CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

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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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INTRODUCTION

1. Toward the beginning of February 1950, the German engineers at Ostashkov had completed work on the supplementary phases of Project R-14 [redacted]. In the period following immediately upon the submission of these reports to the Soviets, the various sections on Gorodomlya Island seemed to have occupied themselves with unrelated and individual tasks, such as the compilation and sorting of reference data and computations which had been obtained in the course of their work on the R-10 [redacted] Only the radio section which had been unaffected by Project R-14 continued with its experimental work.

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2. During September 1950, a requirement was received by the German group on the Island for the design of an antiaircraft missile with a cutoff date of 1 April 1951. After several preliminary drafts were made, the project received the code number "113" and, according to standard procedure, was prefixed by a letter [redacted] "R". /For convenience throughout this report, the project will be assumed as the R-113 project and referred to as such./

3. The requirement received called for a surface-to-air missile based on the principles of the German World War II Wasserfall. It was to have an effective conic area between the angles of elevation of 30° and 90° and an effective range from five kilometers to 30 kilometers in altitude. For the first five kilometers the missile would be ineffective because of lack of speed and control during initial acceleration.

4. In previous assignments the Soviets had extended to the German engineers complete freedom in pursuing the design studies. Once the specifications had been outlined by the Soviets, the Germans were permitted to explore numerous avenues and ultimately select the one design considered most suitable towards satisfying the given requirements. However, in the R-113 project, the Soviets deviated from this practice and strictly circumscribed the work of the German specialists. Thus, it was specified that the R-113 missile was to be based on the principles of the German World War II Wasserfall. Further, the motor of the Wasserfall was to be utilized in the new design without any changes, although, as will be seen later, the German design actually utilized a slightly higher thrust rating. In addition, initial German deliberations in the use of a gimballed motor, similar to the one designed for the R-14, were countermanded quickly by the Soviets, who insisted on the use of an inflexible motor.

5. At the time that the new assignment was issued, the Soviets placed at the disposal of the German engineers drawings and reference data of the Wasserfall. This information did not constitute the original German computations but rather reconstructions that had been prepared in 1945 and 1946 by Germans in Berlin under Soviet direction. [redacted]

6. [redacted] As in the

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earlier major projects, the main burden of the work was carried on by the small core of German specialists representing the creative and theoretically versed element on the Island.

7. The information that follows represents [redacted] the final design of the R-113 missile as submitted to the Soviets. As in the case of the R-10 and R-14 projects, this also was entirely a "paper project" with the final product being a report consisting of drawings and computations. Ultimate dispostion of this report is not known [redacted]

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TABULATION OF THE PHYSICAL CHARACTERISTICS OF THE R-113 MISSILE

8. The following is a tabulation of the significant physical characteristics of the R-113 missile [redacted]

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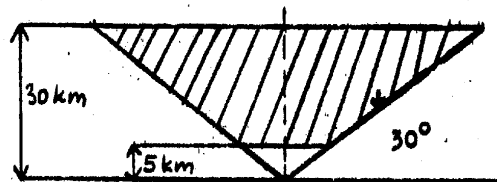
9. Action radius - see sketch.



Remote control was by means of radio. Thrust was to be regulated so as to maintain a constant dynamic air pressure.

10. Dimensions - see sketches, pages 17-28.

11. Thrust - maximum thrust = 8,500 kg. After a given flying period, the thrust was to gradually decrease to approximately 3,000 kg.

12. The weight distribution was as follows:

Warhead (without explosives)	40 kg.
Gas sphere and pressure reducing valve	100 kg.
Containers with panel and foil joints	320 kg.
Tail with formers	40 kg.
Airfoil	65 kg.
Controls, rudder and rudder ring	75 kg.
Motor, thrust frame and lines	200 kg.
Rudder machines and pressure gas ring	40 kg.
Controls	100 kg.
Weight empty	980 kg.
Explosives	500 kg.
Explosives and weight empty	1,480 kg.
Pressure gas (N_2) in sphere	65 kg.
Pressure gas (N_2) in gas ring	9 kg.
Tonka (γ approximately 0.8)	426 kg.
Nitric acid (γ approximately 1.51)	1,820 kg.
Propellants	2,320 kg.
Launching weight	3,800 kg.

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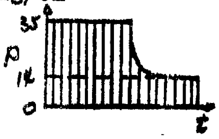
13. The pressurizing was as follows:

Pressure gas	N_2
Pressure in the sphere	$P_1 = 200$ kg/cm2
Volume of sphere	$v_1 = 0.26$ m^3
Original pressure in the container (to be constant during the early part of powered flight)	$P_2' = 35$ kg/cm2
Final pressure in the containers (after sphere becomes exhausted the gas should expand in the containers)	P_2 = (approx) 14 kg/cm^2
Expansion exponent	n = (approx) 1.25
Safety factor of the sphere	γ = (approx) 1.8



14. The safe-load factor and lift was as follows:

Safe-load factor in relation to launching weight = n = 4
This corresponds to a total life A = 4,3800 = 15,200 kg.
Safe-load factor in relation to cut-off weight = n = (approx.) 10

DESCRIPTION

General

15. The first drawing (see page 17) is a layout in three views of the R-113 missile designed by the Germans. As can be seen from this drawing, the missile was to be a cigar-shaped body powered by a single rocket motor. It was to consist of a warhead, central section, and tail section [each of which shall be discussed in detail in the following sections of this report]. The central section was to support two airfoils while the tail section was to support three fins and control surfaces. [redacted] the dimensions are unfortunately not as accurate as those regarding the R-14 [redacted] longitudinal dimensions may be subject to an error of plus or minus five per cent. The largest errors are confined to the warhead, where the error may easily exceed the percentage assigned to the over-all drawing. The diameter of the missile and the angles of leading and trailing edge of the airfoils are exact. The span of the airfoil was not smaller than that shown here but may possibly be as much as five percent greater. The position of the airfoil is not exact, but is relatively correct. [redacted] the grouping of the fins was as shown on page 17, but stated that the possibility existed that the vertical fin might have projected upward rather than downward. Over-all the proportions of the components and their relation to each other should be regarded as generally correct.7

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16. Although the requirements set up by the Soviets called for a surface-to-air missile based on the principles of the <u>Wasserfall</u>, it can be seen that very little similiarity existed between the <u>Wasserfall</u> and the R-113 in design. As stated previously, the motor was left intact with only the operating pressure and consequently the thrust increased so as to improve the performance during the initial phase of flight. The pressure sphere also remained the same in spite of the many disputes that arose regarding it and the many proposals that were suggested as an improvement.

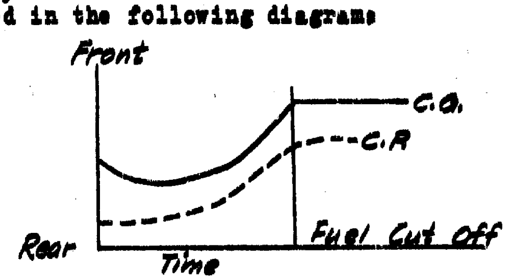
17. The many changes that occurred were based mainly on the desires of the aerodynamics and statics sections. The aerodynamics section disapproved of the Wasserfall particularly in regard to flight stability. This section wanted to attack the stability problem anew and, thus, changed the shape of the missile. The statics section felt that the strength, weight, and rigidity of the Wasserfall were not in proper relation to each other and so a design was produced that was to represent a simple, light, and more rigid missile.

18. Perhaps many of the changes that occurred were more a result of administration policy than a result of technical inspiration. In view of the little time available for the project, it would have been difficult to work with the old structure which was relatively complex and incorporated many components.

19. The most pronounced difference in the R-113 missile was its flight characteristics. The R-113 missile was to perform more as an airplane in which turns were to be coordinated. This was to be achieved by discarding the quadruple airfoils of the Wasserfall and using a double airfoil. One of the main reasons for this change was a matter of weight saving. A second reason offered in support of this modification was the advantage gained in fuel extraction. The extraction of fuel as in the Wasserfall, whereby a moveable nozzle was necessary, had caused a great deal of difficulty. It was expected that these difficulties could be overcome if the missile banked into a turn. This decision was strengthened by the control section which maintained in the early stages of the R-113 project that such a modification would not cause any added difficulties from the standpoint of control. However, it was later found that the control section had been overly optimistic and that difficulties in control did arise. Nevertheless, the design was adhered to.

20. From the structural point of view, the design as shown was an attempt to make the body as compact as feasible and to limit as far as possible any unnecessary and unexploitable spaces.

21. After innumerable drafts, some of which called for completely different shapes, contours, etc., the design shown on the sketch on page 17 was selected. The airfoil was one of short span and large root chord. Stabilization of the missile was to be maintained by three fins and rudders located radially at 120° intervals. A great deal of effort was placed on the relationships of the airfoils, fins, and center of gravity shift so as to produce proper stability during the entire flight. Each was arranged so that distance between center of gravity location and center of pressure location throughout flight would be relatively constant and would be of such magnitude that stability would occur and yet not over-stress the missile. This principle is best illustrated in the following diagram:



[redacted]

22. During the extraction of fuel in powered flight, the center of gravity would move rearward along the axis of the missile until the point would be reached where the weight of the warhead would cause the center of gravity to travel forward again. During the initial part of the flight, the center of pressure would be located relatively far back on the missile. As flight speed increased the center of pressure would move forward on the missile. At propellant cut off, the speed would drop, and the center of pressure would move away from the center of gravity. However, this would generally occur at less dense atmospheres when loads were relatively small, or the missile had spent itself. The concentrated effort placed on the adherence of this principle was reason to believe that the extreme difficulties of flight control and of excessive forces could be eliminated in this missile.

Nose Section

23. /The only reproduction of the nose section [redacted] was that shown on page 17 and the connection of the nose section and central section shown on page 21. [redacted] The nose consisted of a conic shaped body made of plywood. [redacted] a warhead weight of approximately 500 kg. could be carried while satisfying the required range and altitude. The use of plywood provided an excellent heat insulation for the explosive and also kept the weight to a minimum. Plywood also eliminated the undesirable expansion problems associated with steel. Shrapnel effect was not considered, and apparently the destruction was to be through concussion. Discussions were held on the possible use of incendiaries, but this actually had no effect on design since the over-all weight would not be affected.

24. As can be seen (see page 17), a space was provided in the apex of the nose section. [redacted] it was possibly to house a measuring device which permitted the missile to maintain either a constant dynamic pressure or velocity. [redacted]

25. The connection in view A of the fourth sketch (see page 21) shows the method of attaching the wooden warhead to the metal central section. The plywood wall (28) was reinforced by means of a wooden ring (12) glued to the wall. This ring had the dual purpose of serving as a former and also of providing sufficient strength so that the forces could be transmitted through screws.

26. To prevent excessive forces resulting from the expansion of the union ring (32) while heated in flight, the design provided for intermittent slots in the ring (32). These slots cannot be seen in the drawing.

27. Experiments conducted on sample unions of this type showed that failure was more liable to occur in the screw head than the rest of the union.

Central Section

28. Three sketches (see pages 19, 20, and 21) show cross sectional and detailed views of the central section and airfoils, and the method of attachment of the two. /Refer to appropriate legend for identification of parts and material selection of the respective parts./

29. The pressure sphere (3) was to contain N_2 at an initial pressure of 200 kg/cm^2 and was to be located in the forward part of the central section. The design called for a heat treatable steel formed as two half spheres with greater edge thickness for ease in welding. Since the pressure sphere of the Wasserfall had been the cause of many failures in the past, an added safety factor was provided in its design. While the safety factor of the over-all missile was set at 1.5, the safety factor used in the design of this pressure sphere was 1.8. Care was also taken to prevent interruptions in the surface other than a single orifice for extraction and filling.

30. The rings (32) and (33) were to be welded to the sphere first, and then the assembly heat treated to the point where the sphere material had a strength of 120 kg/mm^2. By this method, further welding of the assembly to the rest of the central section could be accomplished without fear of endangering the sphere. The rings (33) were to be of such material that the heat treating process would provide a strength of 60 to 70 kg/mm^2 and not permit the material to become brittle so that further welding could be accomplished.

31. The remainder of the central section was to consist of a steel cylinder separated into two fuel cells by the steel partition (4). The forward cell was to contain Tonka, and the rear cell was to contain nitric acid. [redacted]

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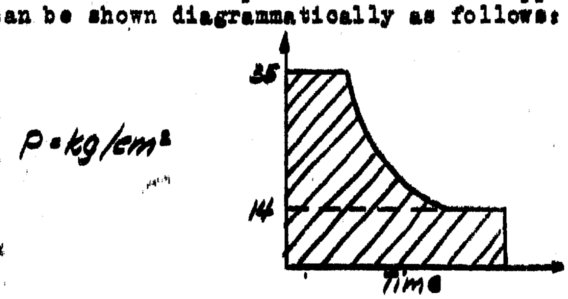
32. Although the fuel container was to be a single wall structure, the concepts in the utilization of internal pressure for support was different from that used in the R-10 design. In the R-10 and also the R-14 design, the internal pressure served as a principle means of supporting the thin wall structure against compressive stresses. In the R-113 missile, where the maximum internal pressure was to be 35 atmospheres, the internal pressure would be many times greater than would be required to prevent buckling and to provide static stability. Thus, the high internal pressure became the lone determinant in the selection of a relatively heavy steel wall of 2.75 millimeter thickness. The resulting tensile stresses in the wall resulting from the internal pressure would be of such magnitude that they would offset the compressive forces that would arise out of bending. Since the wall dimensions were compelled to be large, continuous formers could be dispensed with entirely as a preventive against forces arising in missile transportation and transverse forces arising from the airfoils. Segment formers (14) then would be necessary only for the introduction of the airfoil transverse forces.

33. The partition (4) separating the two fuels would be subject to minor stress since the pressure within the two cells would be approximately the same. However, the partition was to be relatively thick, two millimeters, for reasons of safety. It was felt that the steel would be subject to corrosion from the nitric acid. A great deal of thought went into the problem of protecting the steel container, when finally the Soviets informed the Germans that they had a finish that was relatively safe against nitric acid. The Germans were told that we could take this into consideration in the design, but no further details were furnished concerning this protective finish. It was contemplated that the finish would be applied to all wooden surfaces also for protection against splash.

34. The gas pressure lines (7) and (8) were arranged so that the outlet would be in the upper forward part of the fuel cells where entering pressure gas would not mix with the respective fuels. Since the missile was to perform coordinated turns and fly at a reasonable altitude, this portion of the cells would be free of fuel at all times. Similarly, the fuel extraction lines were located in the lower rear part of their respective cells so that a minimum of residual fuel would remain in the tank whether the missile was in vertical flight or in the process of maneuvering. This locating of the extraction lines and pressure lines along with the determined flight altitude solved one of the problems encountered in the Wasserfall missile configuration.

35. Additional changes that were made were to improve the operating characteristics and to reduce the over-all weight, and had to do with the method of pressurizing the fuel containers. In this missile the feed pressure within the fuel containers was to be maintained at 35 atmospheres during the initial part of the powered flight. At some point during the early part of the power flight, propellant feed pressure was to be reduced until the pressurizing gas within the sphere was practically exhausted and the gas within the fuel containers expended. The minimum pressure was to be approximately 14 kg/cm^2. This can be shown diagrammatically as follows:



36. It was believed that the advantage of this system would permit the missile to reach its full velocity quickly and thereafter avoid undesirable accelerations. It also permitted a saving in the weight of the pressure sphere since the gas quantity and maximum gas pressure would be appreciably decreased.

Airfoil and Airfoil Attachment

37. The airfoil and method of attachment is shown (see pages 19, 20, and 21) and represents the design submitted to the Soviets at the completion of the R-113 project. The form was the result of a compromise between the usual aerodynamic and structural considerations of span, thickness, load carrying capacity, and weight.

38. A major consideration in the design was to produce an airfoil with relatively little deflection and one with no twist. To achieve this, it was found that a surface must be selected with a large load carrying capacity, and that the loads must be transmitted into the central section at many points. Such a design would be extremely heavy unless a material of low specific weight were chosen. A comparative study between various materials, particularly wood and steel, was made; wood was found to be the most advantageous. Using plywood would produce an airfoil with half the weight of steel and would permit much simpler construction. In addition, steel would not only produce many thermal problems, but, unless a greater number of spars were provided a series of waves would form in a thin sheet steel surface between the spars. Since an antiaircraft missile would operate in essentially denser atmospheres, the heat generated would be of such magnitude thata light metal design had to be rejected.

39. Therefore, the airfoil selected was to be triangular shaped and was to be made of wood throughout. The skin or surface (20) was to be plywood of 10 millimeter thickness reinforced at the root on the outer and inner surface,(18) and (22). Seven wooden spars (17) glued to the skin were provided to help carry the load and were slotted (26) so as to receive the lugs (21) welded logitudinal to the central section surface. A slot (27) was to be machined into the ends of the upper and lower surface adjacent to the central section.

40. Two cantilevered steel plates (24) running the length of the airfoil root chord were to be welded longitudinally along the surface of the central section. On attachment of the wing to the central section, the two plates were to be fitted into the grooves (27) machined in the airfoil surface. The metal screws (23) located at intervals along the root of the airfoil were to be provided as a means of fastening.

41. Directly opposite to the plates (24) and welded to the inside of the central section wall were a series of plates (16). These in turn were welded to the cross beams (15) and the former segments (14).

42. The design permitted the transmission of forces from the wing to the central section to take place in the following manner. Approximately half of the wing load was to be carried by the airfoil surface and transmitted to the plates (24) and the extension plates (16). The remaining load was to be carried by the spars (17) and transferred to the lugs (21) welded to the central section surface. To prevent local concentration of loads and the central section, the former segments (14) were to distribute the loads over the central section surface.

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43. Although the wooden airfoil would be half the weight of a steel airfoil, calculations showed that the deflections would be greater. The absolute deflections in themselves would be small and could be disregarded. However, the differential deflections resulting from the variation of load along the chord spans would cause twist. To compensate for this the beams (15) were individually dimensionalized so that each beam would permit a uniform deflection and maintain a symmetrical airfoil section along the span.

44. To prove the feasibility of such a design, a .6 scale model of the airfoil was built and tested structurally at Ostashkov during April and May 1950. The model of the central section could not be constructed ~~because of~~ lack of equipment, but a dummy attachment was provided. The tests proved that the wooden airfoil was capable of carrying the designed loads. In fact, the test equipment broke down several times when the static loading on the model wing exceeded the design load by three. The probable safety factor of three, rather than 1.5, arrived at ~~resulted from the use~~ of relatively low strength values for plywood given to us by the Soviets. It was found that these values already had contained a safety factor.

45. The tests also showed that the deflections of the model were somewhat smaller than the calculations had led us Germans to expect. In addition, the uniform chordwise deflections, which the design provided for, were borne out by the tests.

46. The design loads assigned to the over-all missile were four times that of the total launching weight. This meant that the total load the missile would be subjected to was in the order of 15 tons. The airfoil was to support 60 ~~percent~~ of the total load so that the wing would be required to support nine tons. Since the missile was to operate at a constant dynamic pressure, the safe load factor at propellant cut-off increased to 10.

Modified Airfoil and Attachment

47. Although the original airfoil and attachment fulfilled the requirements structurally, it presented many construction problems. The welding of the long longitudinal plates (24) externally to the central section and the plates (16) internally would prove to be extremely difficult if not impossible. This was borne out especially in the construction of the .6 static test model. The great welding difficulties of this design led to considerable criticism on the part of the Soviets and so a new design was attempted. This new or modified design became a post project to the R-113 project and lasted from four to six weeks. It dealt only with the airfoil and airfoil attachment to the central section.

48. During the course of construction and testing the old model airfoil, the Germans became familiar with a glue that made a new design feasible utilizing wood to steel glued joints. Before proceeding with the new design, a little information regarding this glue seems worthy of mention.

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49. While working on the old model, the Germans requested from the Soviet administration a wood glue but received in its place a metal glue which the Soviets praised highly. A few experiments with the glue showed it to be very reliable if hardened properly, but complete success in its use did not seem to be possible especially over large surfaces. After the tests, data concerning the use of the glue was received from a plant in Moscow. It was a "Warmleim" glue which had to be heated to 100° C. The instructions showed that it was to be used primarily for steel to steel joints. Since the instructions contained all the necessary qualities of the glue, including its strength values, it did not appear necessary to make additional tests. Although the actual properties of a wood to steel joint were not known, this glue was utilized in the design of the new airfoil to eliminate the welding difficulties of the old design.

50. The fifth drawing (see page 23) shows a cross sectional view and details of the modified airfoil and its attachment. The airfoil was to consist, as did the old, of a plywood skin 10 millimeters thick. The spars (3) were not to be of wood but rather of a high grade light metal. To assure a satisfactory glued joint between the skin and spars, a thin wood veneer strip (12) was to be glued first to the spars under a high temperature. Following this, a normal wood to wood glued connection was to be used between the veneer and the upper and lower surface skin. The metal spars were to consist of a flange at their extremity which would permit introduction of a screw (8) at the upper and lower surface. The screws (8) were to be threaded into beams (4) protruding from within the central section. The beams (4) were to be welded at the points of contact with the skin (10) of the central section so that a leakproof seal between (4) and (10) would be obtained. This system would also hold welding to the surface skin (10) to a minimum.

51. Because of small unsymmetrical forces that could possibly arise on the central section surface, thin pipes were welded between the upper and lower beams for reinforcement. The absorption of the main transverse forces took a somewhat different course than in the old wing. In this design the entire load was to be transmitted by the spars (3) to the beams (4) by way of the screws (8). In order to prevent excessive local strains on the central section skin at the various points where the forces would enter, former segments (5) were provided and were to be attached by means of spot welds (11) to the pipe beams (4) as well as the central section skin (10). (See views E-F on page 23.) The spot welding would cause hardly any distortion and, therefore, no difficulties worthy of mention.

52. This solution meant that the welding difficulties of the original design would be eliminated and further, the advantages of the original design would be retained essentially.

53. To provide an aerodynamically clean joint between the airfoil and central section, a wooden triangular fairing (6) was to be glued to the upper and lower airfoil skin. The fairing was to be appropriately formed and the holes, located over the bolts, were to be filled with some kind of putty to prevent aerodynamic interference.

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54. The drawing does not clearly show the method of allowing for longitudinal expansion. Because of the internal fuel pressure and the heat generated in flight, the central section would expand logitudinally at a much greater rate than the wooden airfoil. Should the screwed connections between the central section and the airfoil spars be absolutely inflexible, a considerable expansion force would then arise which would be difficult to control. To prevent this, the design provided for the central airfoil spar only to be connected rigidly to the central beam. The other spar connections were such that flexibility would be possible along the missile's longitudinal axis. The design called for the bored holes for the connection bolt (8) to be oblong rather than concentric. To prevent the spar flange from bearing directly on the protruding beam, when the bolt (9) was tightened, a bushing (9) was provided with a length approximately .10 mm longer than the thickness of the spar flange. Thus, it would be possible for the beams and bolts to move longitudinally relative to the airfoil.

Tail Assembly

55. One of the sketches (see page 25) shows a layout of the tail assembly, and others (see pages 26 and 27) show the supporting details. The attached legend identifies the various components and indicates the materials selected.

Tail Cone

56. Again after many comparative studies, plywood was selected for the surface skin or casing of the tail cone. The wall dimensions or thickness selected for the surface was relatively large, so that the longitudinal and transverse forces, bending moments, and outer pressures could be absorbed without the use of a number of formers and stiffeners. This was particularly desirable, since the tail cone was to be congested and normal formers would occupy a great deal of the needed space. The use of an extremely thick wall actually did make it possible to confine the number of formers to one additional light former (7) other than those required for connection to the central section, motor mount, and introduction of control forces.

57. Detail A, (see page 27) shows the connection of the plywood casing (6) to the steel central section (4). The design called for a reinforcement ring (5) which was to have a dual task. First, the ring would have to provide the material necessary so that the connection to the central section could be made by the use of a smaller number and stronger screws. Second, it would have to serve as a terminal former to absorb the forces imposed as a result of external pressure. The slots (40) in the central section wall were provided to allow for the difference in expansion between the two sections. A series of tests were made on a connection of this type to guarantee the strength of the design.

58. In the area between the reinforcement ring (5) and the former (7), a number of access panels were needed. These panels are not shown since [redacted] They did not present any design or structural problems since it was possible to provide sufficient strength by reinforcing the cutouts and screwing the cover plates firmly to the plywood.

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59. The longitudinal forces that would arise out of the motor thrust, and the lateral force that would arise out of the lateral acceleration had to be contended with in the design of the motor mount. It was felt that the design shown in Detail B, (on page 27) would provide a means of uniformly distributing these forces to the tail cone.

60. The longitudinal force resulting from the motor thrust would resolve itself into two components; one, perpendicular to the axis of the motor, and the other, in the direction of the conic shaped thrust frame (9). The frame (9) should be subjected to only tensile forces, and could, therefore, be of very thin construction. Normally, a thickness of 0.8 mm. would suffice except for the fact that large cutouts must be made to allow for the passage of fuel lines. Thus, it became necessary to select a material thickness of 1.2 mm.

61. The tensile forces in the frame (9) would have to be transmitted to the tail casing. These forces, along with additional bending moments, would produce rather large circular compressive forces on the casing. To support this the former (10) was provided, which had the additional task of acting as a normal former for absorption of external pressures. The former (10) also would become functional in the mounting of the fins.

62. The ring former (27) is discussed in the description of the controls.

63. In summation, the tail cone design consisted of essentially a conic shaped casing and a few simple formers and the design provided for uniform circumferential distribution of motor forces.

Fin and Rudder

64. The design of the fin and rudder (shown on pages 25, 26, and 27) represented a compromise in regard to the use of wood and steel. A more practical solution was no doubt possible, but the relatively short time available for development made it necessary to discontinue further work.

65. A structural design for the fin similar to the design used for the central section airfoil was not feasible, since a thick fin would result with a series of formers requiring space for attachment not available. Therefore, the ideal design, that is, one in which forces could be transmitted at the point of inception, had to be forsaken in favor of one in which the forces could be collected and then transmitted. This led to a design utilizing the main spar (21) which would be capable of absorbing the bending moments, transverse forces, and torsional forces imposed on the fin and transmitting these forces to the tail ring former (27) in the tail cone.

66. The front portions of the fin itself was to consist of a plywood skin (28) and the ribs (12) and (13). The ribs were to be connected to the plywood auxiliary spar (14) by means of small corner posts. Forces on the forward fin were to be deposited on the tail cone skin at the root and on the shield (15) on the fin tip. In addition, the forces that collect on the auxiliary spar (14) would be transmitted to the tail cone skin and the shield. The shield in turn would transmit forces to the main spar.

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67. For reasons of space saving and rigidity, it was necessary to call for steel in the rear portion of the fin. For aerodynamic reasons it was necessary to locate the rudder (3) at the tip of the fin. In order to transmit the great forces imposed on the rudder by way of the rudder shaft (20) it was necessary to select material with a high elastic modulus for the shaft.

68. It was also desirable to select a large shaft diameter for structural reasons, but a small diameter for aerodynamic reasons. As a compromise to the above, it was decided that the shaft diameter should be the thickness of the fin minus the thickness of a thin steel skin, and that the shaft diameter would determine the fin thickness. The use of wood in the rear portion of the fin would have demanded a prohibitively thick fin. The 1.2 mm. steel skin selected was to be supported by the ribs (18) and the main spar (21). The skin was to be connected to the spar by means of spot welds. In order to prevent the loss of space for the rudder shaft, the ribs were to be non-continuous. The ribs were to be attached to the rear auxiliary spar (19), which would collect the forces and transmit them to the bracket (25) and the shield (15). This all resulted in a fin with six per cent thickness at the root and an eight per cent thickness at the tip.

69. The comparatively small dimensions of the rudder and the relatively great forces that would act on it made a design calling for internal and external parts seem impracticable. It was felt that the best design would be one utilizing a solid plywood structure and a solid steel oblong shaft placed within it. The two parts were to be attached by means of a metal glue. In the pure-wood design, rigidity difficulties were encountered in the base of the rudder. For this reason a metal base plate (33) [shown in views G+H] was provided. It was to serve as a seal for the base of the rudder and, above all, was to transmit the torsional moments from the rudder to the rudder shaft (20).

70. The rudder shield (15) was provided for in design for aerodynamic as well as structural reasons. The shield was to prevent a gap between the fin and rudder which would give rise to unpredictable forces and rudder interference. Structurally it was to be used to assist in the transmission of forces.

71. The rudder shaft (16) was to be welded directly to the shaft (20) with the base plate (33) providing a means of transmitting rudder torsional moments. The shaft (20) was to be mounted in the roller bearing (17) at the top and in the roller bearing (22) at the bottom. The upper shaft bearing (17) was to be mounted in the flange (37), which was to be welded to the main spar (21). The lower rudder shaft bearing (22) was to be mounted in the bracket (25), which was to be welded directly to the tail ring former (27). The jet vane (24) was to be attached to the lower end of the rudder shaft and the whole arrangement actuated by means of the rudder lever (23). It was believed that this type of rudder suspension would be extremely rigid and provide a satisfactory means of attachment.

Method of Tail Assembly

72. Should the tail unit be constructed, it would have to be assembled in a manner similar to that briefly described in the following. The tail cone (1) and the forward portion of the fin (2) would constitute one

structural unit. The tail ring former (27), main spar (21), and a flange (37) would constitute a second structural unit. The motor (8) would become a provisional part of the second unit by connecting the motor to the tail ring former. The two units would then be brought together and the motor profile ring (41) would be brought into contact with the support ring (42). The ring former would be attached to the tail cone casing by means of screws and the rear portion of the fin would be screwed to the forward portion of the fin. The rudder shield (15) would be lowered to the assembled structure and screwed to the fin and mounting flange. After having completed the above assembly, the rudder together with the rudder shaft (20) would finally be inserted from the top into its proper position and the jet vanes and rudder lever attached to the rudder shaft.

MOTOR AND FUEL SYSTEM

73. No information is submitted regarding the motor and fuel system. [redacted] they are essentially the same as used in the Wasserfall with the few exceptions already discussed./

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CONCLUSION

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[redacted] a policy decision on the part of the Soviets called for the gradual phasing out of the German-projects by October 1949. [redacted] for example, [redacted] the senseless accelerations of the R-14 project was the direct result of this program. [redacted] a possible cause for this Soviet policy was the decision to return the German engineers, and also the fear that the Germans may obtain an insight into the Soviet missile program which would be detrimental to the security of the Soviets. At any rate, [redacted] consonant with this Soviet policy the German engineers at Ostashkov were no longer to be enrolled in sensitive programs after October 1949.

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[redacted] this apparent contradiction, that is, the phase-out of German engineers from sensitive projects and the assignment of the R-113 project to the German specialists on Ostashkov, [redacted] the following two explanations. By the time the supplementary work was completed on the R-14 (February 1950), the Soviet hierarchy may have decided that the Germans were to remain for another two years in the USSR. Knowing this, the individual research institutes may have decided to utilize the Germans to fulfill requirements that were still outstanding. That is, the institutes may have in fact violated the existing regulations of security by permitting the Germans to work on the classified project.

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However, a more likely explanation [redacted] is the probability that the Soviets may have encountered numerous problems in the development of an antiaircraft rocket. To surmount these, the German engineers were called upon. In order to confine the work of the Germans to non-sensitive areas, the assignment was given to an institute at which no engineers having experience on the Wasserfall were stationed. This

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25X1 [redacted]

would explain the choice of Ostashkov. The few Ostashkov Germans who had contact with the Wasserfall were technicians and launching personnel hardly suitable for research and development work. It was probably hoped that during the period allotted the Germans, the project would not advance to a stage of development considered critical from a security standpoint. In addition, the Soviets may have speculated that this work could be of aid in solving problems encountered in the more advanced stage of the Soviet development on the mere chance that engineers entering the field anew would not be encumbered by the traditional ideas and conventional methods of approach prevalent in the field which may have been the original cause for the problems encountered. Thus, it was essentially a gamble that in the basic or elementary work to be performed by the Germans, some novel or refreshing thought might be generated. [redacted] 25X1 this explanation would resolve the apparent contradiction in that it would offer the Soviets the desired security while at the time offering a possible outlet from a stagnated condition. 25X1

74. In connection with the time element, [redacted] the problems that arose in connection with the R-113 project were not pursued to their ideal or even logical solution. Instead, because of the short time assigned to the project, the development was cut off at a point regarded by many German specialists as unsatisfactory, and permitted time to merely prepare the necessary drawings and multiple calculations so as to meet the date set by the Soviets. This does not mean that the design was not completed, but only that the development was not carried on to the final or logical conclusion thought possible by the Germans. The final product given to the Soviets, therefore, represents not the best the Germans were capable of producing in the field of antiaircraft rockets, but rather the best possible development within a much circumscribed period.

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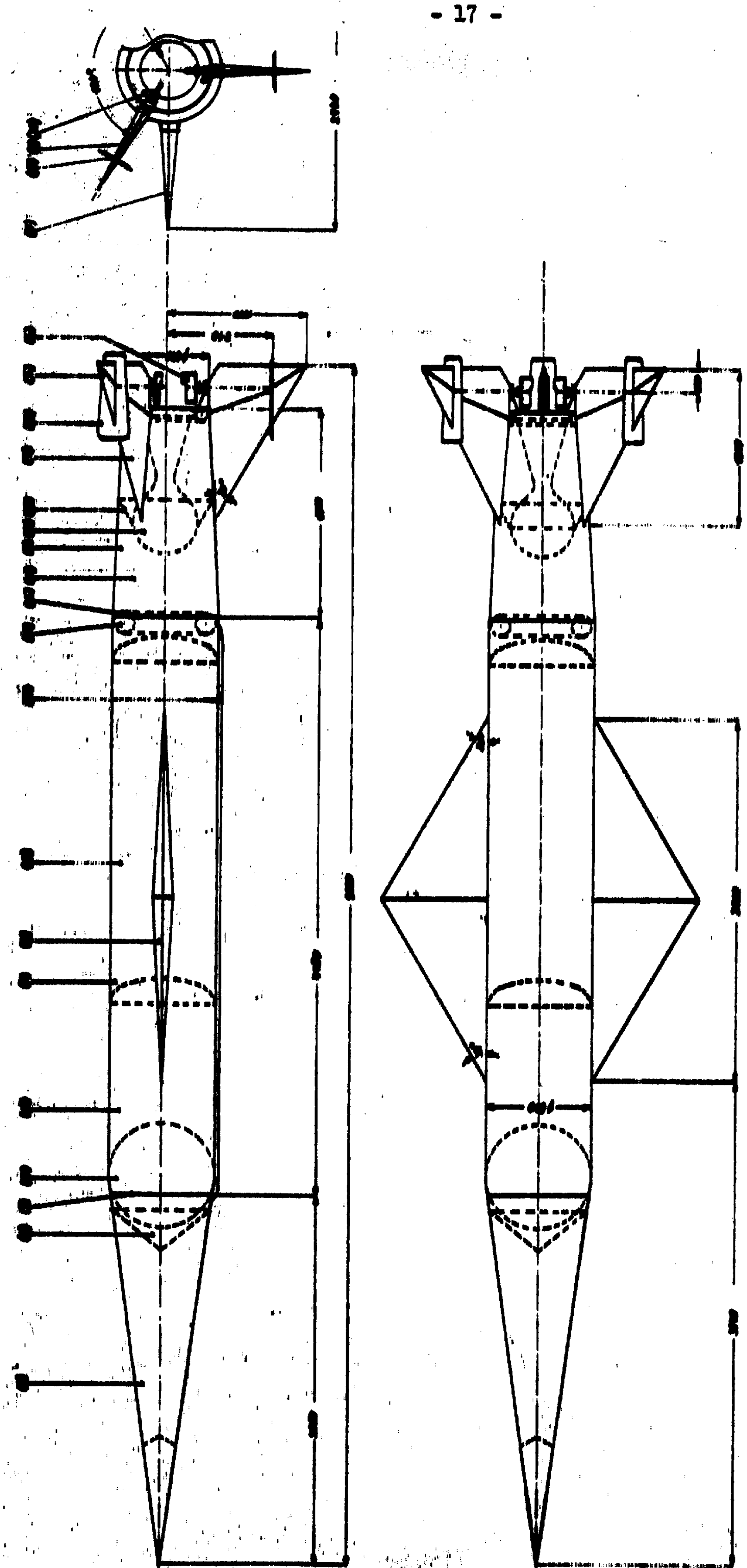


Layout of the R-113 Missile

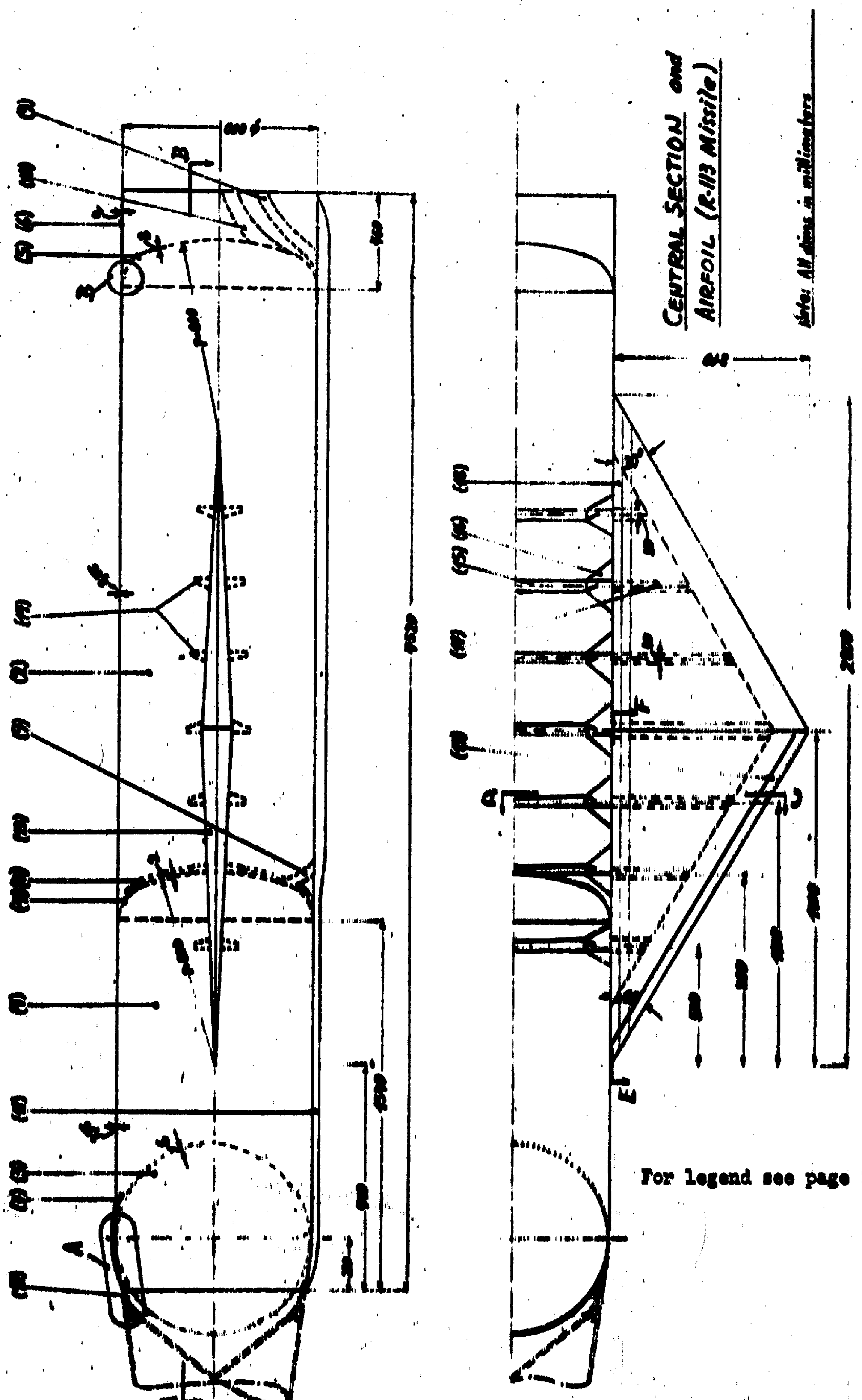
Note: All dims in millimeters

SECRET

LAYOUT OF THE R-113 MISSILE IN THREE VIEWS
(LEGEND)

1. Warhead
2. Central section
3. Tail section
4. Fin
5. Rudder
6. Jet vanes
7. Airfoil
8. Reducing valve
9. Separation between warhead and the central section
10. Pressure gas sphere (N_2)
11. Fuel container (Tonka)
12. Nitric acid container
13. Lines and cable fairing
14. Gas container for rudder control
15. Separation between central section and tail section
16. Control and radio instrument compartments
17. Motor
18. Motor mount
19. Aerodynamic foil
20. Rudder lever

[redacted]



For legend see page 22.

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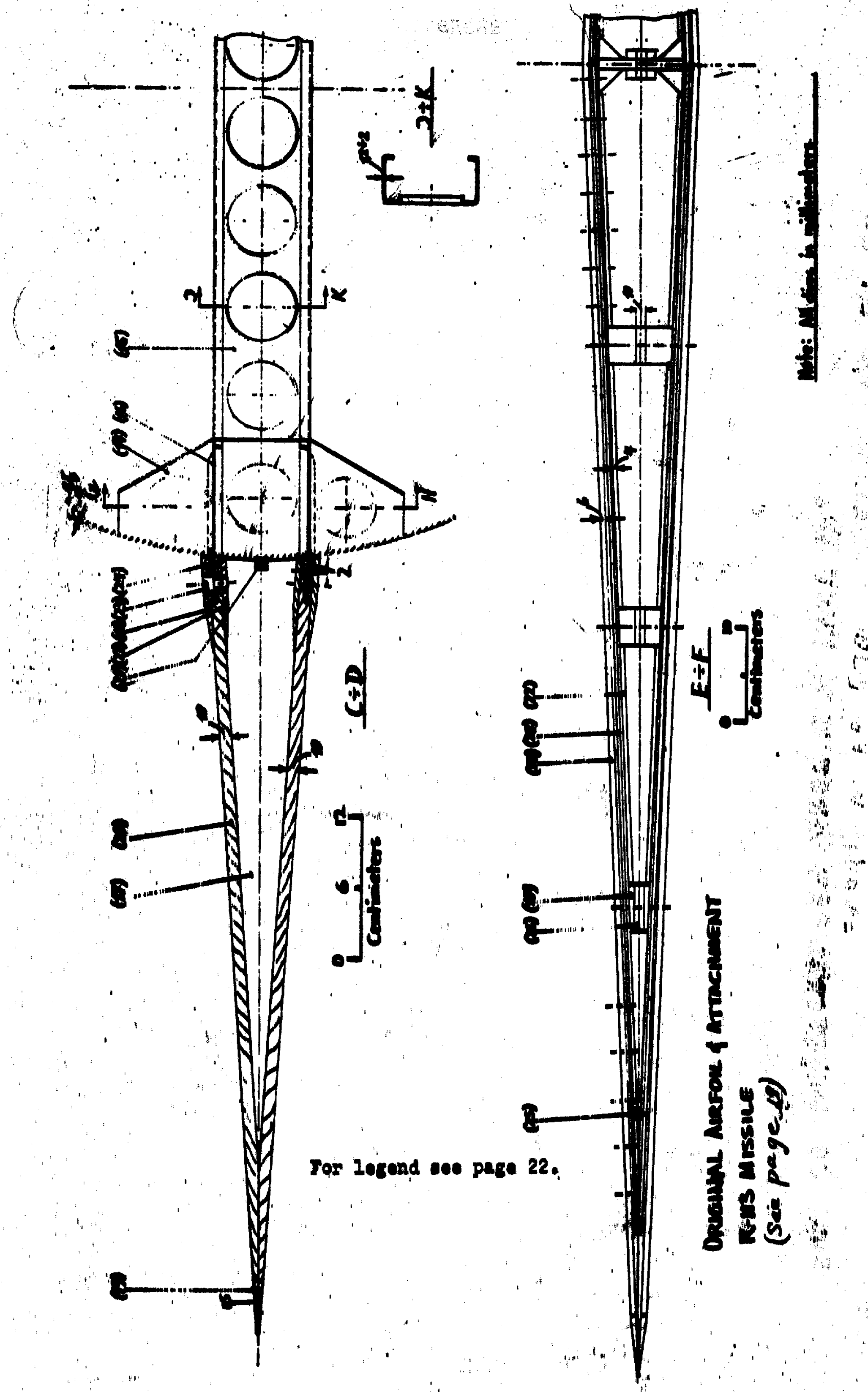

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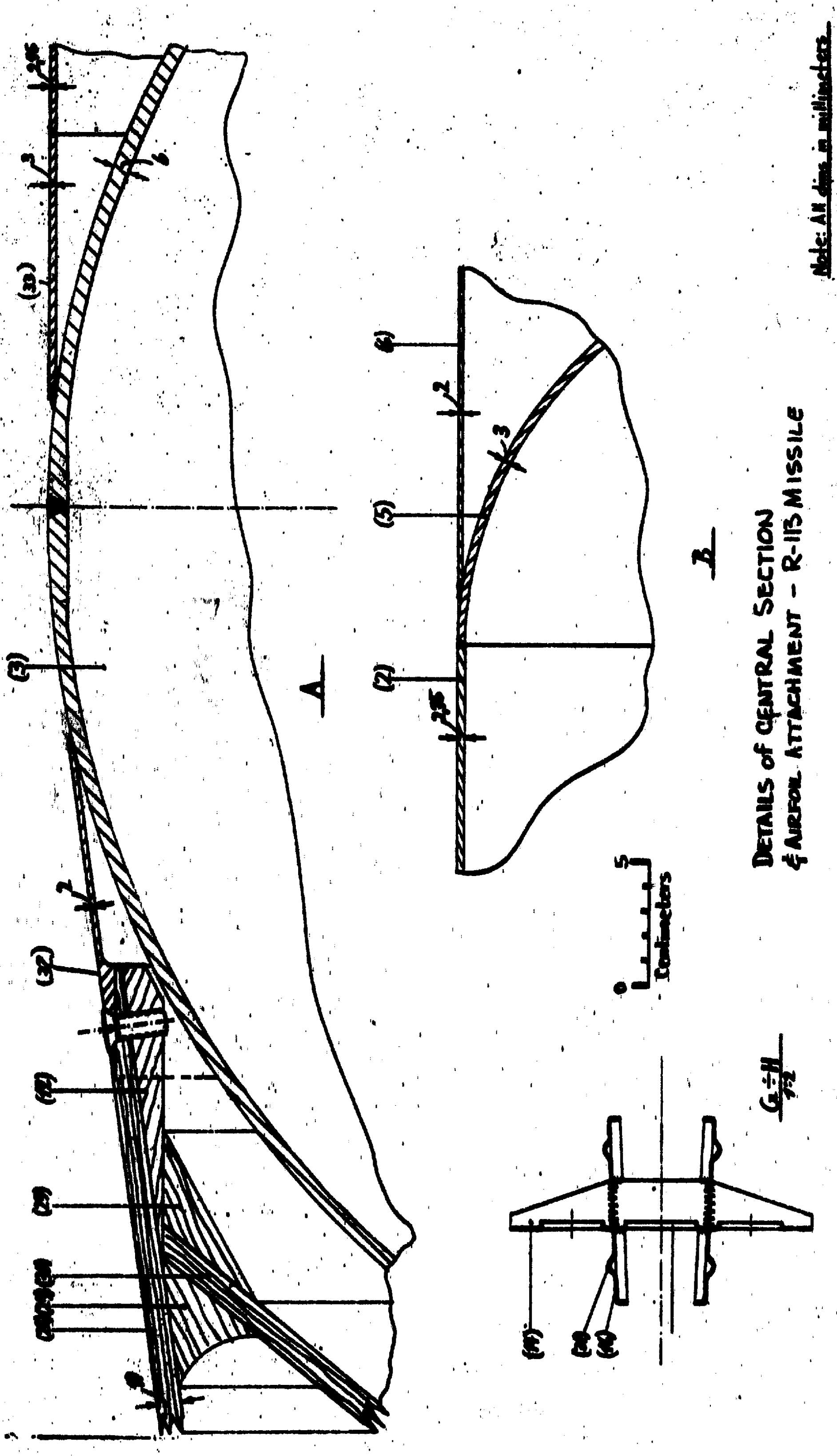
Note: All dims. in millimeters
A
B
Centimeters
DETAILS of CENTRAL SECTION
& AIRFOIL ATTACHMENT - R-115 MISSILE

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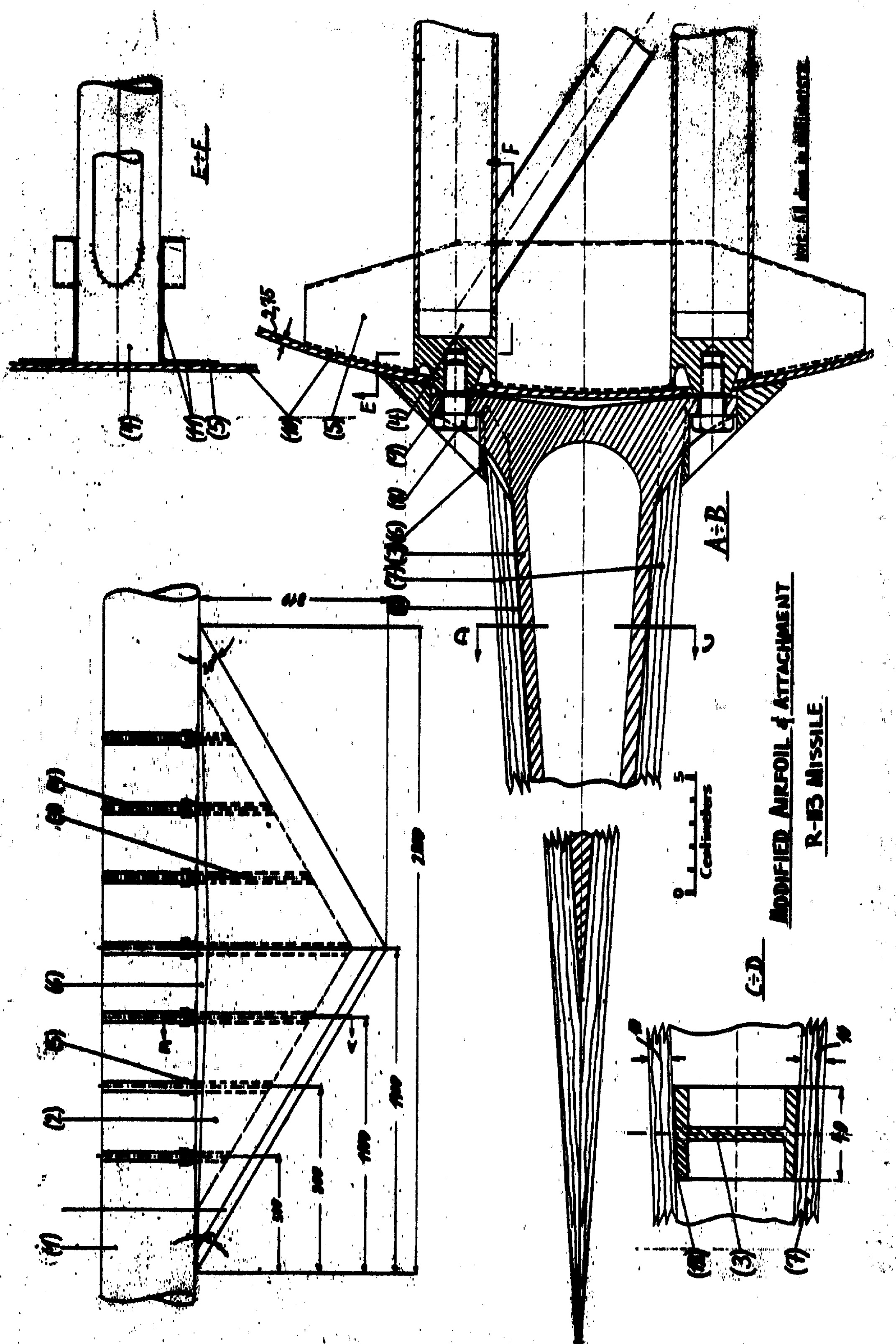
CENTRAL SECTION AND AIRFOIL (R-113 MISSILE)
(LEGEND TO PAGES 19, 20, AND 21)

1. Tonka container (steel σ_B = [illegible] kg/mm^2)
2. Nitric acid container (steel σ_B = 80 kg/mm^2)
3. Pressure gas sphere (annealed steel σ approx. 120 kg/mm^2)
4. Panel (steel σ_B = 80 kg/mm^2)
5. Rear panel (steel σ_B = 80 kg/mm^2)
6. Rear joining ring (steel 30 x ГСА σ_B = 60 kg/mm^2)
7. Gas pressure line for Tonka container
8. Gas pressure line for nitric acid container
9. Feed line for Tonka
10. Feed line for nitric acid
11. Line and cable fairing
12. Warhead central section joint
13. Airfoil
14. Former segments (steel 30 x ГСА σ_B = 60 kg/mm^2)
15. Central section cross beams (Steel 30 x ГСА σ_B = 60 kg/mm^2)
16. Plate (steel 30 x ГСА σ_B = 60 kg/mm^2)
17. Spars (plywood)
18. Joint reinforcement (plywood)
19. Leading edge guard (steel)
20. Load carrying surface (plywood)
21. Longitudinal lugs (steel) to receive wing shearing load
22. Inner joint reinforcement (plywood)
23. Anchoring screws
24. Plate (steel 30 x ГСА σ_B = 60 kg/mm^2)
25. Plug
26. Slot in spars to receive (21)
27. Groove in airfoil surface
28. Warhead load carrying surface (plywood)
29. Reinforcement
30. Warhead conic sealing panel (plywood)
31. Bead in the plate (16)
32. Connecting ring
33. Connecting ring

SECRET


E-E
A-B
C-D
MODIFIED AIRFOIL & ATTACHMENT
Centimeters

MODIFIED AIRFOIL AND ATTACHMENT (R-113 MISSILE)
(LEGEND)

1. Central Section
2. Airfoil (same dimensions and position as original design)
3. Spars (high grade, light metal) σ_B = 42 kg/mm^2
4. Central section cross beams (Steel 30xΓCA σ_B approx. 60 kg/mm^2)
5. Former segments
6. Fairing (wood)
7. Load carrying plywood skin
8. Bolts
9. Bushing
10. Central section skin (steel σ_B approx. 80 kg/mm^2)
11. Welding points
12. Veneer

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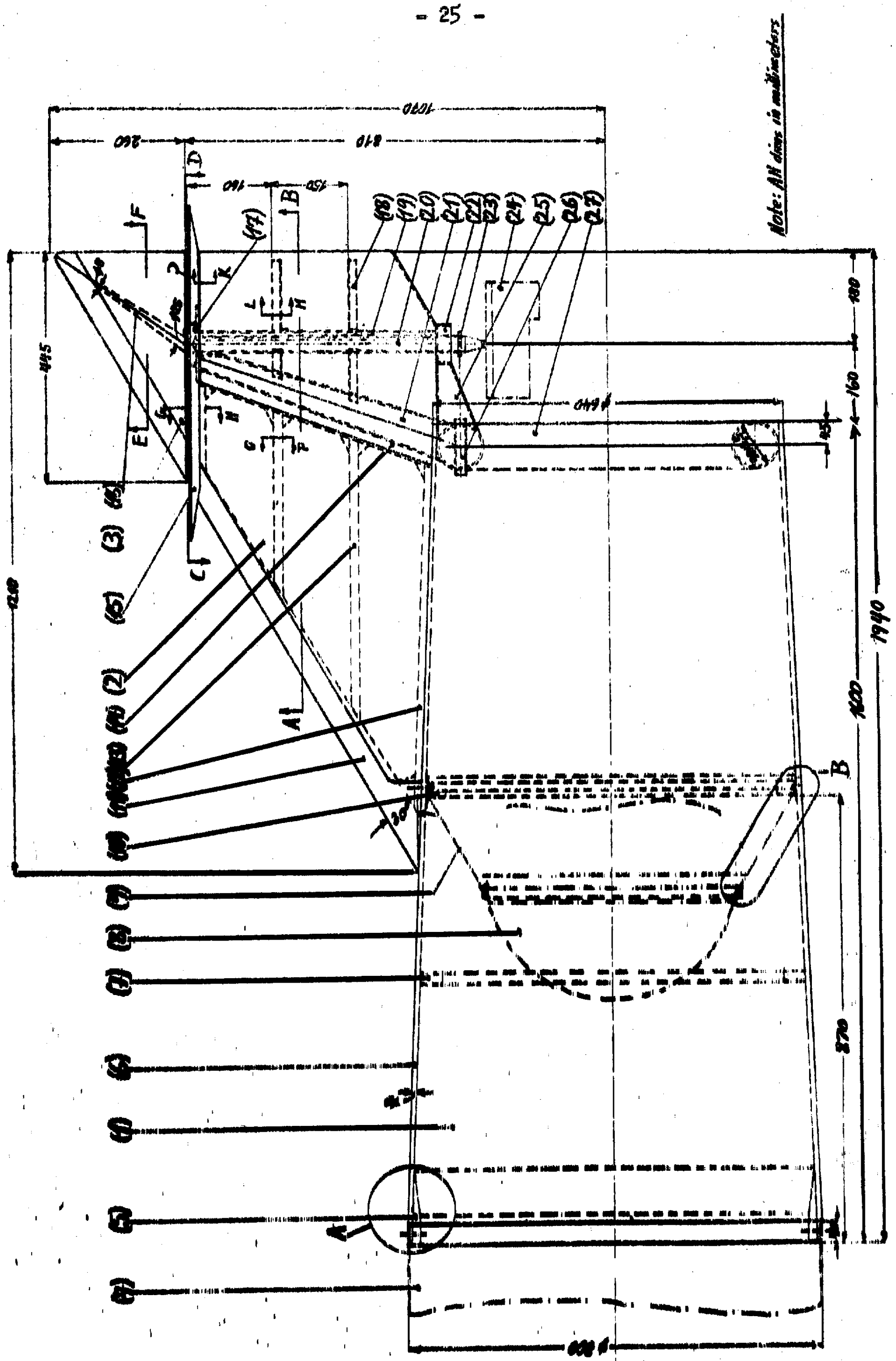
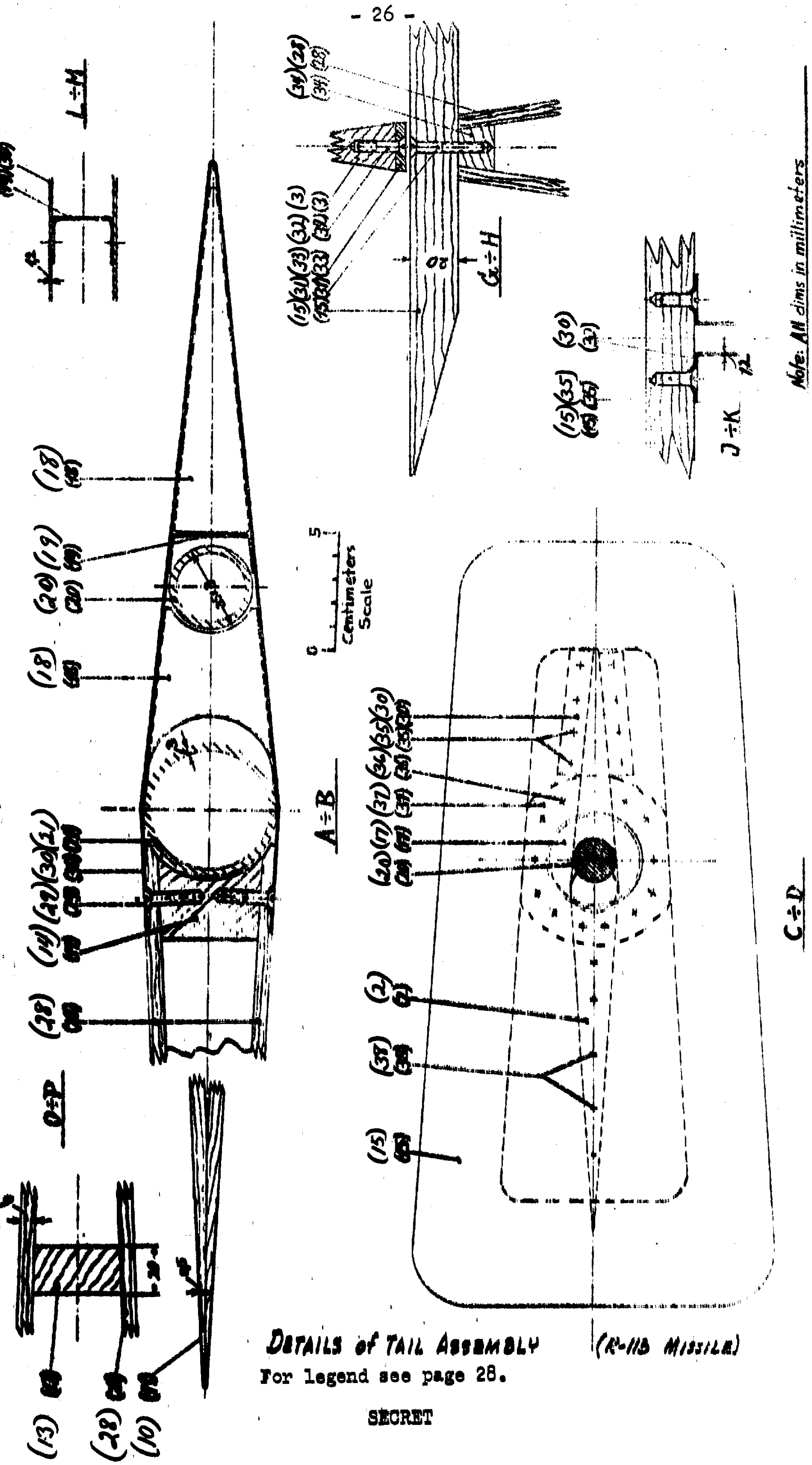


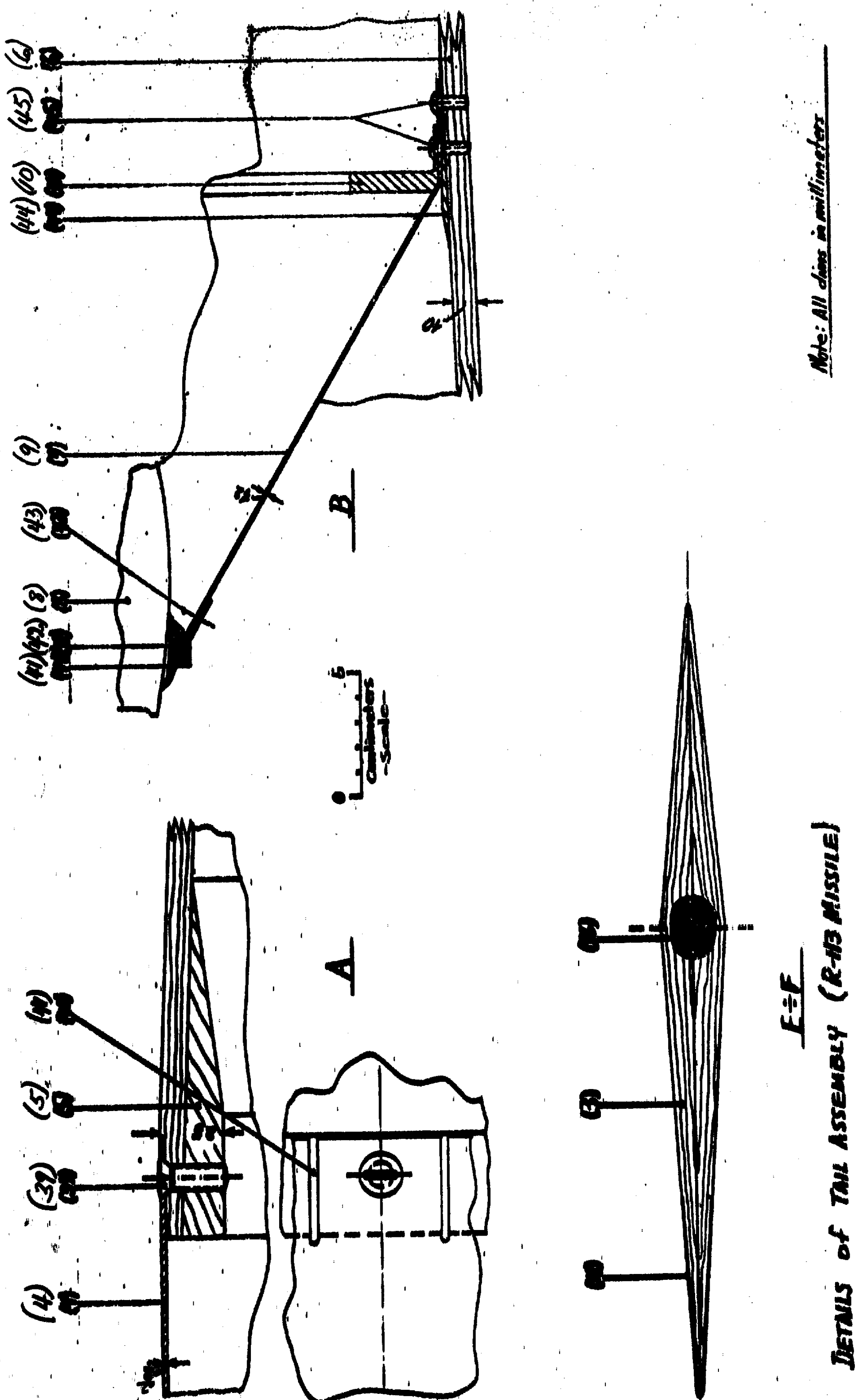
LAYOUT OF TAIL ASSEMBLY (R-113 Missile)

For legend see page 28.



DETAILS of TAIL ASSEMBLY (R-113 MISSILE)

For legend see page 28.



For legend see page 28.

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LAYOUT AND DETAILS OF TAIL ASSEMBLY (R-113 MISSILE)
(LEGEND TO PAGES 25, 26, AND 27)

1. Tail cone
2. Fin
3. Rudder (plywood)
4. Central section
5. Joint reinforcement (plywood)
6. Tail cone casing (plywood)
7. Former (plywood)
8. Motor
9. Conic-shaped thrust frame (dural σ_B approx. 40 kg/mm^2)
10. Former (dural σ_B approx. 40 kg/mm^2)
11. Fin and rudder leading edge protector (steel)
12. Connecting rib, glued and screwed to tail casing
13. Rib (plywood)
14. Auxiliary spar (plywood)
15. Rudder shield (plywood)
16. Rudder shaft (steel σ_B approx. 40 kg/mm^2)
17. Upper rudder shaft bearing
18. Rib (steel σ_B approx. 60 kg/mm^2)
19. Rear auxiliary spar (steel σ_B approx. 60 kg/mm^2)
20. Rudder shaft (steel σ_B approx. 40 kg/mm^2)
21. Main spar (steel σ_B approx. 60 kg/mm^2)
22. Lower rudder shaft bearing
23. Rudder lever (steel)
24. Jet vane
25. Bracket for support of rudder shaft and for mounting of missile on launching platform (steel σ_B approx. 60 kg/mm^2)
26. Guide for push rod (steel)
27. Tail ring former (steel σ_B approx. 60 kg/mm^2)
28. Fin forward skin (plywood)
29. Screws
30. Fin rear skin (steel σ_B approx. 60 kg/mm^2)
31. Screw
32. Screw
33. Rudder base plate (steel)
34. Fin end rib (plywood)
35. Screw
36. Screw
37. Mounting flange (steel σ_B approx. 60 kg/mm^2)
38. Screw
39. Screw
40. Slot in central section skin
41. Motor profile ring (steel)
42. Support ring (steel σ_B approx. 60 kg/mm^2)
43. Rivet
44. Glued reinforcement (plywood)
45. Screws