TURBINE ENGINE ACTIVITY AT ERNST HEINKEL AKTIENGESELLSCHAFT

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

TURBINE ENGINE ACTIVITY
AT
ERNST HEINKEL AKTIENGESELLSCHAFT
WERK HIRTH-MOTOREN
STUTTGART/ZUFFENHAUSEN

May 1945

Reported by:

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C.I.O.S. Target Number 5/21
Jet Propulsion

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE
G-2 Division, SHAEF (Rear) APO 413

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LIST OF ILLUSTRATIONS

TURBINE ENGINE ACTIVITY

AT

ERNST HEINKEL AKTIENGESELLSCHAFT
Werk Hirth-Motoren
Stuttgart/Zuffenhausen

I - Object

To investigate the work carried on by the firm Ernst Heinkel Aktiengesellschaft, Werk Hirth-Motoren at Stuttgart/Zuffenhausen, hereafter called Heinkel-Hirth, in the development of gas turbine power plants.

II - Introduction

The purpose of this report is twofold: to inform those interested in gas turbine power plant development of the nature of Heinkel-Hirth's activity along these lines over the past ten years and to present a brief description of their projects and, secondly, to provide a basis for the conducting of a further investigation of this target at its dispersal points.

This report is intended to provide but a brief outline of the subject and is based upon the investigators' observations, interrogation of personnel and a brief study of some three hundred pounds of documents and 30,000 feet of microfilm records evacuated

from Stuttgart/Zuffenhausen.

III - Summary

There is a wealth of material available from the Heinkel-Hirth organization relating to all phases of their activity, all of which should be studied and evaluated for use by the Allied Powers. A certain amount of material as listed in the Appendix has been evacuated from Stuttgart/Zuffenhausen; this however can represent but a fraction of the total available at their dispersal points and in their archives.

Documents state that Heinkel first flew a turbo-jet propelled aircraft on August 27, 1939. This aircraft was the Heinkel He. 178, a single seat, high wing monoplane, powered with a single Heinkel He S 3 b turbo-jet engine located within the fuselage aft of the pilot. It is not known whether or not this was the first turbo-jet propelled aircraft to fly within Germany.

Subsequent to the flight of this aircraft Heinkel undertook the development of an advanced design engine, the He S 8 and the aircraft division of the firm designed the He. 280 around this engine.

With the failure of this aircraft/engine combination to result in a successful aircraft Heinkel, essentially an aircraft

firm, acquired control of Hirth-Motoren and continued their design studies, investigating ten different engine designs in all and culminating in the He S 11, a 2,860 lbs. thrust turbo-jet engine. Their studies covered centrifugal and axial flow turbo-jet engines, and turbo-jet and piston-engine driven ducted fan units, both with and without exhaust power recovery.

It is evident that the firm experimented with this latter type of engine development, rather than settling down to promote turbo-jet engines as an advanced form of aircraft power plant. It would also appear that they were hesitant to depart from their 1,000 lbs. thrust engine and did not develop a larger size until sometime in 1942.

IV - Narrative

The Hirth-Motoren Werk in Zuffenhausen is located at the north edge of the town, off the Marconi Strasse. The target was found to be but slightly damaged by either bombing or shell fire but had been badly pillaged by the slave labor left behind when the firm moved to their dispersal point in early April.

All key personnel left Stuttgart when the evacuation took place but the Engineering Director, Dipl. Ing. Kurt Schif had returned the week previous to the fall of Stuttgart and was available

for interrogation.

A complete history of Heinkel-Hirth activities from the founding of the organization up to January 1945 is contained in a report, remaining to be translated, entitled "Entwicklungsgeschichte der Ernst Heinkel Aktiengesellschaft" - ("Development History of Ernst Heinkel A.G."), which was written for the historical records of the German Air Ministry Technical Section.

A tree, given in the Appendix, has been compiled from documents, interrogation and investigation, and shows the position of the targets investigated with the complex of the Ernst Heinkel A.G. holding company as at April 1945, together with their relations to other Heinkel-Hirth subsidiaries and dispersals.

It would appear that the original phases of jet engine development within this firm were the work of the Ernst Heinkel Flugzeugwerk Rostock. From Helmut Sachse of Kempten, who in the years preceding the war occupied the position at the RLM recently tenanted by General Eisenlohr, it has been learned that when jet projects were originally being considered the firm of Heinkel was not in the approved list, and that the developments at Rostock were a private venture on the part of Heinkel who wished to be in on the pickings of both airframe and power plant manufacture of the future. This may be correct and if so would explain the facilities afforded to Mueller by Heinkel for the development of the He S 30 (q.v.) and

the absorption by Heinkel of the Hirth firm as a unit with experience in power plant manufacture.

When this latter control was achieved all jet activity of the Heinkel combine was moved from Rostock to the premises of the Hirth-Motoren Gmbh at Stuttgart/Zuffenhausen.

From an engineering standpoint, the organization at Zuffenhausen has enjoyed an enviable position during the war years as they were, for all practical purposes a privately owned, state subsidised research and development laboratory. The only production work of any consequence that they carried out was the manufacture of exhaust turbo superchargers for the BMW 801 engine and the manufacture of their own small in line air-cooled engines.

During the first two years Hirth at Zuffenhausen continued development of their pre-war products including auxiliary power plants, starter motors and general accessories. In 1941, apparently in conjunction with DVL, they undertook development work on exhaust gas turbo superchargers and at the same time started a study of the design of gas turbine auxiliary power plants. With their absorption into the Heinkel complex, those two sides of their activity continued but were gradually over-shadowed in importance by the development of [illegible] jet engines.

V - Heinkel-Hirth Jet Activity

A complete history of Heinkel-Hirth jet engine activity from the time the firm of Ernst Heinkel first became interested in the work to about 1941 is contained in two reports, still to be translated, entitled "Ernst Heinkel Strahltriebwerke", - ("Ernst Heinkel Jet Propulsion Units"), issues 0 and 1.

Jet activity has followed three lines of development over the past ten years. The first, as laid down by the Heinkel/Rostock organization in 1936 and generally credited to Dr. von Ohain, represented the development of a series of turbo-jet engines designed around a centrifugal impeller system. The second line of development was on axial flow turbo-jet engines and was sponsored by a Herr Mueller who came to Heinkel from Junkers in 1938 or 1939. A number of proposals have also been put forward for ducted fan engines where power was supplied by a reciprocating engine, both with and without a turbine stage. While it is not definitely known who sponsored this development, it is believed to be a Dr. Bentele who was in charge of the advanced design department and was concentrating on piston engines. Records indicate that contracts were let on certain of these ducted fan engines, but there is no evidence that they proceeded any further than the construction of single cylinder test units.

In all, the following engines were either projected or constructed by the firm during the period of 1936 to date. Engines are identified by Heinkel project numbers and where RLM numbers are known to have been assigned, they are given:

Year.	Model.	RLM No.	Status.	Number built or Contracted for.
1936 - 39	He S 3 b		E	
1938 - 39	He S 6		P	
1938 - 42	He S 8	109-001	E	30 ?
	He S 9		P	10
1939 - 40	He S 10	109-010	P	3
1939 - 41	He S 30	109-006	E	3
1940 - 41	He S 40		P	
1940 - 41	He S 50		P	3
1940 - 42	He S 60		P	
1941 - 44	He S 11 (V1 to 5)		E	5
1944	He S 11 (V6 to 9)		E	4
1945	He S 11	109-011 A-0	S	

NOTE: He S 3, 6, 8, 9, 10 and 11 are von Ohain designs; He S 30 and 40 are designs by Mueller.

E - Experimental)
P - Projected)
S - Series)

The majority of these engines were projects only, and

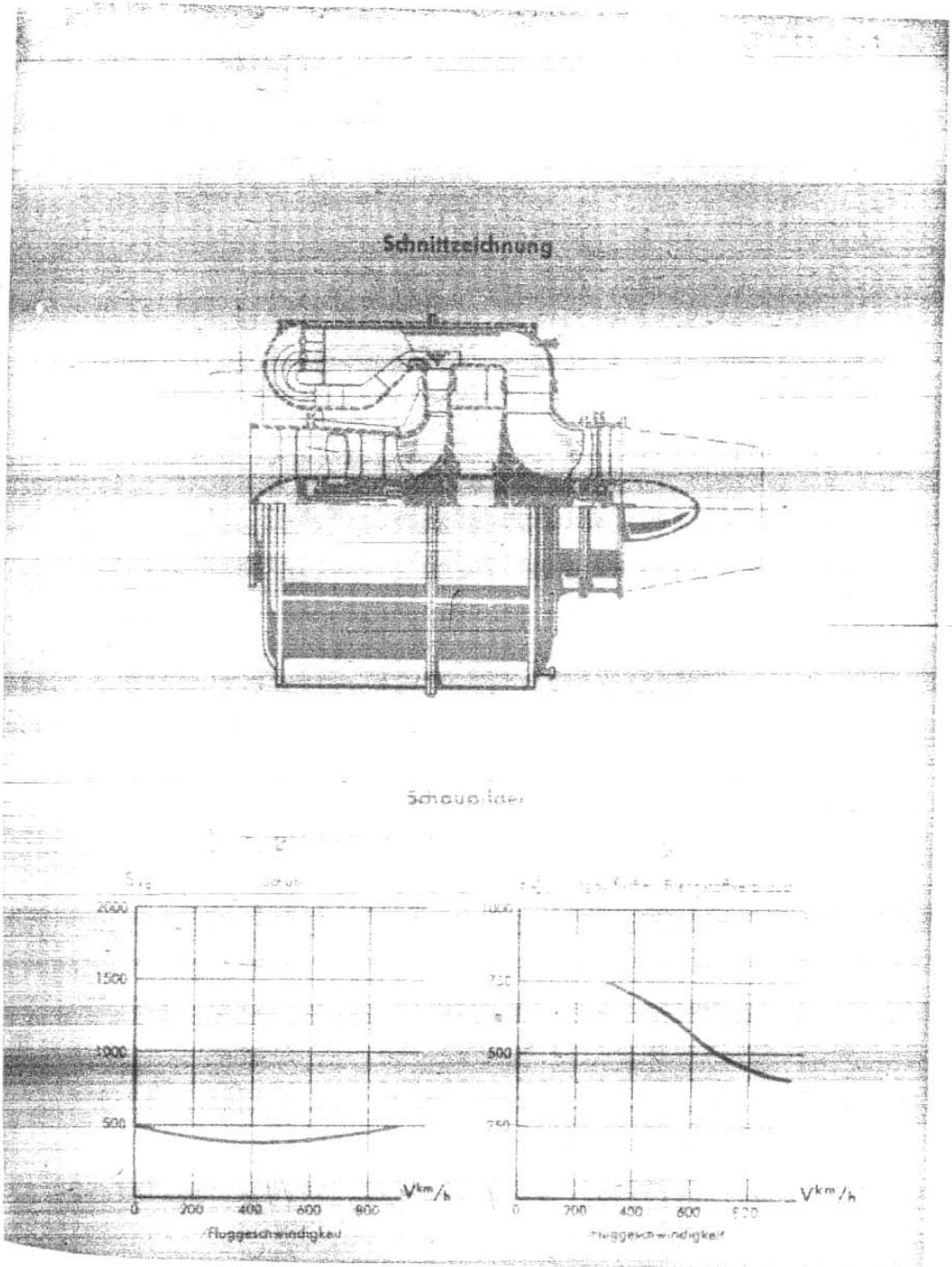
but four were built in an experimental or "V" series. Of these four, the He S 8 and He S 011 are of principal interest and for this reason are described more completely than the rest. References have been noted also in documents to sub-types such as the He S 8 a and the He S 8 b. Where additional material is available for study, it is indicated.

He S 3.

The He S 3 turbo-jet engine is built around a compressor/turbine set comprising an axial flow inducer, a radial flow impellor and a radial inflow turbine. Air from the impellor is divided aft of the diffuser, a portion passing forward through the annular reverse flow combustion chamber and the balance mixing with the products of combustion prior to entry into the turbine. The engine is illustrated in Figure 1, together with curves of thrust and fuel consumption. Other characteristics of the engine, as known, follow:

Speed	13,000 rpm.
Weight	795 lbs.
Frontal Area	7.3 sq.ft.
Specific Weight	.72 #/#F.

Reference is made to Sketch A, illustrating a turbo-jet engine patented by Max Hahn and assigned to the firm of Ernst Heinkel to which this engine bears a striking resemblance. In all probability this engine and a succeeding model were built before the He S 3 and probably bore the designations He S 1 and He S 2, respectively.

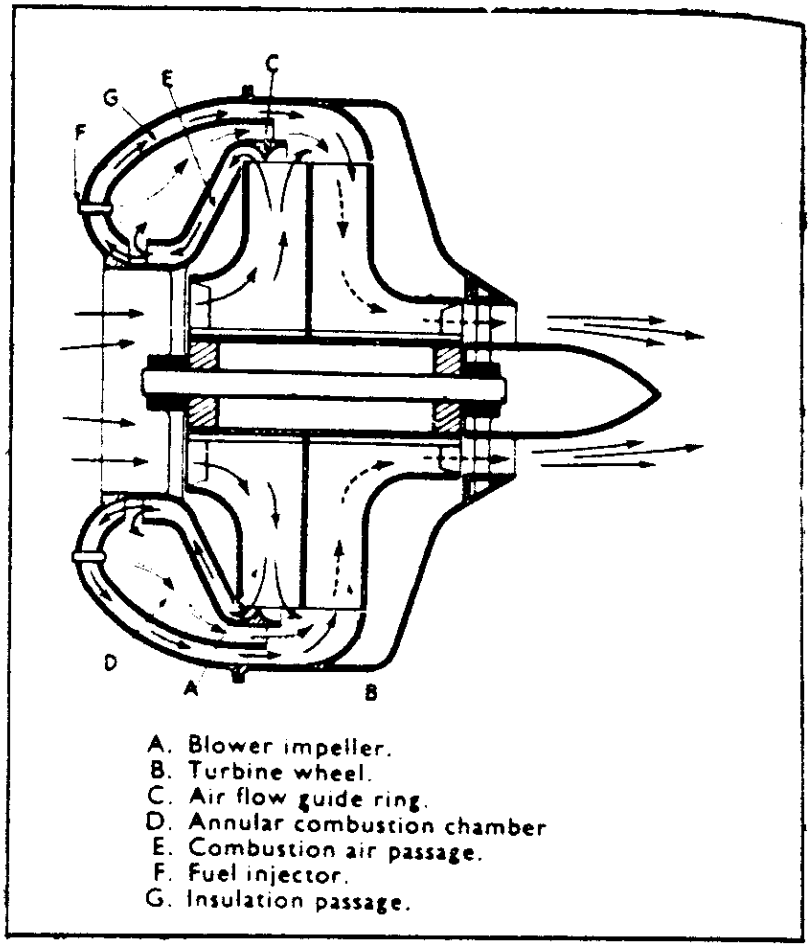


SECTIONAL ARRANGEMENT & PERFORMANCE

FIG. 1.

11. HE S 3B

The He S 3 was installed in the Heinkel He. 178 aircraft illustrated in Figure 2, and flew on August 27, 1939. So far as is known this was the first turbo-jet aircraft to fly in Germany. A limited amount of design and test data is available on the engine.



Sketch A.

He S 6.

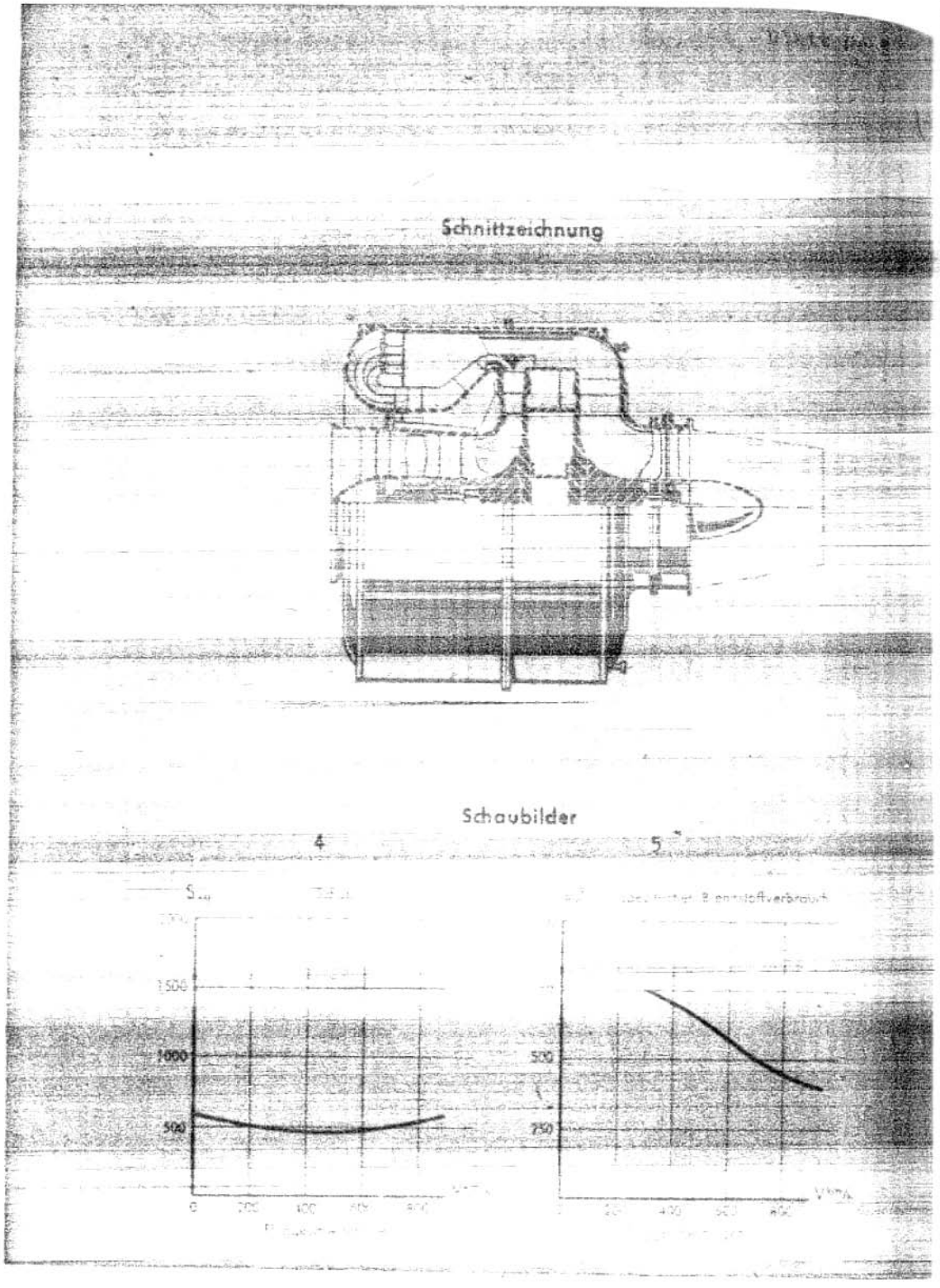
The He S 6 was a further development of the He S 3. Illustrations of the engine do not indicate any obvious change in design so it can only be assumed that the 6 was a refinement of the He S 3. The engine is illustrated in Figure 3 together with curves of thrust and fuel consumption and further known characteristics are as follows:

He 178 mit Strahltriebwerk He S 3 b

TURBO JET-PROPELLED AIRCRAFT

He 178

FIG. 2



SECTIONAL ARRANGEMENT & PERFORMANCE

Fig.

Speed	13,300 rpm.
Weight	925 lbs.
Frontal Area	7.1 sq.ft.
Specific Weight	.70 #/#F.

This engine was test flown underneath an He. 111 Aircraft.

He S 8.

The He S 8 was designed with the specific view to reduce the weight and diameter of the original He S 3/6 design. Improvements in these two points were as follows:

	Weight	Diameter
He S 3/6	925 lbs.	36.5"
He S 8	836 lbs.	30.5"

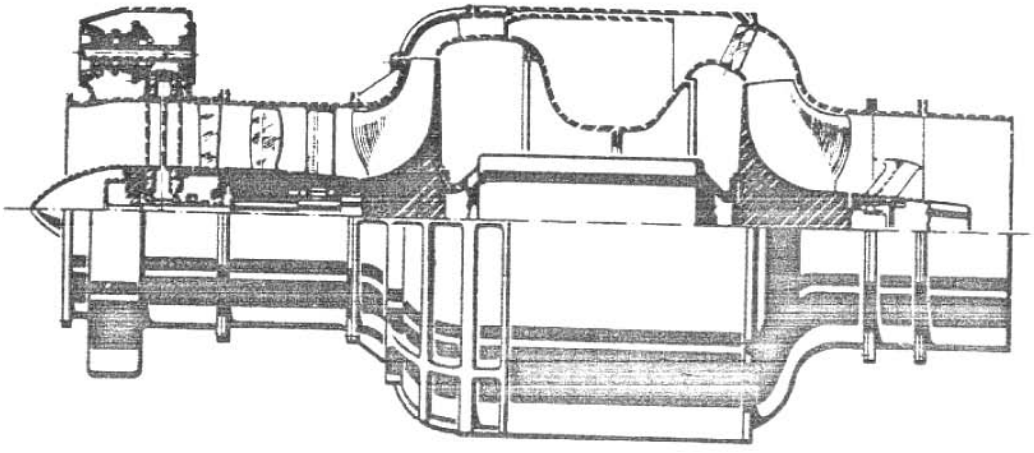
This was accomplished by a redesign of the combustion chamber, making it a straight through design as shown in Figure 4. Curves of thrust and fuel consumption are also given in this Figure and other known characteristics follow:

Speed	13,500 rpm.
Weight	836 lbs.
Frontal Area	5.16 sq.ft.
Specific Weight	.55 #/#F.

The He. 280, a twin engine turbo-jet aircraft illustrated in Figure 5 was designed for this engine.

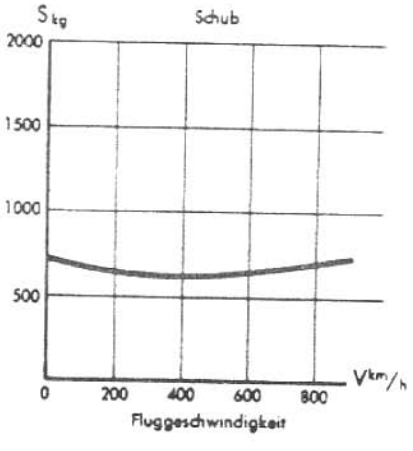
The He S 8 is designed around a compressor/turbine set comprising a 14 blade axial flow inducer, having airfoil type blades as illustrated in Sketch B, which are made from aluminum alloy forgings. This inducer is followed by a 19 vane radial flow

Schnittzeichnung



Schaubilder

6



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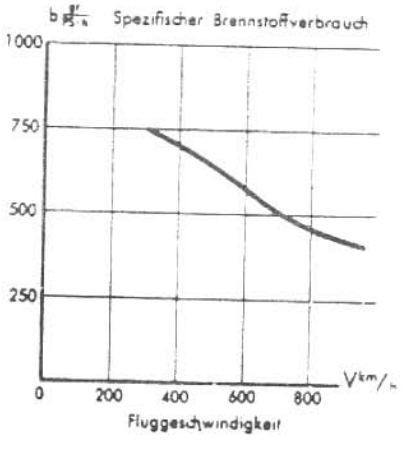
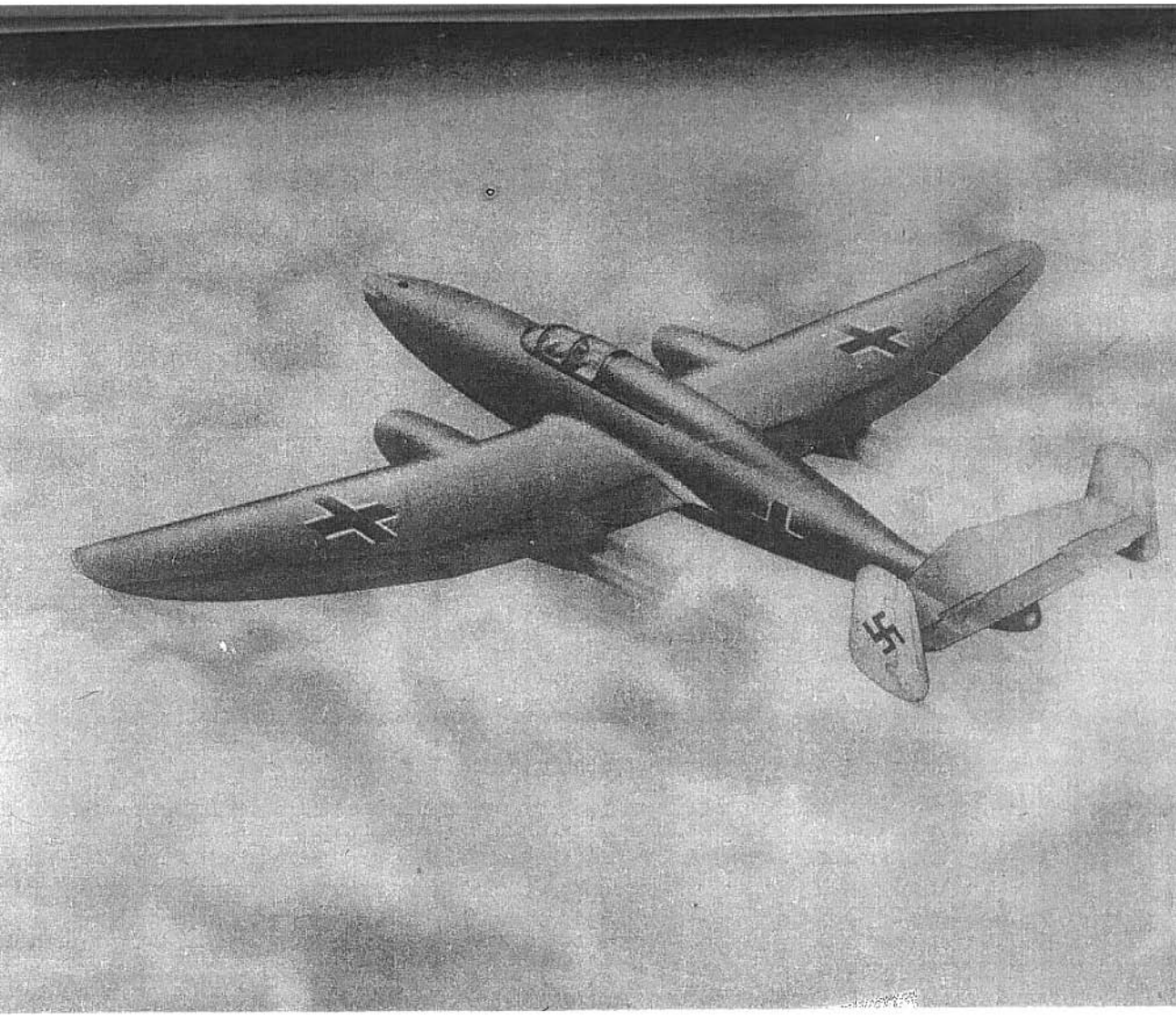
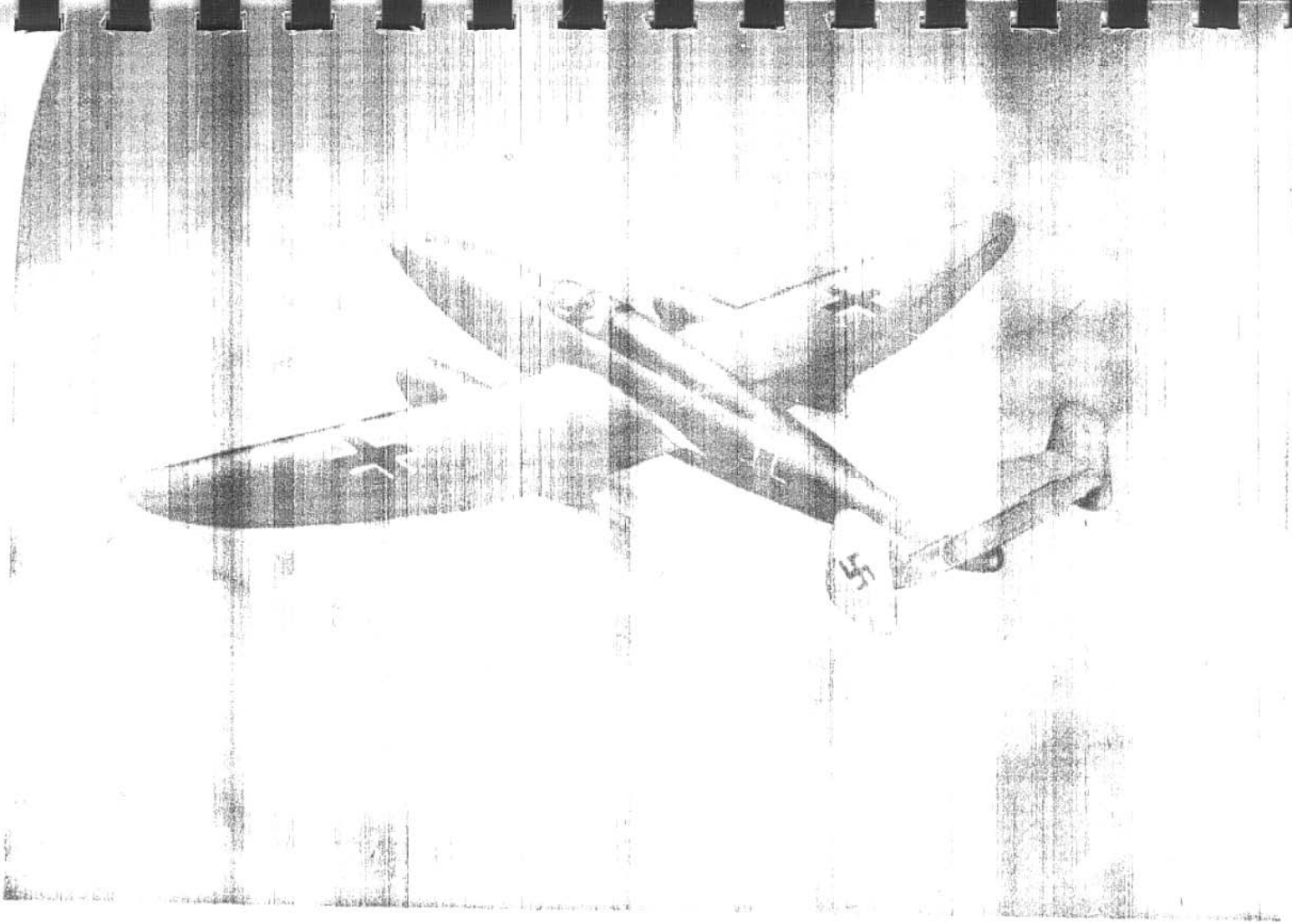


SECTIONAL ARRANGEMENT & PERFORMANCE



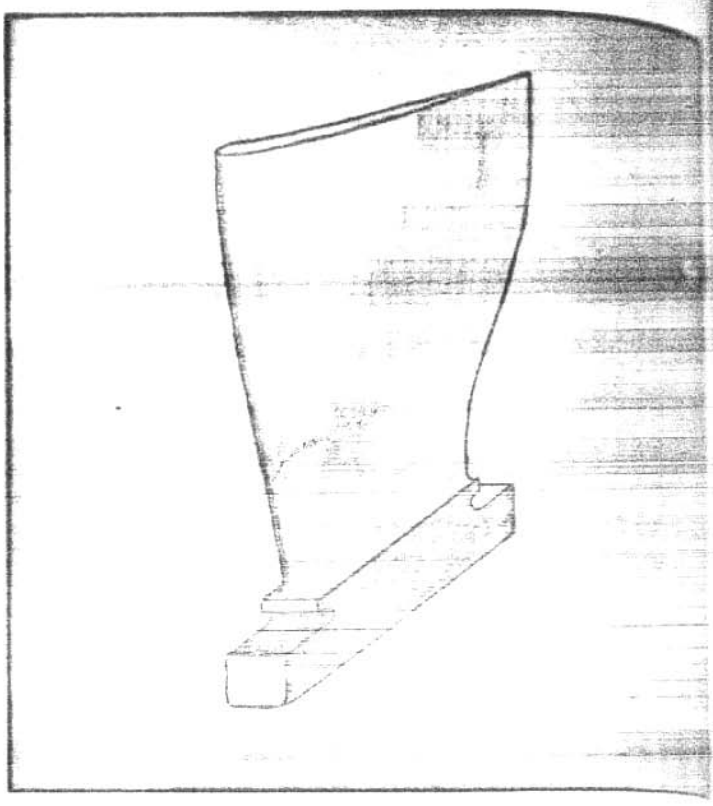
TURBO JET-PROPELLED AIRCRAFT



TURBO JET-PROPELLED AIRCRAFT

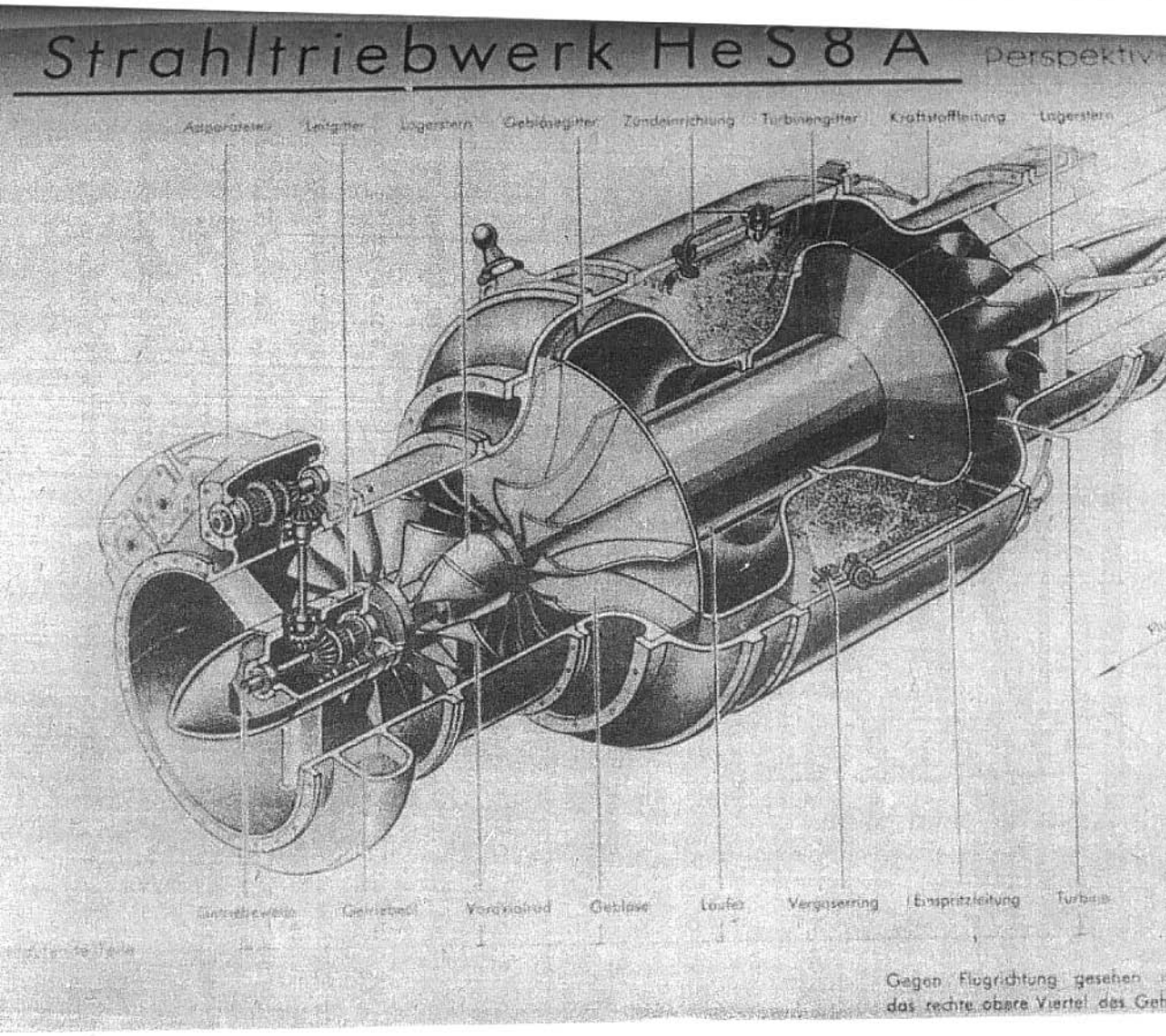
He 280

impellor of composite construction, consisting of aluminum alloy blades retained in a steel hub and rear shrouding plate. After combustion the working fluid passes through a 14 blade radial inflow turbine also being built up of steel blades retained in a steel hub The compressor/turbine set, which is illustrated in the engine cut-away in Figure 6, is mounted on two bearing sets, one between the inducer and impeller and the second aft of the turbine.

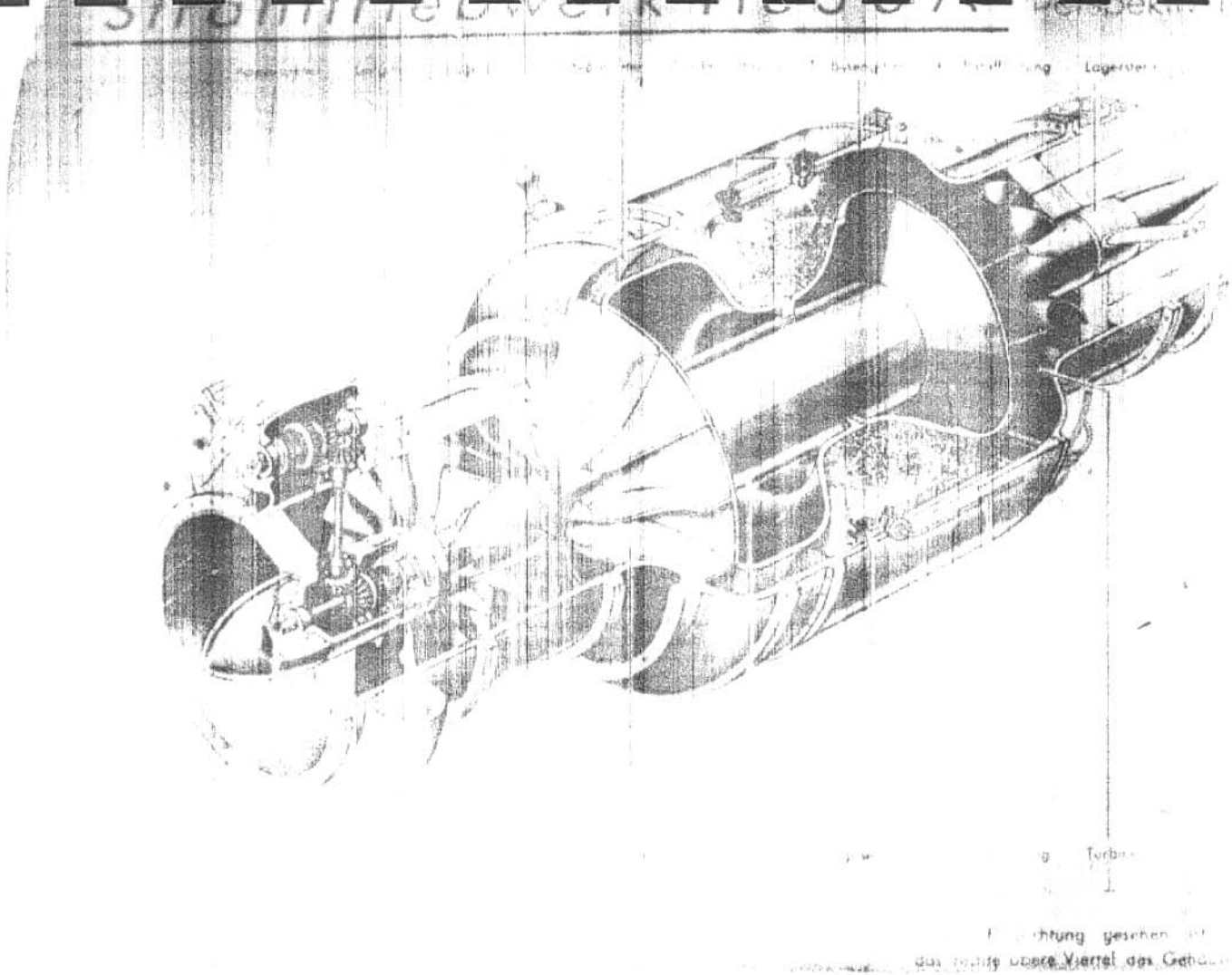


Sketch B.

Combustion is carried out in a straight through annular chamber, the compressor discharge passing through two sets of diffuser vanes before entering the chamber. The fuel system is a vaporizing system functioning in the following manner: Fuel is injected into the chamber through 16 sets of eight nozzles, giving a total of 128 individual nozzles. Each nozzle is a tube approximate



TURBO - JET ENGINE

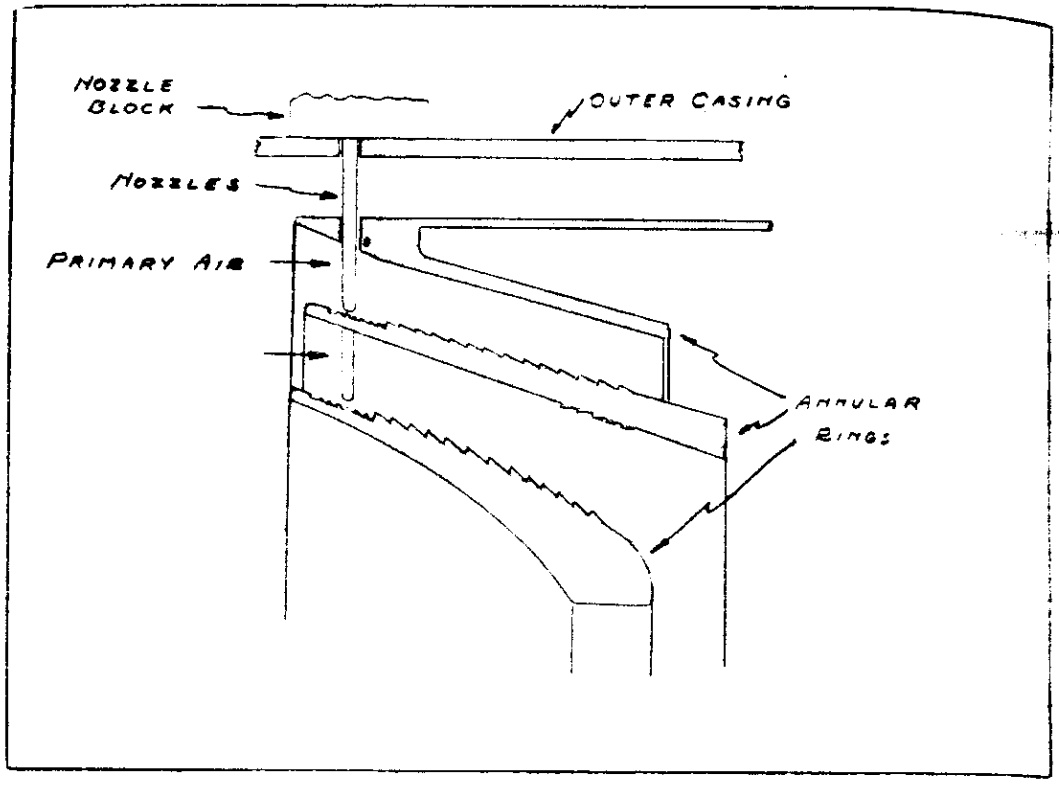


TURBO - JET ENGINE

HE S 8

FIG 6

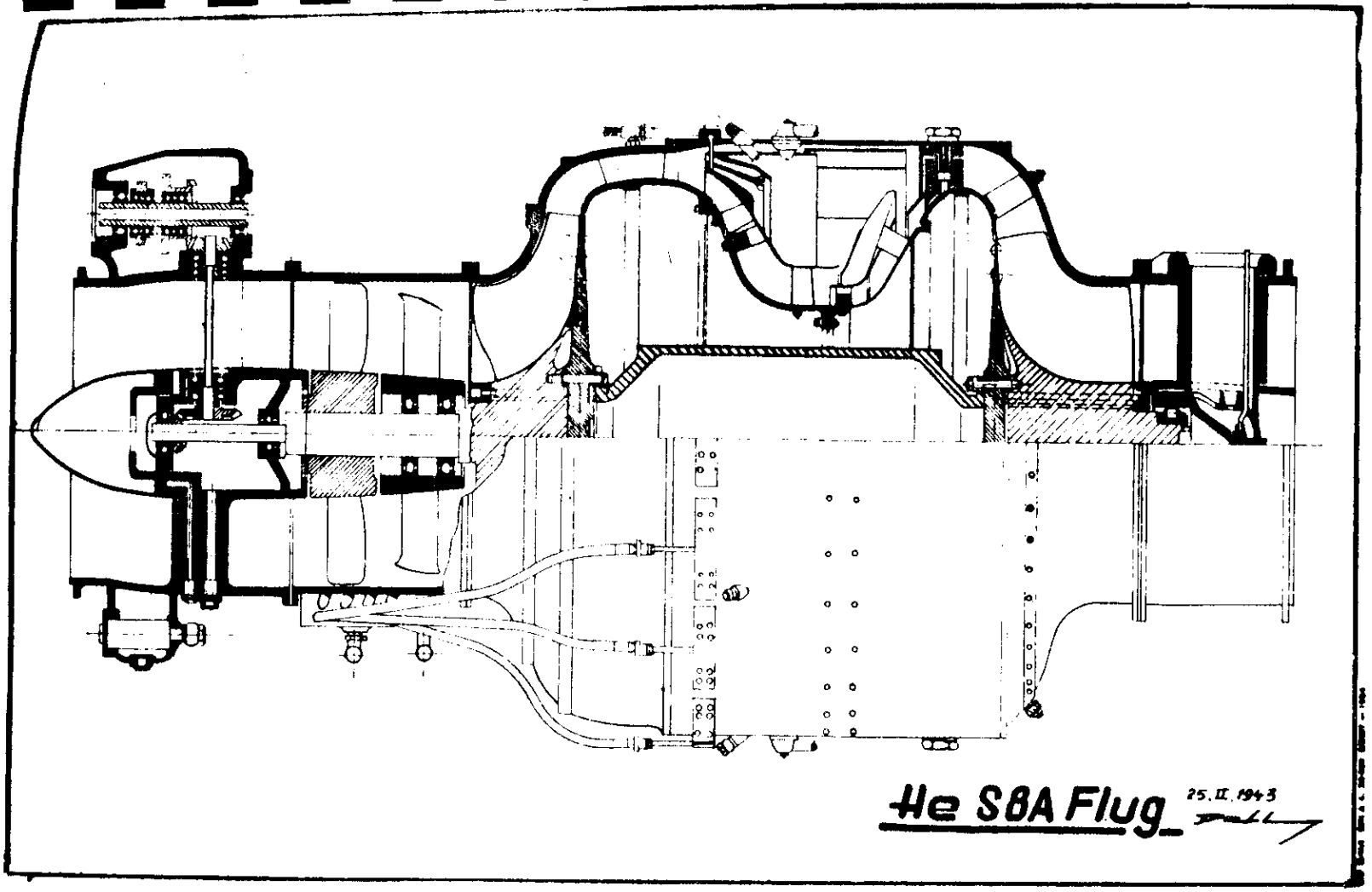
1/16" in diameter. Alternate nozzles differ in length by about 1/2" and spray into two passages as indicated in Sketch C. The



Sketch C.

fuel from the nozzle impinges upon the two surfaces formed by steel rings, having their outer surface grooved, from which it is vaporized and burned. Initially no attempts were made to provide any secondary air distribution, but subsequent models as the V16 illustrated in Figure 7, had such provisions.

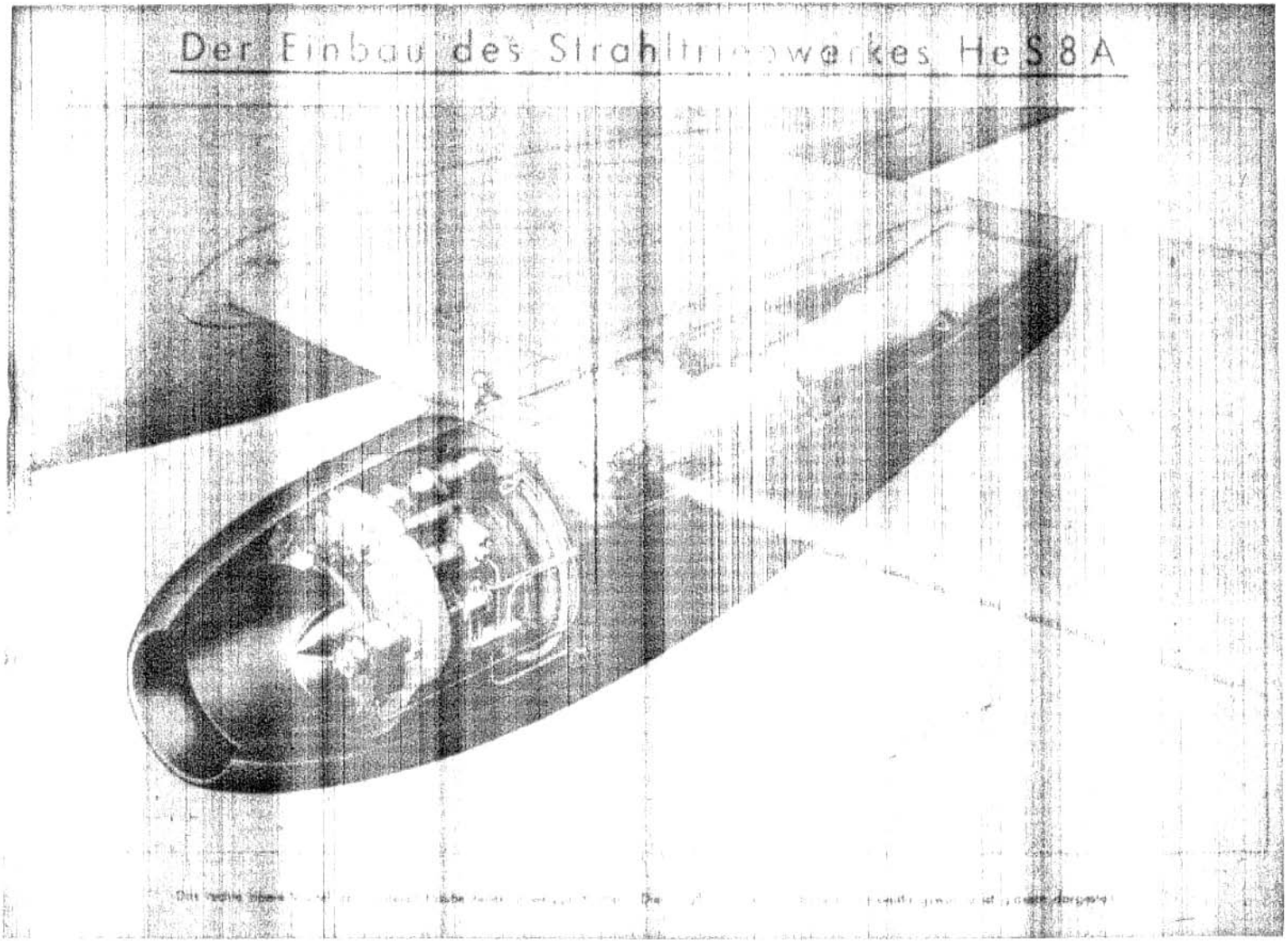
The exhaust nozzle is of fixed area and a tailpipe was used on the He. 280 installation as illustrated in Figure 8.



SECTIONAL ARRANGEMENT

HE S 8 V 16

FIG. 7



22.

Fig

INSTALLATION IN HE 280 AIRCRAFT

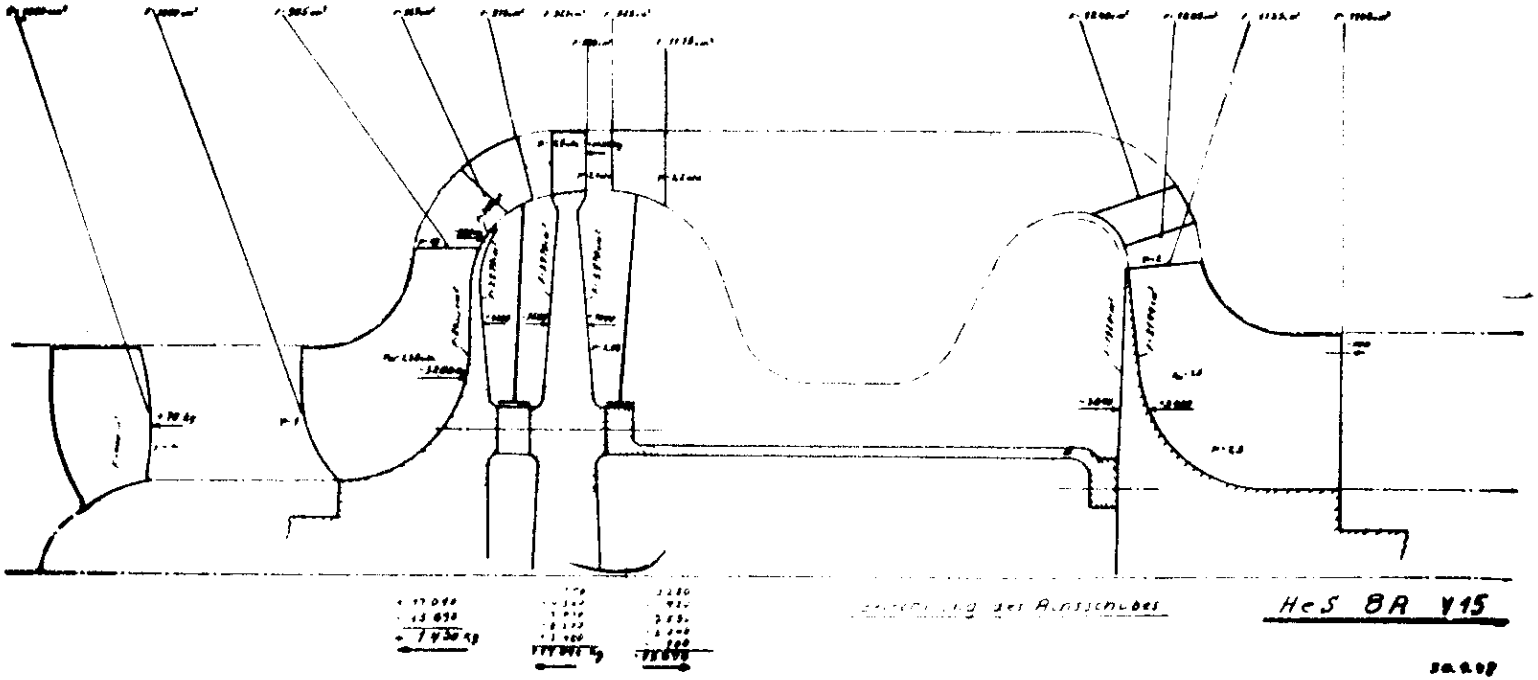
HE S 8

The exact number of engines of this series built is unknown, however, the following have been identified: V1, V5, V6, V7, V13, V14, V15, V16, V28, V29 and V30. Little is known of specific details or changes between these engines except that V16 incorporated sandwich secondary air mixers and V15 was designed with a new type compressor system. In this engine the compressor set consisted of an axial inducer stage, a radial stage and a single axial stage. This is shown in Figure 9. It will be noted that the total pressure ratio as given in this drawing is 3.2:1, .5 of which is credited to the axial stage. It follows that the He S 8 series of engines without this axial stage had a pressure ratio of about 2.7:1.

The V16 unit, illustrated in Figure 7, was test flown under an He. 111 and certain flight test results are available. There is also a certain amount of design and test data available on this engine.

He S 9.

Nothing is known of the He S 9 except that Heinkel-Hirth received a Ministry contract for the construction of ten of these engines. Documents indicate that this design might be one in which the compressor/turbine set consisted of an axial inducer stage, a diagonal stage, two axial stages and a radial inflow turbine. Such



DESIGN STUDY

He S 8 V15

FIG. 9

an engine would fit into the development series between the He S 8 V15, and the He S 11.

He S 10.

The He S 10 was an experimental ducted fan engine built around the He S 8 turbo-jet engine. Power for driving the fan being taken from a drive at the front of the rotating assembly. The engine is illustrated in Figure 10, together with curves of thrust and fuel consumption. Further details follow:

Speed	13,500 rpm.
Weight	1,100 lbs.
Frontal Area	8.6 sq.ft.
Specific Weight	.56 #/#F.

Additional design and test data are available on this engine.

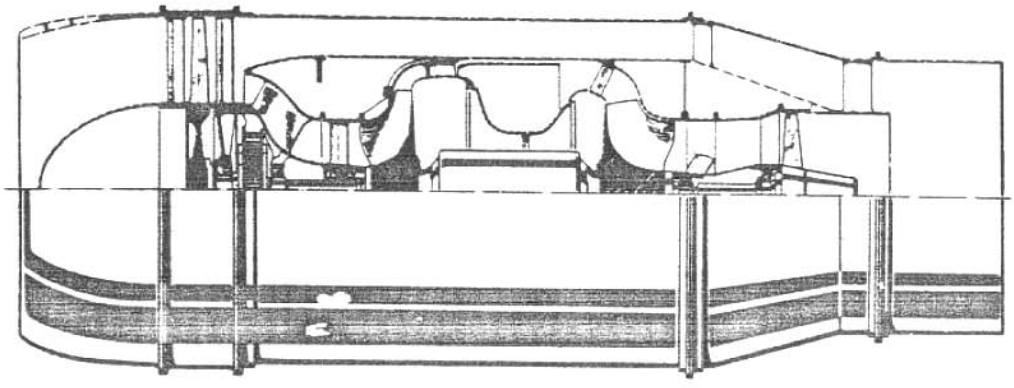
He S 011.

The He S 011 engine was designed in the period from 1941 to date, and represents the culmination of Heinkel's design experience with the preceeding engines. This engine is described in detail in Section VI and a wealth of design and test information is available.

He S 30.

The He S 30 engine is a design of a certain Herr Mueller, who came to Heinkel at Rostock sometime in 1938 or 1939. Records state that Mueller claimed to have been working for Junkers and promised to have an engine running within a year of his arrival.

Schnittzeichnung



Schaubilder

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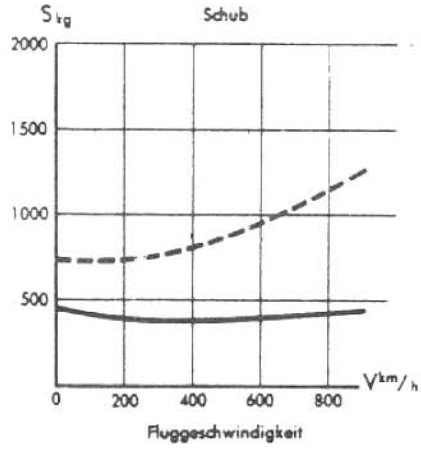

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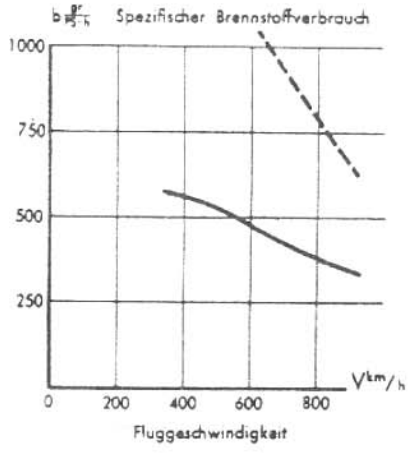


SECTIONAL ARRANGEMENT & PERFORMANCE

HE S 10

FIG. 10.

Since the product of his design is similar to the Jumo 004 it can be assumed that the 004 was running prior to this time and that Mueller based his design upon experience with that engine. The He S 30 is illustrated in Figure 11 together with curves of thrust and fuel consumption. An artist's sectional drawing is given in Figure 12. Further details as known are:

Speed	10,500 rpm.
Weight	857 lbs.
Frontal Area	3.23 sq.ft.
Specific Weight	.52 #/#F.

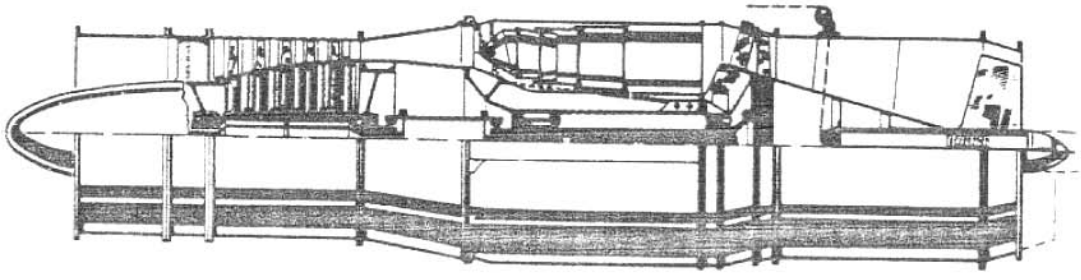
The He S 30 is built around a compressor/turbine set, consisting of a five stage axial flow compressor and a single stage axial flow turbine, with adjustable nozzle guide vanes. What are believed to be ten individual combustion chambers are used, varying from a circular section at the entry to a heart-shaped section at the nozzle vane chamber. A two-position tail cone was used, held in the out position by means of a spring and retracted by a simple pull cord.

Further design information, test records and drawings are available on this engine.

He S 40.

The He S 40 engine was constructed from parts, i.e. compressor, turbine and exhaust nozzle, from the He S 30 but differed in that an attempt was made to carry out combustion at constant

Schnittzeichnung



Schaubilder

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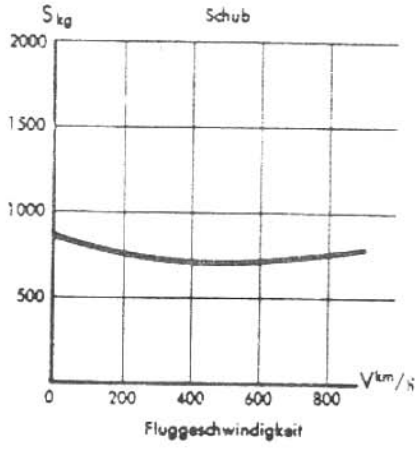

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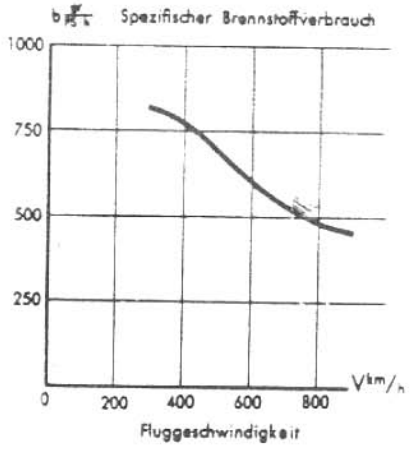
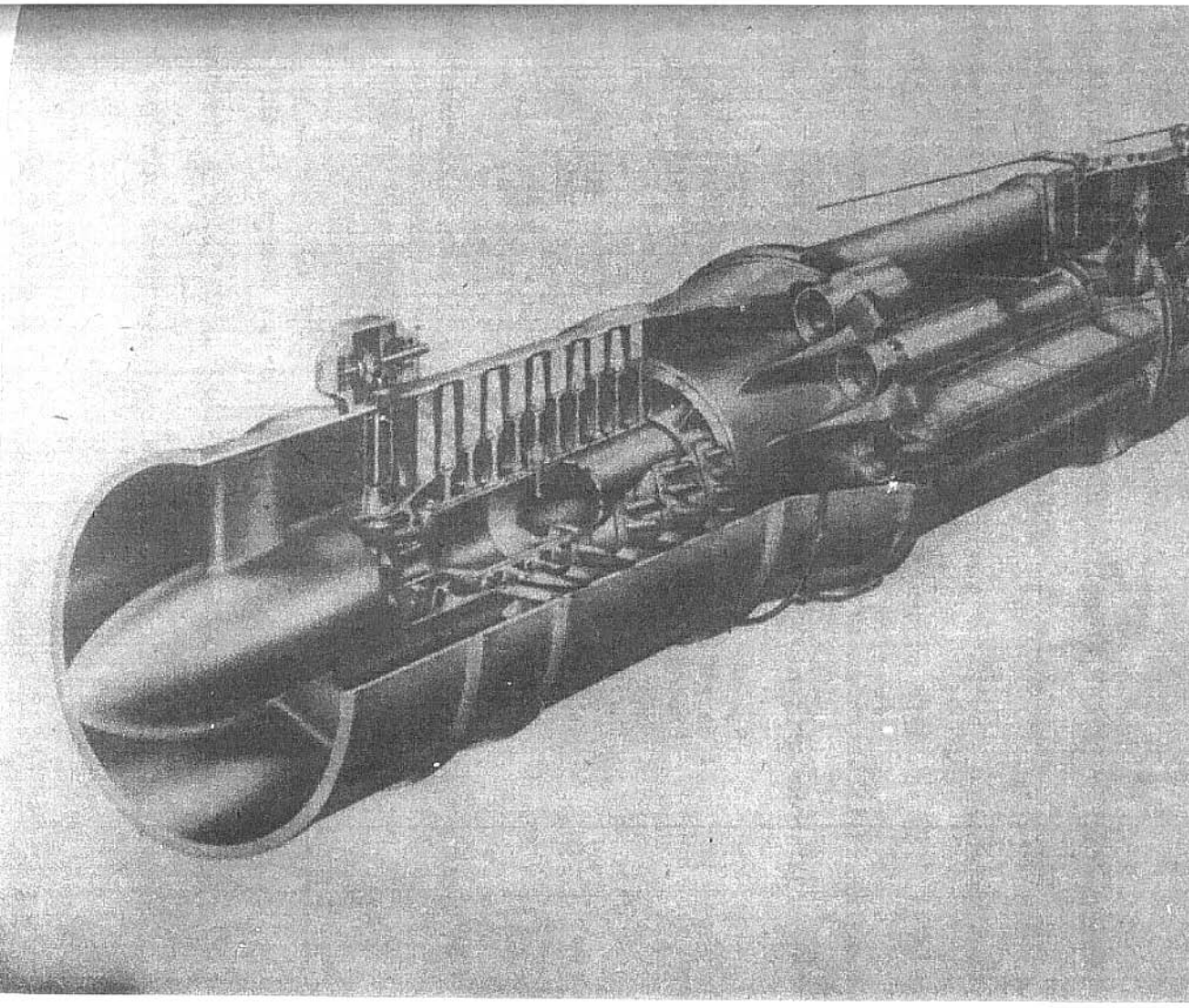


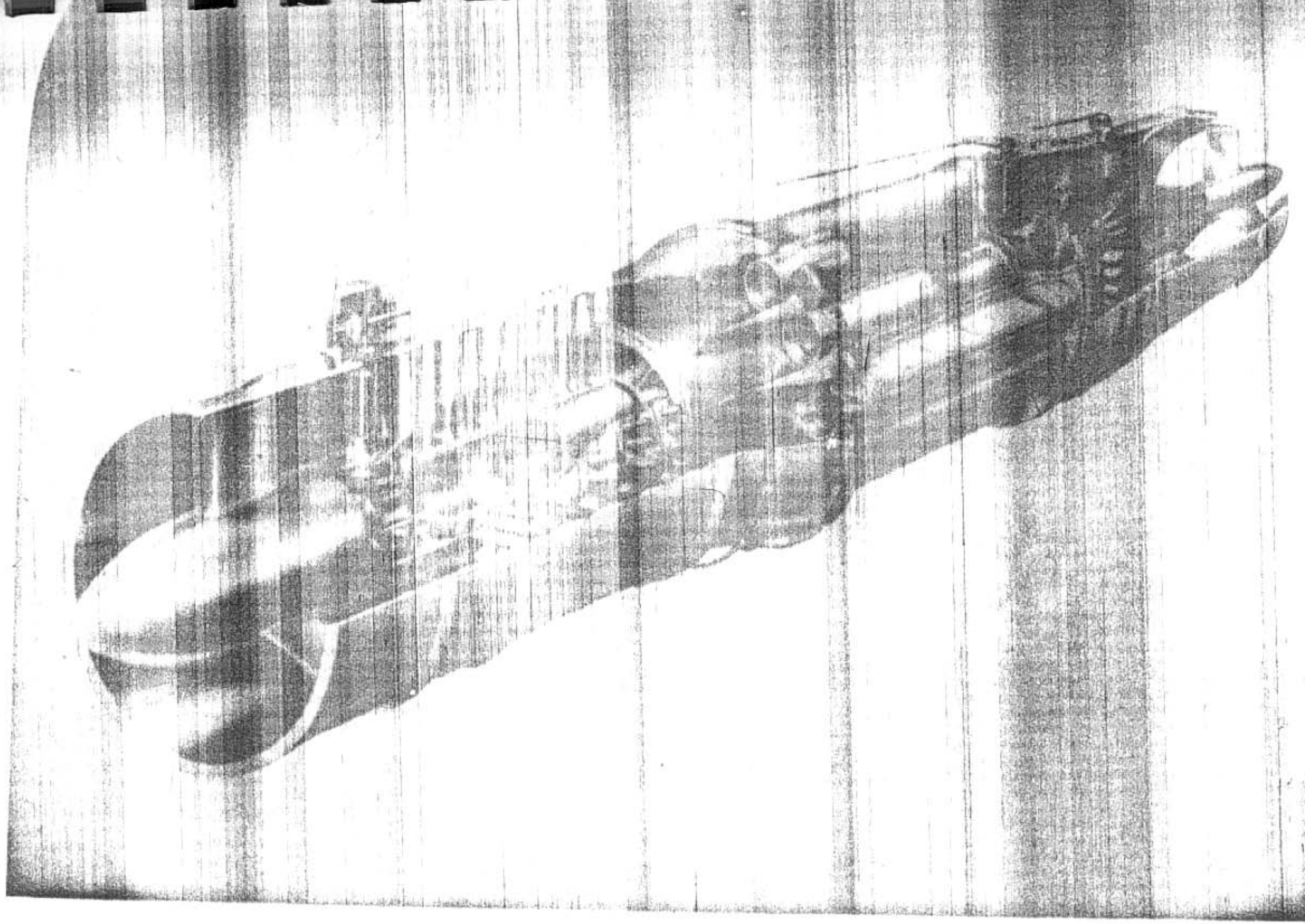
SECTIONAL ARRANGEMENT & PERFORMANCE

28. HE S 30 FIG 11



TURBO JET ENGINE

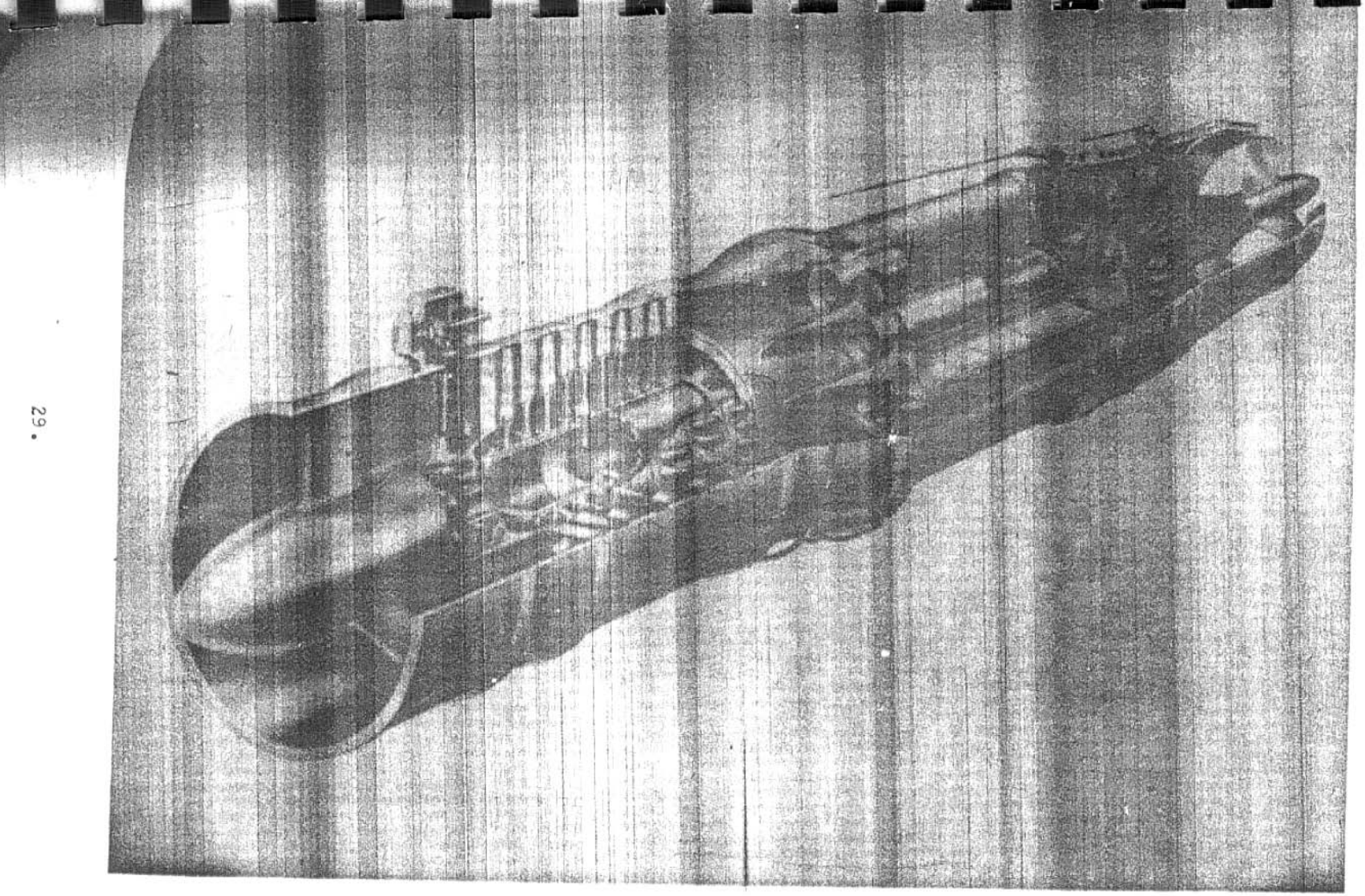
He S



TURBO JET ENGINE

HE S 30

FIG. 12



TURBO JET ENGINE

HE S 30

FIG. 12

volume by means of a combustion chamber of special design employing a sleeve valve in the entry. Nothing is known of this project other than what can be discerned from the illustration given in Figure 13. To date no technical data has become available.

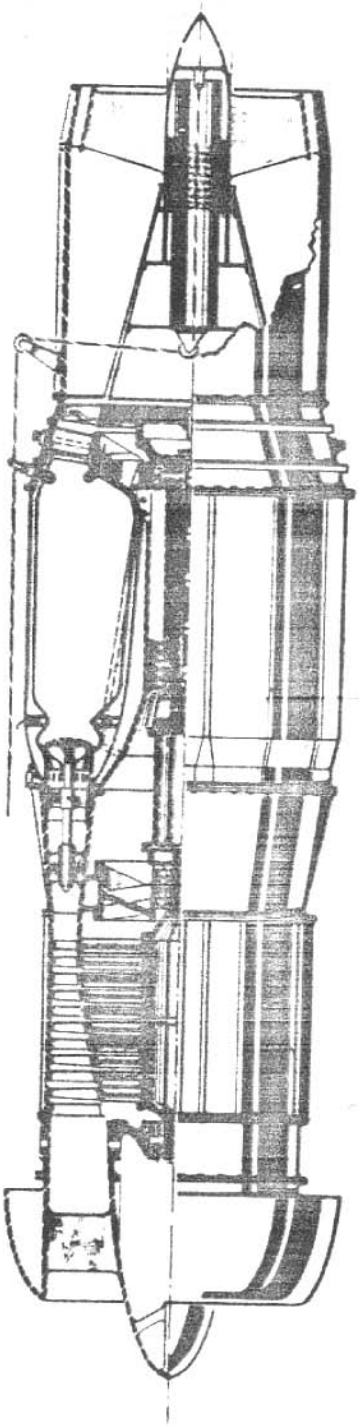
He S 50 d.

The He S 50 d is a ducted fan power unit consisting of a twenty-four cylinder Diesel engine driving a two-stage fan in an enclosed duct. According to the manufacturer, a Diesel power plant was selected in spite of its high specific weight, to take advantage of its low specific consumption for long range operation. The engine is illustrated in Figure 14, together with curves of thrust and fuel consumption. Other details as known follow:

Speed	4,600 rpm.
Weight	1,495 lbs.
Frontal Area	6.13 sq.ft.
Engine:	
Power at take-off	1,200 BHP
Rated Power	1,000 BHP
Bore	3.74 in.
Stroke	3.54 in.
Number of Cylinders	24
Arrangement:	Four rows of six in a horizontal "H". Fan drive taken from center of dual crankshafts.

He S 50 z.

The He S 50 z is also a ducted fan design, in this case consisting of a sixteen cylinder air-cooled "X" engine driving a three-stage lattice fan. A single cylinder power unit has been

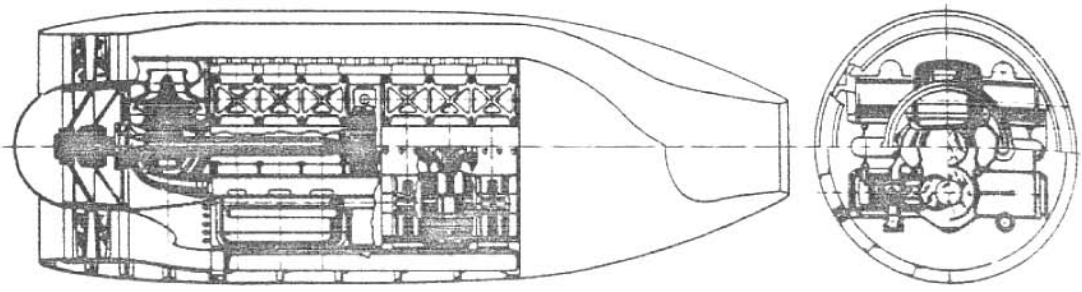


SECTIONAL ARRANGEMENT & PERFORMANCE

HE S 40

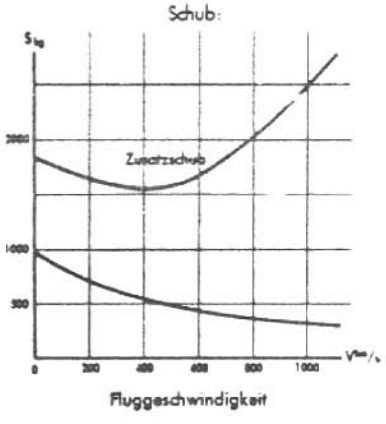
FIG. 13

Schnittzeichnung



Schaubilder

14



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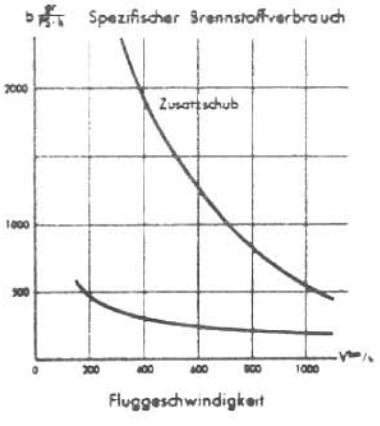


SECTIONAL ARRANGEMENT & PERFORMANCE

HE S 50 D

FIG. 14

constructed and tested but aside from the manufacturer's sales data presented in Figure 15, and the following details, nothing is known of the engine:

Speed	6,000 rpm.
Weight	814 lbs.
Frontal Area	3.23 sq.ft.

Engine

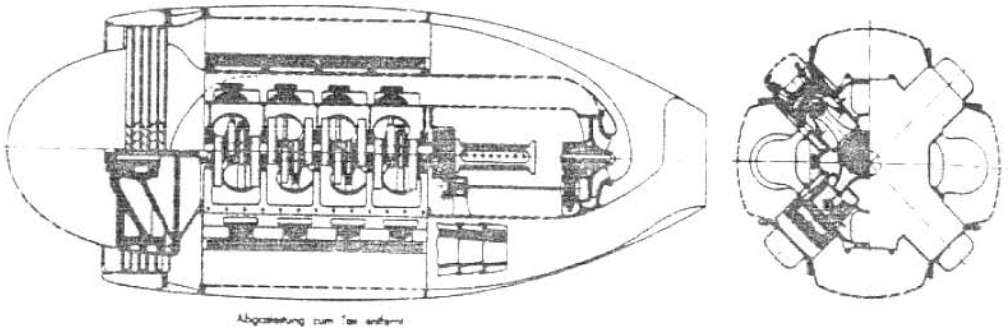
Power at take-off	1,000 BHP
Rated Power	800 BHP
Bore	3.94 in.
Stroke	2.76 in.
Number of Cylinders	16
Arrangement:	Four banks of four. Single crankshaft.

Hs S 60.

This engine, which did not get beyond the project stage, was designed to supercede the He S 50 series. In this case the unit consisted of a thirty-two cylinder "X" engine driving a three-stage fan. This unit differs basically from the He S 50 series in that a certain amount of power is extracted from the working fluid through a radial inflow turbine before the fluid is discharged to the atmosphere. The engine is illustrated in Figure 16, together with curves of thrust and fuel consumption. Other details follow:

Speed	6,000 rpm.
Weight	1,760 lbs.
Frontal Area	6.9 sq.ft.

Schnittzeichnung



Schaubilder

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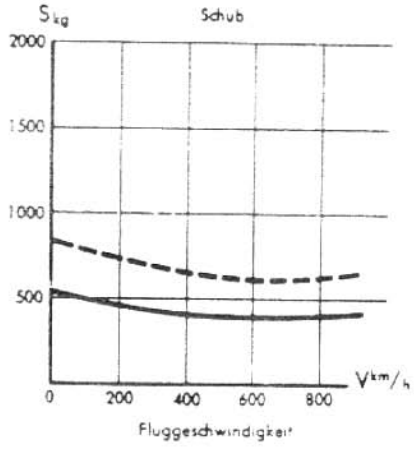

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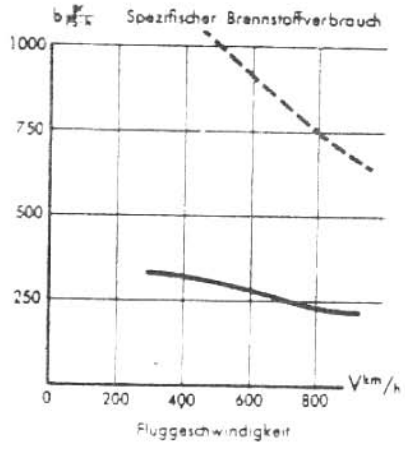
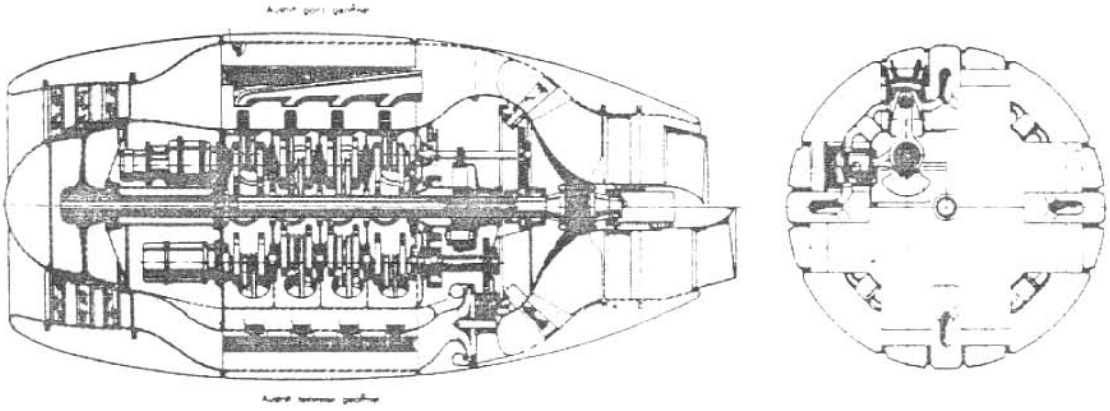


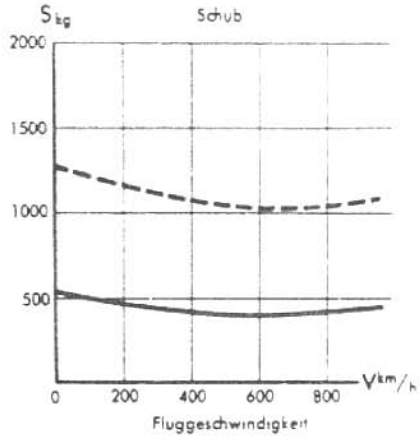
SECTIONAL ARRANGEMENT & PERFORMANCE

Schnittzeichnung



Schaubilder

16



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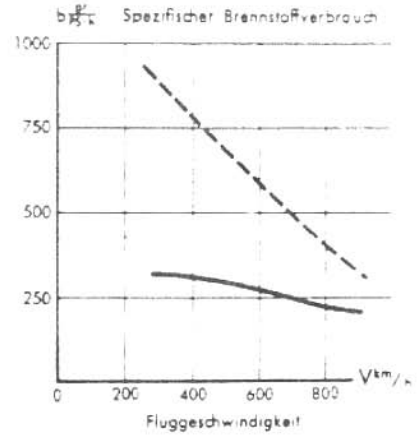


SECTIONAL ARRANGEMENT & PERFORMANCE FIG 16.

35. HE S 60

Engine:

Power at take-off	2,000 BHP
Rated Power	1,000 BHP
Bore	3.94 in.
Stroke	2.76 in.
Number of Cylinders	32
Arrangement:	Four row parallel "X". Four crankshafts. Drive effected through central shaft with what appears to be an overrunning clutch from turbine.

VI - Description of the He S 11 and 109-011 A-0

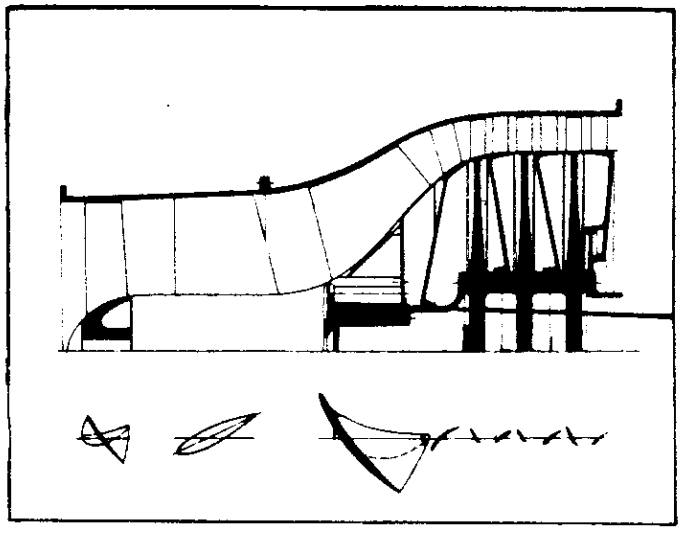
A complete technical description of the Heinkel-Hirth 109-011 A-0 engine is contained in a report, remaining to be translated, entitled "Technische Unterlagen zum Strahltriebwerk 109-011 A-0" - ("Technical Data relating to Jet Engine 109-011 A-0"), dated December 1944.

The He S 11 series engine is the current Heinkel-Hirth development and production model. The design of the engine was the outcome of an RLM bomber specification of 18 July 1941, which specified a propeller/turbine power plant consisting of two compressor turbine sets, two combustion chambers and a power turbine driving a variable pitch propeller. Heinkel-Hirth adopted the policy that prior to the construction of such an engine it would first be necessary to build a turbo-jet unit, which in effect would form half of the propeller/turbine power plant. Preliminary studies were

concluded in September 1942 and the following requirements for a turbo-jet engine were laid down:

Static Thrust	2,860 lbs.
Cycle Temperature	750 °C.
Pressure Ratio	4.4
Airflow	66 #/sec.
Specific Heat Release ...	1.34 x 10^5 BTU/cu.ft.

Preliminary investigations led on two designs, the first believed to be the He S 9, described in the previous section, and the second the He S 11 differing, in that a mixed flow compresser "Kombinationsgebläse" was used. This compressor, illustrated in Sketch D. consists of an axial inducer followed by a diagonal flow impeller and three axial flow stages.



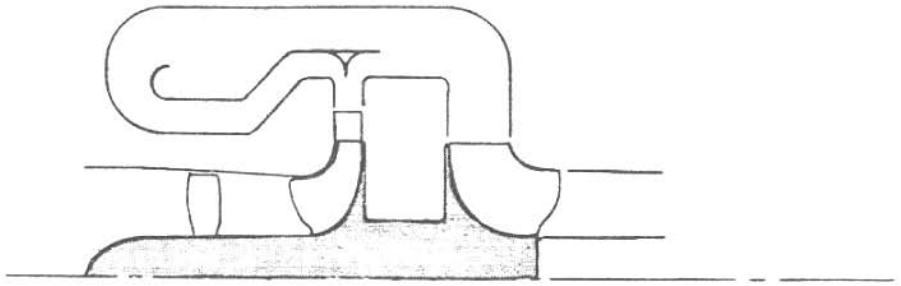
Sketch D.

Engines built in this series fall into three groups: Engines V1 to V5, which were experimental and all differed from one another in major details: V6 to V25, which represented an attempt to build a series of experimental engines: V26 to V85, which represented a second series of experimental engines and which, while

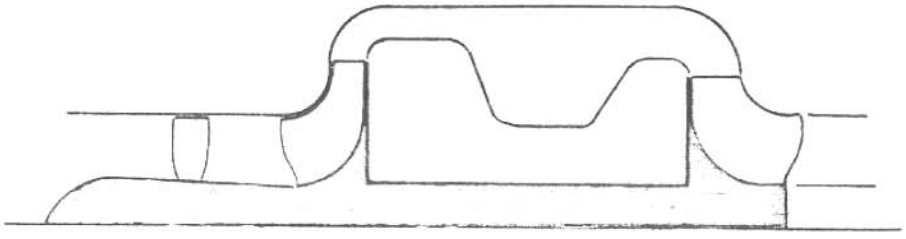
set up, are believed to have been abandoned. It is known that engines V1 to V5 werebuilt and as of January 1945 engines V6 to V9 had been finished and had accumulated running time. Since plans were in hand in December to build the A-0 production series, it is assumed that construction of the balance of the V6 to V25 and the whole of the V26 to V85 program was to be dropped.

The He S 11 series engines are the result of a progressive development from the He S 3 b and the trend in flow path design is illustrated in Figure 17. All engines in the He S 11 series are built around a compressor/turbine set consisting of an axial flow inducer followed by a diagonal flow impellor and three axial stages as illustrated in Sketch D, and a two stage axial flow turbine. The combustionchamber is annular in form and fuel is injected downstream. The exhaust nozzle design has been varied, both fixed and two position nozzles having been used.

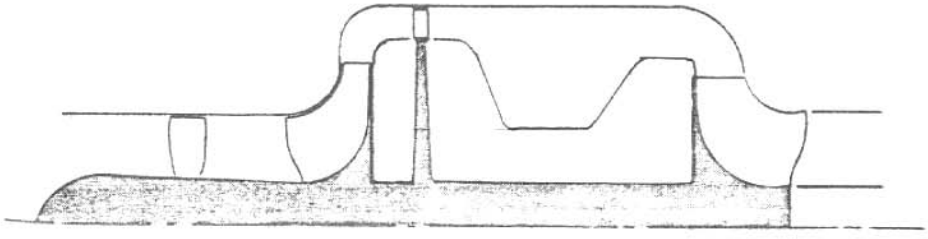
The compressor set for this model engine was selected on the basis of experience gained with the compressor of the He S 8 A engine. In establishing the final design three different axial inducers were tested in combination with three diagonal flow impellors, and the final combination with each of the three axial stages. This work was carried out on a 1,600 kw blower test rig at Zuffenhausen at speeds less than design. In December 1943/



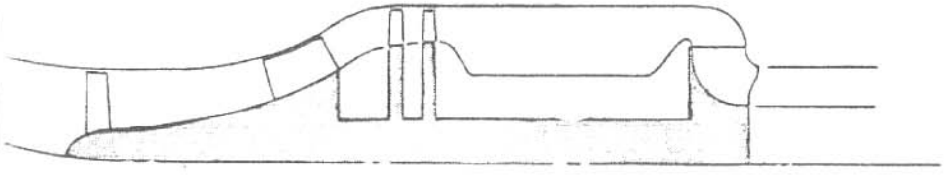
He S 3b



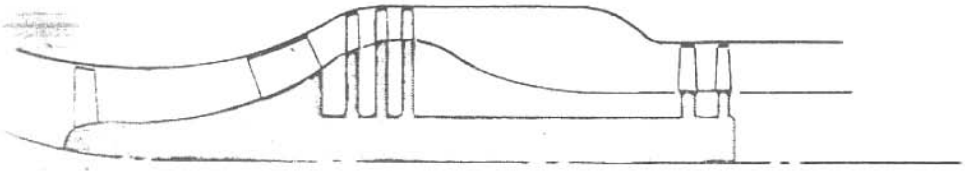
He S 8a



He S 8 V15



He S 9 (?)



He S 11

FLOW PATH DEVELOPMENT OF HE SERIES ENGINES

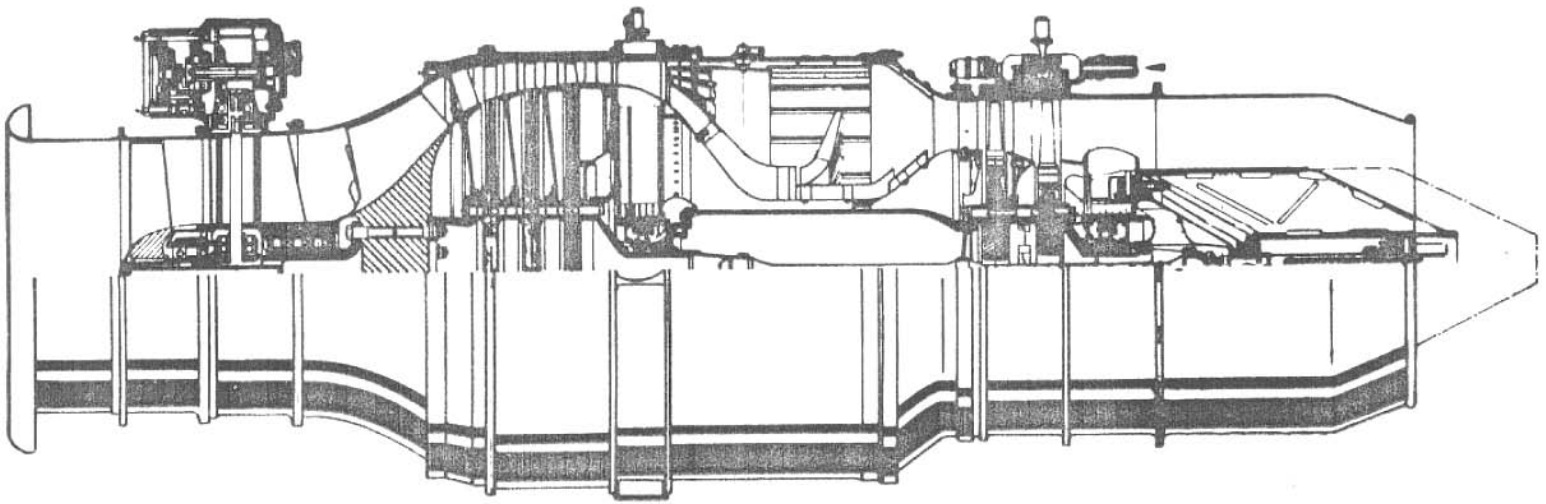
FIG 17

January 1944 the complete compressor set was tested up to speed on a DVL test bed at M.A.N. Augsburg.

In addition to aerodynamic studies, methods of construction have been experimented with and the inducers have been built as castings and forgings, the diagonal wheel with solid and inserted blades and the axial stator stages of forgings and with sheet metal blades.

He S 11 V1.

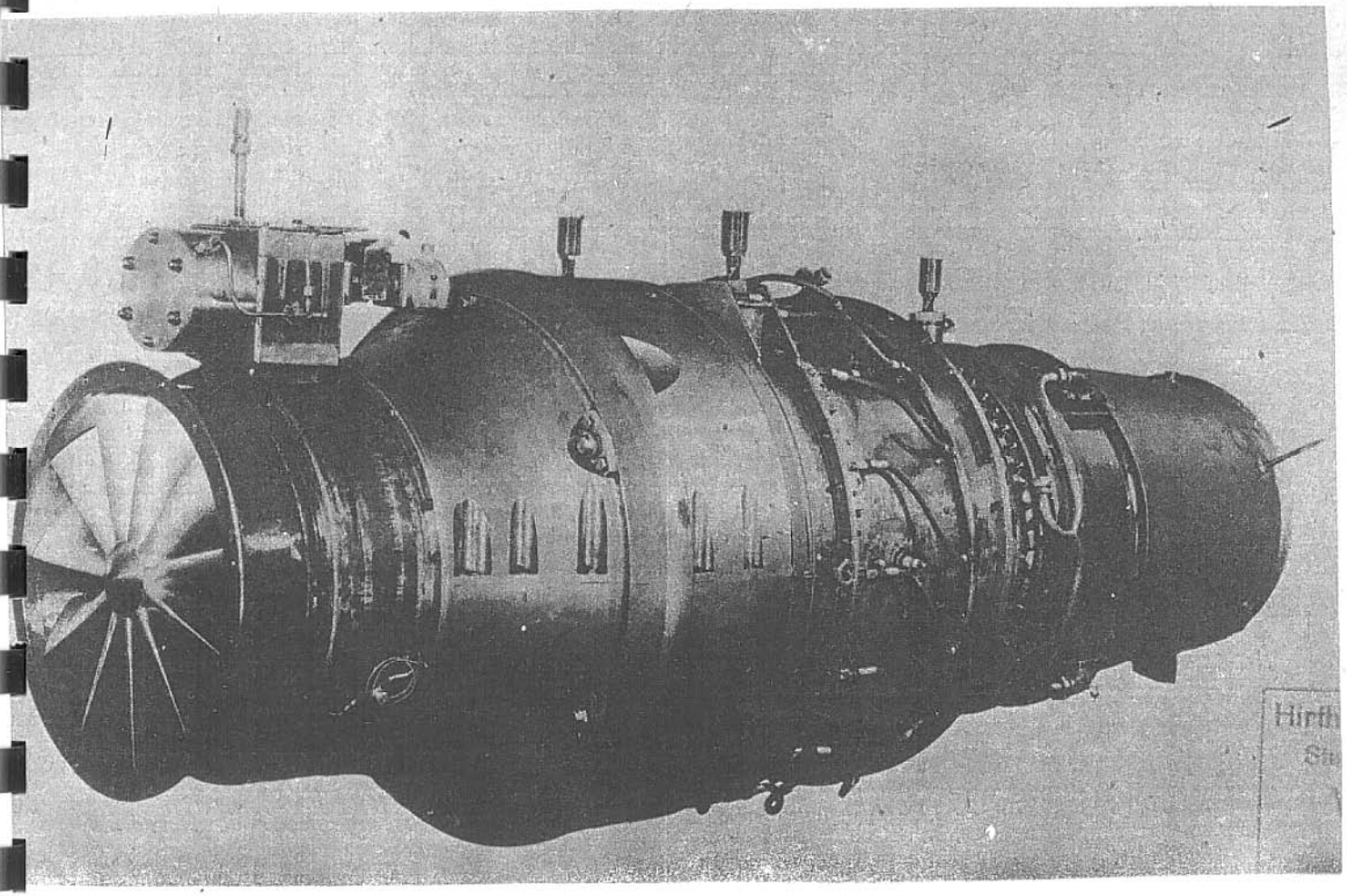
The He S 11 V1 engine is illustrated in Figure 18. This engine, the first of the series, was buitl up from steel castings and sheet and no attempt was made to save weight or meet aircraft design standards. The complete engine is illustrated in Figure 19. The compressor/turbine set is constructed in two sections, connected by a tie rod to take out axial unbalance, and mounted on three sets of bearings. The first bearing set, consisting of three ball bearings, is located ahead of the diagonal stage. Thrust from the axial inducer stage being taken on its own bearing. The second bearing set, consisting of one roller bearing, is located aft of the axial stages and the spider housing is in the plane of the exit guide vanes. The third bearing set, consisting of a single roller bearing, is located aft of the turbine and lubrication and cooling air is carried to the bearing through the spider arms. The diagonal flow



SECTIONAL ARRANGEMENT

HE S 11 VI

Fig. 18



TURBO JET ENGINE

HE S 11 VI

impellor, which is hogged out of a cheese of aluminum alloy, and the three axial rotating rows, are assembled on a common shaft as illustrated in Figure 20.

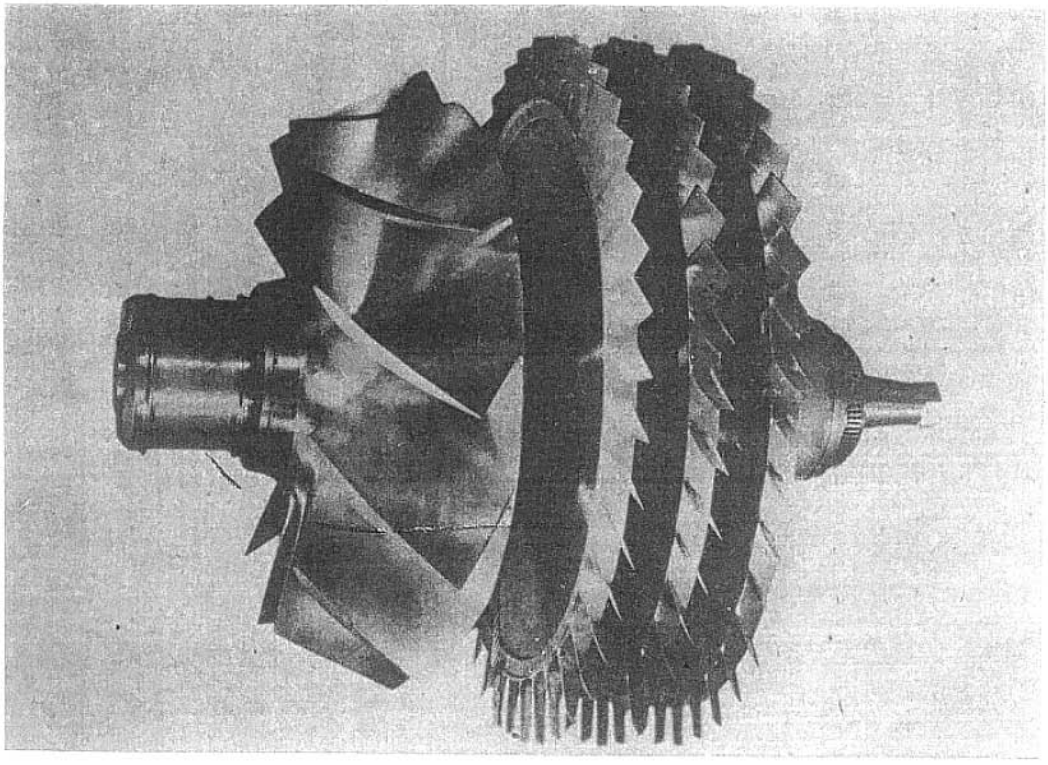
The turbine is of two-stage axial flow design using solid blades retained in the discs by means of a "V" root pinned with two pins on each side of the "V", half in the blade root and half in the disc. The turbine rotor assembly is illustrated in Figure 21.

The combustion chamber used on the V1 engine is similar in design to that used on the last series of the He S 8 engines, typified by the He S 8 V15 illustrated in Figure 9.

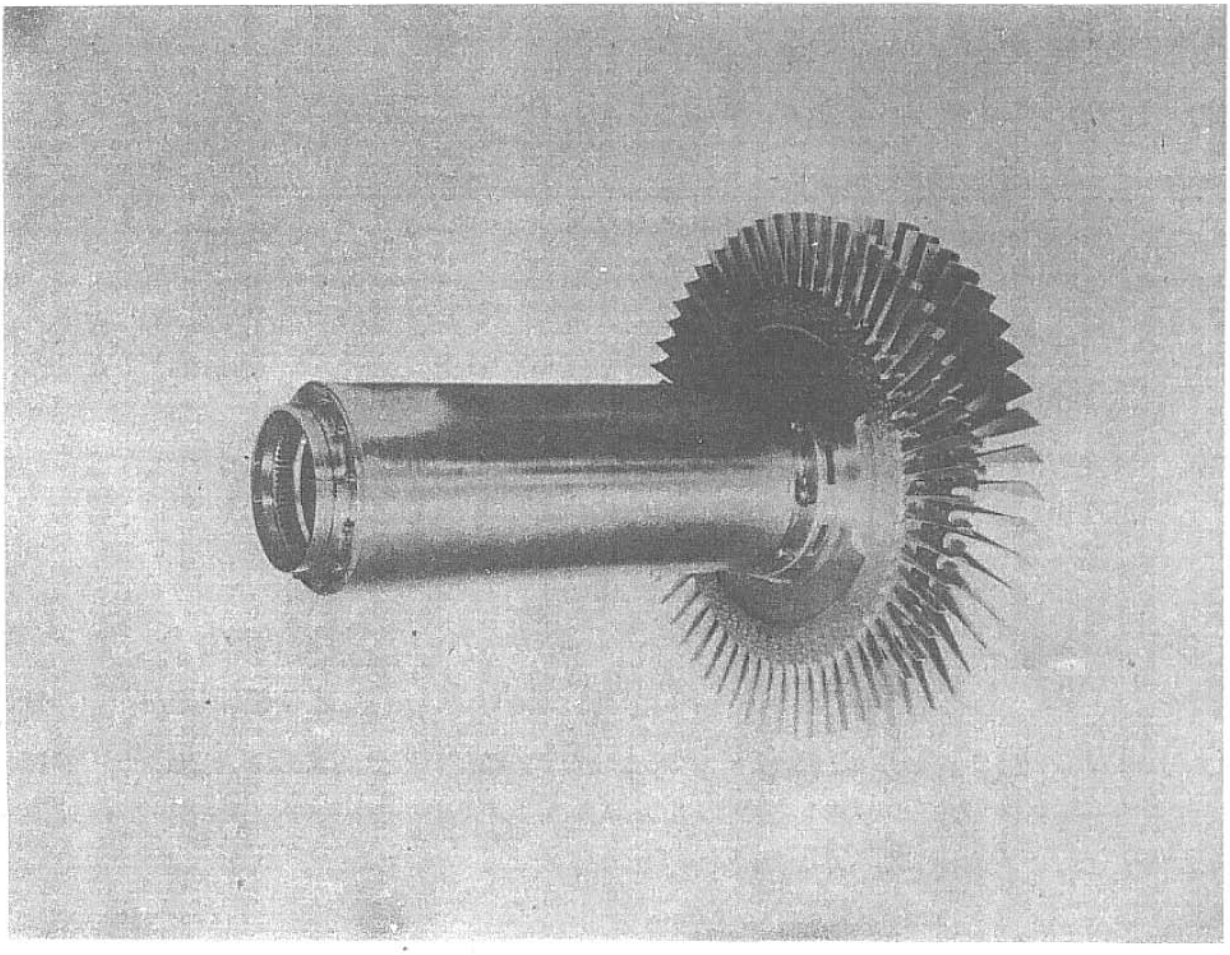
A two-position exhaust nozzle is provided, actuation being by means of a two-position cylinder. The working fluid is oil.

The V1 engine did not have an accessory drive gearbox as such, since the engine was not intended for flight. A single pad was provided, presumably for the fuel system governor, on a box mounted on top of the front bearing spider ring, the drive shaft being carried through one of the spider vanes which also serve as guide vanes for the diagonal stage impellor airflow.

Little is known of subsequent engines in the V1/5 series except that compressor housings having provision for axial stage stator blade adjustment were constructed which, presumably after a



HE S 11 VI



TURBINE SET

HE S 11 VI

setting had been established, were replaced with s implified casting without adjustment provisions.

Engine V5 was fitted with a single stage DVL turbine having air-cooled blades, and in addition design studies were made of two-stage turbines having hollow air-cooled blades, first with BMW type blading and later with blades designed and developed by Porsche of Stuttgart. These were called Topfschaufeln, i.e. pot blades. Several types of air-cooled stator blades were also tried in this first series of engines.

The only performance information on the V1 engine available at this time is given in a report dated January 1944, namely:

Thrust	2,460 lbs.
Speed	9,920 rpm.
Nozzle Area	1,505 sq.ft.
Airflow	47.70 lbs./sec.
Cycle Temperature	660 °C.

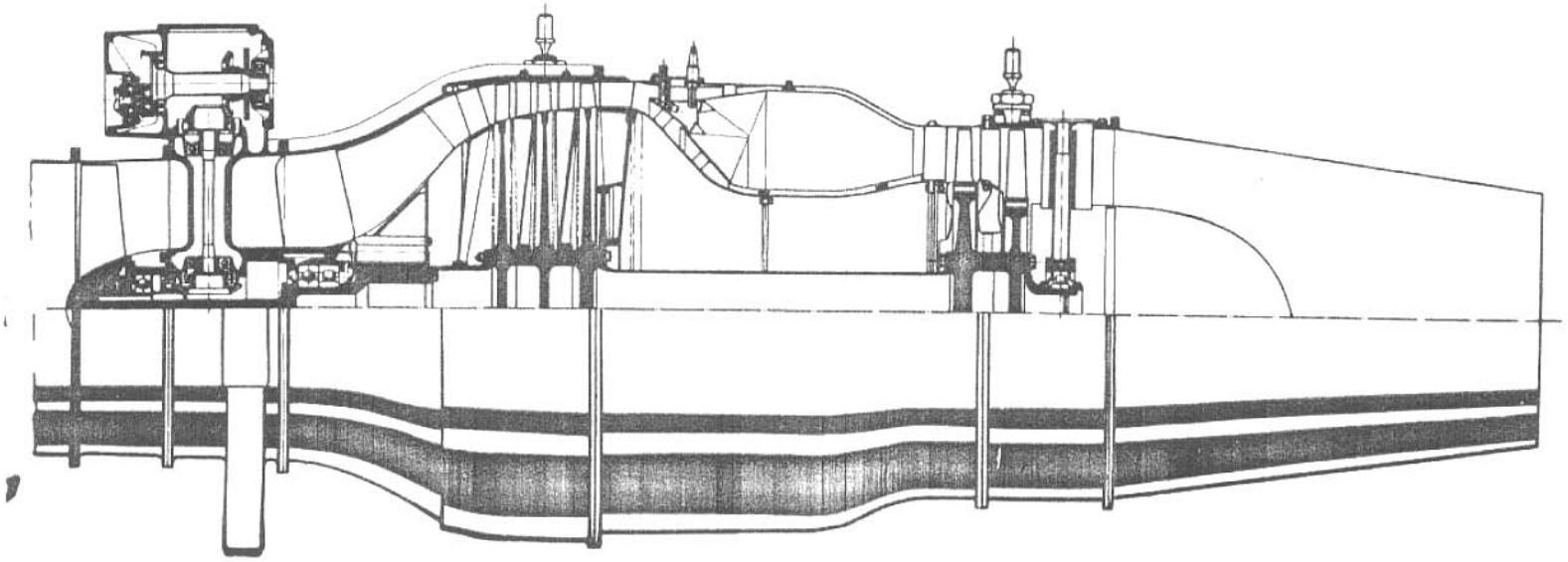
He S 11 V6/25.

Following the construction of the first five experimental engines the V6 series was constructed which marked a serious attempt to produce a turbo-jet engine suitable for aircraft. In the course of the development the three bearing arrangement was abandoned and replaced by two bearings. Considerable shortening of the overall length of the engine was accomplished by this change together with a redesign of the combustion chamber which was also shortened.

At the same time the balance of the engine was redesigned with the view of reducing its weight and making production improvements. The flow path was not changed except for blade settings as determined necessary from tests on the first five engines.

The He S 11 V6 turbo-jet engine is illustrated in Figure 22. It will be seen that the three-bearing shaft has been replaced by a two-bearing arrangement in which the front bearing set, consisting of a ball and roller bearing, is located ahead of the diagonal impellor and the rear bearing set, consisting of a single roller bearing, is mounted behind the turbine as has been the case with all of the engines in this series. The diagonal impellor design was changed to a composite construction in which the blades were machined from aluminum alloy forgings retained by a bulb root of approximately an inch in diameter in a steel hub. Slight changes have also been effected in the axial compressor design, consisting principally of methods of construction and blade retention.

The combustion chamber on this engine was completely redesigned, the original multiple nozzle set being replaced by 16 downstream nozzles. A definite attempt was made in this engine to establish a primary air chamber and secondary air is introduced through a set of sandwich mixers. An attempt was made in this design to replace the combustion chamber parts made from high temperature



SECTIONAL ARRANGEMENT

HE S 11 V6

FIG. 22

alloy with mild steel, aluminized.

An accessory drive housing containing an oil tank was designed for this engine. The design being based on that used in the He S 8 A. The principal drive is through a vertical shaft contained in one of the three spiders used for bearing support. This shaft drives a horizontal lay shaft through bevel gears which receives the starter drive at one end and provides a power take-off at the other. Other accessory drives are driven by spur gears from the power take-off horizontal shaft.

Performance of the V6 series engines is given as 2,860 pounds static thrust at sea level at 11,000 engine rpm. The specific fuel consumption being 1.32 lbs./lb. thrust. In all 184 hours running time had been accumulated on the four engines built in this series by January 1945. 154 hours was at thrusts below 1,760 pounds and but three hours of the remainder was at thrusts in excess of 2,400 lbs.

109-011 A-0.

The 109-011 A-0 engine is the production series engine resulting from the development work on the He S 11. The engine is illustrated in Figure 23 in section, and views of a mock up are given in Figures 24 and 25. Performance data and characteristics are as follows:

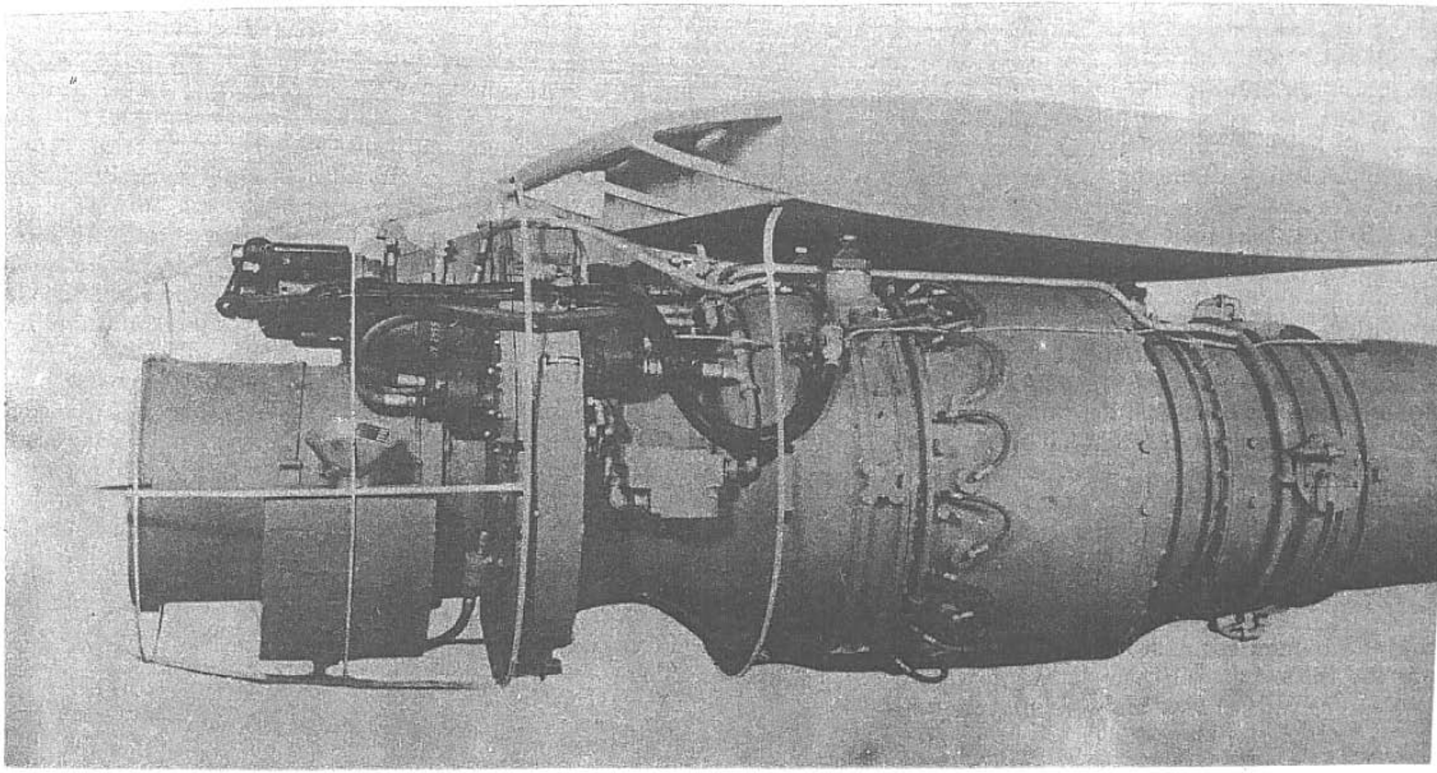


FIG 24.

TURBO JET ENGINE 109 - 011

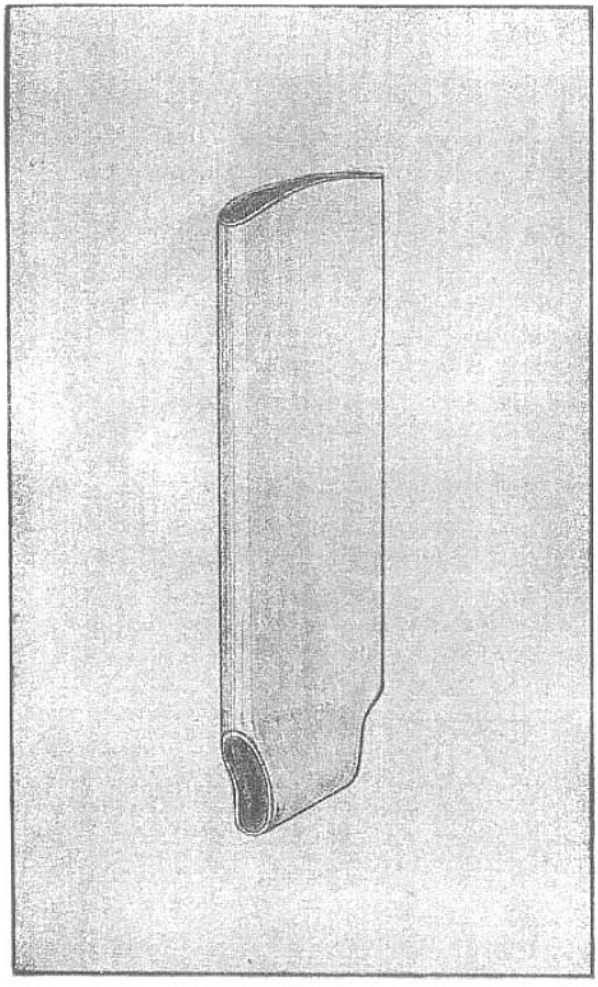
Thrust	2,860 lbs.
SFC	1.31 #/#F
Dry Weight *	2,090 lbs. ± 2%
Height	42.5 in.
Width	34.0 in.
Length	136.0 in.(with nozzle extended).

* Engine is being lightened and expected weight is 1,905 lbs. ± 2%.

Several major changes in design were initiated and a general description of the engine is as follows:

The compressor/turbine set is the same as used on the V6 series except that the bearing arrangement has been further simplified by the omission of the roller bearing, used with a ball, ahead of the diagonal flow impeller. Turbine blades are hollow, of Porsche design, shown in Sketch E. This blade is drawn from a plate in a manner similar to the Junkers hollow blade, but is retained in the turbine disc by means of a single rivet. A small sealing plate is used between blades, retained by means of the rivet. The A-0 engine has been lengthened somewhat over the V6 series by a rearrangement of the front end. Where the guide vanes aft of the inducer were contained in the accessory drive section on the V6 series, they now occupy a separate section and what are apparently two hollow fairings now carry the accessory drive gear shafts in that section. The principal change in the compressor set is the use of sheet metal stator rows in the axial compressor. The are

apparently riveted into sheet metal shroudings and the labyrinth packings have been done away with. Axial compressor rotory blades have been redesigned with a single leg fastening riveted into a disc having a "V" groove at its periphery. The combustion chamber has been redesigned to use turbulance fingers aft of the primary air chamber and secondary air is introduced by two rows of sandwich mixers facing forwards. An aluminum alloy combustion chamber outer casing was used in this design in the interests of saving weight. The tail cone is left open. This engine has also been designed with a propeller, the development of this unit being assigned to the firm of Daimler-Benz. Performance at 750 Km./Hr. at sea level (450 mph) is 2,000 THP and 1,740 lbs. thrust.



Sketch E.

A reasonable amount of technical documentation is available on both the jet and turbine/propeller versions of this engine, which material is awaiting translation and study before a complete report regarding these developments can be written.

HEINKEL-HIRTH DISPERSAL AND ASSOCIATED TARGETS:

1. Cotton spinning mill (Baumwollspinnerei) at Kolbermoor, about half way between Bad Aibling and Rosenheim, Bavaria - Dispersal from Heinkel-Hirth at Zuffenhausen. Dispersal effected during the first week in April 1945. All development records, technical data and certain key personnel will be found here.

2. Staatlichen Saline Friedrichshall/Kochendorf, about ten miles north of Heilbronn. Underground production plant for He S 011 engine. Also archives consisting of twenty-one cases of documents covering HM projects. (This latter material is reported to have been evacuated).

3. Creditanstalt Bankvereine, Innsbruck, Austria. Archives consisting of six cases of documents covering HM projects.

4. "Ernst Heinkel Aktiengesellschaft, Werk Waltersdorf", Waltersdorf bei Berlin-Grünau. Production assembly plant for He S 11.

5. Norbert Riedel K.G., Muggendorf (Obfr). Manufacturer of small gasoline starter engine used on this and other turbojet engines in Germany.

6. L'Orange, Stuttgart/Feuerbach. Manufacturer of fuel injection nozzles.

7. Maschinenfabrik - Augsburg - Nurenburg (MAN), Augsburg. DVL compressor test rig located here and have done compressor testing for Heinkel-Hirth.

8. It is considered likely that if evacuation from Kolbermoor has taken place the most probable destination would be Heinkel at Jenbach.

ENGINEERING DEPARTMENT KEY WITH PERSONNEL

TK	-	Techn. Direktion	Technical Direction	Director Schif
ATD	-	Assistent Techn. Direktion	Assistant Technical Direction	Dr. Stieglitz
MBA	-	Musterbau	Design and Construction	Dr. v Chain (Chief Engineer)
ENA	-	Entwurfsabt	Preliminary Design Office	Dr. Vanicek
VEW	-	Vorentwicklung	Preliminary Development	Dr. Bentele
MKB	-	Musterkonstruktionsbüro	Drawing Office	Schmitz
VSA	-	Versuchsabteilung	Experimental Division	Hartenstein
TVW	-	Techn. Verwaltung	Technical Administration	Rees F
BTD	-	Büro d.Techn. Direktion	Bureau of Technical Direction	Walter
FLV	-	Flugversuch	Flight Test	Schäfer
SKB	-	Serien-Konstrukt. Büro	Production Shop	Rees L
NOR/ AST	-	Normenstelle/Aenderungs-stelle	Standards/Modifications	Böhm
TWE	-	Triebwerksentwicklung	Auxiliary Power Plant Development	Küchen
WKF	-	Werkstofforschung	Material Research	Dr. Slattenschek
TAD	-	Techn. Aussendienst	Field Service	Jllg
PAT	-	Patentabteilung	Patent Department	Rosenke

109-011 A-0 DRAWING NO. KEY

109 - 011.450 - 124.12

Class of Equipment - RLM Number

Number of Project

Mfg. Group Number of Part

Mfg. Part Number (Sub Group)

Class of Part

Format of Drawing

109-011 Groups

200 - Laufer - Compressor/Turbine Set

450 - Brennkammer - Combustion Chamber

551 - Geräteträger - Accessory Drive

570 - Schmierstofflanlage - Oil Pump

580 - Oelleitungen - Oil System

581 - Luftleitungen - Air System

582 - Kraftstoffleitungen - Fuel System

583 - El. Leitungen - Electrical System

584 - Hilfsgerate - Auxiliary Gear

585 - Heissvorrichtung - Heating System

586 - Einlaufhaube - Inlet Fairing

590 - Anlassergetriebe - Starting Gear

650 - Verdichtergehause - Compressor casing

850 - Schubdüse - Exhaust Nozzle

Preliminary inventory of microfilms, documents and drawings removed by CAFT Group IV Field Team 5 from Hirth Motoren GMBH Stuttgart/Zuffenhausen:

Microfilm Records - 500 ft. Roll cans:

1 - Patent Records - 18 cans labeled as follows: 1-6, 7-18 19-34, 35-52, 53-73, 74-94, 95-122, 123-157, 158-188, 189-218, 219-248, 249-284, 285-319, 320-357, 358-391, 392-424, 425-447, 448-475.

2 - Patent Records - 1 can labeled as follows: 1-26.

3 - Patent Records - 2 cans labeled as follows: 1-14, 15-28.

4 - Patent Records - 2 cans labeled as follows: 582182-703532, 713549-5225.

5 - Records of Reopening Patent Applications - 6 cans labeled as follows: S163-356, S163-356, May/June/July, Oct/Nov/Dec 1944, Jan/Feb/Mar/April 1944, Oct/Nov/Dec 1944.

6 - Patent Notices - 2 cans labeled as follows: P500-S527, P476-P485-P487-P497.

7 - Personnel Data - 3 cans labeled as follows: 15/7/43, 30/6/43, 9/6/43.

8 - AVS Card Index, Patent Card Index, DVL Patents - 1 can.

9 - Material Development Reports - 1 can.

10 - Workshop Handbook - 1 can.

11 - Technical Data on Materials - 1 can.

12 - Test Department Reports - 2 cans.

13 - Reports on Supercharger Tests - 1 can.

14 - Reports on Combustion Tests - 1 can.

15 - Photographs of Test Instrument Panel made during Tests of He S 11 and 109-011 - 4 cans.

16 - Reports on Advanced Developments (Dr. Bentle) - 1 can.

17 - Calculation Reports - 1 can.

18 - Agreements with the REA - 2 cans labeled 1 & 2.

19 - Resonance Cards (?) - 1 can.

20 - UK Card Index - 1 can.

21 - Reports and/or Drawings of Projects S50, P254, P358 - 1 can.

22 - Reports and/or Drawings of 109-011 Turbo-Jet Engine - 1 can.

23 - Unlabeled - 1 can.

Microfilm Records - 100 ft. roll cans:

1 - Drawing Number Book for Projects 9-2279, 9-2281 and 9-2426 - 1 can.

2 - Parts list and Drawings of HM 515 piston engine - 1 can.

3 - Parts list and Drawings of HM 501 piston engine - 1 can.

4 - Parts list and Drawings of HM 60 R piston engine - 1 can.

5 - Parts list and Drawings of HM 9-7018 piston starter engine - 1 can.

6 - Drawings of 19-607 Boxer engine - 1 can.

7 - Parts list and Drawings of 19-518 "Fresh Gas Turbine" (Gas Producer) - 1 can.

8 - Deutsche Revisions und Treuhand Aktiengesellschaft, Berlin - 1 can.

9 - Personnel Data - 1 can.

10 - VEW Drawings - 1 can.

11 - VSA Drawings - 1 can.

12 - VSA Reports - 1 can.

13 - WKF Material Data - 1 can.

14 - Workshop Drawings of 9-2281 turbo supercharger - 1 can.

15 - WKF Register of photographs - 1 can.

16 - VKF (RLM Records) - 1 can.

17 - Publication Records or Register - 1 can.

18 - WKF Pictures - 1 can.

19 - Study of gearing and controls for PTL (EII - Reutter) - 1 can.

20 - Parts List for 9-2218 Turbo Supercharger, 19-109 Auxiliary Power Plant and 9-2097 Maihak Pump - 1 can.

21 - Workshop Data on HM-500 and HM-508 Piston Engines - 1 can.

22 - Standards - 1 can.

23 - Final Particulars of the He S 30 1 can.

24 - 19-526 Turbo Auxiliary Set - 1 can.

25 - Card Index of Accessory Drawings - 1 can.

26 - Unstellbauftragter #8 and 9 - 1 can.

Microfilm Records - 10 ft. roll cans:

1 - Drawings, VEW 1 - 1 can. (Single Cylinder Engine).

2.- Tool List - 1 can.

3 - HM - P5090 9-7018 Starter Engine with Hydraulic Drive - 1 can.

4 - W9-2216-50, W9-2279-10, W9-2281-01, Turbo Supercharger Data - 1 can.

5 - Sketch List - 1 can.

6 - Parts List for 9-7018 Starter Engine - 1 can.

7 - Hirth Material List - 1 can.

8 - Work List for 9-501 and 9-504 Piston Engines - 1 can.

Microfilm Records - Paper Wrapped Rolls:

1 - Number Registry of Sales Invoices - 1 roll.

2 - Mob. Kartei Abt. Son. 17/9/44 - 1 roll.

3 - Mobilized Labor - 1 roll.

4 - Drawings and Model Number Book - 1 roll.

5 - Records of Reopening Patent Action - 1 roll.

6 - Original Efficiency Calculations (?) 1/12/43 - 1 roll.

7 - Business Records - 1 roll.

8 - Turbo Supercharged Engine Characteristics - 1 roll.

9 - Drawing List VEW 18/4/44 - 1 roll.

10 - Future Developments of Dr. Bentele - 1 roll.

11 - WKF - 1 roll.

12 - Item number and index of shop instructions for 9-2216 Turbo Supercharger - 1 roll.

13 - STTW History of He S Turbo-jets - 1 roll.

14 - L. u. W. List for 9-2281 Turbo Supercharger - 1 roll.

Documents:

1 - History of Hirth Motoren G.M.B.H. with listing of all projects from 1930 to 1944.

2 - History of Hirth Turbo Jet Engine Development.

3 - Technical Report Covering 109-011 Turbo-Jet Engines V26 to V85.

4 - Technical Report Covering 109-011 Turbo-Jet Engines V86 and onwards.

5 - Record of Contracts from 1937 through 1942

6 - Draft of Description of all Hirth Projects (Incomplete),

7 - Index of Hirth Technical Reports.

8 - RLM Material Specifications.

9 - High Temperature Materials Data.

10 - File of Photographs of Lecture Plates on and Photographs of the 109-011 Development.

11 - File of Photographs of Compressor and Turbine Blade Sections and Diagrams.

12 - File of Basic Calculations for 109-011.

13 - Miscellaneous He S 8 A Data.

14 - Miscellaneous He S 10 Data.

15 - Miscellaneous He S 30 Data.

16 - Miscellaneous He S 3 b Data.

17 - Parts List for 109-011 V1 and V2.

18 - Experimental Combustion Chamber Data 109-011.

19 - Description, Test Reports, Detail Drawings on POO-125 Fuel Regulator for He S 8 A. (Regulator sent to R.A.E.).

20 - Automatic Control Unit Data 109-011.

21 - Blade Vibration Data 109-011.

22 - File of Photographs and Descriptive Materials Covering 9-7018 Starter Engine.

Drawings:

1 - Major Assembly Drawings of 109-011.

2 - Drawing List of Jumo 109-004. BZ Bl.

3 - Drawings of HH 9-7018 Starter Engine (Complete).

4 - Drawings of 19-109 Auxiliary Power Plant.

5 - Jumo 004 Bl Assembly and Installation Drawings.

6 - Miscellaneous Drawings, Notes and Sketches.

7 - Installation Drawings of Reidel Starter Engine.

SUPPLEMENTARY NOTES:

1. Six cases of documents containing a portion of the archives of the Hirth Motoren Werk have been removed from the Creditanstalt Bankvereine at Innsbruck and forwarded to London.

2. Documents at the Staatlichen Saline in Kochendorf will not be accessible until the first week in April.

3. Dr. von Chain, together with Herr Hartenstein, Development Engineer, Herr Tetzloff, Production Engineer, and numerous other Hirth Motoren personnel are in custody at Kolbermoor.

4. Six Hirth 109-011 A-0 Turbo-Jet Engines have been ordered from BMW at Kolbermoor. This firm were preparing to manufacture this engine and have parts on hand for ten engines. Delivery is promised in approximately five months.

May 29, 1945.