated steel disc (14) which clamps the first bursting disc (15) sealing the forward end of both tanks.

4.4 Combustion chamber

After bursting the disc (3) at the rear end of the tankage, the propellants pass into the combustion chamber (7) through two concentric rings of straight jets (5,6), which impinge on the combustion chamber wall. Initially, the flow of Salbei is restricted by a throttling valve (10) which is only fully opened when the pressure in the combustion chamber rises to about 300 lb./sq.in., thus blowing out the expendable choke which initially partly blocks the venturi throat. This gives high initial acceleration and freedom from starting explosions. Combustion of the propellants takes place at 750 or 1500 lb./sq.in. in different models.

4.5 Specific impulse obtained

Although this high combustion pressure, by increasing the gas density and the rate of reaction, partially offsets the small size of chamber for the large rate of fuel flow (24 lb. in $2\frac{1}{2}$ or in 1 sec.), combustion is not complete, and the specific impulse (S.1) obtained is low. While an S.1 of 164 lb.secs./lb. was expected, only about 145 was apparently obtained, judging from the performance figures given.

The L^* value (the ratio of combustion chamber volume to venturi throat area) for the production model is 40 inches, and for the shorter burning time 10 cm. models (types 1 and 2) it is as low as about 26 inches.

4.6 Stabilisation. Fins. Projector.

The rocket is fin stabilised and given a slow rotation by means of offset fins and a special projector, to eliminate dispersion due to errors in manufacture.

4.7 Fuzing

The warhead is fitted at the nose end with a contact fuze (18). At the rear end of the charge is fitted a self-destruction unit (16) which is ignited by a pyrotechnic train from the solid propellant charge (12). This destroys the rocket when it fails to hit the target.

SECTION 5. PERFORMANCE

5.1 Comparison with British 3 inch rocket, with 22.5 lb. warhead and also with an assumed 2 lb. warhead.

A few typical figures are given here. Complete details of five types of Taifun are given in the data sheet in Appendix 1. The values of all-burnt velocities given in the table below are calculated assuming level flight in vacuum.

		Taifun.F.	3" UP with 22.5 lb. warhead	3" UP with 2 lb. warhead
All up weight	lb.	46.2	52.5	32
Empty weight with warhead	lb.	22.0	39.8	19.3
Ratio, fuel/total weight	α	52.5%	24%	40%
"α" excluding warhead		54.7%	42.3%	42.3%
Specific impulse of fuel:- expected	lb/sec./lb.	164	-	-
obtained	lb/sec./lb.	145	177	177
Overall length	in.	75.5	55	-
Motor diameter	in.	3.95	3.25	3.25
Combustion chamber pressure	lb/sq.in.	750	675	675
Thrust obtained. approx.	lb.	1410	1500	1500
Burning time	secs.	2½ appx.	1.6	1.6
All-burnt velocity. Calculated	ft/sec.	3900	1580	2880
Obtained	ft/sec.	> 3000	1580	-
Operational height	ft.	50000	-	-
Velocity at operation height	ft/sec.	975	-	-

5.2 Accuracy

In several significant ways, the liquid Taifun has advantages over solid rockets. These are indicated in the following:-

(a) Due to the special design of combustion chamber which gives an almost instaneous rise of thrust from zero to its full value, the velocity and speed of rotation on leaving the projector are relatively high. This minimises the usually considerable errors at this point of its flight when the fins have little effect.

(b) In solid fuelled rockets, just before all burnt, pieces of unburnt propellant are liable to be thrown out as the thin remaining propellant breaks up. These cause dispersion as was apparently evident in a series of flight photographs, taken by Burkhardt, of the solid Taifun. No such dispersion was evident in similar photographs of the liquid version of the rocket.

(c) There is no dispersion due to the heating up and consequent distortion of the body of the rocket.

(d) The exhaust gas flow is more uniform over its cross section giving a more accurate axial thrust.

The only actual trial known to have been carried out on dispersion of the liquid Taifun was over a horizontal distance of 100 metres, in which a small number of rounds all fell within a field of 1 x 1½ ft.

SECTION 6. DETAILED ANALYSIS OF COMPONENT PARTS.

6.1 Fuels

The propellants used in the Taifun are Visol and Salbei. The first of these exists in several hundred variations - being a mixture of hydrocarbons - and it is not known which visol was used. Probably several were tried, the choice depending on the supply position. Salbei, which is the oxidant, is largely (90% or 99%) fuming nitric acid with the addition of sulphuric acid, and sometimes a very little (1%) phosphoric acid to reduce corrosion of the tankage etc. Again, the exact choice of oxidant probably depended on numerous factors such as, the supply position, the material available for constructing the tankage etc.

6.2 Propellant tanks

The inner tank is 45.3 inches long and is of light alloy construction. The parallel portion is made of sheet .079 inches (2 mm.) thick, rolled and welded; the welds being filed off smooth.

The ends which are welded to the parallel part, are domed and flanged. The flanged ends are secured to the spray injector (4), at the tail end, and at the nose end to the perforated plate (14), each by 12 small studs. The volume of this tank is 320 cu.in. which, allowing an 8% ullage gives a capacity of 294 cu.in. Its weight is 4 lb. 8¼ oz.

The tube which forms the body of the rocket and the outside of the outer tank is of drawn mild steel .040 inches (1 mm.) thick and 45.25 in. long. It is welded at each end to a turned and screwed ring, over which it fits. The two rings are similar, and are screwed at one end into the combustion chamber ring (thus clamping the bursting disc and spray injector (4)), and at the other end into a coupling ring. It thus clamps the perforated locating disc (14), the solid cartridge choke plate (13) and the spun out edge of the solid cartridge container (11) against the head.

The volume between the outer and the inner tank is 191 cu. in., which, allowing an 8% ullage, gives a capacity of 176 cu.in. The weight of the outer tube including welded end rings is 7 lb. 2½ oz.

In operation, the fuels in the tanks are expelled by gas pressure from the powder charge. The hot gases from this impinge directly on the fuels, there being no pistons in the tanks. Channelling of fuel by the gas is probably small due to the high axial acceleration of the rocket (60g approx.).

6.3 Solid expulsion charge and container

The latter is a cylindrical mild steel container (11) closed by a choke (13) fitting over one end and held in place between the head and the forward junction ring of the outer fuel container. It contains a small cylinder of solid propellant of the cordite type, made by Wasag at Reinsdorf, which is wrapped with paper, the two end surfaces being exposed. This is ignited electrically (the exact details of puffer etc. are not known) by leads sealed through the forward end of the container, and burns on the two exposed flat ends, at 2200 lb./sq.in. The gas so formed leaves via the choke orifice and pressurises the fuel tanks.

At the forward end of the expulsion charge container, a fuze (16) is screwed in, which on assembling the rocket, projects into the cavity at the rear end of the warhead. This is apparently omitted in experimental rounds with a dummy head, and in fact only a few rounds were fired with self destruction fuzes fitted as these were still in the development stage.

6.4 Bursting discs

The double fuel tanks are sealed at each end by single sheets of thin aluminium (3,15), which also serve as bursting discs.

Shearing of each disc takes place at the circumference of the hole in the flanged end of the inner tank, and around the outer circumference of this flange.

The outer circumference of the disc at the front end is clamped between the junction ring of the body and the perforated plate (14), and at the rear end by the spray injector (4); sealing of the joints at the circumference being obtained by V'ing the bearing surfaces.

6.5 Combustion chamber and spray injection

6.5.1 - Burning time and operating pressure - The principle of operation of the combustion chamber can be seen from Fig.1; the same size of chamber, with a volume of about 1 litre (65 cu.in.) and a diameter of 10 cm. (3.94 inches), being used for all the Taifun. When the burning time was decreased in the later designs the burning pressure was increased so that the rate of gas flow through the chamber did not increase unduly, if at all. This meant that each particle of fuel had always approximately the same length of time for reaction in the chamber.

An actual improvement in combustion was found in trials with short burning times, due to the increased rate of reaction at high pressures.

6.5.2. - Fuel injection - The fuel and oxidant are injected through a spray injection plate containing a number of holes arranged in two concentric circles, and impinge on the wall of the chamber. Opposing holes do not necessarily impinge at exactly the same point. The correct ratio of fuel and oxidant flow is obtained approximately by using holes of 1.5 mm. dia. in one ring, and 2.8 mm. dia. in the other. In production, this was checked individually for each rocket, and made exact by closing slightly all the holes in one ring with a hand press, and measuring the flow after doing so by the use of manometer flow meters in the fuel lines. This whole process took one man only 3 minutes.

In fixing this ratio, account had to be taken of the fact that when the rocket is actually fired it will have a high forward acceleration, and this will produce different static pressure heads in the fuel and oxidant delivery pipes, due to their different densities. This will alter slightly their relative rate of flow from that on static firing.

6.5.3 - Expendable valve - Trouble had at first been experienced in obtaining quick ignition of the fuels (the lag being of the order of 3/100 sec.), and combustion chambers had frequently blown up when ignition was delayed.

This was overcome by the development of a special expendable valve which initially blocks up most of the venturi throat and at the same time throttles the flow of oxidant from the inner tank (Salbei) to about 1/10 of its normal flow. On firing the solid expelling charge (which reaches its full pressure in 1/10 sec. from the moment of ignition) a very fuel-rich mixture enters the combustion chamber, and the pressure rises to about 10 or 20 atmospheres. During this time the thrust is not sufficient to move the rocket.

At about this pressure the expendable valve is blown out, opening the venturi throat to its full area, and at the same time allowing the correct fuel mixture to enter the chamber. The time from this instant until the full chamber pressure is reached is only 1/100 sec., a fact which gives the rocket a very high initial acceleration.

The valve is held in by a split circlip ring. The valve is initially jammed in. Apparently this gives reproducible results with regard to valve discarding pressures.

6.5.4 - Construction of combustion chamber and venturi - Two types of combustion chamber and venturi were found, one of light construction which was enamelled, and one of somewhat heavier construction with no surface covering.

According to Scheufelen the first type was made from seamless tube, Fig.2, the venturi being formed by spinning while hot. This had the disadvantage of producing a somewhat inaccurately shaped article of rather burnt material lacking in carbon. The inside in this case had to be enamelled and the chamber lasted for 3 seconds on test.

The second type, Fig.3, he said, was a deep drawing from a disc of material; the method being initiated in conjunction with a production expert Mr. Walz. (from the Polderwerke, Magdeburg). This gave a chamber which lasted for 4 seconds without protection.

6.5.5 - Summing up - The combined combustion chamber and venturi used in this rocket is extremely light and efficient when compared with other rockets of both English and German design. Full use has been made of the fact that with such short burning times, steady temperature conditions are not reached and the venturi does not burn out. The manufacture of the chamber and venturi in one piece, its cleanness of line giving the gas a smooth flow out, and for the way it lends itself to giving the venturi a correctly varied thickness along its length, has much to recommend it.

Another factor which permits a very light design of venturi to be used is the absence of erosion caused by solid particles in the exhaust gas.

It would seem that future developments will be with higher and higher combustion pressures and shorter and shorter burning times, with a consequent increase in the accuracy of the weapon and certainly no decrease in the completeness of combustion of the fuels.

The outer tube could be made to withstand these pressures by the use of higher quality steels, though the use of these in the present design would not allow thinner walls, since the limiting factor is the resistance of these to other stresses, such as received in manhandling etc. The hoop stress with 120 atmospheres internal pressure in the 10 cm. model with 1 mm. wall thickness is only 90,000 lb./sq.in.

6.6 Fins

At least two types of fin design were used, but the differences were in detail only. They are of thin sheet steel of double thickness formed with a bend at the outer edge (a later type has a spot welded joint here) and with the inner edges flanged out and spot welded to a covering on the rear end of the rocket, Fig.4.

They were at first set to an angle of incidence of $1\frac{1}{2}^{\circ}$ which gave a rotational speed at all burnt of 18 revs/sec., but Scheufelen later discovered that 0.5 - 0.7° would produce a speed of 12 revs/sec. which would give sufficient slow rotation to eliminate errors due to manufacturing inaccuracies, and also be above the speed ($1\frac{1}{2}$ revs/sec.) at which a yawing resonance would set in. In each case the initial spin given by the spiral projector was 6 revs/sec.

6.7 Warhead and fuzing

6.7.1 - H.E. filling - The warhead was filled with 1.1 lb. of H.E. to give a blast effect sufficient to destroy an aircraft when initiated by contact.

6.7.2 - Self destruction fuze - The self destruction fuze was being worked on by Dr. Weidler (chemist) at DWM. Schlutup, but only 20 to 30 rounds had been fired. The fuze, which was screwed into the breech holding the expulsion charge and projected into the warhead, was composed of two parts:-

(a) The first was a composition next to the breech. It was easily ignited at the same time as the solid charge, but had a rate of burning dependent on pressure. It burnt for about $2\frac{1}{2}$ seconds (the time of burning of the solid propellant charge), and was composed of Pb,O_2, Fe, Si_2, Al, $Ba(NO_3)$ 2, BaO_2 with 10% shellac.

(b) The second part was less easily ignitable, and had a burning rate independent of pressure. It burnt for 16 secs. (making a total delay of $18\frac{1}{2}$ secs.) and consisted of a mixture of $FeSi_2$, $Ba(NO_3)2$, $Ba\ O_2$ with 10% shellac.

The fuze finally set off a detonater taken from standard 15 mm. fighter aircraft ammunition.

6.7.3 - Impact fuze - The usual type of fuze armed by fast rotation (200 revs/sec.) was of no value at the slow rotational speeds of Taifun, so two other types of fuze were consequently developed for the rocket.

The first was developed and made by Rheinmetall-borsig for Flak E.1. of the Luftfahrtministerium and was used in trials successfully. It was armed by the forward acceleration and operated on contact. The fuze had a flat nose.

The second and better fuze was made by Mende radio of Dresden (under Fliegerhoupt Ing Tantow), and although it was a later development it had been completed and used in trials. The operation was ingenious. A condenser in the rocket was charged by the ionisation of the gas stream, and allowed to discharge through a forward pointing rod in the nose, when contact was made with the target, thus firing the explosive. This fuze had a pointed nose.

No samples of any of these fuzes have been found to date, and consequently exact details are not known.

6.7.4 - Ignition - In the head of the rocket and flat against the wall are four coils of insulated wire, connected in series with the puffer which initiates the solid propellant charge. On firing, a current is induced in these coils from an external electro magnetic field and the solid charge is thus initiated. Fuller details of the apparatus on the projector are not available.

6.8 Projector

This consisted of four rails between which the rocket body could slide. The first 8 ft. (2½ metres) of the projector had a twist of 120° giving the spin mentioned above. They were cheaply made and not accurately aligned. The last 4 ft. (120 cm.) which were accurately aligned, were straight with no twist. While passing up this last part of the projector, each fin left contact with one rail and turned through only 35°, therefore, not making contact with the next rail. Hence as the rocket left the projector there was no contact with the fins, and no possibility of a sideways thrust due to one rail being slightly longer than another.

Early versions of the projector were made, either with 4 tubes of outside diameter approximately 1½ in., welded into seven external steel rings from which they were separated by spacing pieces, or with two lengths of angle iron with the interior angles facing each other. Later versions were said to have been made with four strips of rectangular cross section arranged in a circle with the longer side radial.

The first projectors produced in quantity were made by Skoda, and later ones were to be produced at the Mittleweke, Nordhausen, but here production never got going. Projectors to hold 30 rockets were intended to replace the barrel of an 88 mm. gun, this being a one day conversion.

6.9 Analysis of materials

The analysis of the materials used for various parts of the rocket are given in Appendix 3.

APPENDIX I - DESCRIPTION OF 5 TYPES OF TAIFUN

Table 1 contains data relating to five types of Taifun, as given by Scheufelen, These types are as follows:-

Taifun F. (German notation)

This was the model in quantity production at the end of the war, having a 10 cm. outer diameter and $2\frac{1}{2}$ second burning time.

Taifun 1. (English numbering)

This was an exactly similar model using higher expulsion and combustion pressures, and the same venturi, giving a shorter burning time of $1\frac{1}{4}$ secs. This model reached the stage of static tests.

Taifun 2.

This model was the same as the two previously mentioned, in size and weight, working at the higher pressures, but with a different spray injector and venturi. This had a still shorter burning time of .8 to 1 sec., and had reached the stage of being given flight trials.

Taifun 3.

This is a projected design for a 7 cm. model, of lighter weight and the same performance as the previous models when carrying the same warhead. It was considered to be the most economical design to give this performance.

Taifun 4.

This was a smaller (5 cm.) model for shorter range work with the same warhead.

APPENDIX 2. THEORY OF RELATIVE EFFICACY OF CONTACT AND TIME FUZING

The probability of destroying an aircraft by the use of either contact or time fused missiles is worked out and the two probabilities compared.

let P = probability that the aim will be correct in azimuth

m = " " " " " in elevation

n = probability that a time fuze will be set to burst at the correct range.

a = projected area of target aircraft

A = The area in which a burst at the correct range will prove lethal.

Then probability of a direct hit = a p.m.

and probability of a lethal explosion using a time delay fuze = A pmn

According to the Germans, the increase in aircraft size to the heavy bomber has so increased that

$$apm > Apmn$$

Scheufelen supported the above theory and claimed that all German flak specialists held this view. In good weather at the end of the war they were securing 1 kill for 2,000 rounds fired using contact fuzing.

APPENDIX I

Table 1 of data for 5 types of Taifun

	Taifun F. (quantity production)	Taifun 1 Static Tests only	Taifun 2 Flight trials	Taifun 3 Considered best design (never made)	Taifun 4 Static tests only
Time of burning secs.	$2\frac{1}{2}^x$	$1\frac{1}{2}^x$	$.8 - 1^x$	1^x	$.5 - .7^x$
Thrust kg.	840^x	1300-1500	3000^x	1500^x	750^x
Max. velocity (theoretical) m./sec.	1200^x	1200^x	1280^x	1400^x	800^x
Max. velocity obtained m./sec.	1000^x	-	1000^x	-	-
Max. acceleration m/sec/sec	1450^x	-	2100^x	2000^x	1000^x
Angular velocity leaving projector revs/sec	6^x				
Angular velocity to all burnt "	12^x				
Full weight kg.	21	21	21	14	8
Empty weight kg.	10	10	10	6.5	4.5
Fuel weight kg.	11	11	11	7.5	3.5
Warhead weight kg.	.5	.5	.5	.5	.5
Solid propellant weight gm.	150-200	150-200	150-200	120-150	80
Tank volume cc.	7200^x	7200^x	7200^x	5500^x	2400^x
Ullage %	8%	8%	8%	8%	8%
Total length mm.	1920	1920	1920	2150	1500
Tank length mm.	1200	1200	1200	1600	1000
Outside diameter mm.	100	100	100	70	50
Choke diameter mm.	11	11/2	20	11/2	10
Venturi throat mm.	36.5	36.5	45	35-36.5	35//2
Dia. of injector holes (1) Salbei mm.	18x1.5	18x1.5 †	24x1.5	18x1.5	12x1.5
(2) Visol mm.	18x2.8	18x2.8 †	24x2.8	18x2.8	18x2.5
Fin angle of incidence degrees	.5-.7	.5x.7	.5 - .7	.5 - .7	.5-.7
Solid propellant combustion pressure ats.	150	150	150	150	150
Tank pressure ats.	60	120	120	120	120
Combustion chamber pressure ats.	50	100	100	100	100
Operational height km.	15^x	15^x	15^x	15^x	5^x
Velocity at Operational height m/sec.	300^x	300^x	300^x	300^x	
Mean fuel density	1.35				
Spray injector discharge coefficient	0.64				
Gas exit vel. obtained m/sec.	2000^x				

Note: (1) x denotes approx. figures. (2) † denotes inconsistent figure which it has not been possible to check. (3) German units (kg, metres, etc.) are retained so that round figures may remain round.

APPENDIX 3. ANALYSIS OF MATERIALS USED IN VARIOUS PARTS.

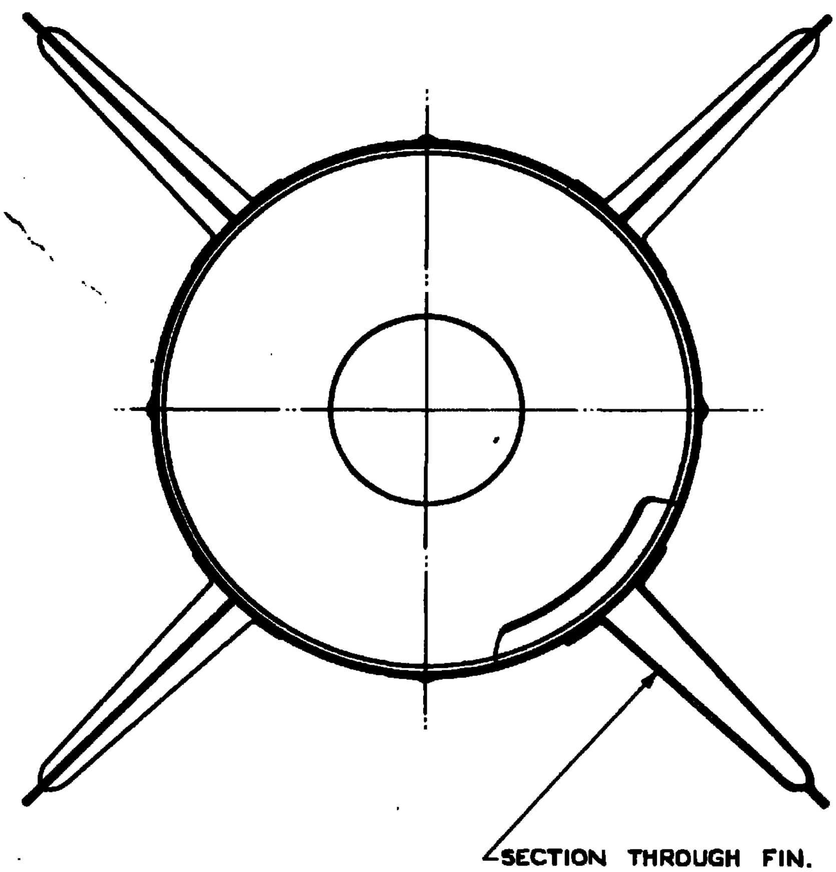
	C	Si	Mn	S	P	Ni	Cr	Mo	Al	V	W	Cu
Deep drawn venturi	.22	.03	.29	.045	.010	Nil	.08	.01	Nil	Nil	Nil	.096
Spun venturi	.23	.36	.95	.059	.022	Nil	.10	.06	Nil	Nil	Nil	.108
Spray injector	.44	.22	.47	.065	.037	Nil	.15	.04	Nil	Nil	Nil	.176
Outer tube	.16	.03	.37	.036	.031	Nil	.14	.05	.004	Nil	Nil	.076

	Cu	Mg	Fe	Si	Mn	Ni	Zn	Su	Pb	Al
Fuel tank	tr	2.10	.43	.24	.88	Nil	tr	Nil	Nil	Remainder.
Bursting disc				--- not yet received ---						

FIG. 4.

"TAIFUN" - GERMAN LIQUID FUELLED FLAK ROCKET.

END VIEW OF FINS.



A.D.D. 6/44.

SCALE :- FULL SIZE.

REEL

C 60

FRAME

2307

ATI No: 2307

US Classification:

R

OA No: TR-6/66

TITLE: German Non Guided Flak Rocket-Taifun.

AUTHOR(S): Hutcheon, I. C.

OA: Ministry of Supply

Foreign Title:

Previously cataloged under No:

Translation No:

Subject Division:

Section:

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ATI No: 2307 (OVER)

US Classification: ~~[illegible]~~

OA No: TR-6/46

TITLE: German Non Guided Flak Rocket-Taifun

C

AUTHOR(S): Hutcheon, I. C.

OA: Ministry of Supply

Foreign Title:

12

Previously cataloged under No:

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