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CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

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COUNTRY	USSR (Kuybyshev, Kalinin Oblasts)	REPORT	50X1
SUBJECT	1. Power Plant Testing at Zavod 2, Kuybyshev 2. Airfield on Gorodomlya Island	DATE DISTR.	24 Sept. 1954
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THE SOURCE EVALUATIONS IN THIS REPORT ARE DEFINITIVE.
THE APPRAISAL OF CONTENT IS TENTATIVE.
(FOR KEY SEE REVERSE)

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Comments:

2. Throughout the report:

KUIBYSHEV is correctly KUYBYSHEV.
Ministry for Air, or Air Traffic Ministry, is correctly Ministry of Aviation Industry.
BERIA is correctly BERIYA.
TUPELOV is correctly TUPOLEV.
KASAN is correctly KAZAN.
OTK is the abbreviation for Otdel Tekhnicheskogo Kontrolya (Technical Control Section).

3. On page 5, Diamler Benz is correctly Daimler-Benz.

4. On page 6, KUZNITZOR is correctly KUZNETSOV.

5. On page 6, WILHELM is correctly WILHELMI.

6. On page 6, SEMENOFF is SEMENOV.

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STATE	#X	ARMY	#X	NAVY	#X	AIR	#X	FBI		AEC					

(NOTE: Washington distribution indicated by "X"; Field distribution by "#".)

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7. On page 11, ISAIEFF is correctly ISAYEV.

8. On page 39, LEBIDEFE is dorrectly LEBEDEV.

9. On page 51, BESIMIANKA is correctly BEZYMYANKA.

10. On page 2 of Inclosure 13, Mech Zavod is correctly Mekhzavod.

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[redacted]

I. LIST OF INCLOSURES

Inclosure #1 [redacted] formulas and explanation of symbols, [redacted]

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[redacted]

Inclosure #3 Drawing No. 1 - Titled "General View of Object "K" with nomenclature.

Inclosure #4 Drawing No. 2 - Titled "View of Control Room for Test Stand 4", with nomenclature.

Inclosure #5 Drawing No. 3 - Titled "Test Stands 1-6 for Objects M&K", with nomenclature.

Inclosure #6 Drawing No. 4 - Titled "Waterbrake for Object "K", with nomenclature.

Inclosure #7 Drawing No. 5 - Titled "Waterbrake Type 70R Power Measurements of Object A&M" with nomenclature.

Inclosure #8 Sketch No. 1 - Titled "Schematic of 24V Electric Safety Petcock"

Inclosure #9 Sketch No. 2 - Titled "Schematic Drawing of Pistol Grip Fueling Nozzle"

Inclosure #10 Sketch No. 3 - Titled "Rocking Stand for Thrust Measurement"

Inclosure #11 Sketch No. 4 - Titled "Schematic of Waterbrake for Object "K", with torque measuring system

Inclosure #12 Sketch No. 5 - Titled "Schematic of Fuel System Test Stand for Object "K"

Inclosure #13 Sketch No. 6 - Titled "Oval Wheel Fuel Flow Meter"

Inclosure #14 Sketch No. 7

Inclosure #15 Sketch No. 8

Inclosure #16 Sketch No. 9

Inclosure #17 Sketch No. 10

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II. GENERAL

A. Introduction 50X1-HUM

[redacted]

2. This report is [redacted] an attempt [redacted] to expound in [redacted] detail the test stand activities and 50X1-HUM procedures at Zavod II, Kuibyshev (5312N/5007E) in the USSR. [redacted]

3. [redacted]

4.

5.

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B. Historical

[redacted] 50X1-HUM

[redacted] when test stand diagrams were completed and usable, [redacted] copies were made and sent to LENINGRAD and MOSCOW. [redacted] in LENINGRAD there is an office for test stands. (When Object "K" was undertaken there were two test stands erected at Zavod II and later four more were shipped in from LENINGRAD. [redacted] A 50X1-HUM high altitude test chamber from the Junkers Plant was brought to Zavod II in disassembled pieces. It was never erected and was later sold to another plant near MOSCOW in a corroded condition.

4. In 1947 the test stand erection had progressed sufficiently and testing began on components of the BMW-003 and the JUMO-004. Development work was also started on the JUMO-012. These then were the first powerplants of German origination to undergo development at Zavod II and had become an important function of the experimental phase within the Ministry for Air. Later, in the spring of 1952, these older test stand units were completely dismounted and a new one consisting of six units constructed. One of the units from the old test stands was used as No. 7 and mounted perpendicular to the others and at one corner of the building.

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[redacted] 50X1-HUM

5. The chief Soviet designer KUZNITZOR, who came from MOLOTOV, once made a trip to MOSCOW and shortly after returned. [redacted] BAADE and a General LUKIN came to Germany to see about starting a new industry within the DDR. The Soviets then were telling the Germans at Zavod II about re-building PIRNA, DESSAU, etc. They were promising them that some day they would all go back to Germany and work on aircraft again within this industry. They were even given an allocation of quarters as commensurate with their position. About the end of 1952 they heard that much building was going on in DESSAU due to the influence of BAADE and that they would be re-situated in this center of the new industry. [redacted]

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6. About MAY of 1953 [redacted] all work in DESSAU, PIRNA and SCHEUDITZ was in a state of collapse. [redacted] many specialists at Zavod II seemed to think that EDC had an effect on this industry collapse. [redacted] There were no publications in the newspapers about the uprisings but within the USSR it was known. The Russians openly blamed the Americans for it. Although they were publicly blaming the Americans for it they griped at the Germans there in KUIBYSHEV for it also. [redacted]

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7. From about December 1952 through June 1953 the Soviets seemed to ignore the German specialists and didn't so much as try to obtain any assistance in learning anymore about the various projects. These Soviet workers did their job alone more and more until they were self-sufficient. They would work alone and do their job over and over until they understood how. [redacted] this was a dictated policy from the Ministry for Air. The Germans were told in 1952 they were to be repatriated and most of the workers seemed to develop a passive resistance and steadily increasing loss of interest in their work. They were afraid that in entering new projects they may be kept there longer. It was noticeable by the Germans that the Soviets in charge didn't like the idea of their not going home either. During 1952 and 1953 tension increased and VOGEL once approached a Soviet by the name of SEMENOFF, who was always present at the Official State Test runs, and who came from the Ministry for Air. He asked, "Why can't we go home?" SEMENOFF answered this by saying that it had all been discussed within the Ministry and everything was cleared for this move, but that something within security that he didn't know about came up and had hindered its progress. [redacted] there seemed to be a definite change taking place in the security phase of events there due to the BERIA complex.

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[redacted] 50X1-HUM

[redacted] 50X1-HUM

8. On the 26th of June 1953 [redacted] They received orders to stop their work. On 30 June 1953 VOGEL was taken with 105 other specialists and their families to GORODOMLYA ISLAND at OSTASHKOV (Branch #1, Zavod 88) where they were to join other specialists from the Air Traffic Ministry. Here they were told they would stay to forget their Zavod II experiences prior to their repatriation sometime in 1954. [redacted] The next [redacted] was to follow in two weeks, and the third in 4 weeks. (Note: Later, [redacted] both groups were reunited into one group and then later again divided. They had been told that because of BERIA's arrest that there would not be anymore transfers). 50X1-HUM 50X1-HUM 50X1-HUM

C. Miscellaneous

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1. [redacted] on GORODOMLYA ISLAND [redacted] an airstrip there. [redacted] biplanes there [redacted] were being radar tracked for practice. These biplanes were 2 seaters, fabric covered and had a 5-cylinder engine [redacted] M-11. [redacted] 50X1-HUM

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2. Many times VIP personnel visited Zavod II. These visits averaged about one every two weeks. Often Directors and Chiefs of other plants and officials from the Ministry for Air came to visit the plant. At one time a chief design engineer came from MOLOTOV to visit the plant. He was with a mission from the Ministry for Air. He stayed for another 4 or 5 days after the mission personnel left. He was Russian but had a short German sounding name [redacted] and spoke [redacted] German. [redacted] During his stay he carried on several experiments with the Object A-022 and drew up a characteristic engine curve for calculating engine output. He also put several different hole-pattern types of sheet metal having various size perforated holes in front of the intake [redacted]. Whenever each new pattern was placed in front of an intake the tailpipe temperature readings were recorded. After this man left, the Germans carried on these same experiments for some time. 50X1-HUM 50X1-HUM

3. One very old man [redacted] came to visit the plant. The Russians mentioned that he was a great scientist in jet powerplants. VOGEL stated the man seemed to feel insecure in the plants atmosphere and didn't show much practical enthusiasm, thus indicating he was a theorist and not experienced in the practical aspects of engineering. Also, [redacted] a man came through the plant with a large committee. He came to see the Official State Tests running. He seemed to be a very important man [redacted] the man's name was TUPELOV, the great Russian designer. 50X1-HUM 50X1-HUM 50X1-HUM

4. Once a supposedly famous Russian pilot, who had shot down many planes, visited Zavod II. He toured the plant with other pilots in a group. [redacted] these Russians openly talked about their flying in KOREA and that some of them had shot down "SABERJETS". They spoke of KOREA as being similar to SPAIN, only as a testing ground for the future. 50X1-HUM

[redacted] 50X1-HUM

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[redacted]

D. Aircraft Sighted

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[redacted]

2. [redacted] the TU-70 [redacted] came into KUIBYSHEV almost every day. [redacted] a DC-3 type transport landed there each day. One other type transport to land there often was the IL-12 [redacted]

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3. [redacted] at Zavod II, MIG-15's would buzz [redacted] quite often. But mostly in the summer and in clear weather. [redacted] it was generally known they flew little under poor weather conditions.) [redacted] all knew at Zavod II what the MIG-15 was. [redacted] they had heard about the MIG-15 defecting in KOREA on the radio about the 22nd October 1953. The Soviets also told them the day following the incident about it. They blamed [redacted] capitalistic influence for the incident and said the pilot would not live long. There was another fighter type similar to the MIG-15 [redacted] buzzed Zavod II one day. These flew not quite so low as the MIG-15's. [redacted] they didn't know what type it was but it was slightly different. [redacted] the nose was different and seemed longer. The wings were slightly different [redacted] the tailpipe was shorter and had a scr bulge (similar to the YAK-23) [redacted]

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[redacted] 50X1-HUM

III. SUMMARY

A. Object 003C

The 003C is covered in slight detail, mainly in procedures set up for the test stand runs. [redacted] 50X1-HUM general specification figures are given. Some indications of the production history will also be included.

B. Object 004

The JUMO 004 development will be briefly described [redacted] with emphasis on historical data and some noted differences of those engines that underwent tests at Zavod II and information known. 50X1-HUM

C. Object 012

The JUMO 012 will be described as to the engine in general and specifications as a matter of interest and comparison to known data. This is more for checking [redacted] if any significant changes occurred at Zavod II. 50X1-HUM

D. Object 018

The BMW-018 will be described as a matter of historical interest also. Specifications will not be entered in great detail [redacted] 50X1-HUM

E. Object 028

The BMW-028 will be described with the same interest as the BMW-018.

F. Object A-022

The Object A-022 will be described in detail [redacted] 50X1-HUM This includes specifications, construction, test stand procedure, propeller, accessory, and development descriptions, along with the dis-assembly procedure. Since this engine was series produced, some points of interest giving indications of a confirmatory nature are included. 50X1-HUM

G. Object M-022

Since this powerplant is two A-022 engines coupled together through a gear reduction box driving a contra-rotating propeller. A brief description of the modifications will be included in this project.

H. Object "K"

This powerplant is an enlarged version of the A-022 and since this power-plant had never reached its full development [redacted] 50X1-HUM

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I. Object "D"

Since this powerplant was being developed only in the primary stages, little can be expounded upon other than it was similar externally to Object "K" and was said to be a "high altitude" version with supersonic compressor.

J. Miscellaneous

Here small items such as extra products, and items of technical interest other than large programs will be included. It is used also to afford additions, and/or re-vision notes obtained while report is in writing.

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IV. OBJECT 003C

A. General

1. The BMW 003C was being developed by the BMW Plant in the Soviet Zone of Germany. The 003-A2 had some slight external changes made in East Germany in 1946. A working model was taken along with plant and test stand facilities as reparations in 1946 to the USSR. The 003C underwent development from summer 1947 through winter of 1948. The "C" model as it was produced had different combustion chambers which were a development of the "A2" model. This was mostly in re-routing of the cooling air to produce greater volume. There were also changes in the turbine bucket design. There were some changes made here too, to pass a greater volume of air for cooling the turbine buckets. The A-2 model had 800 kg thrust, the same as the A-1 model, but the 003C had 1000 kg thrust. (Note: This is quite low for the 003 models. It should be closer to 1800 kg and 2000 kg.)

2. There were various material tests being run on the turbine buckets of the pre-production models of the 003C. Some changes occurred in bucket materials and shapes. A newer type fuel regulator was also used. This newer regulator had an accelerator valve that was built externally into the system. It was mounted on the compressor section and connected to the regulator. Its function was designed to squirt more fuel into the burners through separate jets to the spray nozzles for quicker acceleration. This was essentially based on the carburetor accelerator pump conception. (Note: This system was later built integral into the regulator and used on Object A-022).

B. Production

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1. The 003C was said to have been series produced outside of Zavod II. [redacted] Dr. CHRISTIAN's Group came to KUIBYSHEV from KASAN. [redacted] the 003C was being test run in LENINGRAD. Some of the indicating factors [redacted] which pointed to assurance that the 003C was being series produced include:

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a. A Soviet Lt. Col. by the name of ISAIEFF, who had been in charge of work at STASSFURT, had gone to LENINGRAD and later came to Zavod II. He was well versed on the 003C and [redacted] ISAIEFF had been working on an 003C production project.

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b. [redacted] testing facilities at LENINGRAD comparable to Zavod II or better.

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c. Two specialists from Zavod II were sent to MOSCOW to a factory. They were to help solve a manufacturing problem revolving around the production of the fuel injection nozzles for the 003C. This factory, [redacted] was quite large and was solely producing fuel injection jets in large numbers.

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[redacted]

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[redacted] 50X1-HUM

d. The first group of German Nationals to be returned to the East Zone of Germany in 1950 was replaced at Zavod II by Soviet workers and specialists who came from KASAN, and some from other places. All these personnel were well familiar with the BMW 003C and at times mentioned that it was being series produced.

e. When the second group of Germans returned in 1951, they were also replaced by Soviet technicians. But this group was different. They knew the 003C well, and were well trained in its production phases. but there was no more talk of the 003C. [redacted] they were briefed more strictly about security. 50X1-HUM

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f. [redacted] during the first part of 1949. [redacted] was [redacted] an engine at Zavod II [redacted] there was an engine [redacted] (003C) that was of complete Soviet manufacture. All hos[...]nections and outside accessories were of Soviet manufacture. But these were all of American design and all threads and measurements were in the English inches system. These connections would not fit any of the standard German designed connections on the test stand and much welding was needed before test runs could begin. Also, it was noted that the engine suspension design was different from the type of Zavod II manufacture and appeared more to be for aircraft installation. This engine was to include a modification made by a Soviet engineer and was the sole reason for calling on technicians to work during a holiday. When the test finally began the turbine temperatures were too hot and the testing was halted at 0100 Monday morning. The powerplant was dismounted and taken away. [redacted] 50X1-HUM

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C. Construction

1. The 003C as it was built at Zavod II had both overhead and under-attached types of suspension. It was a turbojet engine with a 7-stage axial flow compressor and a singular annular combustion chamber. There was a single stage turbine having hollow steel blades with cooling air bled through. There were 8 or 10 (Source can't remember, but knows it was an even number) fuel ejection nozzles evenly spaced around the outer wall of the combustion chamber. These were "L" shaped. The jet sprayed downstream directly toward the center of the combustion chamber from the forward part of the chamber itself. There were four starter jets spaced equally around the annular chamber and the four igniter plugs were placed directly behind these jets. The starter jets were slightly to the rear and to the side of four main jets. There were two fuel manifolds; one, a single fuel manifold system for normal running, and two, a separate single manifold leading to the starting jets. This way gasoline could be used for starting. Fuel pump was the BARMAG type with maximum pressure of 0.7 to 0.8 kg/cm² and the fuel control incorporated an accelerator governor, tied in with the master control throttle.

[redacted] 50X1-HUM

2. Lubrication was of the dry sump system with the pressure feed to the main bearings. Normal oil pressure was 6 kg/cm^2. The exhaust nozzle was of the variable area type. It had a steel outer casing with air cooled double skin, and a movable air cooled, 4-position inner cone that operated electrically. [redacted] the specifications of the 003C [redacted]

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a. Diameter............... about 750mm to 800mm
b. Length................. about 3800mm to 3850mm
c. Frontal Area........... about $.4 m^2$
d. Weight................. about 900 kg
e. Thrust................. about 1000 kgt.
f. RPM's (maximum)........ 10,000
   (normal)........ 9,700
   (cruise)........ 9,350
g. Fuel Grade............. kerosene or gasoline
h. Compression Ratio...... (unknown)
i. Air Mass Flow.......... (unknown)

3. Starting was accomplished by a small two-cycle motor installed in a dome-shaped gear reduction housing ahead of the compressor section and centered in the intake ducting. This was connected directly to a shaft by a geared coupling and clutch arrangement that uncoupled automatically when the engine was running on its own. This outboard type engine was in turn started by hand and rope, or by an electric motor which was built into the unit and utilized the aircraft batteries. This was called a "RIEDEL" motor.

D. Testing

1. There were three general types of tests run on this powerplant. Although they were generally similar, they each had a different purpose and at various stages in the formation of development they were dissimilar. They were:

a. Special Tests
b. Endurance Tests
c. Official State Acceptance Tests

2. The following is the testing, i.e. (a,b,c) in breakdown form:

a. Special Tests

(1) Special Tests were run for special experimental testing to solve a particular problem or to test a particular component such as compressor tests, or limit load tests, etc. The first series of tests were compressor tests. Here there were readings of all stages of the compressor. This was to cross check pressure rises against theoretical rises in blade designs and to facilitate the completed compressor developments. Then, there were oil circulater tests along with fuel system pressure checks. Here the fuel pressure was read before the pump (at pump inlet) and after the pump (pump outlet) and in front of the injection nozzles. The oil pressure and temperature readings were taken also at various places.

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(2) Prandtl tubes were used to measure gas velocities and pressures at three places: QU and P4 and around the tail cone.

These Prandtl tubes were linked to manometers using mercury and some using kerosene. Generally there were two types of readings taken: One measuring (+) dynamic, and (-) static pressures together. And the other taking only static pressure readings. The Prandtl tubes could be adjusted to various depths into the slipstream by merely sliding in and out to adjustment by clamping tight with ring clamps. There were special tests run with these tubes at various depths. For the endurance tests the position selected was halfway between the outer engine air intake ducting ring and the intake spinner dome. Reading pick-off points P, P2, and P6 were used to take static pressures only and consisted of a one millimeter hole in three places spaced evenly around the circumference and all leading to a single manometer. These manometers were made of a "U" tube holding kerosene. Sometimes with the Prandtl tubes, pitot pressures were plotted against the static pressure at the same point and the difference was recorded as the differential pressure. The manometers were of German design and manufacture. Later, as some were broken, they were replaced by Soviet manufactured manometers. These Soviet pressure gauges were of the dial indicating type similar to the German designed ones. However, these did not work well and so the mercury tubes were reverted to. At first all manometer tubes were read by Germans and noted on a NORFORM sheet. In addition to this they were photographed. Later all readings were photographed only. This was done by the Soviets.

(3) There was no pre-determined time allocated to the special test runs. They would run as long as required for the tests and then be shut down. There would sometimes be long periods that the engines would be left at on a pre-determined setting. This was to let all readings steadily settle down. Temperature readings were taken in three different places.

(a) Ta (atmosphere) was read somewhere near the intake ducting.
(b) T2 was taken directly behind the compressor.
(c) Temperature readings were taken in the combustion chamber at the head of the chamber near the intake guide vanes.
(d) T6 was the tailpipe temperature readings taken in the tailpipe.

(4) T2 and T6 while being taken were done at various depths from the outside surface. Measurements were recorded by thermocoupling. Temperature readings were sometimes read near the turbine instead of at the head of the combustion chamber, but this was never at maximum power output. Tachometer readings during all special test runs were always cross checked for calibration. Other checks were: Accessory checks, generator checks, including checks on generator cooling efficiency.

b. Enduran e Tests

(1) The enduran e tests on the 003C began in 1948 with the first powerplants undergoing special attention in the preliminary inspections. The first hour of the test running was along the following pattern:

(a) The engine is brought up to starting RPM's (about 800 RPM's) by an electric pendulum type motor and the ignition plugs activated.

(b) Gasoline was pumped into the starting manifold which leads to the four starting injection spray nozzles which in turn sprays fuel into the burner near the ignition plugs.

(c) After atomization and ignition, and when a fire is burning evenly around the annular cam, the speed is brought up to 1100 RPM's by the throttle control. Here kerosene is injected into the burners by the normal manifold and the gasoline is simultaneously stopped.

(d) The RPM's are then increased to 2000 and steadied momentarily while the ignition plugs are shut off and the starting motor is disconnected.

(e) The RPM's are again increased to around 3000 to 4000 and held constant. Here a check is made on:

(1) Tailpipe temperature
(2) Oil temperature
(3) Oil pressure
(4) Fuel pressure
(5) Leaks for fuel and/or oil
(6) General inspection by mechanic for loose connections, etc., on the external part of powerplant

(f) If all appears satisfactory the engine is then slowly advanced to maximum take-off power of 10,000 RPM's. Here it is steadied again and the (variable tail cone outlet) exhaust nozzle area is adjusted to obtain 1000 kgt (thrust). Here the first hour of testing begins.

(g) For the first five minutes the engine is run at full power and all measurements are carefully taken at the beginning and again at the end of this period. Exhaust gas velocities are measured by a tri-hole tube called a "measuring cylinder", (See Sketch No. 8). This cylinder has three holes drilled in it and could be rotated by a control linkage from the test control room. The center hole would be directly into the slipstream when the cylinder is rotated so that the two outer holes have their pressures equalized. At various RPM's this direction would change and the system was designed to obtain a more accurate pitot pressure readings. These tubes have five levels of holes and sometimes for special tests all levels are linked to manometers. But for the endurance tests the middle depth is used.

(h) After the first five minutes of running the tail cone is readjusted to decrease velocity and tailpipe temperatures.

(i) Then the fuel flow is reduced to 8000 RPM's (80%) by the hand throttle linkage to the fuel control valve and the engine is run for twenty-five minutes more.

(Note: During this 25 minute run and only during special tests the tail cone is readjusted.)

For the endurance tests the tail cone was left at the predetermined setting and stayed there.

(Note: There were four pre-set settings that were to be selectable by the pilot for the flight tests.)

During this 25 minutes all these readings were recorded twice more.

(j) After this 25 minutes of continual running, the exhaust nozzle area was again increased. The fuel flow was further retarded and the engine RPM's brought down to 65-70% which, [redacted] is considered the cruising power setting for maximum efficiency.

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(k) The RPM's are steadied and another 25 minute run is made at these conditions. During this 25 minute run the generator and hydraulic pump are put under a load. Also, air is bled from the compressor section from between the 6th and 7th stages to simulate cabin pressurization. In addition to this, air is bled off from the 5th stage and used for turbine cooling.

(l) The last 5 minutes of the hour are used as alternate loading checks. This was accomplished in the following manner:

(1) The tail cone is opened to maximum travel and the engine throttled back to idle. Here a mechanic will make a quick visual check of the engine (externally).

(2) Then the throttle is advanced and the speed is increased to 60% with tail cone left open. The engine runs here for 1 minute then is brought back to idle.

(3) Then again the engine is accelerated from idling speed, but this time to 100% RPM's. A man with a stopwatch times the acceleration to 100%. (Note: Tail cone still open).

(4) After this, it is brought back to idling very slowly.

(5) The timing to 100% RPM's is repeated, but this time the engine is left at 100% and the tail cone is re-set to maximum output.

(2) After the tail cone is re-set, the second hour begins. This hour by hour testing would go for five hours. A five-hour period was then considered Phase I of the endurance tests. At the completion of each phase, all filters are checked. These phases were repeated by various amounts to make up various types of tests.

(a) Ten phases originated the 50 hour tests and was at first considered satisfactory. Later it was a standard for plant records tests.

(b) Twenty phases made the 100 hour test which was later adopted for the Official State Tests standard.

c. Official State Tests

(1) The official state tests were a special thing. For this test which was monitored constantly by the Ministry for Air, everything was more rigidly controlled. All pre-test assembly was inspected by the military commission. The conditions for the tests were, however, the same as the Plant Endurance Tests. This military commission calibrated all instruments for reading errors. After inspections by the commission, everything was sealed and safetied. At the completion of the test, all seals were again broken and reading instruments were again calibrated for errors or noted changes.

(Note: Paragraph A.2. [redacted] the fuel accelerator added more fuel for acceleration. This, of course, is the opposite in theory of auxiliary units necessary within the fuel regulator system. It might be [redacted] an over-speed governing component. Par. A.2. is [redacted] system functioned.)

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[redacted]

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[redacted] 50X1-HUM

V. OBJECT 004

A. General

50X1-HUM

1. The JUMO 004 powerplant was a Junkers development that paralleled the 003C development, both in Germany, and at Zavod II when test work first began. [redacted] there were no important tests made of the JUMO 004 powerplant development at Zavod II. There was component testing and some special tests made of a preliminary nature. These were made in preparation for the development of the JUMO 012. [redacted]

50X1-HUM
50X1-HUM

2. [redacted] this small use of the 004 at Zavod II was only to pick up some experience in turbine engines for the Soviet engineers. [redacted] not [redacted] many tests of this engine run at Zavod II.

50X1-HUM

[redacted]

3. The 004 was later used and run to drive, by a coupling, the compressors in various types of tests on the 012 development. It was again later used in the same manner in the development of the A-022. This system of power availability was accomplished by coupling a drive shaft from the turbine shaft, behind the turbine, and running straight behind to the test compressor mounted on a stand directly behind the 004. The exhaust gases were funneled rearward and then upward by an "L" shaped exhaust tunnel thus avoiding interference with the compressors being tested. The driveshaft passed through a hole cut in the exhaust tunnel at the elbow. This project utilizing the 004 had an engine redesignation. It was re-designated the OT-2.

B. Specifications

50X1-HUM

1. [redacted] Some changes made at Zavod II may show up in the listing of general specifications:

Type .... Axial flow turbojet engine

Compressor....... 11-stage axial flow, 2-piece aluminum alloy with aluminum stators and guide vanes, with 11 rows of steel rotors and spaced with aluminum rotor discs forming the bullet that was held to shaft by flanges.

Turbine.......... Single stage with solid steel bucket blades and hollow steel air-cooled nozzle guide vanes.

Combustion....... 6 individual but interconnected cans of the straight through flow type having a single injection nozzle.

Exhaust Nozzle....Variable type, inner cone hydraulically controlled and a steel outer casing.

Fuel System.......Dual manifold system with a BARMAG type fuel pump of 1400 ltrs/min. capacity and 50 kg/cm^2 pressure. Speed governor within regulator.

Diameter..........850mm

Length............4000mm

Frontal Area......Unknown

Weight............1100 kg

Fuel Grade........Kerosene or gasoline

Thrust (maximum)..1800 kg at 9000 RPM
(normal)..1500 kg at 8500 RPM
(cruise)..1300 kg at 8200 RPM

VI. OBJECT 012

A. General

50X1-HUM

1. The JUMO 012 underwent development production at Zavod II. [redacted] Two of these engines were sent to museums in 1951 and two were scrapped. This scrapping was on a general basis and other older powerplants were also scrapped at that time. There was a large number of cans to the 012 burners manufactured and when the project was halted they became surplus. They were later used as waste baskets. The man who suggested the cans be used for this purpose received a 6 month's pay increase bonus.

2. In the spring of 1953 an 012 was used to assist in the air flow calibration for the intake ducting for Objects "K" and "D". This was accomplished by connecting an aluminum tubing from the intake ducting of the "K" to the intake of the 012. Then, by running the 012 they passed the air mass through the "K" ducting and could thus take readings which were used for calibration.

B. Production

1. [redacted] not more than 11 or 12 engines were made at Zavod II. 50X1-HUM Some engines of the 012B series were shipped from Zavod II but no personnel from the plant went with them. These engines were first given trial tests of about 10 to 25 hours; then packed up and made ready for shipping. [redacted] because of the manner in which they were test run, [redacted] they were shipped 50X1-HUM for flight testing. Always when an engine was to be flight tested on an aircraft more care was taken during the trial tests.

a. (Note: [redacted] 50X1-HUM they were flight tested as an auxiliary powerplant.)

The models 012A and the 012B had very little changes from the original 012. There were some changes in the turbine, and some changes in the fuel system had been made.

2. The 012B was prepared for Official State Tests (100 hour) for possible selection into production. However, these tests were never undertaken. The 012B did, however, pass the plant tests (50 and 100 hour). The last test runs of the 012B were in the spring of 1949. The complete testing period was from 1948 to 1949. The plant test runs were not too satisfactory and because of continually excessive tailpipe temperatures which, because of various types of defects, could not be controlled and the project was abandoned in favor of work on the A-022.

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[redacted] 50X1-HUM

C. **Specifications**

Type.............. The 012 was an axial flow turbojet engine similar to the JUMO-004H in construction.

Compressor......... An 11-stage axial flow compressor of welded steel plate construction with a stator blade ring welded integral. The stator ring consisted of the two rings, an outer ring and an inner ring. The stator blades were welded to the outer ring and then inner ring alternately. The inner ring formed the static part of the bullet housing to the drive-shaft. Then, at intervals of about every 12 inches around the outer ring, a lock pin was installed to hold the whole stator ring on and to keep it from rotating about the inside of the casing plate. The rotors were of solid aluminum alloy in the first half section and of steel in the latter [redacted] half of the assembled section. There were air pressure relief valves on the compressor section housing which were hydraulically operated in the 012B models and mechanically operated in the earlier 012 engines. These were to relieve compressor surges at low RPM's and in starting and during acceleration.

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Combustion......... 8 interconnected tubular steel combustion chambers of the straight through flow type with two fuel injection nozzles. One injection nozzle was for normal running and one for starting only.

Turbine............ 2-stage axial flow turbine consisting of solid steel alloy construction.

(Note: On one test a turbine flew apart and one turbine blade penetrated the walls and entered the next test stand [redacted] it was solid steel).

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Exhaust Nozzle.....Variable adjustable type with steel outer casing and mechanically adjustable inner cone.

Fuel System....... Fuel system of dual manifold type. The starting fuel system was separated from the running fuel system. Both manifolds were controlled from a single fuel control unit and the switch from gasoline to kerosene was made at the regulator when engine reaches sufficient RPM's. The fuel pump was a Soviet manufactured copy of the BARMAG German designed pump. Of this, there were two types:

1. Rated at 1400 ltr/min.
2. Rated at 1600 ltr/min.

The 1600 ltr/min capacity pump was used on the 012 and the 1400/ltr/min pump was used on the BMW 003C and JUMO 004 powerplants.

(Note: These pumps were series produced in the USSR).

[redacted] 50X1-HUM

Accessories....... Hydraulic pump was the same as that on the 003C and the generator the same as used on 003C and 004, only these were Soviet produced.

Starting System... Compressed air starter installed in the intake dome and driving through a gear reduction to compressor drive shaft. This compressed air was generated by a 24V electric motor driving an air compressor and operated at 1.7 to 1.75 atmospheres.

(Note: This is the first an electric-driven air compressor starter has been heard of.)

Diameter.......... Unknown, but larger than the 003C

Length............ Unknown, but the inlet was of a shorter design than that of the 003C. Approximately 1/3 longer overall than 003C.

Frontal Area...... .9 m^2

Weight............ Estimated 1400 to 1500 kg

Fuel.............. Kerosene, gasoline for starts

Fuel Consumption....... Specific (1.05 kg/kg thrust/hr)

Thrust: Maximum... 2300 kg (only on the first group produced)
Normal.... 2000 kg
Cruise.... Unknown

D. **Miscellaneous**

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1. [redacted] helped construct the system for measuring the thrust (see Sketch No. 3), and helped in operating it. [redacted]

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(Note: This low thrust rating was only on the first few engines built. Later, the thrust maximum was more.)

2. Starting temperature limits were 700°-750° C and the run temperature limits were 500°-600° C. There was much difficulty in maintaining these limits and many small defects would keep the 012's test runs continually going beyond these limits.

VII. OBJECT 018

A. General

1. In 1946 within the Soviet Zone of Germany, the BMW group had under development the BMW-018. This was constructed and brought to the test stand for testing but was never run. It was motored over for compressor and turbine blade checks but never fired up. Although the 018 was in the project stage of development in 1945 it was mostly developed by the BMW plant after occupation and until late 1946.

2. Late in 1946 and early 1947 the test stand was erected at Zavod II to test the 018. This was the same stand that this powerplant was suspended on in Germany. It was merely reconstructed in the USSR. However, the powerplant suspension was changed. In Germany the suspension was overhead, but at Zavod II it was from below. This one engine that was brought from Germany was the only 018 [redacted] that was pro- 50X1-HUM duced. It was the only one that underwent testing at Zavod II.

3. About the end of 1947 this powerplant was put on the test stand and ignited for the first time. The primary tests were a failure. It was not run to very high RPM's because the turbine buckets expanded due to excessive heat and cut into the outer shroud ring housing. This made a very loud scraping noise and also began to deform the outer housing. The engine was immediately shut down. It was then taken from the stand, dismantled and sent to the disassembly section and scheduled for various design changes.

4. During the time this powerplant was in disassembly a new policy change was issued from higher authority to give this project up and concentrate on the 003C. Also, during this time the design department was working on the BMW-028 project and the JUMO-022 and seemed pre-occupied. This was in the winter of 1947-48. [redacted] 50X1-HUM [redacted] the BMW-018 [redacted] design features were adapted to Object A-022. 50X1-HUM

B. Specifications

1. The BMW-018 was a turbojet engine with a 12-stage axial compressor and a single annular combustion chamber. It had a 3-stage turbine fabricated of steel and hollow alloyed guide vanes that were air-cooled in the 1st and 2nd stages. The first stage turbine rotor was hollow steel and was air-cooled, while the second and third stage had root-cooled solid steel buckets. The exhaust nozzle was variable and electrically operated by an automatic control. The general construction pattern of this engine was the direction in which all later and more successful engines went and is described in more detail later in Object A-022. The BMW was never run to maximum power output but was said to have well over 3000 kg of thrust.

VIII. OBJECT 028

A. General

1. The BMW-028 was being worked on in the design stages only in the Soviet Zone East Germany and after World War II. It was a turboprop version of the BMW-018. Although drawings were made, no parts were manufactured up to [redacted] 1946. 50X1-HUM

2. At Zavod II the design group was given requirements to develop a new powerplant. This was to be a turboprop engine and seemed to be designed around the JUMO-022 requirements. This was to be called Object "A", but was later called Object "A-022". The BMW design group working on the 028 and the Junkers design group were pooled and moved into this new design together. The design features of the combustion chambers were taken from the 028 and in conjunction with the JUMO-022 features were pooled and development on Object A-022 was started. This was to be an all new design development.

IX. OBJECT A-022

A. General

1. Jumo 022

a. The JUMO 022 had a parallel existence of the BMW-028, in that Source believes none were built and only data was taken in KUIBYSHEV to be used in Object A-022. The drawings were completed in DESSAU in 1946 and went with the Junkers Group to the USSR. The BMW and Junkers Groups at first worked separately until the specifications for Object "A" were laid down. Then both groups were pooled together on this single project. The specifications on Object "A" fit the specifications of the JUMO-022 almost precisely, and so it was called "Object A-022".

2. A-022

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a. About spring of 1948, Object A-022 was started. In the fall of 1948 Test Stand #3 at Zavod 2 was rebuilt to test the A-022. In March of 1949 the first engine was brought to the test stand. [redacted]

B. Construction

Type............. Turboprop, 14-stage compressor, single annular combustion chamber and 3-stage turbine with fixed exhaust nozzle.

Compressor....... 14-stage axial flow, two-piece welded sheet steel casing that is described more in detail in Object "K". Rotor blades were of aluminum alloy for the first 8 stages (this was a sort of brass color when freshly machined) and the last 6 stages were steel alloy, oxidized, and blue colored like a gun barrel. There were stringers spaced evenly around the sheet steel casing which was welded in "T" fashion to add strength. These were drilled with holes for lightness and were hollow, ("U" shaped). The top stringer housed the accessory driveshaft and also served as an oil return line from accessory drive gears to a scavenger pump.

1st stage compressor blade dimensions were:

(1) width...................... 50mm
(2) length..................... 120mm
(3) distance between blades... 25-30mm (at base)

last stage compressor blade dimensions were:

(1) width...................... 50mm
(2) length..................... 50mm
(3) distance between blades... 25-30mm

[redacted]

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Combustion Chamber.. Single annular steel combustion chamber with equally spaced flame tube separators, [redacted] and having "Nene" engine type spray nozzles.

(Note: [redacted] there were some "Nene" burners tested here. The fuel nozzles in the Nene and the A-022 start jets were the same).

Turbine............. 3-stage axial flow type with an 60-80mm difference in diameter between the first and last stage.

Size: (last stage)

(1) shafts, wheel............ 70-80mm diameter
(2) wheel, turbine........... 550mm diameter
(3) blades, turbine.......... 120-140mm length

(Note: All three turbine wheels were the same in diameter only the blades were longer on the last stage).

The three stages were bolted by 6 bolts that were copper coated. The retainer nuts were copper also. The turbine blades were highly polished with an "X-mas Tree" base retainer design that was copper plated. This was for anti-corrosion and for installation ease. (To keep from chipping or cracking the steel). Later, they tried chromium plating some turbine blades. [redacted] they were successful and were used along with the others. The blades were forged and machined to a fine finish. The blades and bolts were of "EAIT" steel.

Exhaust Nozzle...... Fixed type, pre-determined area, with steel outer casing and inner cone.

Lubrication......... Dry sump type with scavenger pump type return from gravity feed "Y" drain under bearings.

(1) pressure..............4 atü with ± .5
(2) consumption..........2.5 to 3 kg/hr.

Fuel System......... BARMAG type fuel pump with 65-70 atu, pressure on the first group of engines and later, in the 100 series, 75-80 atu. Fuel regulator was called the KTA. The ring manifold was a single unit with two lines leading to each of the 12 ejection nozzles. These two lines leading into a single ejection outlet in an inverted "T" fashion. This was found to give better atomization than the single line "straight through" lead that was installed on the first group of engines. These nozzles were machined from bar stock. In 1951, 1952, 1953 the Soviets manufactured all nozzles. [redacted] special tests with silver-bronze injections in fuel. The silver bronze was to leave deposits on the metal inside the burners in order to better trace combustion expansion and airflow. These tests were done only once. GUENTHER LANGE was said to be the real brain in combustion design.

[redacted]

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C. **Performance and Dimensions**

Fuel Grade................ Kerosene with a specific gravity .825 and was colored golden yellow (like a cup of weak, light tea)

Specific Fuel Consumption.............. (1) 1st group engines.......260-280 grms/PS/hr
(2) 2nd group engines Serial #100 and later ....245-248 grms/PS/hr
(3) Special tests (allowing higher tailpipe temperatures) ....238 grms/PS/hr
(4) Some special tests showed at take-off power (maximum) 1460 kg/hr of fuel used
(5) One fuel spray test was noted by Source. The readings as remembered were:

(a) ~ 1.8 ltr/min for each jet
(b) ~ 1460 kg/hr for all

Then, taking 1.8 ltrs times 12 burners times 60 min times sp gr (.825) = 1070 kg/hr. The formulas used [redacted] were: 50X1-HUM

$$PK = \left(\frac{\text{measured consumption}}{1070}\right)^2 \times 23 \text{ atü.} + P2$$ (Pressure behind compressor)

$$PK = \left(\frac{1460}{1070}\right)^2 \bullet 23 + P2$$

PK = 44.0 atü.

These figures are [redacted] forwarded for study. 50X1-HUM

Dimensions................ (1) Diameter......................... 800-1000 mm
(2) Length..........................4500-4700 mm

The short burner engines were about 100-150 mm less.

(3) Weight...........................1400-1700 kgs
(4) Air Intake Area....5 m^2 with 4 intake struts

(Here, the Prandtl tube was 70 mm from its base mount and was half way between inner and outer surfaces. It was mounted 100-110 mm forward of the first stator (guide vane) stop.

Power Output.............. Maximum, take off (ESHP)

(a) First group..............................5200 PS
(b) Serial #100 and over.....................6250 PS

(Note: One PS = .9863 HP)

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(2) Residual thrust:

(a) first group........................ 500 kg
(b) serial #100 and over................ 400 kg

RPM's...............(1) Maximum take-off......................7700
(2) Cruise...................................7400
(3) 98 of cruise.............................7250

Temperature
Readings............(1) T1 compressor inlet.................free air temp.
(2) T2 compressor outlet................ 250-270° C
(3) T3 inside burner before turbine..... 1100° C
(4) T4 tailpipe temperature

(a) Maximum...........550-570° C
(b) Normal.............500° C

D. Disassembly Procedures

1. It took about five hours from engine stoppage to completed tear down in the disassembly shop (called Shop #1). One hour was spent for cooling down period and Phase I of the teardown. Four hours were utilized in Phase II of teardown. This four hours was spent in Shop #1. The following breakdown shows each phase of disassembly.

a. Phase I

(1) Disconnect water brake

(a) Check alignment of engine with waterbrake.

(Note: This was done particularly and very carefully with an engine which had excessive vibration)

(2) Disconnect all attachments such as:

(a) All measuring instruments and their attachments
(b) Tachometer
(c) All oil lines
(d) All fuel lines
(e) All electric connections
(f) All throttle and control linkages from control room

(3) Drain all residual oil and fuel from engine, close up all openings and drain plugs.

(4) Loosen all stand mounts and attach overhead hoist mounts.

(5) Lift engine out of stand mounts by overhead hoise and rail. Then move to a movable stand dolly.

(6) Move by dolly to disassembly shop (Shop #1) and set into engine teardown frame there.

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b. Phase II

(1) Remove tailpipe

(2) Remove turbine

(a) Third stage turbine first, then stator
(b) Second stage turbine, then stator
(c) First stage turbine, then stator

(3) Turn up on end with burners down

(a) Remove support stand

(4) Remove intake housing (outer ring)

(5) Remove gear housing and reduction gearing together (as one unit). These are unbolted at the base of housing and the compressor guide vanes.

(6) Remove fuel regulator, and all external accessories

(7) Accessory reduction gear housing is removed (this is by 8 bolts holding it to outer compressor casing)

(8) Remove compressor (complete), from combustion chamber burner section

(a) Move it to sub-assembly for splitting in half and disassembly

(9) Remove from inside the annular combustion chamber the airflow separators and guide vanes.

E. Pre-Test Running

1. The new engine is at first turned over by an electric motor, (up to between 300 and 500 RPM's). This is done to check oil circulation, bearing checks and in general, obvious faults and failures. The bearings are checked by a special sensitive thermal coupling giving an accurate heat reading thus making the coefficient of friction, μ(mu), readily computable. This was a 5-minute run. During this run, air pressure readings throughout the engine were read on the manometers. This is the first chance to plot actual readings against theoretical readings. There was also oil quantity check by measuring quantity flow in and quantity flow out.

2. During these 5-minute runs, they would also accomplish the compressor break in. This was because of the compressor guide rings being made of a soft fiber-plastic material. For bonding purposes an uneven surface was ground on this plastic similar to small screw threads. This was matched by the other surface of the retainer ring and together they formed a bond. This plastic was to take up the heat expansion tolerance that was in the metal blades and housing. The compressor blades simply would cut their own tolerances, making the plastic housing act as a seal ring and maintain close tolerances. This type of 5-minute run was repeated for a week to

ten days, and until all apparent defects were ironed out. The engine would then be taken from the stand to disassembly. It would be returned later for another motored run.

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3. The starter motor was a D.C. pendulum type motor of a maximum amperage of under 300 amps. ([redacted] a 300 amp. circuit breaker installed in circuit). The transformer installed in the cellar for the test stand was 6000 watts. Fifty cycle A.C. power was piped in from the city and was changed to D.C. by a WARD-LEONARD unit produced by the SIEMANS Co., East Germany.

4. At the completion of this 500 RPM, 5-minute running phase, the engine was increased to higher RPM's (2800). This was done in steps and the time was increased to 15 minutes up to 30 minutes at various times. This phase of running took about 20 more days. The same type checks as previously completed were accomplished here also. But in addition, there were checks on the waterbrake and couplings. (The waterbrake was new and needed computation checks also.)

F. Firing up the Burners

1. At the completion of the 2800 RPM break in tests and when all seemed to be well and ready the combustion chambers were fired up. This was at 800 RPM's and with gasoline having about a 5% oil addition. The fuel pressure used for this start was supplied by a special electric pump of 2 atu. During these first runs, there was considerable difficulty in ignition. It was thought that an improper mixture of fuel-air was the cause. There followed, of course, changes in the ignition plug types, fuel pressure changes, and later, changes in the fuel jet nozzle types. Then some starts from 400 to 800 RPM's were tried. Various combinations were tried and the best combination was found to be:

a. At 400 RPM's the ignition plugs came on
b. At 800-1100 the fuel was turned on into the burners

2. During the first series of start tests, "hot starts" were frequently experienced (700-800° measured at T6). Whenever the engine went beyond 700-800° C they would nearly always shut the engine down and inspect it. Sometimes temperatures would go to 1000° C and this would always be cause for a shut down. Later normal starts were being made at 400° C.

3. Good starts were taken up to 3500 RPM's. The starter motor was then cut out and the engine left to idle on its own. All measurements were taken here. These idling runs were sometimes up to an hour, and then again sometimes only 10 minutes. When the engine was shut down again, sometimes it was taken to disassembly and checked for turbine, compressor and internal material failure. This type of testing extended over a period of about 2 to 3 months. They were also having difficulty with the waterbrake coupling (Dwg. No. 5). The waterbrake mounting, the pendulum motor, and the engine were all mounted on separate stands. The tolerances were too difficult to maintain and considerable instability in proper alignment was plagueing the success of this series of tests. The turbine break-in period was included in this 3500 RPM test.

[redacted]

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G. Trial Runs

1. The next stage of testing was a gradual increase in RPM's. This was up to 6500 RPM's. Here they found that the tailpipe temperature rose correspondingly to the RPM's, but by too large of increments. At the 6500 RPM's they started experimenting with the hydraulically controlled air bleed valves. These were remotely controlled from control room. They tried various settings to determine how many needed and how much to open, and at what RPM's necessary to maintain a desired temperature.

2. The correct amount was done finally by a characteristic curve of the compressor which predicted that at a setting of 6500 RPM's there would be a compressor stall and a small vibration would take place within the compressor. This would result in a consequent rise in tailpipe temperatures. [redacted] this proved out in practice as was predicted in theory. In addition, though, in practice it was noted that if the holes closed too soon a stall also occurred.

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3. They tried stopping up the air holes used for cooling the turbine in engine #104 which was in preparation for Object M-022. The specific fuel consumption dropped noticeably but the temperatures rose too rapidly. They tried various systems here until they reached the compromise they wanted. Engine #104 also was run at an overload condition for 50 hours; small changes were always being made during construction on the "next to be run" powerplant. Later they all had more power.

H. Plotting the Characteristic Curve

50X1-HUM

1. The next series of tests were to plot a characteristic curve for engine. Under 3500 RPM's it was difficult to maintain a constant and so the plotting was done from 3500 RPM's up. This was then considered idling. [redacted] burners would stay lit back to 2000 RPM's, but then the tailpipe temperature starts to rise rapidly and shuddering would take place. This was from a compressor stall, but it also would sometimes flame out here without a stall.

2. At each 200 RPM increments from idling to 7700 RPM (maximum), the various engineering groups took their respective readings to plot against their theoretical curves. These tests were re-run, and each time, with increased loads. This continued until the engineering group considered everything satisfactory. This testing period consumed about 2-1/2 to 3 months. During this time, one powerplant was assembled with gear reduction housing and propeller. The propeller pitch change was operated by a manual hydraulic control, remotely from the control room.

3. After a curve test on each engine produced, the engine is either selected for flight tests or it is used for endurance testing. When it is to be flight tested, it receives an additional 5 hours run for an endurance test. It is then pickled and shipped. During this curve testing phase, some engines were purposely overloaded and over-run to determine some of the ultimate limits. Ultimate temperature limits were also determined by cutting holes into turbine bucket roots and filling with various metals of known melting temperature points. Sometimes holes were drilled in the turbine wheel between the "X-mas Tree" bucket retainers. Then as the temperatures were increased these metals passed into a liquid state and

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resolidified in passing out the tail cone. They could tell this way how much heat the turbine buckets had been subjected to. Sometimes turbine buckets flew apart on these tests.

4. Curve Plotting Procedures

a. Engines are inspected at disassembly and then sealed. This was inspected by OTK inspectors.

b. All the following measuring instruments are calibrated: (Also inspected by OTK men)

(1) Manometers
(2) Prandtl tubes
(3) Tachometers
(4) Temperature indicating instruments
(5) Weights
(6) Flow meters (See Sketch No. 6)

c. The waterbrake was calibrated in 100 kg increments up to 850 kgs. This was plotted for a characteristic curve against atmosphere conditions and was then used for a torque calibration curve (See Inclosure No. 18).

d. The thrust calibration curve is plotted on same chart by using a 2 to 1 ratio. This is done by the leverage arm moments and simply making 100 kgs read 200 kgs. (This was plotted to only 450 kgs but was made to read 900 kgs). See Inclosure No. 18 and No. 10.

e. During engine calibration on test stand for characteristic curve, no engine readings are taken. Everything is plotted with the calibration curve of the waterbrake stand.

f. The test stand operator goes up the scale according to the atmospheres read and back down in the same manner as indicated on the pressure gauge indicator [redacted] 50X1-HUM

g. Load moments of torque would be taken from the calibration curve of the waterbrake stand.

(1) Total range was from 300 kgs to 780 kgs at 7700 RPM's (maximum)
(2) Increments were of 100 each
(3) Each new point on curve had to be left 5 minutes to settle before readings were taken.

h. There were later five points selected on a curve from which to take readings. This was for the series development engines. The four settings other than idling were:

(1) 7000 RPM's ± 50
(2) 7250 RPM's ± 50
(3) 7400 RPM's ± 50
(4) 7700 RPM's ± 50

resolidified in passing out the tail cone. They could tell this way how much heat the turbine buckets had been subjected to. Sometimes turbine buckets flew apart on these tests.

4. [illegible]

a. Engines are inspected at disassembly and then sealed. This was inspected by OTK inspectors.

b. All the following measuring instruments are calibrated: (Also inspected by OTK men)

(1) Manometers
(2) Prandtl tubes
(3) Tachometers
(4) Temperature indicating instruments
(5) Weights
(6) Flow meters (See Sketch No. 6)

c. The waterbrake was calibrated in 100 kg increments up to 850 kgs. This was plotted for a characteristic curve against atmosphere conditions and was then used for a torque calibration curve (See Inclosure No. 18).

d. The thrust calibration curve is plotted on same chart by using a 2 to 1 ratio. This is done by the leverage arm moments and simply making 100 kgs read 200 kgs. (This was plotted to only 450 kgs but was made to read 900 kgs). See Inclosure No. 18 and No. 10.

e. During engine calibration on test stand for characteristic curve, no engine readings are taken. Everything is plotted with the calibration curve of the waterbrake stand.

f. The test stand operator goes up the scale according to the atmospheres read and back down in the same manner as indicated on the pressure gauge indicator shown in [redacted] 50X1-HUM

g. Load moments of torque would be taken from the calibration curve of the waterbrake stand.

(1) Total range was from 300 kgs to 780 kgs at 7700 RPM's (maximum)
(2) Increments were of 100 each
(3) Each new point on curve had to be left 5 minutes to settle before readings were taken.

h. There were later five points selected on a curve from which to take readings. This was for the series development engines. The four settings other than idling were:

(1) 7000 RPM's ± 50
(2) 7250 RPM's ± 50
(3) 7400 RPM's ± 50
(4) 7700 RPM's ± 50

i. The ESHP was computed thus:

(1) Md · n = PS (Note: This is read from chart, Incl 18.....10 atü = 700 kg.• (RPM) = PS = 5000)

(2) Then using same chart and multiplying each unit measured by a factor of 2 (5 atü = 500 kg 0.91 = 455 PS)

(3) Then totaled: (5000 + 455 = 5455 PS = ESHP)

j. PS was called N also and is referred to in formula: $\frac{P \cdot 2r \cdot \pi \cdot n}{60 \cdot 75}$

The unknown propeller moment (P · r) is replaced by the known moment of torque of weights placed on arm (G · l), so = $N = \frac{G \cdot l \cdot \pi \cdot n \cdot 2}{60 \cdot 75}$ but since $2\pi/60 \cdot 75$ is a constant or; $N = \frac{G \cdot l \cdot n}{716}$ or $\frac{1}{716}$. In this case the level arm is made the same as the constant: N (in PS) = $\frac{G \cdot 0.716\, n}{716}$ where "G" is read on manometer and 0.716 is in meters because PS is in kg m. Then: N = G · n · 0.001 = Kg · n · 0.001. "G" can also be taken from the calibration curve by reading the pressure gauge on the water-brake stand in atü and converting to kilograms. 50X1-HUM

(Note: PS = .9863 hp. The use of 0.91 as a constant was arrived at by the design group but was dependent on the test stand design. [redacted]

k. At various times instruments were re-checked and re-calibrated and at the end of each calibration run the measuring instruments were always re-checked and re-calibrated. Some of this work was done at nearby Universities under the supervision of OTK.

I. Endurance Tests

1. All endurance tests were run with propellers, with the exception of a few that were to be run with overloading conditions. These tests were run (minus propellers) on the waterbrake test stand with a controlled amount of overloading. The endurance tests were the same in principle as the 003C in that there were similar types of inspections prior to running and the five-hour phases were run in the same manner. However, in the A-022, all phases were worked out in more detail and closer tolerances were held. And while the Official State Test of the 003C was only 50 hours, the A-022 was 100 hours.

2. After 5 hours of testing (Phase I) the prop pitch and feathering was tested. In general, there were more external loads put on this engine than on the 003C, such as generators, compressor, hydraulic pump loads, etc. There was also an air bleed from the compressor section that was used for cabin pressurization. During each 5 hour stage of testing, this air was analyzed for its gaseous contents. The greatest difference in the A-022 endurance tests was that no output was measured on the propeller stand. These newly constructed test stands for props were erected differently and a groove was cut into the flooring wide enough for the blade tips to pass. The blade tips passed below the horizontal level of the flooring.

J. Endurance Start Tests

1. Starting was considered completely automatic. The starting motor utilized was the TS-1 also known in the project listings as "Object C".

2. There were start tests to test the endurance of the TS-1. The first phase consisted of 150 starts, which later was considered a standard. There was one special test that ran to 200 starts. During these tests they would sometimes let the engine set until cooled down to the winter's temperatures to simulate setting over night. Then re-starting was accomplished. These tests took weeks to run.

3. In cold weather tests kerosene was mixed with oil at various percents to determine how much dilution was necessary in utilizing the TS-1 for starting. This was done at -30° C to -40° C temperatures, and up to 75% kerosene was tried. All regulators and accessories using oil were diluted with kerosene in the same manner in order to insure fluid conditions and not have failures of an important regulator control due to congealing of the oil.

4. The starting procedures were as follows:

a. An electric motor was started by a switch in the control room. This started the TS-1 gas turbine starter engine which then accelerated to maximum RPM. Starting igniter plugs were also in this circuit.

b. The maximum RPM's acceleration is timed, and when reached, an electric timer relay shoots an oil pressure that hydraulically couples the TS-1 to the engine for starting torque rotation.

c. At 400-500 RPM's the "stop-start" sensitizer sends an impulse to the igniter relay which in turn starts the igniter plugs.

d. At 800 RPM's the operator in the control room starts handling the throttle to keep fuel pressure correct and thus tailpipe temperatures within limits.

e. When the powerplant has reached 2000 RPM's, the "stop-start" sensitizer actuates an oil pressure that ties into the accessory section idler gears, and thus hydraulically disengages the TS-1.

f. At the same time the TS-1 is disengaged, an oil hydraulic impulse is sent to a relay that turns off the fuel and thus shuts down the TS-1. The turboprop engine is then accelerating on its own.

g. Also, at 2000 RPM's a starting sequence light in the control room that is tied into the TS-1 relay circuit would go "out".

h. A second light tied into the sensitizer relay circuit would go out also.

i. Then the operator would be free to increase the RPM's by the throttle control to 3500 which was considered idling.

K. Icing Tests

1. During the experimental and endurance tests, much icing occurred and various experiments were made in an attempt to eliminate icing. Some of these included:

a. A collector ring manifold was installed around the leading edge of the intake. This had numerous small spray holes. Water was pumped through this manifold and consequently sucked into the intake. This was to see the effects of icing. It was in October and in slightly below freezing temperatures. However, nothing happened and no icing developed.

b. Later icing developed from natural effects. For this they ran tests on selected days. These tests were performed by installing a spray ring using an alcohol-glycerin mixture. This was also a failure and ice formed on the intake bracing struts anyway.

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c. Later they tried some sort of salve from fats. [redacted] it was yellow in color. This, too, was a failure in preventing ice formation. The ice would break off in large chunks damaging rotor blades and causing shut down.

2. [redacted] Icing control was not accomplished on the test stands.

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L. Propeller Tests

1. With the A-022 on the prop test stand there were special tests also. The same first five-hour (Phase I) tests were also used to "wear-in" the reduction gears. During the experimental phase of testing, there were different types of blades tested. For some of these tests there were thermodynamic instruments set at different planes on the blades. This was accomplished by cutting channels into the solid aluminum blades. These channels were then filled with a plastic substance with thermo-elements running between the plastic and aluminum. On later blades (which were wider) there was a collector ring at the tip of each blade for all these thermal elements and then this was funneled up the back to a master distributing ring. (Note: [redacted] probably meant strain gauges). 50X1-HUM

2. The first tests with the propellers were for testing the synchronizing of the fuel regulators and propeller governor. The regulators and governors were pre-set and pre-inspected on a test bench for the proper amount of fuel flow. This fuel flow was known on charts and adjustments were made to correspond. The governor and regulator, of course, were pre-tested and adjusted on separate test stands. The final fine adjustment was made together on a "mock-up" test stand with propeller.

3. The RPM control was dependent upon two things:

a. The RPM's at that instant, and/or their own inclination to change due to changes in air densities.

b. The fuel regulator at the same instant, and at what power setting it is set for.

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4. [redacted] the propeller governor and fuel regulator system [redacted] are as follows:

a. The regulator was dependent upon tailpipe temperature and pressure changes in compressor.

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(Note: [redacted] the fuel regulator being tied into the circuit of the tailpipe temperature (T6) [redacted] for about six months on the later A-022 this was done. It was not continued however. The principle of operation was: a single piece of metal as heated, changed in electrical resistance (ohms). This allowed an electrical impulse to move a piston in an oi[redacted] 50X1-HUM hydraulic system linked by a single line to another piston. This secondary piston, which was within the fuel regulator, was in turn activated and regulated fuel flow. Source knows nothing of inside of fuel regulator (KTA).

(Later, there was in instrument called "Temperature Measuring Instrument", which was on the right side of all engines. This instrument had a metal covered shielded cable leading to the regulator (KTA) and having a male plug. The cable was about 1 cm in diameter and carried electrical wiring. There were always electric wiring leads coming from T1 and T2, but only for 6 months at T6.

(A pressure line also led to the (KTA) from behind the last (14th) stage of the compressor.)

b. The propeller regulator was tied directly to the fuel regulator by an oil pressure line. Its operation was dependent on an oil pressure impulse from the fuel regulator. This pressure was at 20-25 atu maximum.

c. The governor itself incorporated a booster pump within itself that operated the blade pitch angle changes. This was from the signal of the fuel regulator pressures, (20-25) atü. There were three pumps in all for the propeller pitch change:

(1) The normal pitch angle pump (explained above)
(2) A separate system pump for the reverse pitch control
(3) A separate system pump for feathering.

d. The only control of the RPM's was through the fuel regulator itself. When the throttle is advanced, the pitch angle is flattened out to increased RPM's by an impulse sent from the regulator.

e. The fly weights within the governor itself, and which operates the pitch angle change also, then have only two functions:

(1) To maintain a constant RPM's in various densities

(2) Prohibit an over speed condition during maximum RPM's and in-flight pitch changes and during engine acceleration.

M. Miscellaneous

1. Tachometer Systems Used:

a. At first the tachometer was directly connected to the engine by a driveshaft that operated a set of contact points which opened and closed. A 24V D.C. current was fed into this counter and by a return line passed through a junction box that also utilized a 220V A.C. power fed into it from the city. This junction box also contained a counter and a stop watch. To read the RPM's, a button is pushed and the counter window is zero'd. Then when the button is released the counter system runs for exactly one minute. The number of times the circuit breaker is actuated is recorded thus giving RPM's.

Note: A curve for this apparatus also had to be calibrated for the Calibration and Official State Tests to compensate for pulse changes in the city's 50-cycle AC current).

b. Later an aircraft type tachometer system was used. This system incorporated two separate aircraft type tachometers.

(Note: A curve plot was also made to check the accuracy of these tachometers during calibration and official state tests. A hand strobe-light system was also used for counting the RPM's).

2. Turbine Failures:

a. In the testing of the A-022 and AF-2 there was one failure where the wheel came off. (AF-2 was a version of the A-022 before 100 Series and only one was built. It failed at turbine).

b. There were about two other failures: one where two stages of turbines flew off and one where a single stage disentigrated.

c. Many times blade failures occurred and blades flew off. Most of these failures were where the blades broke off at the roots.

3. Combustion chambers up to engine #18 did not incorporate the short combustion chambers. Engine #25 did but these were only for special tests and were not continued in production. No short burner engines were flight tested.

4. Graphite seal rings came into production engines only after engines in the 100 series. These were flight tested and endurance tests were run on stands.

5. Engine #14 was first to go to flight testing. About 6 to 8 total of these series went to flight testing.

6. Some of the Test Stand Control readings that Source could remember are listed below:

a. Q_u = 2300-2400 m m kerosene

b. P1, P3(+) = 110-120 m m mercury

c. P2(+) = 5.8-6.0 atü

d. P2(-) = 5.7 - 5.9 atü

e. P6(+) = 907 mm mercury

f. P8(-) = 1200 mm kerosene

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[redacted]

X. OBJECT M-022

A. General

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1. Object M-022 was a powerplant made up of two A-022's [redacted] and coupled together by a reduction gear housing. In the M-022 configuration two A-022 engines were coupled to a dual 4-blade contr 50X1-HUM rotating propeller [redacted] a combination of planetary and spur gears (Planetengetriebe und Strinvardergetriebe). 50X1-HUM

2. For Object M-022 a newer test stand was built. This was also used for Official State Tests. It was 10m x 10m inside dimensions. The M-022 never underwent the Official State Tests but the stand was later used for Object "K". There were more test stands for the M-022 built at Zavod II. These were shipped out disassembled along with a full set of drawings for each stand. There were also three stands left there at Zavod II for testing Object "M" and later all of these stands were re-built into "Object K" test stands.

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3. [redacted] the Object M-022 engine had been flight tested somewhere near MOSCOW. A Mr. LEBIDEFE (a Soviet technician with Group #8) went with some propeller reduction gears one day for exchange on an aircraft [redacted] at one airfield near MOSCOW. [redacted] an aircraft had crashed near MOSCOW with an Object "M" powerplant. [redacted] the reason for the crash was some fault with the mountings, and that the engine had torn itself out of the mounts. [redacted] 50X1-HUM [redacted] there was much talk of a Special Commission from the Ministry for Air. They did visit Zavod II and came only to check the dampers and suspension mounting of the engine test stands on Object M-022. As this happened the OTK men had to rush around the plant and stamp pre-inspection dates on all parts making up the suspension units. 50X1-HUM

4. The air compressor that was run from the M-022 was called the "AK-75".

B. Dimensions

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1. [redacted] Personnel here were all Russian technicians. [redacted] the spur gears were about 120 mm in thickness with a diameter of about 400 mm. Then the planetary gears that rotated about the spur gear had the same thickness but were about 150 mm in diameter. The gear teeth were straight. (However, angle teeth gears were tried also but not for long.)

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2. [redacted] could not give any information about gear reduction but gave a hazy version of the propeller diameter. This was about 6.8 meters. The prop rotation was [redacted] about 900-1000 RPM's. 50X1-HUM

[redacted]

[redacted]

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C. Propeller

1. Both engines were right hand rotation and the rear propeller was also right hand rotation. The contra-rotating arrangement was accomplished by a 50X1-HUM hollow shaft. One powerplant was to one propeller and the second was to the other.

2. On earlier mounting systems although when one engine would be partly or fully shut down that engine would not be disengaged but no longer would be engaged and other engine swung both props.

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3. The propeller was eight blade contra-rotating with the first group having rounded tips and a slight taper from the shank toward the tip. These were later cut off to square tips. Then newer blades came with square tips. These were very wide blades and these props were later used on Object "K".

4. There was one governor mounted on each engine for each propeller. The fuel regulator for each engine was connected to the governor for that propeller and operated the blade pitch angle booster pump within that governor. There was also an equalizing line connecting both lines from regulator to governor. This was tied in to each pulse line to the governor at the governor inlet. Alongside the fuel regulator was a control box that had a mechanical linkage to the regulator. An oil hydraulic line ran from this box to the governor in parallel to the line from the fuel regulator.

(Note: Here there were two lines coming into each governor but only the lines from the regulator had an equalizing line.) 50X1-HUM

5. The small differences in RPM's that would arise in each engine would be compensated for in the propeller pitch angle change by this equalizing line and the separate control box. The box was known as an electric pulse producing control and operated from a 24V current. if the propeller governor lines were criss-crossed. not too much effect was noticeable. there were some small differences but mostly in the test readings. Although the engines ran almost the same, the manometer readings in the control room were all off. 50X1-HUM

6. The feathering was a separate system. A single pump was mounted on each engine, one for each individual propeller. Later on there was a single pump designed and built to feather both sections of the propeller. This was mounted independent of the engines and operated by an electric motor driven hydraulic pump. A separate tank was incorporated in parallel to the oil system. This was so that the feathering pump would not be putting too much drain on the normal oil system.

D. Testing

1. Testing of Object M-022 was much the same as the Object A-022. In the M-022 the fuel regulators were coupled by mechanical linkage to a single throttle. A single oil circulation and cooling system serviced both engines. The starting sequence was synchronized by a switch in the control

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room. There were two buttons but the operator could not operate either button individually. When the operator pushed the two buttons both engines started simultaneously.

2. The M-022 was run at full power on the propeller test stands but not on the waterbrake stand. The existing stand and waterbrake had insufficient capacity. (The three disc brake see Dwg. No. 5).

3. H.P. was computed by adding the output curves of two A-022's and multiplying the results by the gear loss factor. (This was a constant worked out by the gear design group, [redacted] 50X1-HUM

4. The gear box coupling tests were in summer 1951 and until fall 1952. In September 1952 the first 100 hour tests were completed. There were four failures in spring through summer 1952. They were:

   a. The first failure was due to the teeth stripping out and distorting the casing. This happened in winter of 1951 and 1952.

   b. The second failure was the same as the first except the casing wasn't distorted. (Winter 1952, 1952).

   c. The third failure, the gears became too hot from insufficient lubrication and burned out all the bearings.

   d. The fourth was a small failure. One bearing burned out due to lack of lubrication caused from sludge stopping up the oil discharge jet.

5. Various types of gear teeth were tried, straight and angular mostly. In spring 1953 straight teeth were finally selected and used from then on.

6. There was one more test failure about the fall of 1952 on a 100 hour test (Official State Tests) with dignitaries present. This was also due to a bearing failure. A Russian engineer had redesigned the gear housing with different materials and used a new type of bearing. He had it entered on the 100 hour test above the protest of the German project engineer. It failed at 20 hours and they went back to the German design.

XI. OBJECT K

A. General

1. Object "K" was a further development of the A-022 series powerplant. In general it was of similar construction and in outward appearance there was a great likeness. Inside, of course, the engine was not the same with the greatest noticeable difference being a 5-stage turbine. It was larger in overall dimensions and was said to develop more HP than Object M-022. [redacted] if Object "K" had more than the 14-stages of compression as in the A-022. 50X1-HUM

2. In general, the engine was longer and wider. Chief of the design section (Section "C") for the test stand and waterbrake for Object "K" was TRIEBER, but Source said that he thought the real designer was HEBER, Johannes, Dipl. Engineer.

B. Production

1. At first, in the spring of 1952 (April-May), Object "K" was only a prototype. There was not many personnel assigned to this project. About 3 months later, K2 and K3 were completely assembled and brought to the test stands for running components and blade checks. This was in the same general manner as the A-022. Then in December 1952 the first "K" was fired up and run. This was with much difficulty as it was a cold winter (as low as -50° C) and the waterbrake stand froze up twice, delaying the testing. (In the opinion of the reporting officer, -50° C is extremely low temperature to be running tests and working men outdoors. It is, therefore, believed that the -50° C [redacted] was a random guess and could easily have been closer to -30° C or -40° C). 50X1-HUM

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2. The number of personnel working on this project had increased substantially by fall of 1952, but the engine had not still been put into production. [redacted] six or seven engines had been test run. The project as a whole was showing success and Object A-022 was being shelved more and more in favor of the Object "K". In July [redacted] they were starting [redacted] experimental series produce Object "K" at Zavod II. [redacted] they are now, in Jan-Feb 1954, producing about 2 or 3 a month with a steady gradual increase. Production of course, will be affected by Object "D" which will be covered later in this report. 50X1-HUM

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C. Construction

Type...................... Turboprop engine with 14-stage axial flow compressor, with single annular combustion chamber and a 5-stage turbine.

Compressor............... 14-stage axial flow similar to the A-022 in construction. This consisted of two welded steel plates comprising the two half sections. Steel stators were attached to the outer casing by the use of a steel (square "U") shaped ring. This was at both ends of the stators making up an inner and outer ring. The stator blades were welded alternately to each ring. (See Sketch No. 10). One blade to the

Compressor...... (Cont'd) outer, and one blade to the inner ring. The end that was not welded fit into shaped guide slots made into each ring. The two halves of the compressor are held together by a welded "L" attachment and using a 3mm aluminum spacer. The two "L" attachments are bolted together. (See Sketch No. 10). Where the two halves are joined, and at the point of the channel attachment, both ends of the stator blades are welded to each "U" ring. At each end of the "U" ring also two lock pins are attached. These lock pins pass through the casing and serve two purposes:

1. To prevent rotating of the "U" ring and thus the stator blades within the compressor.

2. To serve as an additional support for clamping the two sections together by the "L" channels.

The stator blades are completely milled from solid stock as was done in the fabrication of the A-022. The rotor blades are press forged and machined to a highly polished finish. They were copper plated at the base and were pressed into a machined "inverted T" slot retainer in the compressor drive-shaft rotor disc. This is similar to the turbine with the exception that it was not the X-Mas Tree designed retainer groove (See Sketch No. 10).

These compressor drive shaft rotor discs are machined so that every other one has a spacer ring integral with disc and with a cross-sectional "L" flange at one end to act as a spacer and utilizing the "L" flange to allow for bolt holes. (See both Sketch No. 10 and Dwg. No. 1). The compressor drive-shaft rotor disc not having the spacer ring was wedged to the rotor shaft at the last stage. The disc with the "L" flanged space ring was bolted by the flange end of the spacer ring to the disc that is wedged to the shaft itself. In this manner the spacing for the stator blades was maintained.

Compressor Air Vents...... There were four rows, of four each, compressor vents built into the compressor section similar to the A-022. These were arranged in two rows on top and to the bottom and each row being about 45° to the X and Y axis. (See both Sketch No. 7 and Dwg. No. 1). These were oval in shape and operated hydraulically. At first these were operated by remote hydraulic control from the control room to determine how many needed in design, and how wide and at what RPM's to open them. The operating oil pressure came from the oil system at 3 to 4 atü. This controlling pressure operates a valve within the booster pump which in turn supplies pressure (12 to 15 atü's) enough to overcome spring tension. Thus, operating the valves. The booster pump has two sets of pump pressure gears: (See Sketch No. 7).

1. A high pressure low capacity (12-15 atü) pump
2. A low pressure pump (3-4 atü).

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The low pressure pump had a spring controlled valve allowing pressure at 6500 RPM's to bleed by which in turn opens a valve to the high pressure pump. As this valve is opened, the pressure is bled off from the high pressure pump. Thus allowing the return springs to close the valves. Following is a listing of valve operation comensurate to RPM's.

Engine Speed	Valve Action
1. Stopped	Closed
2. Starting (at 200 RPM's)	Opening Action
3. Idling (3500 RPM's)	Open
4. 6500 RPM's and above	Closed
5. Below 6500-retarding at 6450	Open

The first stage of stator blades (or inlet guide vanes) was adjustable. These blades were movable to different pre-set positions. The intake housing was of a cast aluminum alloy. A small change in design was incorporated after the third completed engine. [redacted] 50X1-HUM

Combustion Chamber........ Singular annular combustion chamber with 12 partially separated sections. Straight through flow with turbulence guide fins at about the midway point downstream. It was of stainless steel construction and had 12 fuel spray nozzles having "T" connections and two fuel lines running from a single ring manifold. The two separate jets were the "Nene" type jet nozzles which were used only for starting had a separate fuel manifold. The other 12 were Soviet designed and were used for running. There were no guide vanes between the last stage of compression and the combustion chamber.

Turbine........ 5-stage axial flow of fabricated stainless steel and carbon type spacer seal shroud ring similar in construction to A-022.

Exhaust Nozzle........ Fixed area type with steel outer casing and fixed inner core.

Propeller..... Gear reduction housing was of cast aluminum alloy. (Note: [redacted] no evidence of forgings anywhere on A-022 or Object "K". Gear housing was similar but larger than the A-022. The early propellers were the ones used on the later "M". (6.8 meters dia.) Propeller RPM's about 1000.) 50X1-HUM

There were 4 or 5 different types of propeller blades used but the second most significant type had square tips, was wider, and with a slimmer chord profile. This propeller was painted a dark green with a yellow stripe about 2/3 toward the tip. This propeller arrived with an OTK stamp of inspection and appeared to have been series produced.

[redacted]

Propeller (Cont'd)........ Dimensions are estimated as follows:

1. Width............... 380mm
2. Diameter............. 6.8 meters
3. Type................ 8-blade contra-rotating solid aluminum with screw in type retainer in hub and individual pistons for each blade.

The first props had thermal units installed with the collector ring at the tips. These propellers were believed to have been delivered from MOSCOW and had Soviet specifications and instructions with them. [redacted] designer LEUTHOLD might have worked on it. [redacted] a newer type propeller was coming for this powerplant but never saw it. 50X1-HUM

Starting System......... The old TS-1 starter that was eventually used on this powerplant was known as Object "C". This system was only used on the propeller installation stand. It was first believed that this would be insufficient for starts on Object "K" and 600 PS would be needed. It was decided that a torque moment test was necessary to find exact requirements.

An electric pendulum type motor was coupled to the powerplant and the resistance to starting was measured (torque required). In these tests it was discovered that the early theory of the inability of the new TS-1 requirements for starting Object "K" was in error. (Later computations showed that only 200 PS was needed and a design was started for a 200 PS type TS-1. Designation unknown). The torque resistance moments scale as measured by the pendulum motor fell within the limits of the new TS-1 design. They then tried the old TS-1 for experiments while they were working on the new TS-1 design and found it worked anyway. The old TS-1 developed 65 PS.

The first starts for the TS-1 on the "K" powerplant surprised the test stand engineers and it later became the standard accessory. [redacted] they were running endurance start tests on the TS-1 for Object "K". 50X1-HUM

Center of Gravity........ ROW (P) was located near the burner inlets behind the last stage of compression. This is where the main hook for hoisting the engine was located. At first they lifted the engine by rope tied around gear housing and the turbine section. But later these points were used only as a help in balance. The main hook supported over 80% of the complete load. The overhead crane designed to swing the engine had a load limit of 3000 kg.

Oil System...... Dry sump type with separated tank and cooling. One large scavenger pump with drain lines leading to drain pans under each bearing spray nozzle. The oil lines for the pressure part of the system was about 2mm larger in diameter than those used on Object A-022.

1. Pump pressure....(5 atü)
2. Pump capacity....2680/kg/hr/ max at 8250 RPM's

Fuel System .... Single manifold with double lines leading into an "inverted T" inlet to spray nozzle. There was an auxiliary manifold with single line inlets to "Nene" type spray nozzles for starting. This utilized a separate pump and fuel for starts.

Fuel used was kerosene but starts were with gasoline. With Object "K" various mixtures were tried using various amounts of gasoline added but nothing was concluded when Source left.

Fuel consumption checks were better than that of the "M" project. However, since "K" had not been run to full power, exact scales could not be set up and comparisons with "M" could not be concluded. Fuel consumption was said to be 215 gr/PS/hr.

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D. Dimensions and Specifications

Diameter........ About 150-200mm larger than A-022 (Est. 1100 to 1150mm)

Length.......... About 5000 to 5200mm (about 500mm longer than A-022)

Dry Weight
w/o Propeller... 2400-2800 kg (about 1.6 or 1.7 of the A-022 or about 400 kgs less than twice)

Frontal Area.... Unknown

Oil
Consumption..... More than that of the A-022

Fuel Grade...... Kerosene (gasoline for starting)

Fuel
Consumption.....2680 kg/hr at 8250 RPM's
2570 kg/hr at 8000 RPM's
2450 kg/hr at 7850 RPM's

RPM's.......... Maximum 8250)
Rated 8000) (All RPM's ± 50 tolerance)
Cruise 7850)

Rating........ 8000-9000 P.S. at 8250 RPM with spec. fuel consumption 250 grams/hr/P.S.

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(Note: This was the starting figure achieved [redacted] at Zavod II and no curve charts had been accomplished. These figures were bettered at a later time).

Residual thrust, static..... 500-550 kgs (100-150 kgs more than A-022)

Fuel Pressure. 80 atü.

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(Note: [redacted] at Zavod II Object "K" had been run only to 8000-9000 P.S. It was said, however, engine could develop 13,000 P.S.)

E. Test Stands

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1. [redacted] the construction of the new single wheel waterbrake (See Dwg. No. 4) stand that was designed to absorb 12,000 to 14,000 PS. The 50-hour and 100-hour endurance tests had been completed on one engine [redacted] Up to 10,000 PS had been achieved in these tests, but the full power run had not been accomplished as of July 1953.

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2. Stands #3 and #4 were converted to testing the "K". In summer 1953, the first one of the newer test stands was completed. In July 1953 six Object "K" engines had been tested and there were others still being run on the test stands. Some of the German engineers were still working there in November 1953. [redacted] the Soviets could take over from there. [redacted] Object "K" would be the main project at Zavod II for the immediate future. Object M-022 was being put aside in favor of some special "K" tests.

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3. In April and May 1953 the "K" was endurance tested to 25 hours with propeller and full load. This was run to 5500 RPM. [redacted] all current planning was being worked around Object "K" including the newer waterbrake stands. Four propeller test stands were completed in July 1953. Work was progressing at the <u>highest possible speed</u> to bring this engine development up to the <u>Official State Tests</u> and <u>Flight Testing</u> standards.

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[redacted]

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XII. OBJECT "D"

1. [redacted] Object "D". [redacted] testing was being accomplished and no "D" engines had been "fired up" for runs. The main testing was on the compressor test stand and each compression stage was being tested individually as all previous type engines had been. The compressor tests were manned entirely by the Soviets and [redacted] the blade tips had been run through the speed of sound. The Soviet personnel and management here was not so unique, however, they were doing this throughout Zavod II. The Germans here didn't desire to work on the projects as this might impair their chances for an early return to their homeland. 50X1-HUM

2. [redacted] one "D" powerplant assembled and that it looked like the Object "K". But the compressor guide vanes and blades were of a different design and [redacted] this was called a "high altitude engine". The intake guide vanes had a slightly different angle and slightly larger diameter. About 80% to 85% of the engine troubles during tests on both the "K" and the "D" were in the compressor section and were mostly due to the graphite seal rings. 50X1-HUM 50X1-HUM

3. Some of the people who were supposed to have worked on and accomplished some of the calculating on blade design were: DEINHARDT, Dr. SCHROEDER, SCHUELER, and SABLINSKY. The inlet guide vanes were mechanically movable at this phase of testing and were used mostly during starting tests.

[redacted]

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[redacted] 50X1-HUM

XIII. MISCELLANEOUS

A. Standardizing

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1. The hose connections of the 003C production series [redacted] were of American design with measurements in the English inches system. Later on the A-022 they were of American design similar to the 003C but were in millimeter measurements. These had [redacted] 50X1 BRIGGS CONICAL type of threads.

Sketch: 

2. Before 1951 to 1952 the size and type standards were a design mixture of:

   a. American
   b. German
   c. Russian

   Then in early 1952 they started standardizing. Connections to the fuel manifold were of American ring clamp type. Threads to the propeller feathering pump were of American design. This was true with the fuel and hydraulic pump also. The air compressor was of American design.

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[redacted]

4. About the beginning of 1952 they started using NORM sheets. This was part of an overall Quality Control System. Also, in 1952 a second scrapping of old engines took place. This was also for the recovery of metals. (See Object "012", General, Para 1). [redacted] NORM sheets here were American instruction sheets simply translated into Russian.

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B. By-Products

50X1-HUM

1. [redacted] sugar tongs [redacted] 50X1-HUM [redacted] had been manufactured at Zavod II and had been made from scrap metal. They had been packed at the plant for shipment [redacted] They had had their nickel plating at the 50X1-HUM plant also. Five or six men at the plant had been working steady on this project. The Soviets told them that every plant had to produce something from scrap for the civilian economy. This type of production was planned from the Ministries, but at the same time, it was earning extra revenue for the plant.

2. Another by-product was a gasoline measuring device that was in the shape of a pistol and was used in conjunction as a refueling nozzle. (See Sketch No. 2). This was connected to about a 60-70mm hose. This was

used as a quick fueling nozzle. This was being manufactured in 1950 and through 1952. It was made of cast aluminum. It measured fuel flow against time (M/S), and read fuel flow in ltrs/hr.

C. Test Stand

1. Mercury manometers were also a large problem. Tubes were frequently breaking with a result of mercury fumes spreading throughout the test rooms. Workers were becoming effected with mercury poisoning. When the medical inspectors visited Zavod II they condemned this area (Test Stands 1, 2, 3 and 4). This caused the newer stands to be built quicker. The old stands were shut down for a short period during this condemning cycle.

2. Once there were some tailpipe extensions brought into Zavod II. These were designed for aircraft installation and were manufactured by an airframe company. See Sketch No. 9. It was made of metal with an asbestos inner lining sandwiched between two sheets of steel and was 4.5 to 5 meters in length. It was round at the engine attachment point and oval at the end with the Y axis having the greatest distance. The thickness of the two sheets of steel was:

a. Outer surface.......... .8 mm
b. Inner surface.......... 1.5 mm

These were supported by a "hat channel" stringer spot-welded to the inner and outer sheets. These stringers were evenly spaced around the circumference. On the outside of the outer sheet there were metal bands held together by [redacted] "Zuse" fasteners. These were strength supports also. Engine tests with the A-022 were run with these exhaust funnels to check influences on exhaust duct losses to engine output and fuel consumption as to kg/PS/hrs. [redacted] figures using $Ca = 0.77(1 + .0524 \frac{Wa Vp}{Fn})$ where:

a. Wa = airflow in kg/sec
b. Vp = airspeed in kilometers
c. Fn = net thrust in kgs.

This being used as estimating thrust correction. [redacted] the effect of this exhaust ducting was negligible as test readings showed, and [redacted] no calculations were attempted.

D. Fuel Valve and Air Compressor

1. There was an electrically operated shut-off valve (See Sketch 1) installed in the fuel system for the "M" tests. This valve was between the tanks and the fuel pumps. This was a Soviet manufactured item and was not made at Zavod II.

2. When the engines were shut down, the gas still leaked through the valve and would fill the lines to the fuel spray nozzles. This would eventually create a normal gravity pressure of about 1.5 atmospheres. And, since the fuel spray nozzles to each burner were set at .8 atü's the fuel would leak out of the lower 1/3 burner spray nozzles causing a

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[redacted]

fire hazard upon starting. After setting overnight, each day when an engine was to be started it was necessary to drain all the lower burner sections.

3. There were about 100 of these fuel valves stocked at Zavod II. They changed them almost every day. After they were operated a few times and the metal parts and seals seated they began to leak. [redacted] [redacted] there were thousands of these produced but at Zavod II it created an operational problem. The OTK personnel seemed very excited about these, and they were later discarded in favor of a manual valve locally manufactured.

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4. The air compressor for the "M" was known as the AK-75.

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[redacted]

E. Testing Large Engines

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1. [redacted] [redacted] engines being test run at BESIMIANKA, which was about 15-18 km away. The vibration shook the house and rattled the windows. [redacted] the sounds were a deep rumble. [redacted] jet engines and their various sounds [redacted] engines being run were of a much larger type.

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2. [redacted]

[redacted]

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[redacted]

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AIR INTELLIGENCE INFORMATION REPORT

Nw = shaft output in hp

Nwo = shaft output in hp during normal day

Nw = 760/Pa $\sqrt{288/273 \pm ta}$

N equiv = Equivalent output in hp (Note: shaft hp)

N $equiv_o$ = Equivalent output, converted to normal day.

S = Thrust in kg = S 0.91 = thrust in hp

N $equiv_o$ = Nww + So 0.91 = hp

So = kg 760/Pa 0.91 = hp

0.91 = a constant, for conversion of thrust into equiv shaft hp

Pa = barometric pressure on day of experiment

ta = temperature on day of experiment (ambient temp)

Md = torque, in m/kg

n = RPM

n_t = RPM turbine

$N_{t\ corr}$ = corrected turbine RPM

n_o = RPM converted for normal day

$n_o = n_t \sqrt{288/273 \pm ta}$

Hz = frequency of 220 volt emf

B = fuel consumption in kg/h

B_o = fuel consumption in kg/h on normal day

B_o = B760/Pa $\sqrt{288/273\ ta}$

b = specific consumption = gr/hp/h = B/N (equiv) = b

$b_o = B_o/N(equiv_o)$

B = number of liters times 3600 multiplied by γ divided by time in seconds

γ = specific weight of fuel

b = liters x 3600/stopping time x n equiv = gr/hp/h

Note: Fractions indicated as n/x rather than $\frac{n}{x}$

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(At times some experiments with jets of 1.6 l/min)

Flow through of inspection nozzles: = 1.8 l/m at 28 atm

Calculating the constant:

$$1.8(12(60\gamma)) = \sim 1070 \text{ kg/hr}$$

Determination of fuel injection pressure: (PK)

$$PK = \left(\frac{B\,gem}{1070}\right)^2 (23 + P_2) = PK \text{ in atm.}$$

Proof:

Bgem = 1416 kg

$$\left(\frac{1415}{1070}\right)^2 (23 + P_2) = PK = 40.00 + 4.00 = 44.00 \text{ atm.}$$

γ = s.g. of fuel (kerosene)

PK = Fuel injection pressure, ahead of nozzle in atm.

P_2 = Pressure, after compressor

Bgem = Fuel consumption rate in kg/hr

Air Flow Through

GL = weight of air in kg

L = Nozzle factor (constant)

F = Area of entry orifice (constant)

$$GL = LF_o \gamma^u \sqrt{2 g \; qu}$$

$$\Delta p = Po \text{ static} - P1 \text{ static} = g^U$$

Explanation of Symbols

PS = HP = 75 m/kg/sec

qu = measured ahead of compressor with "U" column (kerosene)

P1 = ahead of the 1st stator ring

P2 = pressure after the compressor

P4 = pressure ahead of turbine

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Spec. g. of kerosene in experimental plant #2: 0.821 - 0826

P_6 = pressure in tailpipe behind turbine

P_7 = pressure at the end of tailpipe

P_T = pressure in the turbine tunnel

P_L = pressure in relief labyrinth

P_{OEL} = lubricating oil pressure

P_{RUECK} = by-pass oil pressure

P_{VAKUM} = oil vacuum on oil pump

$P_{vorlauf}$ = kerosene tank pressure

$PK_{VORPUMPE}$ = kerosene pressure ahead of pump

PK = fuel (kerosene) pressure ahead of nozzles

P_{ANLASS} = pressure ahead of Nene jets

t_a = outside air temperature

t_2 = air temperature after compressor

t_4 = gas temperature ahead of turbine

t_6 = gas temperature after turbine

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DWG #1

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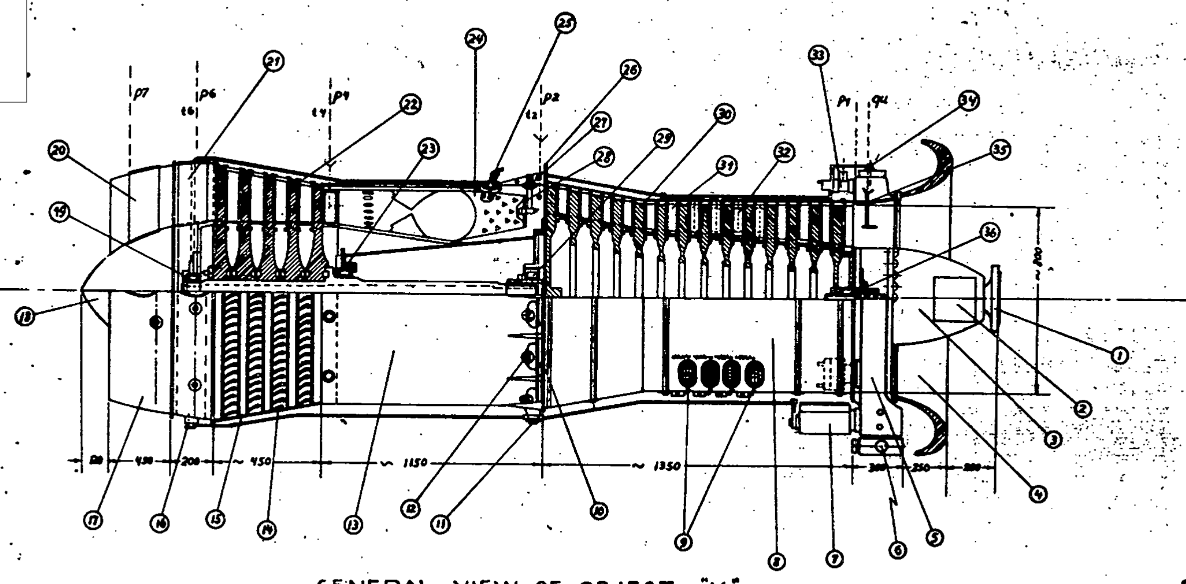

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GENERAL VIEW OF OBJECT "K"

50X1-HUM

INCL #3

DESCRIPTION OF GENERAL VIEW OF POWERPLANT "K"

1. Flange for the Drive Shaft to the Water Brake
2. Mounting surface for Propeller Regulator
3. Gears
4. Intake Ring made of aluminum alloy
5. Intake Housing with gearing for the accessories (Pumps, KTA Regulator, Air Compressor AK75, Generators, RPM Indicators, etc.)
6. Main Oil Pump (2 stages, fresh oil and oil return).
7. RPM Regulator (only for use with the Water Brake, otherwise the KTA Regulator is used)
8. Compressor Housing (2 parts, steel welded together)
9. Hydraulically (oil) controlled lower Blow-Off Valves (8)
10. 2-Piece Ring Piping for the fuel
11. Return oil connection (oil from the last compressor bearing and the middle turbine bearing)
12. Main Injection Nozzles (each with two connections)
13. Combustion Chamber Housing (steel)
14. Turbine Guide Vane Rings
15. Turbine U-Ring Inserts
16. Oil Return Connection from the last turbine step bearing
17. Thrust Nozzle (Schubduese) with measuring points for P6, P7, T6 and Flow Thermo Element T6.
18. Thrust Nozzle Cone (fixed)
19. Step Bearing behind Turbine
20. Support Ribs
21. Support Ribs for intermediate parts with oil ducting for Step Bearing
22. Turbine Rotors
23. Turbine Bearing
24. Circular Combustion Chamber with mixing fins and mixing borings
25. Nene Starting Aggregate (Spark Plug and Starting Nozzle)
26. Flange on Turbine Housing
27. Main Nozzles (12)
28. Whirl Rosette (Drallrosette or Wirbelrosette)
29. Last Compressor Bearing and foremost Turbine Bearing
30. Compressor Rotors
31. Compressor Guide Vanes
32. Upper Blow-Off Valves (8)
33. RPM Transmitter (Drehzahlgeber)
34. Oil Distributor
35. Intake Housing with borings for the Prandtl Tube (Qu.)
36. Foremost Compressor Bearing

LEGEND TO INCL. #3

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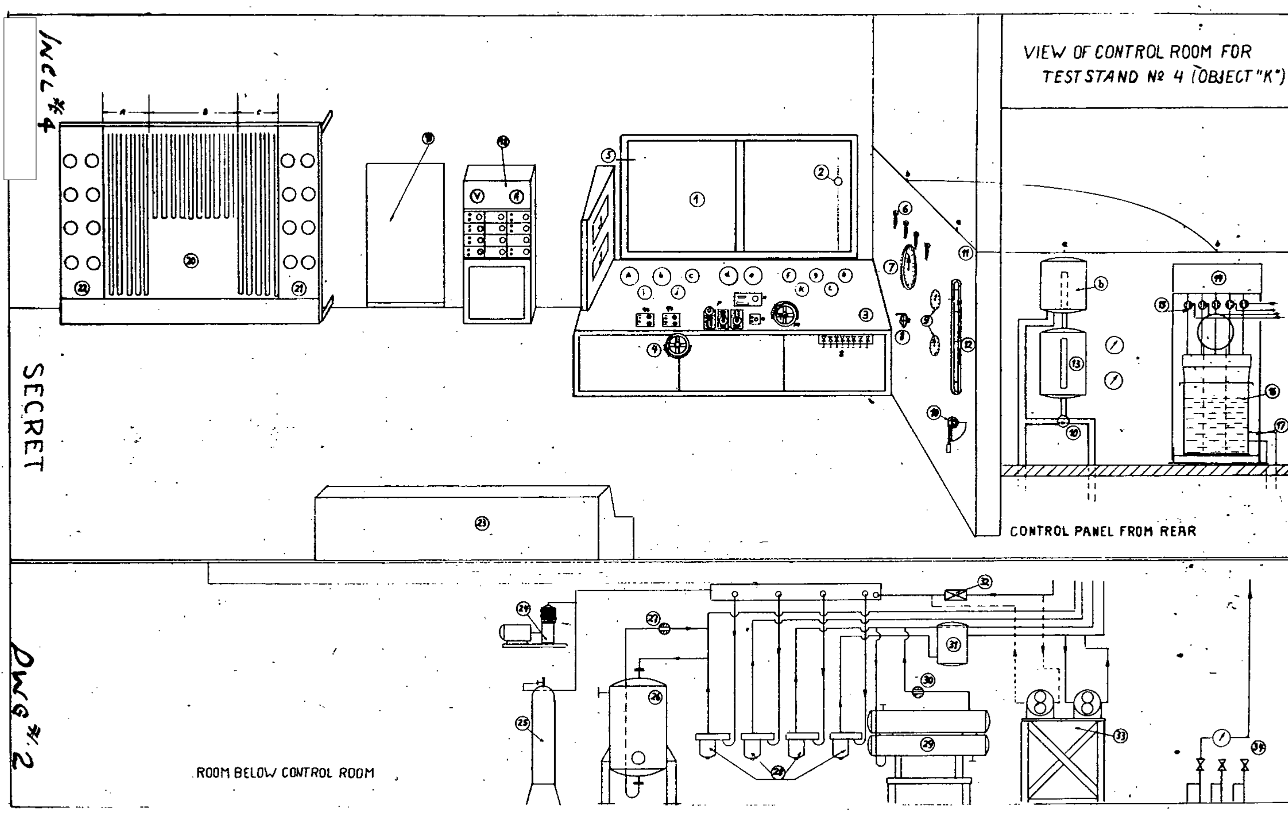

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[redacted]

LEGEND FOR CONTROL ROOM DRAWING

1. Test stand windows, double thickness safety glass, about 2.5 cm thick

2. Indicator gauge for the contents of the waterbrake tank

3. Measuring bench with manometers (dial indicators), servicing levers, switches, tachometers, etc.

   a. Indicator for thrust in atue. (atmospheres-excess-absolute)
   b. Indicator for torque (Md-Movement of turning)
   c. Indicator for water supply level
   d. Fuel pressure before the nozzles, PK
   e. Fuel pressure behind the pump
   f. Main oil pressure P_{oil} in Atue
   g. Return oil pressure in Atue
   h. Kerosene tank pressure (supply) in Atue
   i.) [redacted]

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   k. Kerosene pressure before the pump in Atue
   l. Vacuum before the oil pump
   m. Positioning indicator with handwheel for the P6 measuring cylinder
   n. Tachometer with stopwatch
   o. Main switch, 24 volt
   p. Main servicing lever and main oil cock with a control light. Qu automatic electric switch with control lights for the safety petcock for kerosene
   [redacted]

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   r. Thermal indicator instruments
   s. Battery of cocks for activating the blow-off valves

4. Handwheel for loading of the waterbrake

5. Panel with thermo-elements T6 (exhaust gas temperature) and oil temperature

6. Switching valves for the oil system for the determination of the quantity of oil circulating.

7. Oil scale

8. Handwheel for the regulation of the oil cooling

9. Manometers (dial indicators) for compressed air

10. Switching cock for fuel measurement

11. Paneling

12. Viewing window for the spot checker (switchprober), type Seppler, for determining the fuel consumption

13. Spot checker type Seppler - b. overhead tank

14. Overhead oil tank

15. Oil switching cocks

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16. Main oil tank with heating

17. Main oil supply line to the powerplant

18. Electrical switchboard with servicing of the pendulum motor

19. Double door to the test channel

20. Measuring board with U-Tubes for mercury and kerosene

    a. tubes 2 meters long (P6, P7, etc.)
    b. tubes 1 meter long battery for compressor stages
    c. measuring tubes 2 and/or meters long for P_1 and Qu.

21. Manometer panel with precision measuring manometers for the compressor stages.

22. Manometer panel with precision measuring manometers for P4, P2, Pt, P1, etc.

23. Measuring board for temperatures with temperature indicators and potentiometers for measuring T2, T6, thermal flow indicators (Stromthermogeber), and bearing temperatures. Waterbrake starting temperatures were switchable.

24. Air compressor AK 75 with electric motor.

25. Compressed air bottle

26. Oil cooler 50,000 thermal units (WE)

27. Switching cock, internal diameter (NW) 60mm

28. Oil filter: Type 2522 A1

29. Double oil cooler, 20,000 thermal units (WE)

30. Switching cock, internal diameter (NW) 60 mm

31. Oil heater

32. Non-return valve for the oil feed

33. Frame for the oil feed pump and oil return pump (18,000 liters)

34. Piping for kerosene from the pumping station with meter (Ovalradzaehler)

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Incl #5

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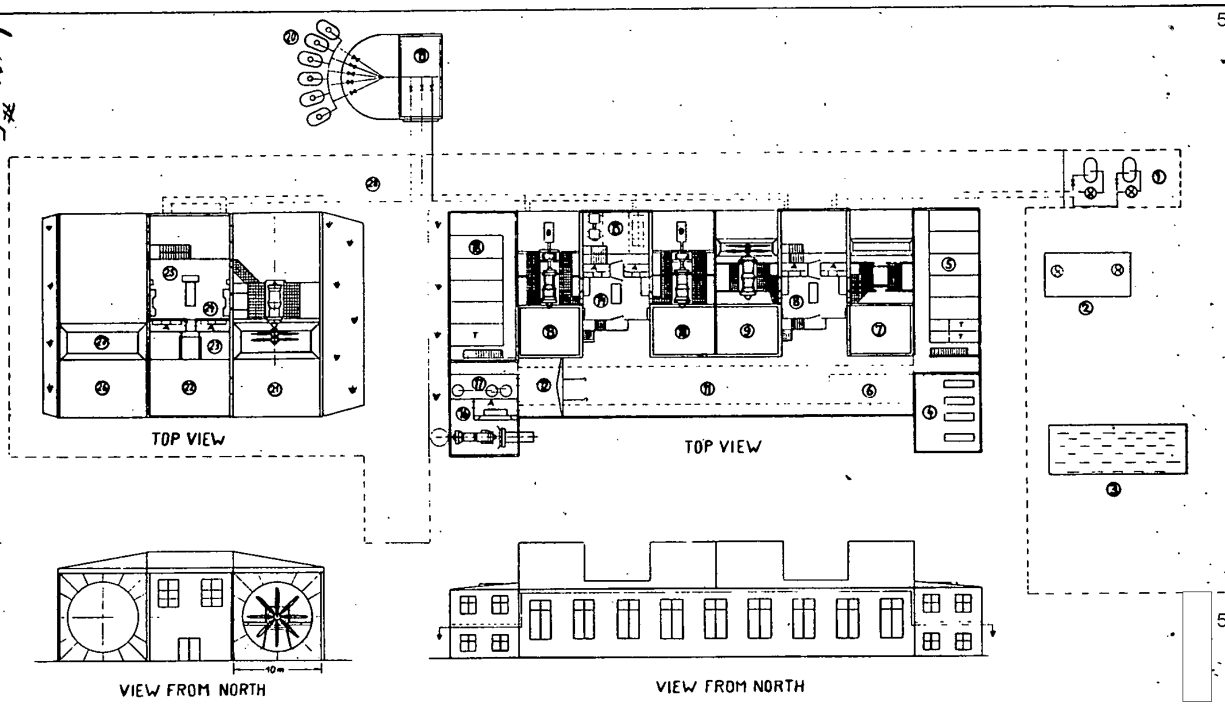

Dwg #3

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TEST STANDS 1-6 FOR OBJECTS
,M' AND ,K'

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DESCRIPTION OF TEST STAND (1-6) DRAWING

1. Filling station for kerosene, 2 containers each holding 20,000 liters. The pumps taken from Germany as reparations Type "Sihi". Tank pressure to test stands about 1.5 atmospheres (excess) absolute.

2. Pumping station for the cooling of the water from the waterbrake.

3. Cooling tank for cooling the water. Tower made of wood.

4. Machine Shop for the test stands. 4 lathes, 2 electric drills, 1 shaping machine, 2 milling machines - ground floor. Test stand chief's office - first floor.

5. Electrical shop, storerooms, and spare parts room - ground floor. Offices for test engineers and the OTK - first floor.

6. Assembly section for assembly of the propellers.

7. Test Stand #1 for propeller engine runs. Exhaust gas lead-off tower and propeller orifice in the test channel.

8. Measuring cabin for test stands 1 and 2. A = measuring rooms for measuring fuel and oil.

9. Test stand #2 for propeller test runs with Object K.

10. Test stand #3 for waterbrake with mounted Object K shown. B = electric pendulum starting motor.

11. Assembly hall.

12. Electric travelling overhead crane (DEMAG manufacture).

13. Test stand #4 for waterbrake with mounted Object K shown. B = electric pendulum starting motor.

14. Measuring cabin for test stands 3 and 4. A = measuring rooms for measuring fuel and oil.

15. Room with Ward-Leonard regulator for electric pendulum motors. Also held electric switching installation with 6 KV air-blast circuit breakers.

16. Compressor test stand with an Object A-022 as motive power. Exhaust gas tube and intake air tube. A = control room.

17. Room for oil reclaiming. Contained in oil thrower and filter apparatus.

18. Cloakroom, shower room, and a day room. Ground floor. Workshop for thermo-electric design, construction and repair for the test stand, plus a precision machine shop - first floor.

19. New kerosene tanking station with 6-50,000 liter tanks including the pumping station with the piping system. (This station was finished in the Fall of 1953).

20. Six 50,000 liter tanks for kerosene.

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21. Test Stand #5 for propeller test runs with Object "K". (Finished Fall-Winter 1952-53 - originally built for "M" and later rebuilt for "K").

22. Assembly room with a balancing frame for the propeller balancing. This room also contained an electric overhead (travelling) crane.

23. Office rooms for test stand engineers and personnel.

24. Measuring rooms for test stand #5 (Object K) with a measuring bench, electric switching bank, thermo measuring bench, bench for oscillographs, measuring panel for U-tubes (mercury and kerosene). A = measuring rooms for measuring oil and fuel consumption. Contained scales for oil and graduated containers for fuel consumption measurements.

25. The same as item 24 above but for test stand 6. These two test stand measuring rooms (points 24 and 25) are situated above a room which contains the piping and pumps for the fuel and oil systems. Also present were two oil coolers (50,000 thermal units), two for each test stand. Large air blower for the electric generators which were mounted on the engines. Hydraulic pumps, air bottles, and other such apparatus used for the various test arrangements on the engines.

26. Test stand #6 for propeller test runs with Object K. (Finished in Fall of 1953).

27. Propeller orifice.

28. Fuel lines from the tanking station to the test stands. (2 lines one way, 2 lines back). (Nominal inner diameter of the pipes = 60mm).

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WATER BRAKE FOR OBJECT „K"

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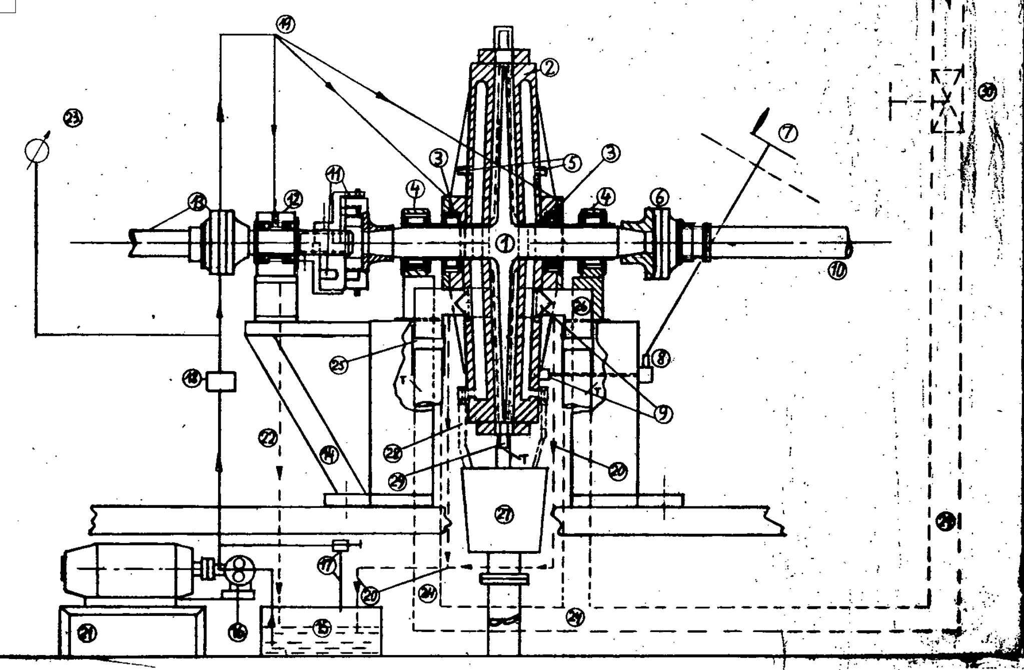

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Dwg #4

Incl #6

50X1-HUM

50X1-HUM

LEGEND OF THE ONE DISK WATER BRAKE FOR OBJECT "K"

Designed and built in State Research Plant #2, Kuibyshev. Done in Department 8 (Designer: HEBER). Power absorption 14000-15000 P.S. Three of these water brakes were built at the plant. Four of these water brakes were built in another plant (to the same design) and delivered to plant in Spring 1953.

Difficulties encountered putting the water brakes into operation

1. Regulation of water into the water brake was too difficult. In Spring 1953, therefore, the mechanical regulator was re-designed for electric operation, but with no results. In Fall 1953, the mechanical regulator was installed in the piping leading to the water brake rather than on the brake itself.

2. The power measurements with the pressure cell were not acceptable. In the course of the year 1953 many changes were carried out. In Fall 1953 the power measurements were being obtained properly.

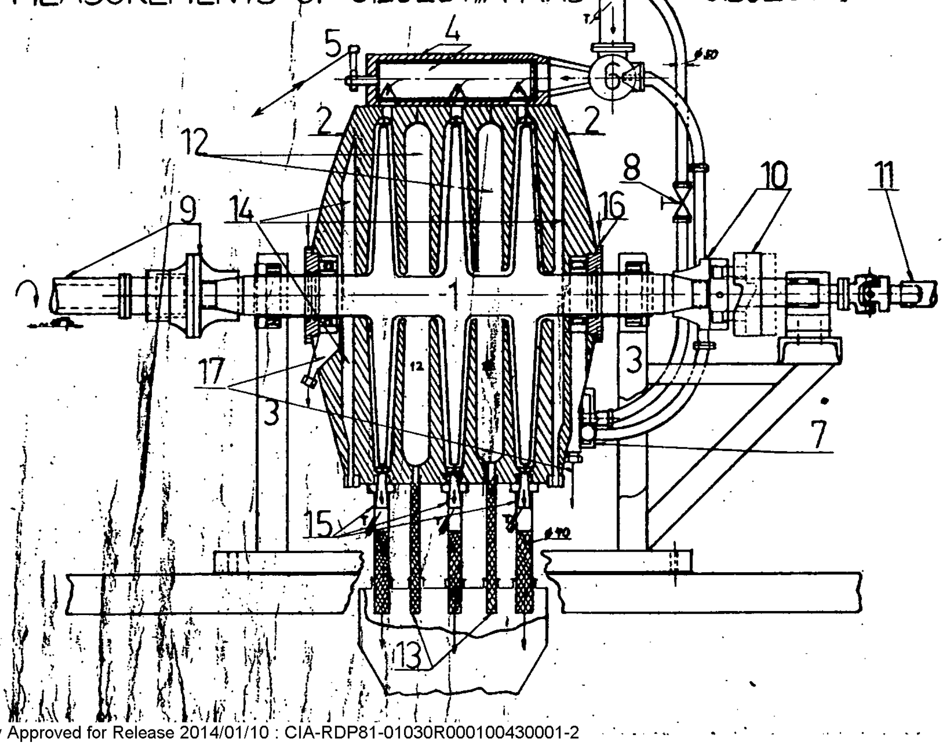
Points on Drawing

1. One disk rotor made of steel
2. Steel housing, made of three steel parts put together (bolted together)
3. Bearings (each with a ball bearing and a roller bearing)
4. Roller bearings for taking moment of rotation thru a pendulum effect
5. Ventilation holes from the ventilation and drainage chambers
6. Coupling flange for the connecting shaft to the engine
7. Mechanical adjustment of the water input regulation
8. Miter-wheel gearing for the mechanical adjustments of the water input regulation
9. Adjustment linkage and gearing for the cone
10. Drive shaft between the engine and waterbrake. This shaft is shiftable 10mm.
11. Starting clutch coupling (shown engaged in upper drawings, disengaged in lower)
12. Bearing block
13. Flange and connecting shaft between gears on the pendulum motor and waterbrake
14. Frame of the waterbrake welded out of U iron.
15. Oil container
16. Gear (-type) oil pump
17. Overflow valve with return to tank
18. Filter
19. Oil distributor with piping to the single bearing points
20. Return piping from the bearing points to the tank
21. Frame with electric motor for the oil pump
22. Return from bearing block to the tank
23. Manometer indicator for lubricating oil pressure (2.3-2.5 atmospheres absolute (excess) pressure).
24. Main water intake piping forked as it enters the waterbrake. (Pipe inner dia. 150-180mm). Temperature measuring points are located in the intake pipe immediately after it forks.
25. Connecting hose made of rubber
26. Water intake with elbow and adjustable nozzle cone
27. Discharging funnel
28. Drainage piping for oil and water
29. Exit nozzle with temperature measuring point
30. Electrically activated collar valve for water supply

Incl #7

SECRET

WATER BRAKE TYPE 70 R FOR POWER MEASUREMENTS OF OBJECT „A" AND OBJECT „M"



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Dwg #5

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AIR INTELLIGENCE INFORMATION REPORT

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LEGEND FOR OBJECT "A" AND "M" WATER BRAKE (TYPE 70R) DRAWING

1. Rotor with 3 discs
2. Cast aluminum Housing (4 pieces bolted together)
3. Water Brake Frame with roller bearing
4. Slide Valve Casing with slide valve (3 openings)
5. Lever for opening and closing the Water Brake (i.e. loading of water brake)
6. Water Intake with diffuser Blast Nozzle (Diffusor-Strahlduese)
7. Water-jet (vacuum) Pump
8. Regulator Valve (internal diameter: 50 mm)
9. Flange with driving shaft (powerplant side)
10. Flange with mechanical starting clutch (mechanische Anwerfkupplung). (pendulum motor side)
11. Cardan Shaft (Kardenwelle)
12. Exhaust Chambers
13. Exhaust Hoses
14. Drainage Chambers for excess oil and water
15. Discharge Nozzle with temperature measuring points and Drainage Hose
16. Intake for lubricating oil (3.5-4.0 atm. absolute pressure)
17. Oil Return Nipples (Oelruechlaufstutzen)

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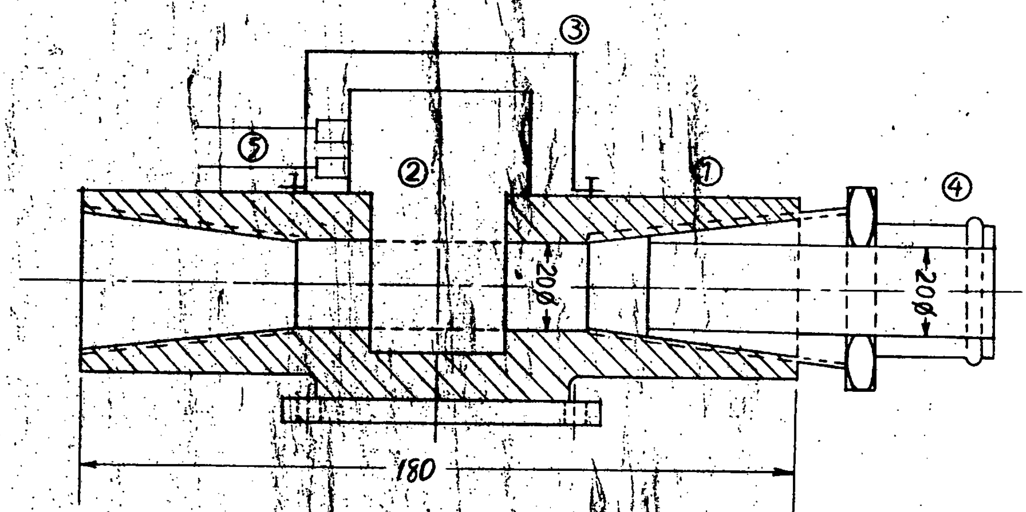

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SCHEMATIC OF 24V ELECTRIC SAFETY PETCOCK

SKETCH #1

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AIR INTELLIGENCE INFORMATION REPORT

50X1-HUM

LEGEND FOR ELECTRICAL SAFETY PETCOCK (BRANDHAHN) 24 VOLTS

1. Light metal housing.
2. Magnetic slide valve.
3. Protective casing.
4. Steel threaded nipple with conical threading (self-sealing threading) (Stahl-Einschraubstutzen mit Konus-Gewinde)

   N.B. copies from an American design (sic) Brix. (Briggs -?)
5. Connections for lead wires.

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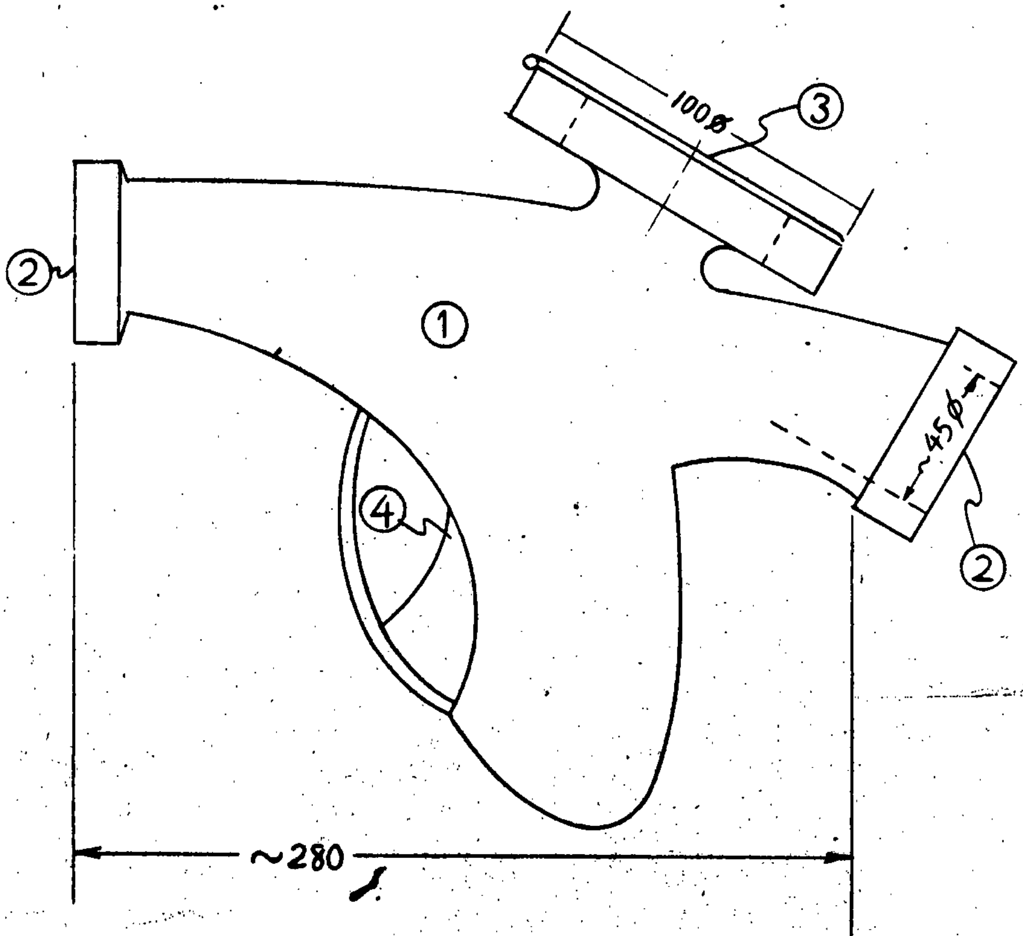

SCHEMATIC DRAWING OF PISTOL GRIP FUELING NOZZLE

INCL #9

SKETCH #2

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LEGEND FOR SCHEMATIC OF PISTOL GRIP FUELING NOZZLE

This was a by-product of the State Research Plant #2. Parts were molded and poured at the plant itself. Assembly and the final manufacture was done at a branch in ARM (about 1 km distant from the main plant on the road to Mech Zavod). This branch was a part of Shop 5 from the plant.

1. Light metal housing
2. Connecting flange with a bayonet joint (Bajonettverbindung)
3. Liter counter with cover
4. Activating lever

Sketch

50X1-HUM

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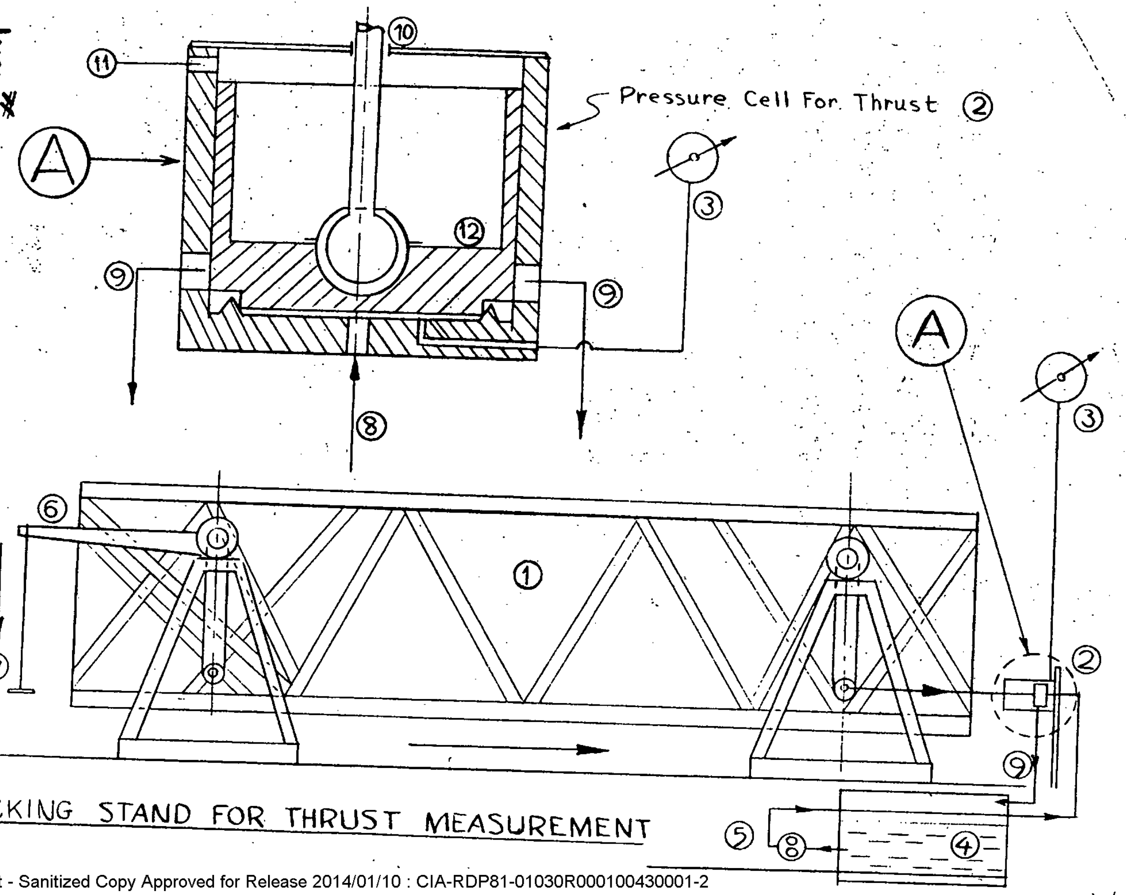
INCL #10

SECRET

SKETCH #3



ROCKING STAND FOR THRUST MEASUREMENT

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LEGEND FOR SCHEMATIC FOR THRUST MEASUREMENT

1. Frame - rocking stand
2. Pressure cell (piston/disc) hydraulic
3. Manometer indicator in atmospheres absolute (0-20) (converted to kg by a calibration curve)
4. Oil container
5. Oil pump with the pressure piping to the pressure cell (Type M Sha 3)
6. Calibration lever arm 1:2
7. Rod upon which the calibration weights are set
8. Pressure piping from the hydraulic pump to the pressure box
9. Return piping to the oil container (2 times)
10. Plunger with a sphere
11. Connection for drainage oil
12. Disc/Piston (104 cm^2)

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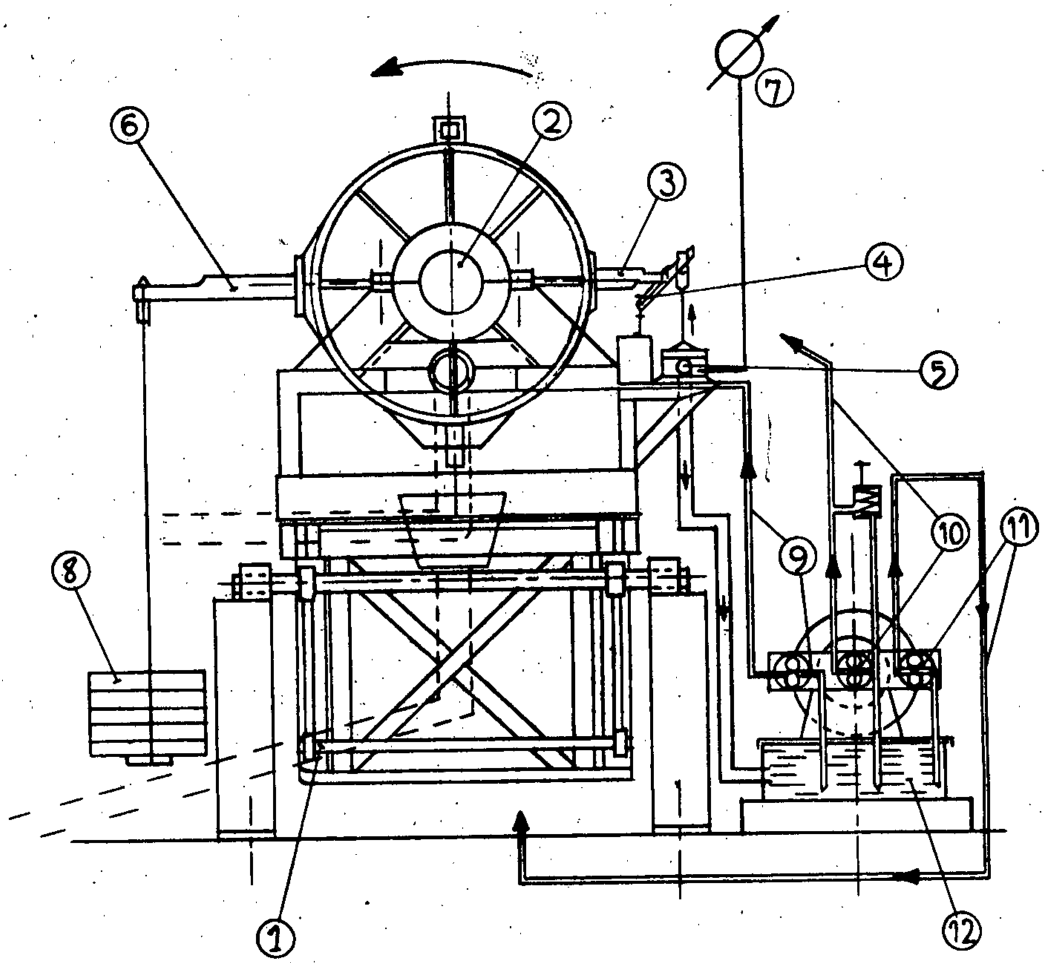

SCHEMATIC OF WATER BRAKE FOR OBJECT "K"
WITH TORQUE MEASURING SYSTEM

INCL #11

50X1-HUM

SKETCH #4

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AIR INTELLIGENCE INFORMATION REPORT

LEGEND FOR DRAWING OF WATER BRAKE FOR OBJECT "K"
with Torque Measuring System

1. Rocking frame for thrust measurement.
2. One disc water brake.
3. Lever arm to the pressure cell for torque measurement (works on tension-pulling) reduction = 1: 3.9
4. Lever reduction with prisms and a drawbar for the pressure cell.
5. Pressure cell with pressure piping, return piping and piping to the manometer.
6. Lever arm for calibrating (1210mm long).
7. Indicator manometer for torque in atms.
8. Calibration rod with attached calibration weights (25 kg).
9. Oil pump for controlling the blow-off valves.
10. Oil pump for the thrust pressure cell.
11. Oil container.

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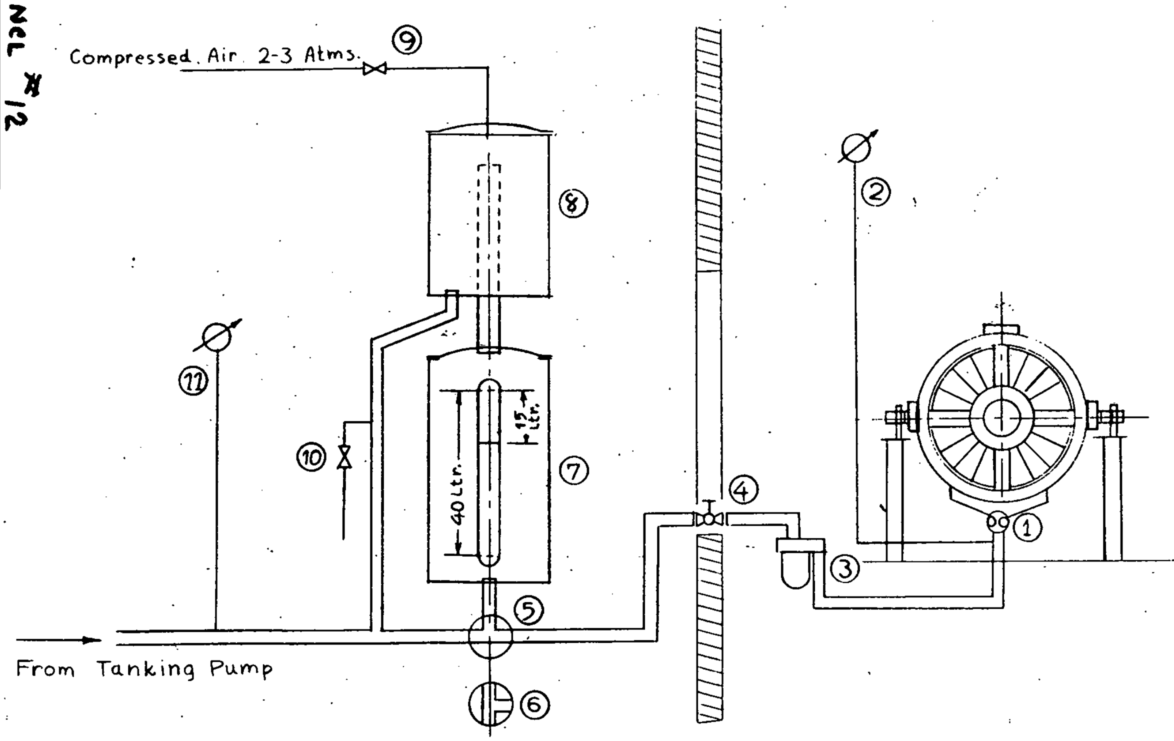
INCL #12

SECRET



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SKETCH #5

50X1-HUM

SCHEMATIC OF THE FUEL SYSTEM TEST STAND FOR OBJECT K

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LEGEND FOR SCHEMATIC OF THE FUEL SYSTEM FROM TEST STAND OBJECT "K"

1. Fuel connection on the engine before the fuel pump (pipe inner diameter 32mm)
2. Manometer indicating pressure in front of the pump (1-8 atmos)
3. Fuel filter type 2215 Al
4. Main safety petcock, electrically activated - 24 volts
5. Switching cock (three-way) Inner diameter 32mm (position on "operating")
6. Switching cock on the position "measuring".
7. Measuring container (Stichprober) with two measuring ranges. Type: Seppler (15 liters and 40 liters) (Container calibrated every month by measuring contents)
8. Overhead tank for the measuring container
9. Connection for compressed air with activating valve
10. Sampling valve (for analysis)
11. Manometer for tank pressure (1.2 - 1.4 atms.)

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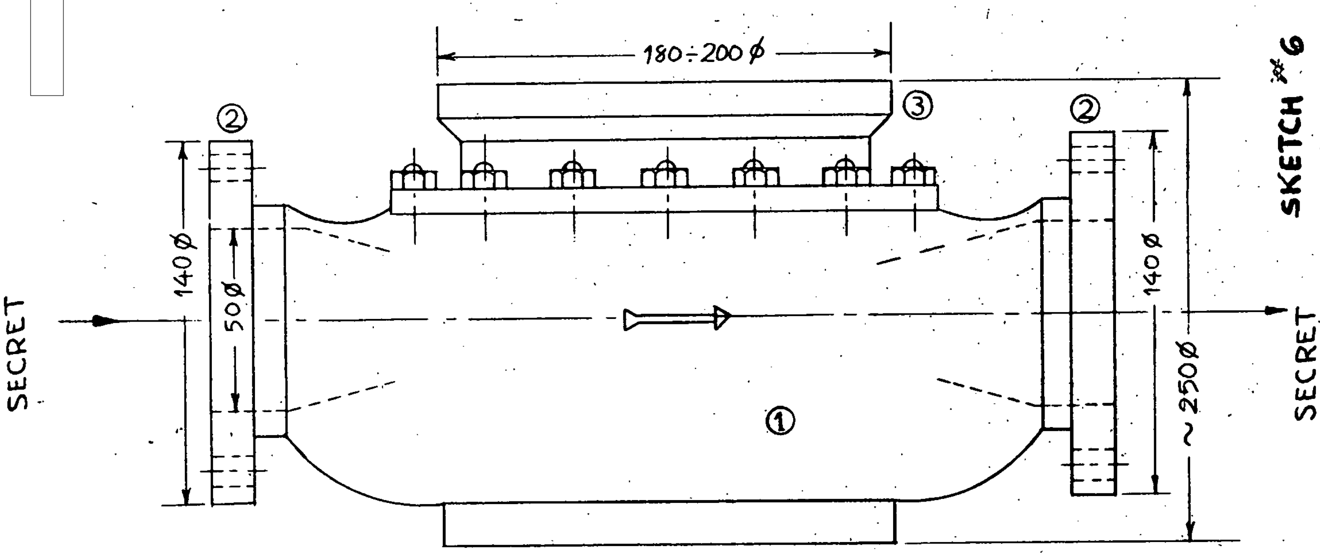

OVAL WHEEL FUEL FLOW METER

INCL #13

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AIR INTELLIGENCE INFORMATION REPORT

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LEGEND FOR THE OVAL WHEEL METER FOR KEROSENE

Produced as a by-product of the State Research Plant #2 at Kuibyshev. Assembled in the precision workshop in Arm (1 kilometer distant from Zavod 2 on the road toward Mech Zavod)

1. Light metal housing
2. Connecting flange (opening nominal 50mm)
3. Round dial with indications of the quantity of flow in liters and the counter works.

The apparentii which were delivered to the test stand were, for the most part, not exact in their indications.

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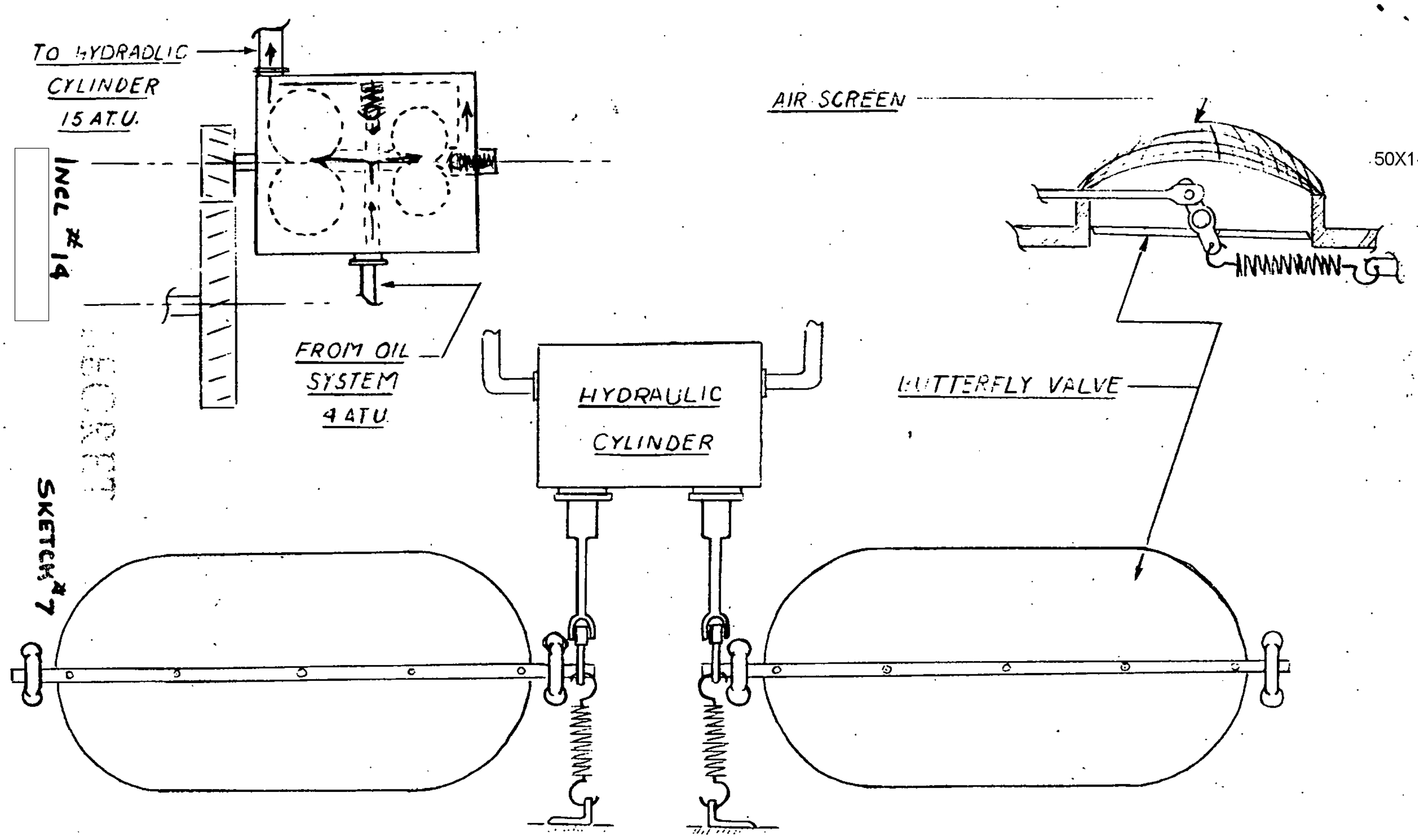
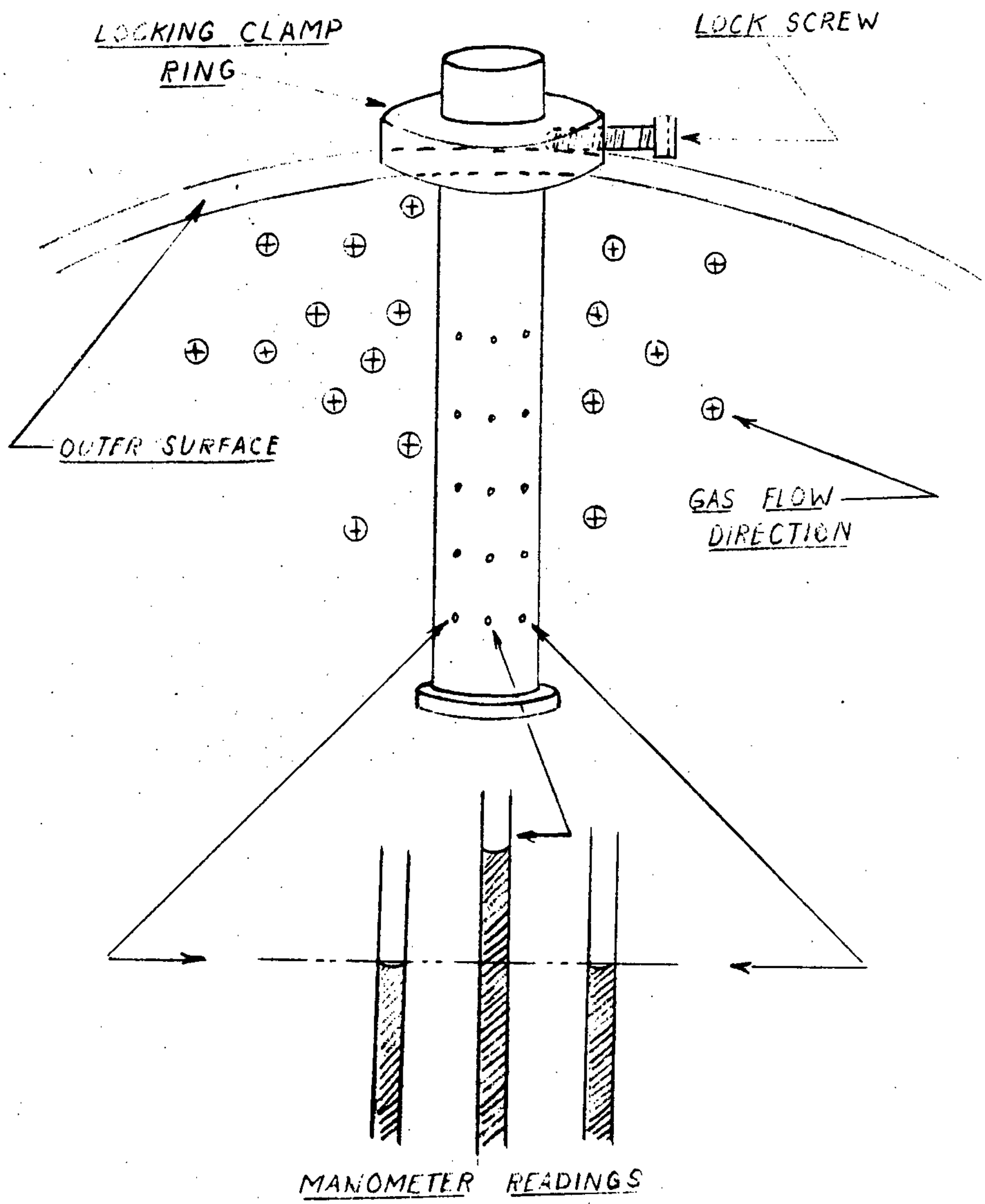


SKETCH #7



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SKETCH #8

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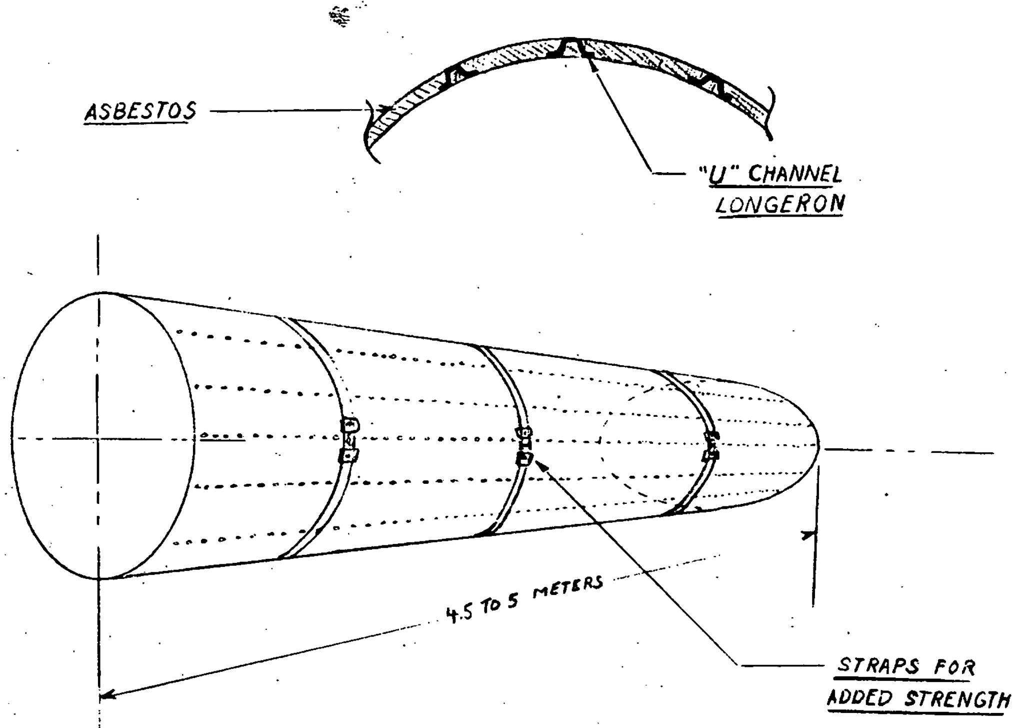
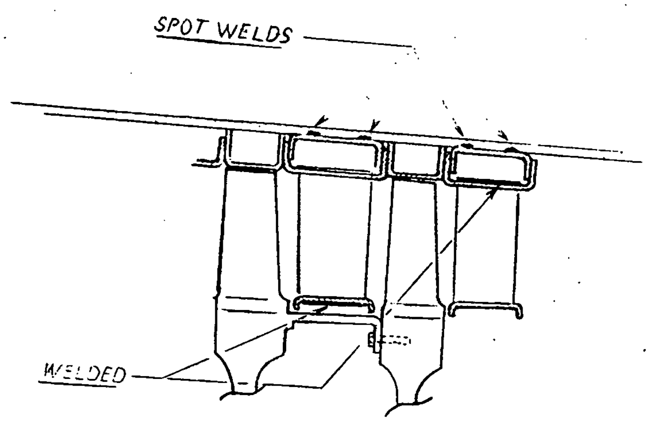
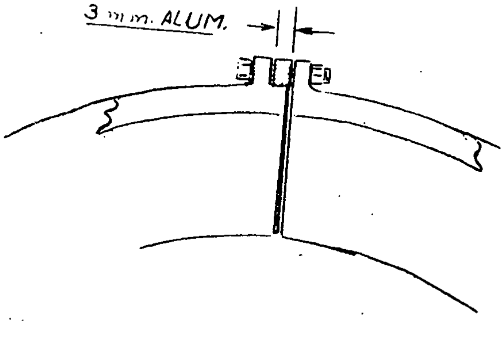
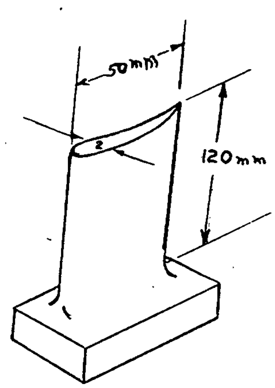
SKETCH #9









INCL # 17

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