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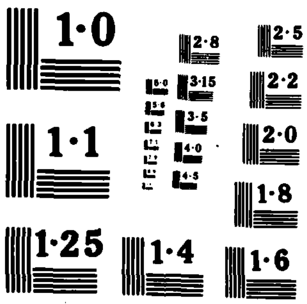
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INTA	N.°	Pág.

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STUDY OF AEROSPACE MATERIALS, COATINGS, ADHESIONS AND PROCESSES

Aircraft Icing Processes

2nd Volume

Principal Investigator:
Dr. E. Montiel Rodriguez
INTA. Torrejón de Ardoz.
(Madrid). Spain

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14th September 1984

Final Scientific Report, 15th Sept. 1983 - 14th Sept. 1984

Approved for public release; distribution unlimited.

Prepared for INSTITUTO NACIONAL DE TECNICA AEROESPACIAL "Esteban Terradas". Torrejón de Ardoz, Madrid, Spain.

and

EUROPEAN OFFICE OF AEROSPACE RESEARCH AND DEVELOPMENT
London, England.

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This report has been reviewed by the EOARD Information Office and is releasable to the National Technical Information Service (NTIS). At NTIS it will be releasable to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

LARELL K. SMITH, Major, USAF
Chief, Physics/Physical Chemistry

INTA	N.°	Pág.

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STUDY OF AEROSPACE MATERIALS, COATINGS, ADHESIONS AND PROCESSES

Aircraft Icing Processes

Secondary Aim

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14th September 1984

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A-1/002.8 Imprenta del INTA

INTRODUCTION

The secondary aim of the work "Aircraft Icing Processes", now in its second year, is the desing construction, and testing of an icing simulator, and a system for measuring parameters.

The purpose of this is to obtain a system capable of producing ice on a circular, or aerodynamic profil, section under known conditions in order to check experimentally the analytical results obtained in the primary aim of the work (theoretical studies).

Thus, in the simulator, we have attempted to obtain incidental flow conditions on the test model as similar as possible to those set out in the mathematical model of the theoretical study: a laminar, bidimensional, incompressible, airstream.

In the choice of the simulator we took into account the above mentioned conditions and tried to avoid unnecessary mechanical complications in the construction and assembly.

For these reasons we rejected the simulator mentioned in the "Final Scientific Report" of 15th July 82/14th Sept. 83, consisting of a bar rotating around an axis perpendicular to itself in the appropiate environmental conditions.

In this simulator the mechanical complications are evident and to obtain the conditions for the stream around the model appears quite difficult.

We thought of an easy to manufacture simulator where a bidimensional quasilaminar current could be obtained and the

A-0002.3 Imprenta del INTA

decision was taken that the simulator would be an icing tunnel.

It would be an open circuit tunnel with a closed test section with a test model refrigerated from the interior, where speeds similar, or assimilable to those of an aircraft, always of course in subsonic incompressible circunstances, could be obtained.

Prior to begining the desing consultations took place with those responsible for the various wind tunnels existing in the INTA: the subsonic and supersonic wind tunnels in the Aerodynamic and Navigability Department and the very low speed wind tunnels for contamination tests in the Energy and Propulsion Department, in order to ascertain the advantages and disadventages of the systems to be chosen.

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A-1

I ICING TUNNEL DESING

For the desing of the icing tunnel we consulted two sources: "Aerodinamique experimental" by P. REBUFFET and above all, "Low speed wind Tunnel Testing" by A. POPE and J. HARPER

Below is a description of each part of the tunnel, with the reason for having being designed in that particular way.

I.1 TEST SECTION

In order to decide the form and dimensions of the section the following parameters have been taken into account.

1. Diameter of the cylindrical test model.
2. Streamflow which can be obtained by the ventilators existing in the market.
3. Required speed.

The diameter of the test model is 40 mm and thus, in order tu avoid wall effets, a ratio diameter of test model, height of tunnel, of ten seemed reasonable, fixing the first dimension.

$$\text{Height of tunnels, } Hm = \phi m \times 10$$

$$Hm = 40 \times 10 = 400 \text{ mm}$$

The volume of air is limited to 5 m^3/s equal to 18.000 m^3/h by the power and pressure of the ventilator, and speeds of 50-60 m/s are wanted.

A circular section tunnel and a test section witn a diameter of 400 mm, was thought of, which would avoid having

A-4/088.3 Imprenta del INTA

other section changes in the length of the tunnel than area changes, this producing a more uniform jet, but he following difficulties were found.

1. In order to obtain a speed of 50 m/s in the test section the necessary flow of air would be

$$Q = V \times A$$
$$v = 60 \text{ m/s}$$
$$A = \pi r^2 = 0.126 \text{ m}^2$$

therefore:

$$Q = 60 \times 0.126 = 7.5 \text{ m}^3/\text{s}$$

which is clearly superior to the limit fixed.

2. If we maintain the flow at 5 m^3/s the speed that would be obtained is:

$$V = Q/A$$
$$Q = 5 \text{ m}^3/\text{s}$$
$$A = 0.126 \text{ m}^2$$
$$v = 5/0.126 = 39.7 \text{ m/s}$$

which is inferior to the speeds wanted in the testing section.

Added to this is the fact, in the case of a circular section, the non-useful zone of the test model is too large.

Bearing this before, together with the fact that to obtain a bidimensional flow the height must greater than the width, we opten for a rectangular section with a height of

A-4082.3 Imprenta del INTA

400 mm. The width is fixed by the volume of air per time unit and the speed required

$$Q = v \times h \times w$$
$$Q = 5 \ m^3/s$$
$$v = 60 \ m/s$$
$$h = 0.4 \ m$$
$$w = 5/(60 \times 0.4) = 0.208$$

Therefore:

$$w = 200 \ mm$$

In this section the ratio height/width is 2, and it's possible to have a bidimensional flow in the test section.

Once the section and its dimensions have been determined, and bearing in mind the common practice, according to Pope, that the length of the test section should be one to two times the size of the larger dimension, the ratio 1.5 was taken as valid and the length of the test section is 600 mm.

This we have a rectangular section of 400 x 200 x 600 mm., in the centre and throughout the width of which, goes the test model.

The manufacturing drawings, are in Annexo II and are: 84-023.A/2, A/2-1, A/2-2. A/2-3 and A/2-4.

The material of the test section is transparent metacrilat and has been chosen precisely be cause of its transparency, as this it's possible to follow the experiment visually.

A-4/662.3 Imprenta del INTA

This is exceptionally interesting in this case as we can see the layer of ice as it forms and stop the expeciment when convenient.

I.2 THE COLLECTOR

The collector, or entrance cone, is the part of the tunnel that goes before the test section. The narrowing of the section throughout its lenght allows us to accelerate the current so it reaches the test section at a greater speed.

The form of the entrance section is fixed by that of the test section, that is, rectangular. The ratio between the sections is one of nine, which is a value intermediate between 7 and 14, a contraction ratio between which according to Pope, is a good aid to acheive a good jet. In another paragraph he states that a contraction ratio of 9.8:1 is adequate for a low turbulence tunnel.

The dimensions of the entrance section are proportional to those of the test section, and bearing in mind that the ratio between the areas is 9:1, the ratio of the sides of the rectangle will be of its square root, that is 3:1. Thus as the test section is 400 x 200 mm, the entrance section will be 1200 x 600 mm.

The length of the collector is 2 1/2 times the larger dimension of the test section, that is one metre.

The shape, or profile of the collector is of the Gottingen type which is tangential to the test section, with a straight section at the entrance, and a inflection point further on.

The manufacturing drawings of the collector are 84-023 A/1, included in annex II.

A-4/002.3 Imprenta del INTA

The material for the collector is stainless steel F-314, in order to avoid possible oxidazation by the current loaden with water droplets.

I.3 HONEYCOMB

At the entrance the thunnel will have a type of filter which, as well as filtering the stream, will break the entrance vortex so a more homogeneous current will arrive at the testing section.

The type of filter chosen is of the honeycomb type, because apart from filtering and breaking the entrance vortex, it also straigntens the stream, and also, the cells are of sufficiently small dimensions, that the vortices caused will be so small that the current will arrive at the test section substantially improved, and a quasi-laminar flow can be obtained.

It will be loaged in the straight section of the collector and the length of the straight section will be that of the honeycomb.

The honeycomb was supplied by the firm C.A.S.A. (Construcciones Aeronáuticas, S.A.) and it was only possible to choose be between the types existing in their storage.

The most appropriate for the characteristics of the tunnel is the model:

1/8 - 5056 - .0007 - 3.1.

where:

1/8 is the cell size in fractions of an inch.
5056 is the Aluminum alloy used.

A-1/0012.3 Imprenta del INTA

.0007 is the nominal foil thickness in inches.
3.1 is the density in pounds per cubic feet.

The cell is hexagonal and the length of the honeycombs is 155 mm, the dimensions being those of the straight section of the collector.

I.4 DIFFUSER

The diffuser is the part of the tunnel which goes between the test section and the ventilator. Its mission is to decelerate the stream so it arrives more slowly at the entrance to the ventilator, and in our case as well, in the diffuser will take place the change in section shape and its adaptation to the ventilator catch-basing inlet.

Our diffuser has two clearly distinguished parts. The first part is a transition zone from the rectangular section of 200 x 400 mm, which we have at the end of the test section, to a circular section of 400 mm diameter with a lenght of 1.5 metres.The second part, which is properly speaking the diffuser, is a truncated cone with a final section of 500 mm in diameter and a length of one metre.

In the first part the maximun angle of opening, or of divergence is 3.81^{o}, and in the second part 2.86^{o}, which are totally acceptable as Rebuffet talks of angles of up to 9^{o} and Pope of angles up to 8^{o}.

The material of the diffuser, as that of the collector, is stainless steel F-314. The manufacturing drawings are numbers 84-023.A/14, A/14-1 y A/14-2, and are in annex II.

A-4002.8 Imprenta del INTA

I.5 VENTILATOR

In the cnoice of the ventilator or fan the following parameters have to be taken into account.

- Volume of air per time unit or streamflow.
- Energy consumed.
- Pressure.

The flow is fixed by the area of the test section and the speed we wish to acheive in that section.

For a speed of 60 m/s the flow we need is:

$$Q = S \times V, \text{ where}$$

Q - flow of air.
S - area of cross sectional of test section.
V - speed

$$Q = 0.2 \times 0.4 \times 60 \ m^3/s$$
$$Q = 4.8 \ m^3/s$$

This value is one of our parameters and we must remember that we have a limit of flow in the ventilator of 5 m^3/s.

The energy consumed is fixed by the loss of head in the length of the tunnel plus that produced by the discharge into the atmosphere.

The power of the electric motor attached to the ventilador has beed fixed at a maximun of 15 CV because of limitations in the electric system. The pressure required of the ventilator will be at least equal to the loss of pressure in the tunnel, plus the discharge loss.

A-1/002.3 Imprenta del INTA

There losses of head, throughout the length of the tunnel as well as on discharge, have been calculated by a Computer Programme developed by the Contamination Laboratory of the Energy and Propulsion Department of the INTA, based on the work "Memento des pertes de charges, coefficients de pertes de charges singulières et de pertes de charges pour frottement" by J.E. IDEL'CIK, and whose striped is included in annex I.

The results obtained for the several flows and speeds, with the previously described configuration of the tunnel, are reflected in table I, in annex I.

With this data and what was available in the market a ventilador was chosen with a volume per time unit of 17.000 m^3/h which gives us a total pressure of 150 mm C.A. (1 m^3/S = 3600 m^3/h, 1 mm C.A. = 1 Kg/cm^2) and with a motor of a maximun power of 15 CV.

The curves of the ventilador are represented in figure 1 and the curve of the funtionating of the tunnel is in figure 2.

A centrifugal ventilator was chosen, as with these types of ventilators it s easier to guide the current to the exterior of the chambre where the tunnel is, and in our case its very importan as the current carries water drops.

The manufacturing drawing of ventilator, P/41.561,is in annex II.

I.6 THE TEST MODEL

The test model is a hollow bar, cylindrical or aerodynamical shaped, of anodized duralumin.

A-4002.3 Imprenta del INTA

Hochleistungs-Ventilator
Typ HNN/R$^{U}_{E}$ 500

Saugöffnungsdurchmesser ______ : 507 mm (entfällt bei RE)

Ausblas ______ : 569/361 mm

Laufraddurchmesser ______ : 675 mm

Massenträgheitsmoment ______ : 2,46 kg m²

Massenträgheitsmoment verstärkt : 2,75 kg m² (ab 2100 1/min)

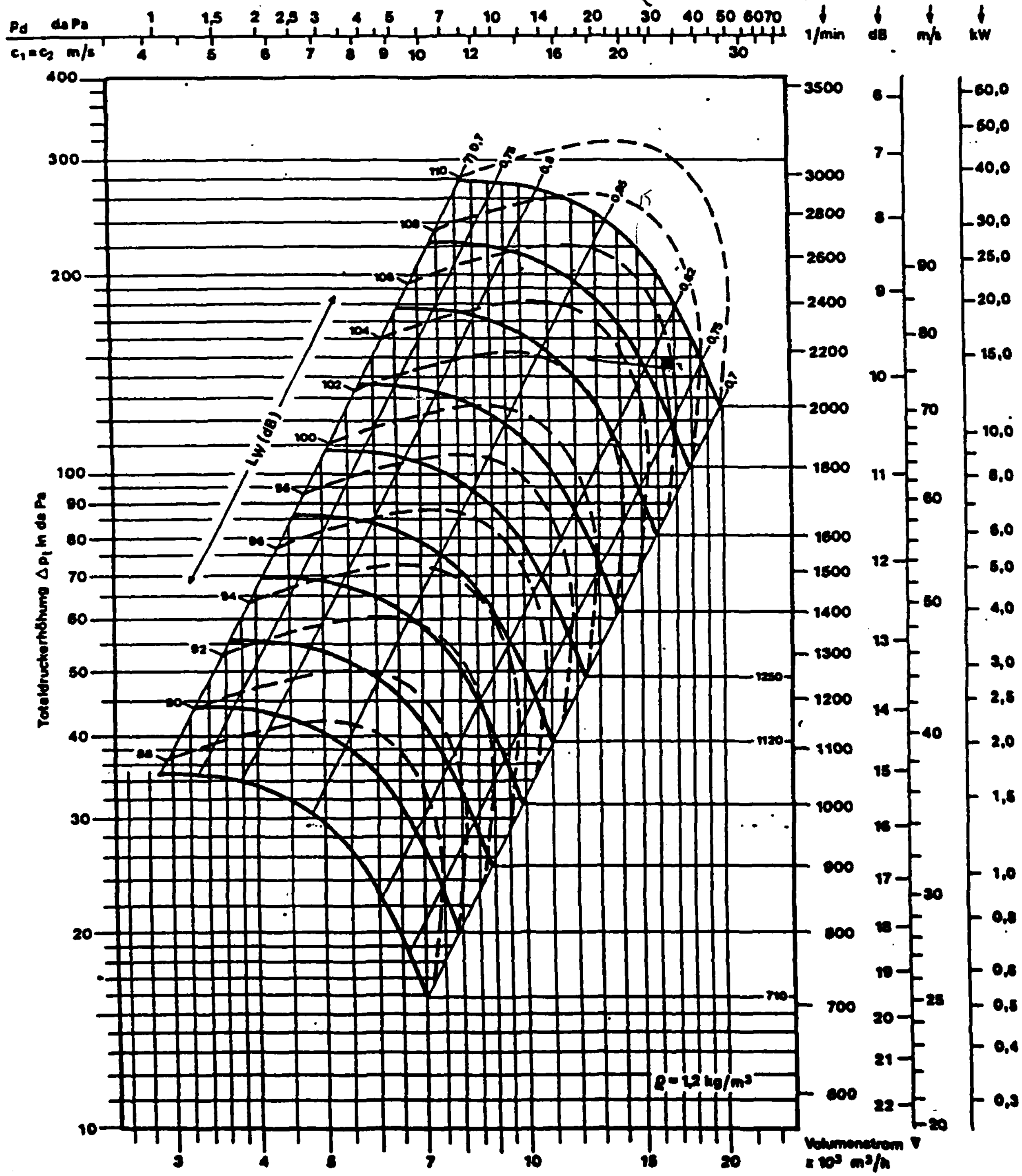


FIG. 1.

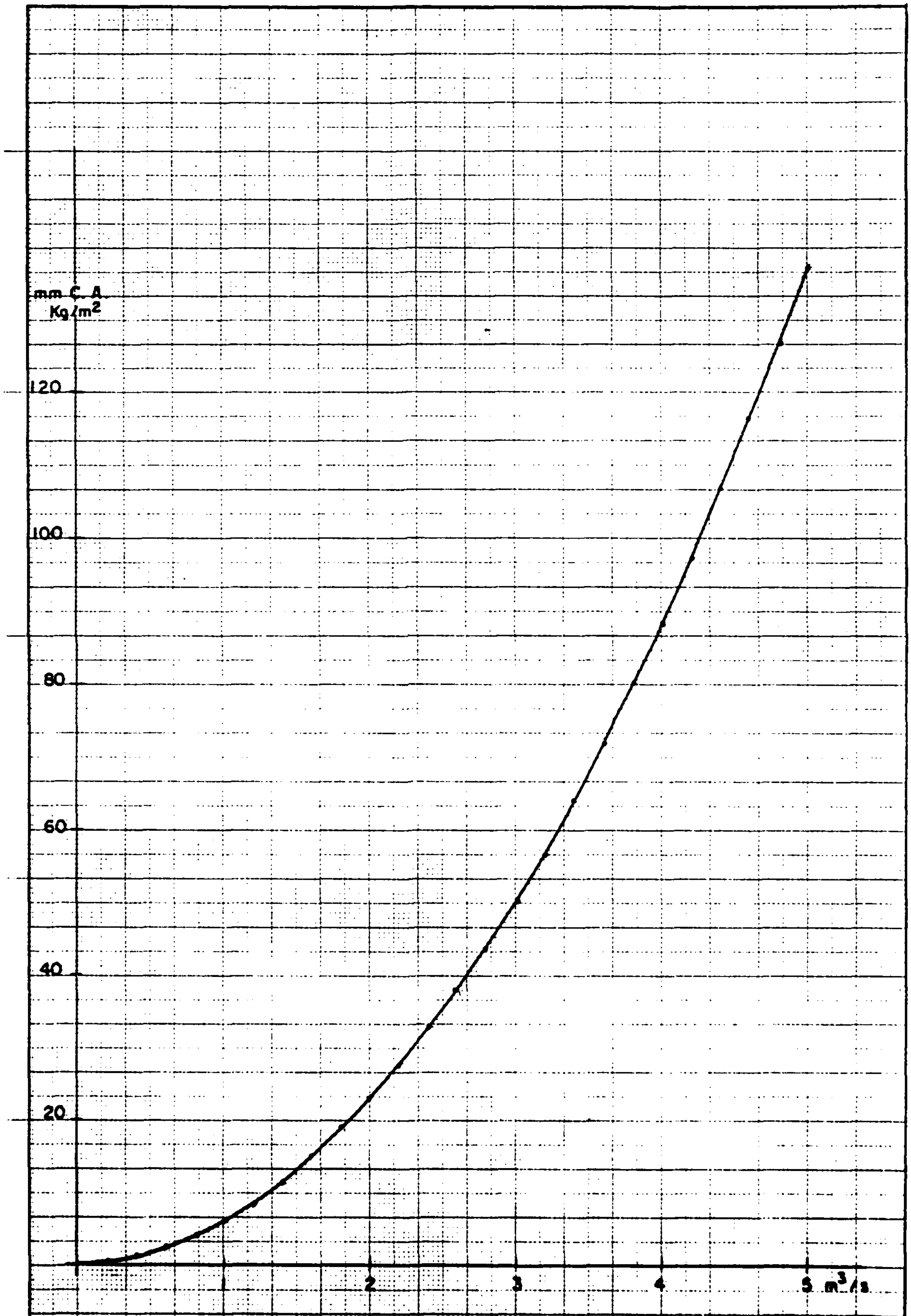


FIG. 2

In its inside is placed carbonic snow or another cryogenic product in order to keep the temperature of the test model considerally below zero degrees centrigrade.

This temperature is necessary so that the microscopic water drops which the current carries, will at the moment of collision with the test model adhere to it in the form of ice.

It s situated in the centre of the test section, crossing it horizontally and perpendicular to the stream.

The test model, its situation, and fixing, are described in the drawing 84-023 A/3, 84-023B, B/1, B/2, B/3, B/4 and are in annex II.

A-4008.3 Imprenta del INTA

II. CLOUD GENERATION

The cloud of water droplets which will circulate in the icing tunnel is formed in the settling chamber, before of entrance to the icing tunnel, and will be absorbed by the tunnel at the same time as the rest of the volume of air.

This cloud is formed with the atomizer described in the FINAL SCIENTIFIC REPORT 82/83 and manufactured in the INTA according to the drawings adjoined to that report.

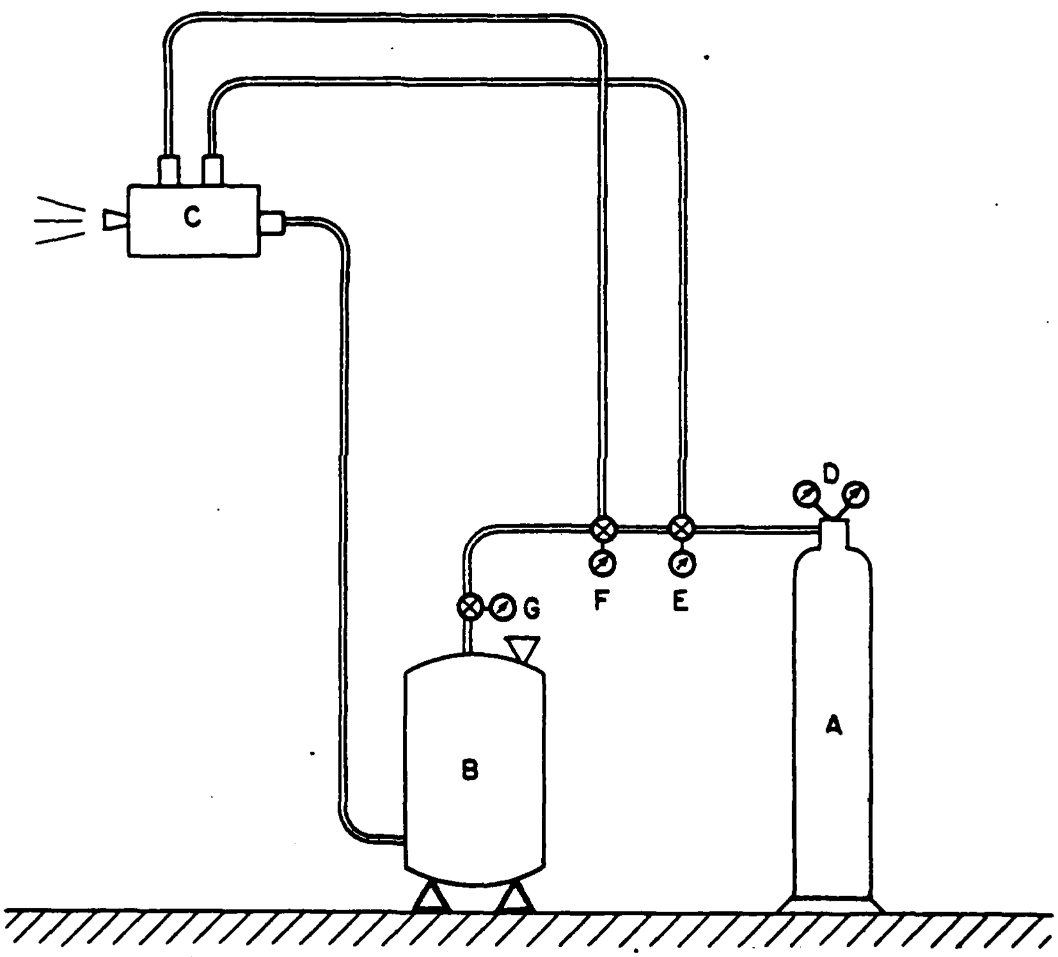
The definitive atomizer installation is described in figure 3 where:

A. - Bottle of compressed air.
B. - Water tank.
C. - Atomizer.
D. - Manoreducer.
E,F,G. - Pressure regulator valves with manometer.

The bottle of compressed air pressurizes the whole circuit, and by varying the pressures at the air and water entrances to the atomizer we can obtain several droplet sizes and thus different liquid water content.

The testing of the size of the water droplets was carried out before the installation of the tunnel as a result of the delay in its manufacture and coming into service. The water droplet sizes obtained at different pressures will be tabulated.

A-4000.3 Imprenta del INTA



INSTALACION SISTEMA ATOMIZADOR

FIG - 3

III. MEASUREMENT OF PARAMETERS

The essential parameters to be measured in the icing tunnel are

- Speed and turbulance.
- Droplet size.
- Liquid water content.
- Temperature

III.1 SPEED AND TURBULENCE

The speed and turbulance of the airstream is measured by and anemometer of hot wire, TSI make, model IFA 100.

The hot wire anemometry has been chosen because of the possibility of giving us both the average speed and the instantaneous speed of the stream and this the ripply or turbulance of the same. Another important characteristic of this technique is that the reaction time is of the order to microseconds, and thus the perturbation of the test probe es very small ans the signal/noise ratio is high. Also thermal anemometric instruments are exceptionally stable, sensitive, and resistent.

Hot wire and hot film test probe has been acquired for the different experiments and their calibration has been carried out by the Aerodynamics Section of the Aerodynamics and Navigability Department. The equations and calibration curves are described in annex III.

The calibration covers the the field of action of:

Speed	0 to 70 m/s
Frecuency	2 Hz to 150 KHz

A-4008.3 Imprenta del INTA

The measurement sistem of the speed and turbulance has been completed by means of a digital osciloscope, make TEKTRONIX, model 468, which captures the perturbation waves of the airstream through the anemometer, visualizes them in real time, digitalizes them, and sends them to a process and control system for their analysis.

This process and control system consists of a Hewlett-Packard scientific personal computer, model 9816, an H.P. plotter, model 7470 A, and H.P. impact printer model 82906A, which analyzes the wave, draws its, and prints the relative data about it which interests us.

III.2 DROP SIZE

The method used to measure the size and distribution of water droplets is the microphotography.

The capture of the droplets in the tunnel is carried out by means of the droplet-catching probe described in the drawings 84-023-A, A/4, A/5, A/6 and A/7 of the annex II.

The flat covered with a slow evaporation oil, is exposed to the airstream for a little time as posible, and this sample as taken to the microscope and photographed: From the positive photo, knowing the enlargment ratio of the microphoto we can measure the size of the drop, as well as the mumber and distribution of sizes.

The equipment is a Carl Zeiss Jena stereomicroscope which magnifies 200 x, and incorporates a MF 24 x 36 WERRA camera with the adequate devices for microphotograpny.

A-3000.8 Imprenta del INTA

III.3 LIQUID WATER CONTENT

The liquid water content can be found out if we know the distribution-size, and number of water droplets on the surface photographed, its area, the speed of the stream, and the exposure time of the sample.

Another, perhaps easier and more trust worthy way, is to measuree the amount of water used in the experiment and the amount of air which has circulated in the tunnel in the duration of the experiment.

We find out the volume know the volume of air per time unit and the area of the test section.

III.4 TEMPERATURE

In the experiments we has to measure two temperatures: The environmental temperature and the surface temperature of the test model.

The environmental temperature we measured by means of a mercury thermometer and the surface temperature of the test model by means of thermistors.

The thermistors were connected to an analogic recorder make YEW, model 4088 in order to obtain a grafic record of the temperature variation in the test model as has been said before.

A-4088.8 Imprenta del INTA

FINAL CONCLUSION

As final conclusions of the whole work, Primary and Secondary Aims, performed concerning "Aircraft Icing Processes", that constitutes the last one of the four proposal covered by Grant NO. AFOSR 83-0340 "Study of Aerospace Materials, Coatings, Adhesions and Processes", they can be established the following:

1. The Primary Aim concerning the Theoretical Study (Mathematical Model , FORTRAN Program and Sets of Results), has been reached.

2. The Ambient Pressure Simulator and Metering System, whose design, manufacturing, set up and operation constitutes the Secondary Aim of the proposal, has been partially reached:

It has been designed in its whole. Some of the parts, as for example the fan and electric engine that moves it have been adquired in the market after a detailed selection among the different possibilities. Other parts as the air-duct and the observation chamber have been designed by our scientists and manufactured by our General Works. The equipments constituting the Metering System, have been selected among the most adequate in the market and adquired. Its proper operation has been verified and some tests have been performed in order to familiarize the personnel with their possibilities. The anemometric probes have been calibrated.

A-40083 Imprenta del INTA

Though, due to several reasons, the final installation has not been performed, it is expected that the whole of the Simulator and Metering System will be operative for the next Marz.

Torrejón de Ardoz, 12th November 1984

Research Assistant
Esperanza Olivo Esteban

The Principal Investigator
Ernesto Montiel Rodriguez

V° B°
EL DIRECTOR DEL DEPARTAMENTO DE
AERODINAMICA Y NAVEGABILIDAD
José Warleta Carrillo

A-4008.3 Imprenta del INTA

ANNEX I

A-4902.3 Imprenta del INTA

COMPUTER PROGRAM OF LOSS PRESSION

A-1/1162.3 Imprenta del INTA

```
10 REM ....13.MARZO.1984.............
20 REM ......PERDIDAS DE CARGA......
30 REM ..PROGRAMA."TUNEL1".....
40 REM ...K(I)=1 ES SECC.INIC.CIRCULAR.=2 ES RECTANGULAR
50 REM ...S(I)=1 ES SECC.FINAL.CIRCULAR.=2 ES RECTANGULAR
60 REM ...INCLUYE CONOS.TOBERAS.DIFUSORES.TUBOS..REJILLAS.HONEYC
OMBS.
70 DIM Z(20),P(20)
80 DIM D(20),D1(20),L(20),A(20),A1(20),B(20),B1(20)
90 DIM S(20)
100 DIM K(20)
110 DIM E(20),E1(20)
120 DIM F(3)
130 DIM C(10)
140 DIM X(20)
150 SELECT D
160 SELECT PRINT 005(64)
170 INPUT "NUMERO DE ELEMENTOS",I8
180 INPUT "RUGOSIDAD(MM)",R8
190 R8=R8*1E-3
200 PRINT "TECLEAR POR ORDEN AGUAS ABAJO"
210 PRINT "1.CONO/TOBERA/PRISMA..2..DIFUSOR..3.TUBO..4.REJILLA..
5.HONEYCOMB."
220 V8=1.51E-5
230 FOR I=1 TO I8
240 PRINT I
250 INPUT "ELEMENTO",Z(I)
260 NEXT I
270 J8=0
280 PRINT "LADOS VERTICALES.A...HORIZ.B"
290 INPUT "CAUDAL MINIMO,MAXIMO(M3/S)",Q1,Q2
300 INPUT "INCREMENTO CAUDAL",Q3
310 FOR Q=Q1 TO Q2 STEP Q3
320 SELECT PRINT 211(100)
330 PRINT
340 PRINT "CAUDAL(M3/S)=",Q:PRINT
350 J8=J8+1
360 RO=1.2*Q↑2/19.6
370 U8=0:W8=0
380 FOR I=1 TO I8
390 ON Z(I) GOSUB 440,730,1540,1750,2410
400 W8=W8+L(I):U8=U8+P(I)
410 NEXT I
420 GOTO 2770
430 REM ......SECC.ENTRADA........
440 SELECT PRINT 211(100)
450 IF J8<>1 THEN 470
460 INPUT "TOBERA(1).CONO(2).PRISMATICO(3)",G8
470 ON G8 GOTO 480,530,600
480 PRINT "TOBERA...."
490 SELECT PRINT 005(64):PRINT "TOBERA"
500 K(I)=1:S(I)=1
510 GOSUB '1
520 X(I)=.03:GOTO 690
```

A-4/002.3 Imprenta del INTA

```
530 PRINT "CONO......"
540 SELECT PRINT 005(64):PRINT "CONO"
550 K(I)=1:S(I)=1
560 GOSUB '1
570 IF J8[]1 THEN 690
580 INPUT "COEF.DE PERDIDA..0.1 SI L/D=1 Y ALFA ENTRE 30 Y 50 GR
ADOS",X(I)
590 GOTO 690
600 PRINT "PRISMATICO"
610 SELECT PRINT 005(64):PRINT "PRISMATICO"
620 K(I)=2:S(I)=2
630 GOSUB '1
640 IF E(I)[]0 THEN 650:E(I)=E1(I):GOTO 660
650 IF E1(I)[]0 THEN 660:E1(I)=E(I)
660 D=2*S1/(A1(I)+B1(I))
670 R=W1*D/V8:D8=R8/D:GOSUB '2
680 X(I)=.11*(1-S1/S0)+(L8/16)*(1/SIN(E(I)/2)+1/SIN(E1(I)/2))*(1
-(S1/S0)!2)
690 P(I)=R0*X(I)/S1!2
700 GOSUB '7:GOSUB '8
710 RETURN
720 REM ..........DIFUSORES.............
730 PRINT ".......DIFUSORES..........."
740 PRINT "CONICO(1)..PIRAMIDAL(2)..PLANO(3)..CURVILINEO CIRCULA
R O RECTANGULAR(4)..CURVILINEO PLANO(5)"
750 IF J8[]1 THEN 770
760 INPUT "TIPO DE DIFUSOR",C(I)
770 ON C(I) GOTO 780,890,1040,1120,1360
780 SELECT PRINT 211(100)
790 PRINT ".DIFUSOR CONICO.."
800 SELECT PRINT 005(64)
810 PRINT "DIFUSOR CONICO"
820 K(I)=1:S(I)=1
830 GOSUB '1
840 D=D(I):R=W0*D/V8:D8=R8/D
850 GOSUB '2
860 F9=L8*(1-(S0/S1)!2)/(8*SIN(C/2))
870 K2=3.2
880 GOTO 1440
890 SELECT PRINT 211(100)
900 PRINT ".DIFUSOR PIRAMIDAL.."
910 SELECT PRINT 005(64):PRINT "DIFUSOR PIRAMIDAL"
920 IF J8[]1 THEN 940
930 INPUT "CON PLACAS DE SEPARACION(1),SIN PLACAS(2)",G9
940 K(I)=2:S(I)=2
950 GOSUB '1
960 D=2*S0/(A(I)+B(I))
970 IF C(I)=4 THEN 1320:IF C(I)=5 THEN 1320
980 R=W0*D/V8
990 D8=R8/D
1000 GOSUB '2
1010 IF C(I)=3 THEN 1100
1020 F9=L8*(1-(S0/S1)!2)*(1/SIN(E(I)/2)+1/SIN(E1(I)/2))/16
1030 K2=4:IF I[]1 THEN 1440
1040 SELECT PRINT 211(100)
1050 PRINT "DIFUSOR PLANO..."
```

A-U682.8 Imprenta del INTA

```
1060 SELECT PRINT 005(64)
1070 PRINT "DIFUSOR PLANO"
1080 K(I)=2:S(I)=2
1090 GOTO 950
1100 F9=L8/(4*SIN(C/2))*(A(I)*(1-S0/S1)/B(I)+.5*(1-(S0/S1)!2))
1110 K2=3.2:GOTO 1440
1120 SELECT PRINT 211(100)
1130 PRINT ".....CURVILINEO....."
1140 SELECT PRINT 005(64):PRINT "DIF.CURVILINEO"
1150 IF J8[]1 THEN 1170
1160 INPUT "CIRCULAR..1.RECTANG..2",M
1170 IF M=1 THEN 1190
1180 GOTO 1260
1190 SELECT PRINT 211(100)
1200 PRINT "DIFUSOR CURVILINEO CIRCULAR.."
1210 SELECT PRINT 005(64)
1220 PRINT "CURV.CIRCULAR"
1230 K(I)=1:S(I)=1
1240 GOSUB '1
1250 GOTO 1320
1260 SELECT PRINT 211(100)
1270 PRINT ".DIFUSOR CURVILINEO RECTANGULAR..";
1280 SELECT PRINT 005(64)
1290 PRINT "CURV.RECTANGULAR"
1300 K(I)=2:S(I)=2
1310 GOSUB '1
1320 K=L(I)/D
1330 IF C(I)=5 THEN 1420
1340 F0=1.0165-.65038*K+.3165*K!2-7.8565E-2*K!3+7.5058E-3*K!4
1350 F9=0:GOTO 1490
1360 SELECT PRINT 211(100)
1370 PRINT ".DIFUSOR CURVILINEO PLANO.."
1380 SELECT PRINT 005(64)
1390 PRINT "CURV.PLANO"
1400 K(I)=2:S(I)=2
1410 GOSUB '1
1420 F0=1.0135-.39365*K+.11737*K!2-1.8378E-2*K!3+1.1294E-3*K!4
1430 F9=0:GOTO 1490
1440 X(I)=F9+K2*(TAN(C/2))!(5/4)*(1-S0/S1)!2
1450 IF C(I)[]2 THEN 1500
1460 IF G9=2 THEN 1500
1470 F2=F2*.65
1480 GOTO 1500
1490 X(I)=F9+F0*(1.43-1.3*S0/S1)*(1-S0/S1)!2
1500 P(I)=R0*X(I)/S0!2
1510 GOSUB '7:GOSUB '8
1520 RETURN
1530 REM .............TRAMO RECTO.........
1540 SELECT PRINT 211(100)
1550 PRINT ".TRAMO RECTO...."
1560 SELECT PRINT 005(64)
1570 PRINT "TRAMO RECTO"
1580 IF J8[]1 THEN 1600
```

A-4pmt.3 Impresos del INTA

```
1590 INPUT "TIPO DE SECCION..INICIAL,FINAL (1 CIRC..2 RECT)",K(I
),S(I)
1600 GOSUB '1
1610 IF K(I)=2 THEN 1630
1620 D=D(I):GOTO 1640
1630 D=2*S0/(A(I)+B(I))
1640 R=W0*D/V8:D8=R8/D
1650 GOSUB '2
1655 IF J8[]1 THEN 1710
1660 IF I[]1 THEN 1700
1670 INPUT "CON PARED INICIAL(.5)..SIN PARED(1.0)",N8
1680 X(I)=L8*L(I)/D+N8
1690 GOTO 1710
1700 X(I)=L8*L(I)/D
1710 P(I)=R0*X(I)/S0!2
1720 GOSUB '7:GOSUB '8
1730 RETURN
1740 REM ...........REJILLAS.............
1750 SELECT PRINT 211(100)
1760 PRINT ".REJILLA...."
1770 SELECT PRINT 005(64)
1780 PRINT "REJILLA"
1790 IF J8[]1 THEN 1860
1800 IF I=1 THEN 1810:K(I)=K(I-1):GOTO 1820
1810 INPUT "TIPO DE SECCION (1 CIRCULAR..2 RECT)",K(I)
1820 S(I)=K(I):L(I)=0
1830 INPUT "AREA LIBRE/AREA TOTAL",T0
1840 INPUT "DIAMETRO HILO(MM)",D4
1850 D4=D4*1E-3
1860 GOSUB '1
1870 R=W0*D4/V8
1880 X(I)=1.3*(1-T0)+(1/T0-1)!2
1890 IF R[400 THEN 1910
1900 GOTO 1930
1910 K8=1.6256-4.7328E-3*R+1.2228E-5*R!2-1.2480E-8*R!3+4.3552E-1
2*R!4
1920 X(I)=X(I)*K8
1930 P(I)=R0*X(I)/S0!2
1940 GOSUB '7:GOSUB '8
1950 RETURN
1960 REM ...SUBRUTINA.PERDIDAS POR FRICCION.........
1970 DEFFN'2
1980 DEFFNC(X)=X-(-2*LOG(2.51/(R*SQR(X)))/2.302+D8/3.7)!(-2)
1990 Z=8
2000 IF R]23/D8 THEN 2030
2010 L8=(1.8*LOG(R)/2.302-1.64)!(-2)
2020 RETURN
2030 IF R[560/D8 THEN 2060
2040 L8=(2*LOG(3.7/D8)/2.302)!(-2)
2050 RETURN
2060 IF D8[.00008 THEN 2100
2070 IF D8].0125 THEN 2100
2080 L8=.1*(1.46*D8+100/R)!(.25)
2090 RETURN
2100 A=1E-9:B=.1
2110 S=SGN(FNC(A))
```

A-40812 Imprenta del INTA

```
2120 T=SGN(FNC(B))
2130 PRINT
2140 IF S*T=0 THEN 2340
2150 IF S*T[0 THEN 2260
2160 FOR I=1 TO 1000
2170      X=A+RND(Z)*(B-A)
2180 V=SGN(FNC(X))
2190 IF V=0 THEN 2380
2200 IF S*V[0 THEN 2250
2210 NEXT I
2220 PRINT "NO CHANGE OF SIGN FOUND"
2230 PRINT
2240 STOP
2250 B=X
2260 F(2+S)=A
2270 F(2-S)=B
2280 X=(F(1)+F(3))/2
2290 U=SGN(FNC(X))
2300 IF U=0 THEN 2380
2310 F(2+U)=X
2320 IF ABS(F(1)-F(3))/(ABS(F(1))+ABS(F(3)))[5E-6 THEN 2380
2330 GOTO 2280
2340 IF S=0 THEN 2370
2350 X=B
2360 GOTO 2380
2370 X=A
2380 L8=X
2390 RETURN
2400 REM .............HONEYCOMBS.............
2410 SELECT PRINT 211(100)
2420 PRINT ".HONEYCOMB...."
2430 SELECT PRINT 005(64)
2440 PRINT "HONEYCOMB"
2450 IF J8[]1 THEN 2530
2460 IF I=1 THEN 2470:K(I)=K(I-1):GOTO 2480
2470 INPUT "TIPO DE SECCION (1 CIRCULAR..2 RECT)",K(I)
2480 INPUT "AREA LIBRE/AREA TOTAL",T5
2490 INPUT "LADO DE LA ABERTURA(MM)",D5
2500 D5=D5*1E-3
2510 INPUT "ESPESOR DEL HONEYCOMB",L(I)
2520 S(I)=K(I)
2530 GOSUB '1
2540 R=U0*D5/V8
2550 D8=R8/D5
2560 GOSUB '2
2570 L=L(I)
2580 IF L/D5]2 THEN 2610
2590 T1=1.324+.562*(L/D5)-4.236*(L/D5)!2+3.391*(L/D5)!3-.788*(L/
D5)!4
2600 GOTO 2620
2610 T1=0
2620 IF R[1E5 THEN 2660
2630 F5=((.5+T1*SQR(1-T5))*(1-T5)+(1-T5)!2+L8*L/D5)/T5!2
2640 X(I)=F5
```

```
2650 GOTO 2740
2660 E5=.2259*R!.12385
2670 IF R]1E4 THEN 2710
2680 REM .......G5 AJUSTADO PARA T0=.6..........
2690 G5=7.7101*R!(-.77707)
2700 GOTO 2720
2710 G5=0
2720 F5=(G5+E5*((.5+T1*SQR(1-T5))*(1-T5)+(1-T5)!2)+L8*L/D5)/T5!2

2730 X(I)=F5
2740 P(I)=R0*X(I)/S0!2
2750 GOSUB '7:GOSUB '8
2760 RETURN
2770 P8=R0/S1!2
2780 U8=U8+P8
2790 SELECT PRINT 211(100)
2800 PRINT "PERDIDA DESCARGA(KG/M2)=",P8
2810 PRINT "PERDIDA CARGA TOTAL     =",U8
2820 H8=U8*Q/75
2830 PRINT "POTENCIA ABSORBIDA(CV) =",H8
2840 PRINT "LONGITUD TOTAL(M)       =",W8:PRINT
2850 SELECT PRINT 005
2860 NEXT Q
2870 END
2880 DEFFN'7
2890 IF S(I)=2 THEN 2940
2900 IF S(I)=K(I) THEN 2920
2910 D(I)=A(I)
2920 P1=D(I):P2=P1:P3=D1(I):P4=P3
2930 GOTO 2970
2940 IF S(I)=K(I) THEN 2960
2950 A(I)=D(I):B(I)=D(I)
2960 P1=A(I):P2=B(I):P3=A1(I):P4=B1(I)
2970 P5=L(I):P6=K(I):Y8=S(I):P7=S0:P8=S1
2980 P9=W0:X1=U1:X2=P(I)
2990 RETURN
3000 DEFFN'8
3010 SELECT PRINT 211(100)
3020 IF J8=1 THEN 3060
3030 PRINTUSING 3040,P9,X1,X2
3040 %          VELO ###.##   VEL1 ###.##   KG/M2 ###.##
3050 GOTO 3110
3060 IF I[]1 THEN 3090
3070 PRINTUSING 3080
3080 % A0   B0    A1    B1    LONG  K4 K3  S0    S1     V0
V1   KG/M2
3090 PRINTUSING 3100,P1,P2,P3,P4,P5,P6,Y8,P7,P8,P9,X1,X2
3100 %##.## ##.## ##.## ##.## ##.##  #  # ##.## ##.## ###.## ###
.## ###.##
3110 SELECT PRINT 005(64)
3120 RETURN
3130 DEFFN'1
3140 IF J8[]1 THEN 3330
3150 IF K(I)=2 THEN 3230
3160 IF I=1 THEN 3180
3170 D(I)=D1(I-1):GOTO 3190
```

A-U002.3 Imprenta del INTA

```
3180 INPUT "DIAMETRO INICIAL",D(I)
3190 IF Z(I)[4 THEN 3200:D1(I)=D(I):GOTO 3340
3200 IF S(I)=2 THEN 3300
3210 INPUT "DIAMETRO FINAL",D1(I)
3220 GOTO 3310
3230 IF I=1 THEN 3250
3240 A(I)=A1(I-1):B(I)=B1(I-1):GOTO 3260
3250 INPUT "LADOS INICIALES..VERT,HORIZ",A(I),B(I)
3260 IF Z(I)[4 THEN 3280
3270 A1(I)=A(I):B1(I)=B(I):GOTO 3380
3280 IF S(I)=1 THEN 3210
3290 IF Z(I)[]3 THEN 3300:IF K(I)[]S(I) THEN 3300:A1(I)=A(I):B1(
I)=B(I):GOTO 3310
3300 INPUT "LADOS FINALES..VERT,HORIZ",A1(I),B1(I)
3310 IF Z(I)]3 THEN 3330
3320 INPUT "LONGITUD",L(I)
3330 IF K(I)=2 THEN 3380
3340 S0=#PI*D(I)!2/4:U0=Q/S0
3350 IF S(I)=2 THEN 3400
3360 S1=#PI*D1(I)!2/4:U1=Q/S1
3370 GOTO 3410
3380 S0=A(I)*B(I):U0=Q/S0
3390 IF S(I)=1 THEN 3360
3400 S1=A1(I)*B1(I) U1=Q/S1
3410 IF J8[]1 THEN 3460
3420 IF K(I)[]S(I) THEN 3460
3430 IF Z(I)-1]1 THEN 3460
3440 IF K(I)=2 THEN 3470
3450 C=2*ARCTAN(ABS( 1(I)-D(I))/(2*L(I)))
3460 RETURN
3470 E(I)=2*ARCTAN(ABS(A1(I)-A(I))/(2*L(I)))
3480 E1(I)=2*ARCTAN(ABS(B1(I)-B(I))/(2*L(I)))
3490 IF E1(I)]E(I) THEN 3510
3500 C=E(I):RETURN
3510 C=E1(I):RETURN
```

A-1/002.3 Imprenta del INTA

TABLE I

RESULTS OF COMPUTER PROGRAM

A-4062.3 Imprenta del INTA

CAUDAL(M3/S)= .2

.HONEYCOMB....

A0	BO	A1	B1	LONG	K4	K3	SO	S1	VO	V1	KG/M2
1.20	0.60	1.20	0.60	0.15	2	2	0.72	0.72	0.27	0.27	0.13
PRISMATICO											
1.20	0.60	0.40	0.20	1.00	2	2	0.72	0.08	0.27	2.50	0.04
.TRAMO RECTO....											
0.40	0.20	0.40	0.20	0.60	2	2	0.08	0.08	2.50	2.50	0.01
.TRAMO RECTO....											
0.40	0.40	0.40	0.40	1.50	2	1	0.08	0.12	2.50	1.59	0.04
.DIFUSOR CONICO..											
0.40	0.40	0.50	0.50	1.00	1	1	0.12	0.19	1.59	1.01	0.00
.REJILLA....											
0.50	0.50	0.50	0.50	0.00	1	1	0.19	0.19	1.01	1.01	0.03

PERDIDA DESCARGA(KG/M2)= 6.35221788E-02
PERDIDA CARGA TOTAL = .3526966751413
POTENCIA ABSORBIDA(CV) = 9.40524467E-04
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= .4

.HONEYCOMB....						
	VELO	0.55	VEL1	0.55	KG/M2	0.29
PRISMATICO						
	VELO	0.55	VEL1	5.00	KG/M2	0.16
.TRAMO RECTO....						
	VELO	5.00	VEL1	5.00	KG/M2	0.07
.TRAMO RECTO....						
	VELO	5.00	VEL1	3.18	KG/M2	0.19
.DIFUSOR CONICO..						
	VELO	3.18	VEL1	2.03	KG/M2	0.02
.REJILLA....						
	VELO	2.03	VEL1	2.03	KG/M2	0.13

PERDIDA DESCARGA(KG/M2)= .2540887152223
PERDIDA CARGA TOTAL = 1.135151251027
POTENCIA ABSORBIDA(CV) = 6.05414000E-03
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= .6

.HONEYCOMB....						
	VELO	0.83	VEL1	0.83	KG/M2	0.49
PRISMATICO						
	VELO	0.83	VEL1	7.50	KG/M2	0.36
.TRAMO RECTO....						
	VELO	7.50	VEL1	7.50	KG/M2	0.17
.TRAMO RECTO....						
	VELO	7.50	VEL1	4.77	KG/M2	0.42
.DIFUSOR CONICO..						
	VELO	4.77	VEL1	3.05	KG/M2	0.05
.REJILLA....						
	VELO	3.05	VEL1	3.05	KG/M2	0.26

PERDIDA DESCARGA(KG/M2)= .5716996092501
PERDIDA CARGA TOTAL = 2.356952527758
POTENCIA ABSORBIDA(CV) = 1.88556202E-02
LONGITUD TOTAL(M) = 4.255

A-4/002.3 Imprenta del INTA

```
CAUDAL(M3/S)=     .8

.HONEYCOMB....
            VELO   1.11    VEL1   1.11    KG/M2    0.73
PRISMATICO
            VELO   1.11    VEL1  10.00    KG/M2    0.65
.TRAMO RECTO....
            VELO  10.00    VEL1  10.00    KG/M2    0.30
.TRAMO RECTO....
            VELO  10.00    VEL1   6.36    KG/M2    0.76
.DIFUSOR CONICO..
            VELO   6.36    VEL1   4.07    KG/M2    0.08
.REJILLA....
            VELO   4.07    VEL1   4.07    KG/M2    0.45
PERDIDA DESCARGA(KG/M2)=          1.016354860889
PERDIDA CARGA TOTAL     =         4.012602944313
POTENCIA ABSORBIDA(CV)  =         4.28010980E-02
LONGITUD TOTAL(M)       =         4.255

CAUDAL(M3/S)=     1

.HONEYCOMB....
            VELO   1.38    VEL1   1.38    KG/M2    1.01
PRISMATICO
            VELO   1.38    VEL1  12.50    KG/M2    1.01
.TRAMO RECTO....
            VELO  12.50    VEL1  12.50    KG/M2    0.47
.TRAMO RECTO....
            VELO  12.50    VEL1   7.95    KG/M2    1.19
.DIFUSOR CONICO..
            VELO   7.95    VEL1   5.09    KG/M2    0.13
.REJILLA....
            VELO   5.09    VEL1   5.09    KG/M2    0.69
PERDIDA DESCARGA(KG/M2)=          1.588054470139
PERDIDA CARGA TOTAL     =         6.109700567488
POTENCIA ABSORBIDA(CV)  =         8.14626742E-02
LONGITUD TOTAL(M)       =         4.255

CAUDAL(M3/S)=     1.2

.HONEYCOMB....
            VELO   1.66    VEL1   1.66    KG/M2    1.31
PRISMATICO
            VELO   1.66    VEL1  15.00    KG/M2    1.46
.TRAMO RECTO....
            VELO  15.00    VEL1  15.00    KG/M2    0.68
.TRAMO RECTO....
            VELO  15.00    VEL1   9.54    KG/M2    1.71
.DIFUSOR CONICO..
            VELO   9.54    VEL1   6.11    KG/M2    0.19
.REJILLA....
            VELO   6.11    VEL1   6.11    KG/M2    0.99
PERDIDA DESCARGA(KG/M2)=          2.286798437
PERDIDA CARGA TOTAL     =         8.654544001874
POTENCIA ABSORBIDA(CV)  =         .13847270403
LONGITUD TOTAL(M)       =         4.255
```

A-4082.3 Imprenta del INTA

```
CAUDAL(M3/S)=     1.4

.HONEYCOMB....
                VELO   1.94    VEL1   1.94    KG/M2    1.65
PRISMATICO
                VELO   1.94    VEL1  17.50    KG/M2    1.98
.TRAMO RECTO....
                VELO  17.50    VEL1  17.50    KG/M2    0.93
.TRAMO RECTO....
                VELO  17.50    VEL1  11.14    KG/M2    2.33
.DIFUSOR CONICO..
                VELO  11.14    VEL1   7.13    KG/M2    0.25
.REJILLA....
                VELO   7.13    VEL1   7.13    KG/M2    1.35
PERDIDA DESCARGA(KG/M2)=             3.112586761473
PERDIDA CARGA TOTAL     =             11.63357811892
POTENCIA ABSORBIDA(CV)  =             .2171601248865
LONGITUD TOTAL(M)       =             4.255

CAUDAL(M3/S)=     1.6

.HONEYCOMB....
                VELO   2.22    VEL1   2.22    KG/M2    2.01
PRISMATICO
                VELO   2.22    VEL1  20.00    KG/M2    2.59
.TRAMO RECTO....
                VELO  20.00    VEL1  20.00    KG/M2    1.21
.TRAMO RECTO....
                VELO  20.00    VEL1  12.73    KG/M2    3.04
.DIFUSOR CONICO..
                VELO  12.73    VEL1   8.14    KG/M2    0.33
.REJILLA....
                VELO   8.14    VEL1   8.14    KG/M2    1.77
PERDIDA DESCARGA(KG/M2)=             4.065419443558
PERDIDA CARGA TOTAL     =             15.04693288118
POTENCIA ABSORBIDA(CV)  =             .3210012347985
LONGITUD TOTAL(M)       =             4.255

CAUDAL(M3/S)=     1.8

.HONEYCOMB....
                VELO   2.50    VEL1   2.50    KG/M2    2.40
PRISMATICO
                VELO   2.50    VEL1  22.50    KG/M2    3.28
.TRAMO RECTO....
                VELO  22.50    VEL1  22.50    KG/M2    1.54
.TRAMO RECTO....
                VELO  22.50    VEL1  14.32    KG/M2    3.85
.DIFUSOR CONICO..
                VELO  14.32    VEL1   9.16    KG/M2    0.41
.REJILLA....
                VELO   9.16    VEL1   9.16    KG/M2    2.24
PERDIDA DESCARGA(KG/M2)=             5.145296483252
PERDIDA CARGA TOTAL     =             18.8935172618
POTENCIA ABSORBIDA(CV)  =             .4534444142832
LONGITUD TOTAL(M)       =             4.255
```

A-4008.3 Imprenta del INTA

CAUDAL(M3/S)= 2

.HONEYCOMB....						
	VELO	2.77	VEL1	2.77	KG/M2	2.82
PRISMATICO						
	VELO	2.77	VEL1	25.00	KG/M2	4.04
.TRAMO RECTO....						
	VELO	25.00	VEL1	25.00	KG/M2	1.90
.TRAMO RECTO....						
	VELO	25.00	VEL1	15.91	KG/M2	4.76
.DIFUSOR CONICO..						
	VELO	15.91	VEL1	10.18	KG/M2	0.51
.REJILLA....						
	VELO	10.18	VEL1	10.18	KG/M2	2.77

PERDIDA DESCARGA(KG/M2)= 6.352217880558
PERDIDA CARGA TOTAL = 23.17241852623
POTENCIA ABSORBIDA(CV) = .6179311606995
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= 2.2

.HONEYCOMB....						
	VELO	3.05	VEL1	3.05	KG/M2	3.26
PRISMATICO						
	VELO	3.05	VEL1	27.50	KG/M2	4.89
.TRAMO RECTO....						
	VELO	27.50	VEL1	27.50	KG/M2	2.30
.TRAMO RECTO....						
	VELO	27.50	VEL1	17.50	KG/M2	5.76
.DIFUSOR CONICO..						
	VELO	17.50	VEL1	11.20	KG/M2	0.61
.REJILLA....						
	VELO	11.20	VEL1	11.20	KG/M2	3.35

PERDIDA DESCARGA(KG/M2)= 7.686183635473
PERDIDA CARGA TOTAL = 27.88285677454
POTENCIA ABSORBIDA(CV) = .8178971320532
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= 2.4

.HONEYCOMB....						
	VELO	3.33	VEL1	3.33	KG/M2	3.73
PRISMATICO						
	VELO	3.33	VEL1	30.00	KG/M2	5.82
.TRAMO RECTO....						
	VELO	30.00	VEL1	30.00	KG/M2	2.74
.TRAMO RECTO....						
	VELO	30.00	VEL1	19.09	KG/M2	6.85
.DIFUSOR CONICO..						
	VELO	19.09	VEL1	12.22	KG/M2	0.72
.REJILLA....						
	VELO	12.22	VEL1	12.22	KG/M2	3.98

PERDIDA DESCARGA(KG/M2)= 9.147193748002
PERDIDA CARGA TOTAL = 33.02415445622
POTENCIA ABSORBIDA(CV) = 1.056772942599
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= 2.6

.HONEYCOMB....						
	VELO	3.61	VEL1	3.61	KG/M2	3.65
PRISMATICO						
	VELO	3.61	VEL1	32.50	KG/M2	6.83
.TRAMO RECTO....						
	VELO	32.50	VEL1	32.50	KG/M2	3.21
.TRAMO RECTO....						
	VELO	32.50	VEL1	20.69	KG/M2	8.04
.DIFUSOR CONICO..						
	VELO	20.69	VEL1	13.24	KG/M2	0.84
.REJILLA....						
	VELO	13.24	VEL1	13.24	KG/M2	4.68

PERDIDA DESCARGA(KG/M2)= 10.73524821814
PERDIDA CARGA TOTAL = 38.02644462232
POTENCIA ABSORBIDA(CV) = 1.31825008024
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= 2.8

.HONEYCOMB....						
	VELO	3.88	VEL1	3.88	KG/M2	4.12
PRISMATICO						
	VELO	3.88	VEL1	35.00	KG/M2	7.92
.TRAMO RECTO....						
	VELO	35.00	VEL1	35.00	KG/M2	3.73
.TRAMO RECTO....						
	VELO	35.00	VEL1	22.28	KG/M2	9.33
.DIFUSOR CONICO..						
	VELO	22.28	VEL1	14.26	KG/M2	0.98
.REJILLA....						
	VELO	14.26	VEL1	14.26	KG/M2	5.42

PERDIDA DESCARGA(KG/M2)= 12.45034704589
PERDIDA CARGA TOTAL = 43.97013759162
POTENCIA ABSORBIDA(CV) = 1.64188780342
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= 3

.HONEYCOMB....						
	VELO	4.16	VEL1	4.16	KG/M2	4.62
PRISMATICO						
	VELO	4.16	VEL1	37.50	KG/M2	9.09
.TRAMO RECTO....						
	VELO	37.50	VEL1	37.50	KG/M2	4.28
.TRAMO RECTO....						
	VELO	37.50	VEL1	23.87	KG/M2	10.71
.DIFUSOR CONICO..						
	VELO	23.87	VEL1	15.27	KG/M2	1.12
.REJILLA....						
	VELO	15.27	VEL1	15.27	KG/M2	6.23

PERDIDA DESCARGA(KG/M2)= 14.29249023125
PERDIDA CARGA TOTAL = 50.36029154165
POTENCIA ABSORBIDA(CV) = 2.014411661667
LONGITUD TOTAL(M) = 4.255

A-4002.3 Imprenta del INTA

```
CAUDAL(M3/S)=     3.2

.HONEYCOMB....
          VELO   4.44    VEL1   4.44    KG/M2    5.13
PRISMATICO
          VELO   4.44    VEL1  40.00    KG/M2   10.34
.TRAMO RECTO....
          VELO  40.00    VEL1  40.00    KG/M2    4.87
.TRAMO RECTO....
          VELO  40.00    VEL1  25.46    KG/M2   12.19
.DIFUSOR CONICO..
          VELO  25.46    VEL1  16.29    KG/M2    1.27
.REJILLA....
          VELO  16.29    VEL1  16.29    KG/M2    7.09
PERDIDA DESCARGA(KG/M2)=          16.26167777423
PERDIDA CARGA TOTAL     =          57.16956293388
POTENCIA ABSORBIDA(CV)  =          2.439234685179
LONGITUD TOTAL(M)       =          4.255

CAUDAL(M3/S)=     3.4

.HONEYCOMB....
          VELO   4.72    VEL1   4.72    KG/M2    5.67
PRISMATICO
          VELO   4.72    VEL1  42.50    KG/M2   11.67
.TRAMO RECTO....
          VELO  42.50    VEL1  42.50    KG/M2    5.50
.TRAMO RECTO....
          VELO  42.50    VEL1  27.05    KG/M2   13.76
.DIFUSOR CONICO..
          VELO  27.05    VEL1  17.31    KG/M2    1.43
.REJILLA....
          VELO  17.31    VEL1  17.31    KG/M2    8.00
PERDIDA DESCARGA(KG/M2)=          18.35790967481
PERDIDA CARGA TOTAL     =          64.4064779888
POTENCIA ABSORBIDA(CV)  =          2.919760335492
LONGITUD TOTAL(M)       =          4.255

CAUDAL(M3/S)=     3.6

.HONEYCOMB....
          VELO   5.00    VEL1   5.00    KG/M2    6.22
PRISMATICO
          VELO   5.00    VEL1  45.00    KG/M2   13.08
.TRAMO RECTO....
          VELO  45.00    VEL1  45.00    KG/M2    6.17
.TRAMO RECTO....
          VELO  45.00    VEL1  28.64    KG/M2   15.42
.DIFUSOR CONICO..
          VELO  28.64    VEL1  18.33    KG/M2    1.60
.REJILLA....
          VELO  18.33    VEL1  18.33    KG/M2    8.97
PERDIDA DESCARGA(KG/M2)=          20.581185933
PERDIDA CARGA TOTAL     =          72.07070884028
POTENCIA ABSORBIDA(CV)  =          3.459394024333
LONGITUD TOTAL(M)       =          4.255
```

A-4002.3 Imprenta del INTA

CAUDAL(M3/S)= 3.8

.HONEYCOMB....						
	VELO	5.27	VEL1	5.27	KG/M2	6.80
PRISMATICO						
	VELO	5.27	VEL1	47.50	KG/M2	14.57
.TRAMO RECTO....						
	VELO	47.50	VEL1	47.50	KG/M2	6.87
.TRAMO RECTO....						
	VELO	47.50	VEL1	30.23	KG/M2	17.19
.DIFUSOR CONICO..						
	VELO	30.23	VEL1	19.35	KG/M2	1.77
.REJILLA....						
	VELO	19.35	VEL1	19.35	KG/M2	10.00

PERDIDA DESCARGA(KG/M2)= 22.931506654881
PERDIDA CARGA TOTAL = 80.161963278 54
POTENCIA ABSORBIDA(CV) = 4.06153947278
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= 4

.HONEYCOMB....						
	VELO	5.55	VEL1	5.55	KG/M2	7.40
PRISMATICO						
	VELO	5.55	VEL1	50.00	KG/M2	16.14
.TRAMO RECTO....						
	VELO	50.00	VEL1	50.00	KG/M2	7.61
.TRAMO RECTO....						
	VELO	50.00	VEL1	31.83	KG/M2	19.04
.DIFUSOR CONICO..						
	VELO	31.83	VEL1	20.37	KG/M2	1.96
.REJILLA....						
	VELO	20.37	VEL1	20.37	KG/M2	11.08

PERDIDA DESCARGA(KG/M2)= 25.40887152223
PERDIDA CARGA TOTAL = 88.67999729308
POTENCIA ABSORBIDA(CV) = 4.729599855631
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= 4.2

.HONEYCOMB....						
	VELO	5.83	VEL1	5.83	KG/M2	8.02
PRISMATICO						
	VELO	5.83	VEL1	52.50	KG/M2	17.79
.TRAMO RECTO....						
	VELO	52.50	VEL1	52.50	KG/M2	8.40
.TRAMO RECTO....						
	VELO	52.50	VEL1	33.42	KG/M2	21.00
.DIFUSOR CONICO..						
	VELO	33.42	VEL1	21.39	KG/M2	2.16
.REJILLA....						
	VELO	21.39	VEL1	21.39	KG/M2	12.21

PERDIDA DESCARGA(KG/M2)= 28.01328085326
PERDIDA CARGA TOTAL = 97.62450418359
POTENCIA ABSORBIDA(CV) = 5.466972234281
LONGITUD TOTAL(M) = 4.255

A-1/002.3 Imprenta del INTA

CAUDAL(M3/S)= 4.4

.HONEYCOMB....

VELO	6.11	VEL1	6.11	KG/M2	8.67

PRISMATICO

VELO	6.11	VEL1	55.00	KG/M2	19.53

.TRAMO RECTO....

VELO	55.00	VEL1	55.00	KG/M2	9.21

.TRAMO RECTO....

VELO	55.00	VEL1	35.01	KG/M2	23.04

.DIFUSOR CONICO..

VELO	35.01	VEL1	22.40	KG/M2	2.37

.REJILLA....

VELO	22.40	VEL1	22.40	KG/M2	13.40

PERDIDA DESCARGA(KG/M2)= 30.7447345419
PERDIDA CARGA TOTAL = 106.9951351918
POTENCIA ABSORBIDA(CV) = 6.277047931252
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= 4.6

.HONEYCOMB....

VELO	6.38	VEL1	6.38	KG/M2	9.33

PRISMATICO

VELO	6.38	VEL1	57.50	KG/M2	21.34

.TRAMO RECTO....

VELO	57.50	VEL1	57.50	KG/M2	10.07

.TRAMO RECTO....

VELO	57.50	VEL1	36.60	KG/M2	25.19

.DIFUSOR CONICO..

VELO	36.60	VEL1	23.42	KG/M2	2.58

.REJILLA....

VELO	23.42	VEL1	23.42	KG/M2	14.65

PERDIDA DESCARGA(KG/M2)= 33.60323258816
PERDIDA CARGA TOTAL = 116.7917771709
POTENCIA ABSORBIDA(CV) = 7.163228999815
LONGITUD TOTAL(M) = 4.255

CAUDAL(M3/S)= 4.8

.HONEYCOMB....

VELO	6.66	VEL1	6.66	KG/M2	10.01

PRISMATICO

VELO	6.66	VEL1	60.00	KG/M2	23.23

.TRAMO RECTO....

VELO	60.00	VEL1	60.00	KG/M2	10.97

.TRAMO RECTO....

VELO	60.00	VEL1	38.19	KG/M2	27.42

.DIFUSOR CONICO..

VELO	38.19	VEL1	24.44	KG/M2	2.81

.REJILLA....

VELO	24.44	VEL1	24.44	KG/M2	15.95

PERDIDA DESCARGA(KG/M2)= 36.58877499201
PERDIDA CARGA TOTAL = 127.014179195
POTENCIA ABSORBIDA(CV) = 8.12890746848
LONGITUD TOTAL(M) = 4.255

A-1002.3 Imprenta del INTA

CAUDAL(M3/S)= 5

.HONEYCOMB....						
	VELO	6.94	VEL1	6.94	KG/M2	10.71
PRISMATICO						
	VELO	6.94	VEL1	62.50	KG/M2	25.21
.TRAMO RECTO....						
	VELO	62.50	VEL1	62.50	KG/M2	11.90
.TRAMO RECTO....						
	VELO	62.50	VEL1	39.78	KG/M2	29.76
.DIFUSOR CONICO..						
	VELO	39.78	VEL1	25.46	KG/M2	3.04
.REJILLA....						
	VELO	25.46	VEL1	25.46	KG/M2	17.31

PERDIDA DESCARGA(KG/M2)= 39.70136175348
PERDIDA CARGA TOTAL = 137.6620548338
POTENCIA ABSORBIDA(CV) = 9.177470322253
LONGITUD TOTAL(M) = 4.255

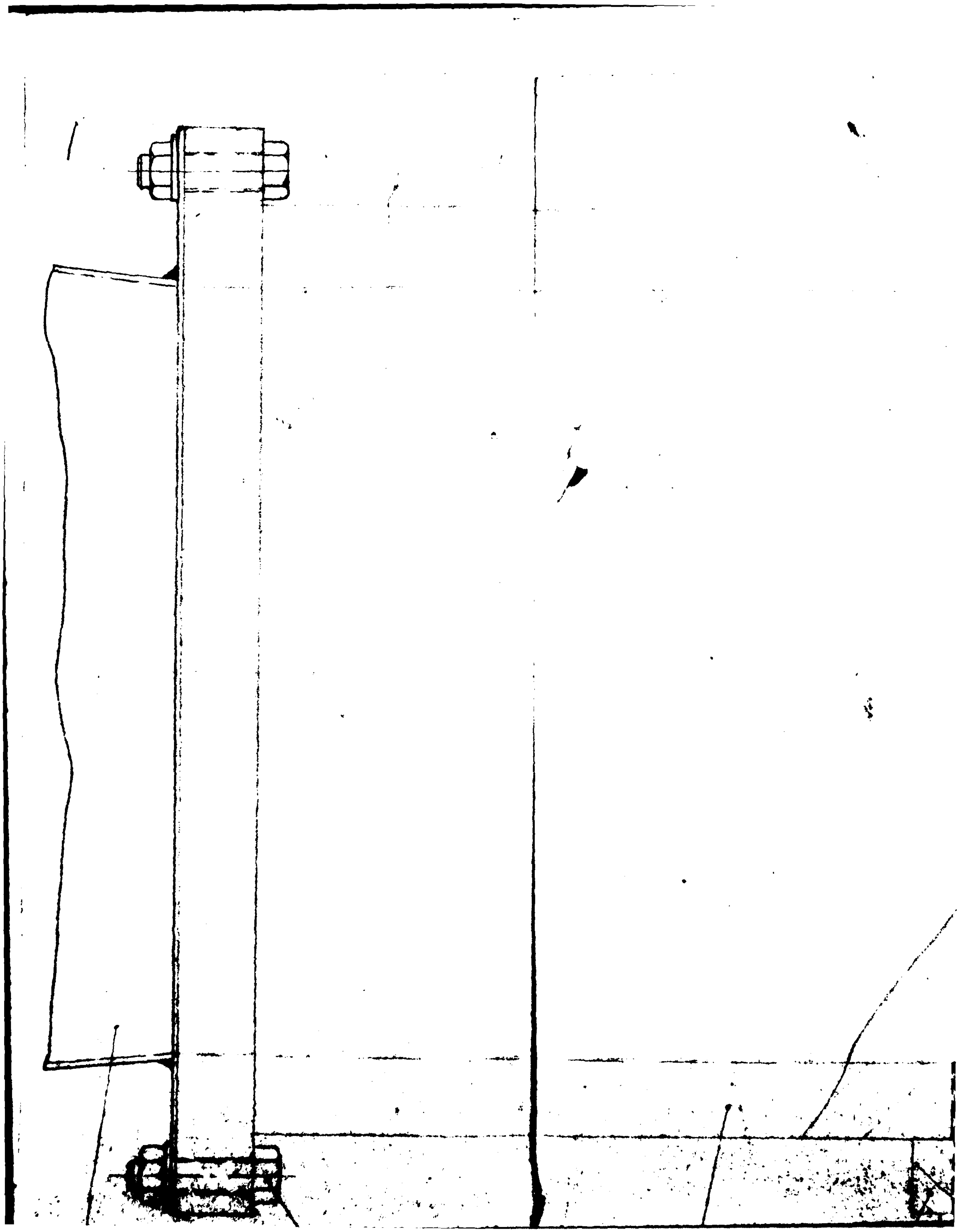
A-4002.3 Imprenta del INTA

ANNEX II

A-1/0012.3 Imprenta del INTA

MANUFACTURING DRAWINS OF ICING TUNNEL

A-4002.3 Imprenta del INTA



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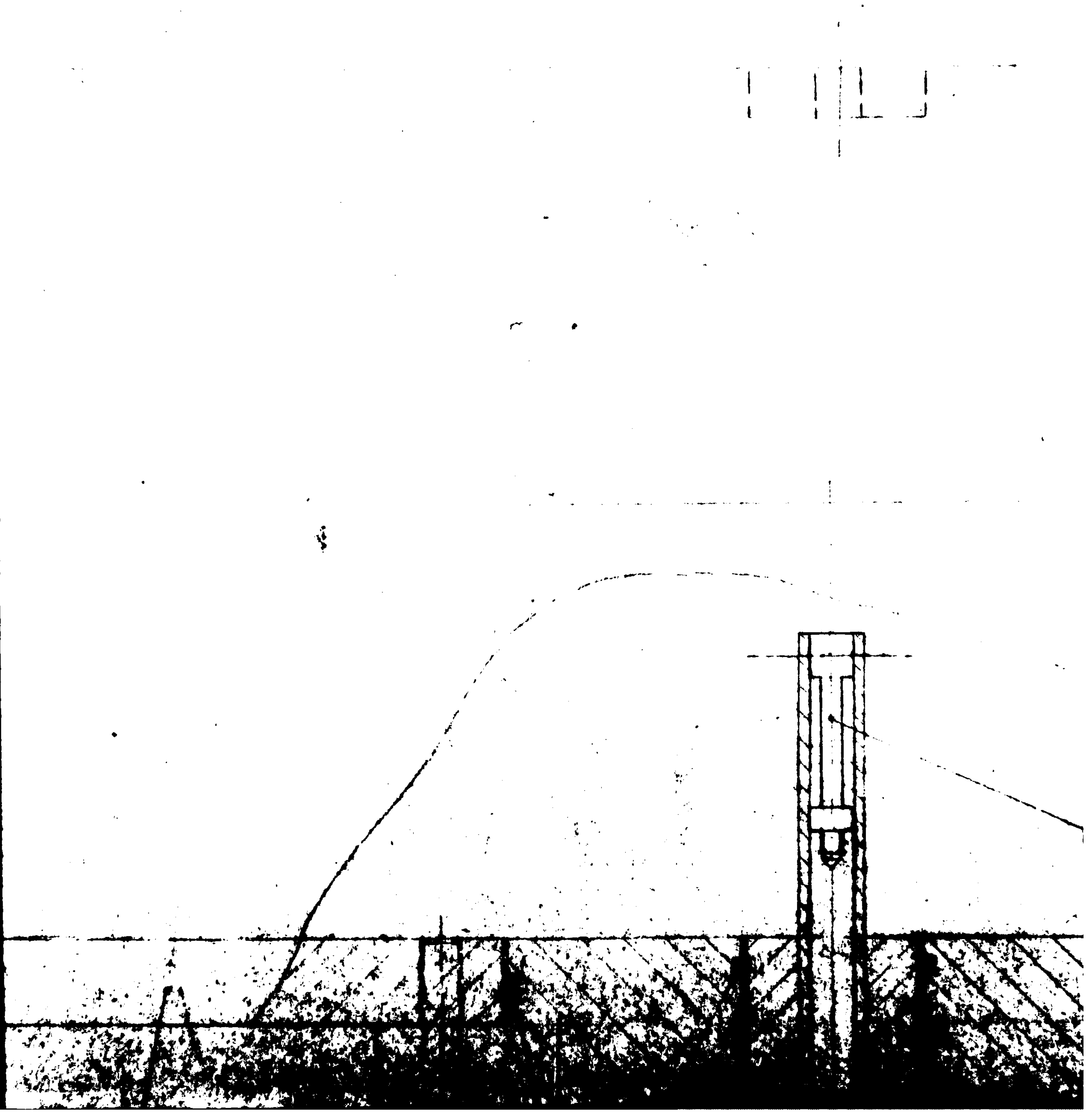

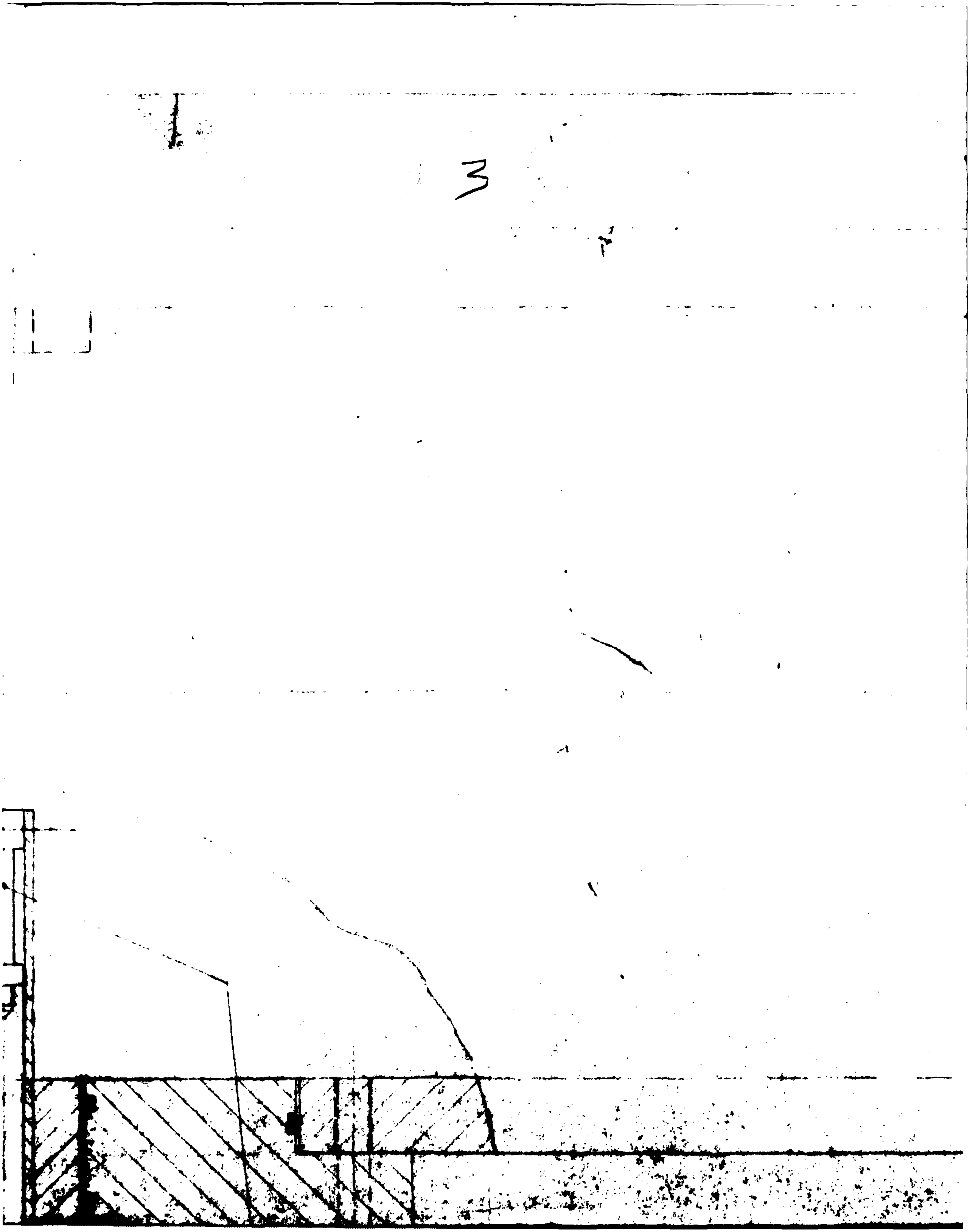
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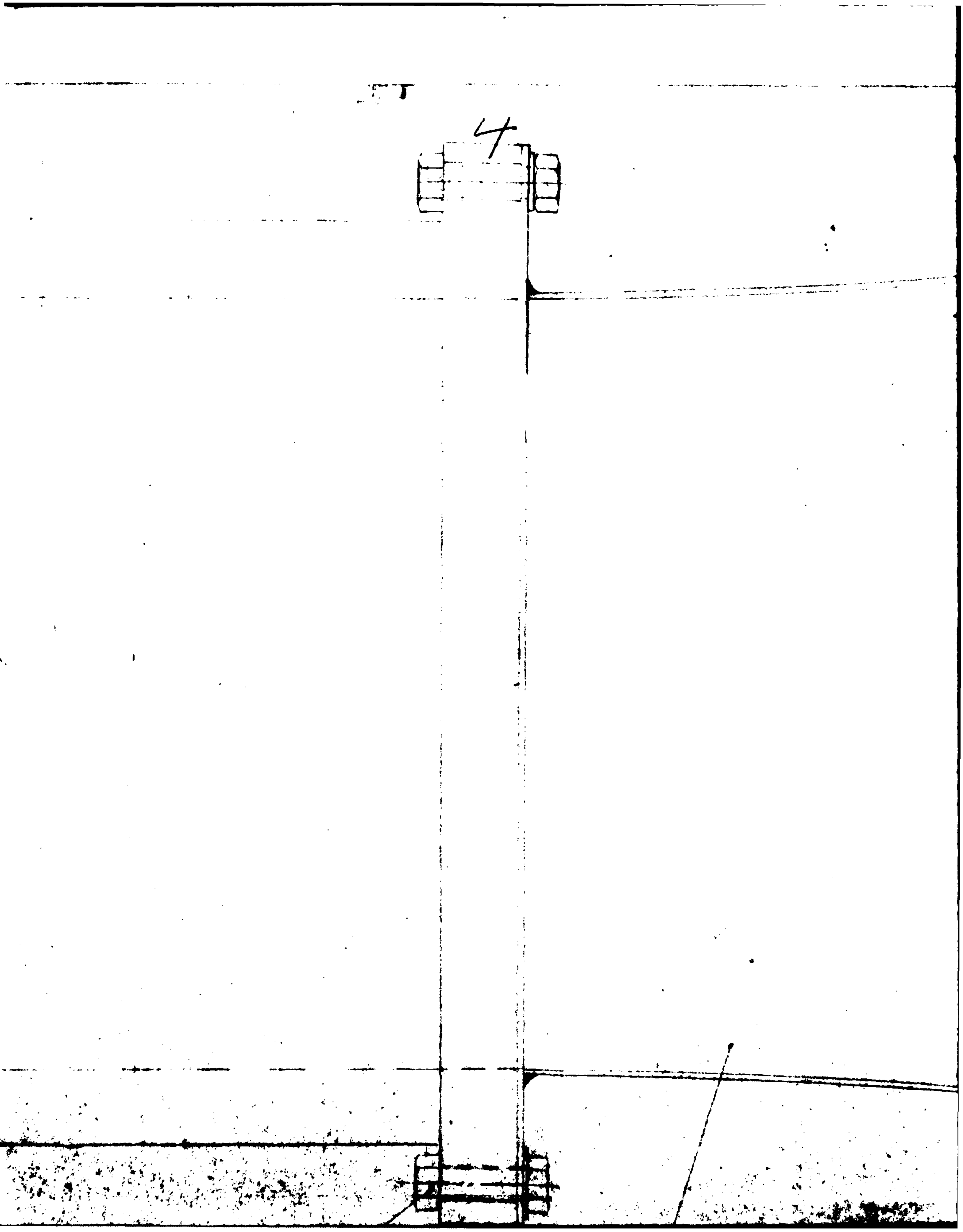
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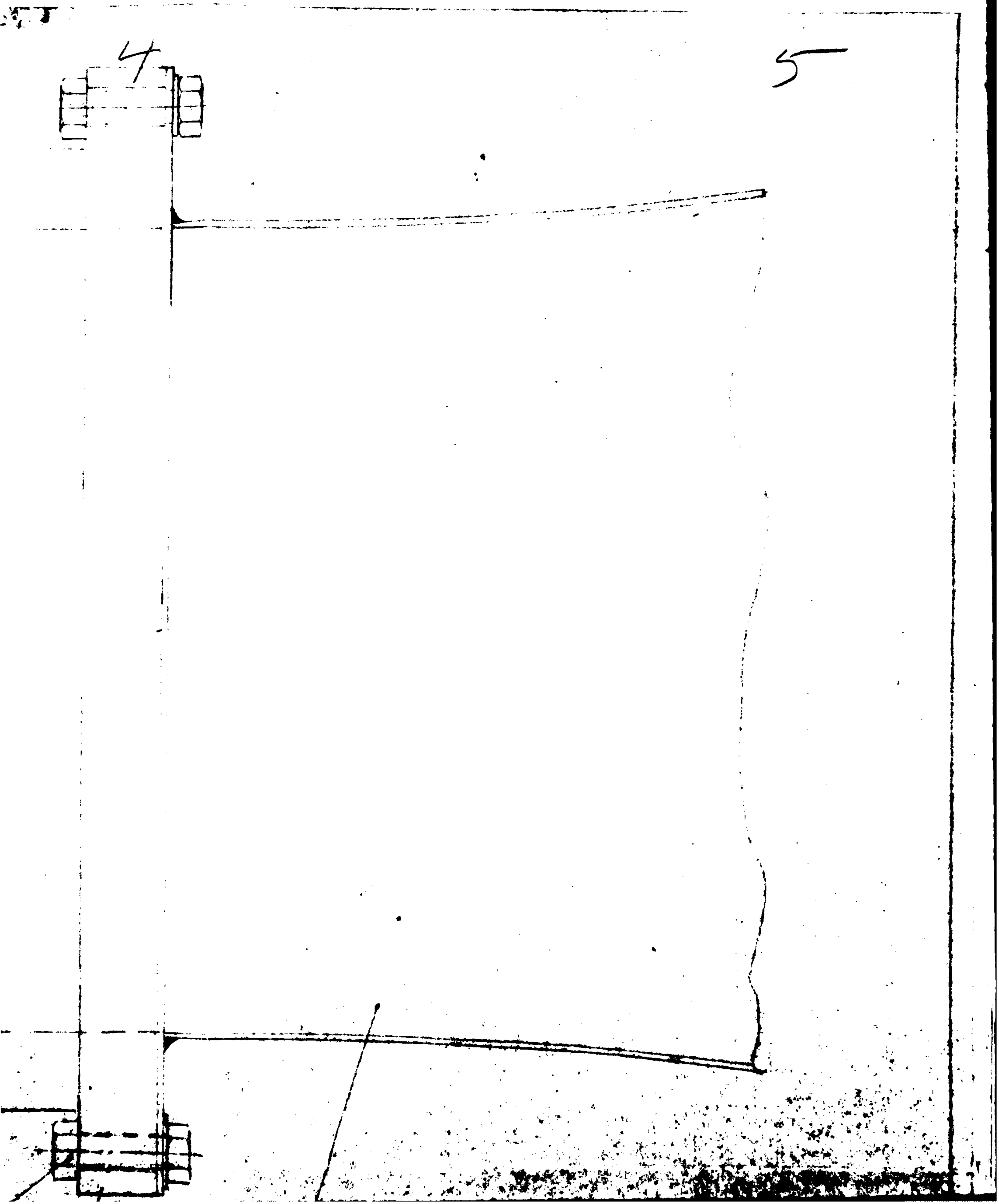
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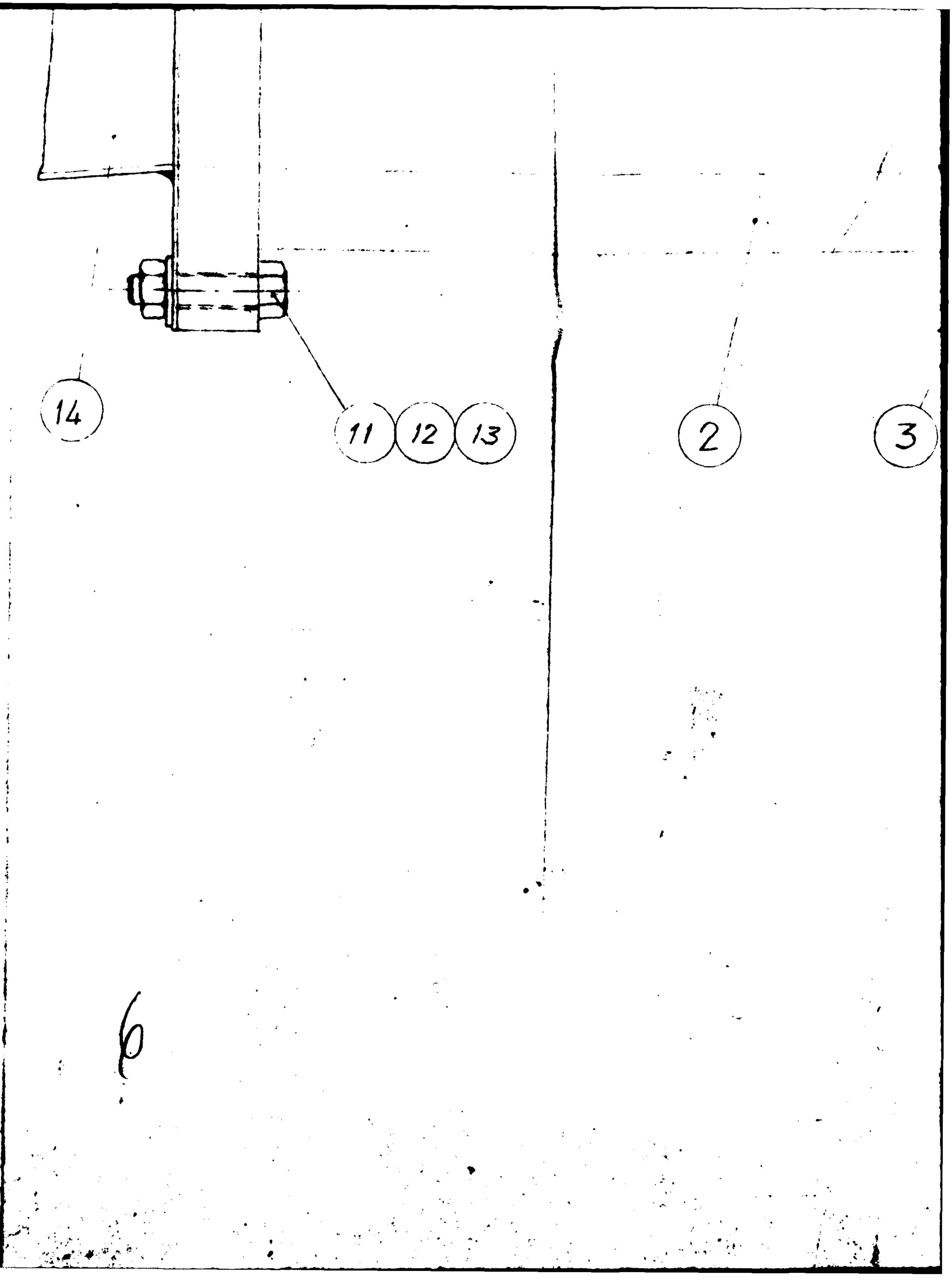

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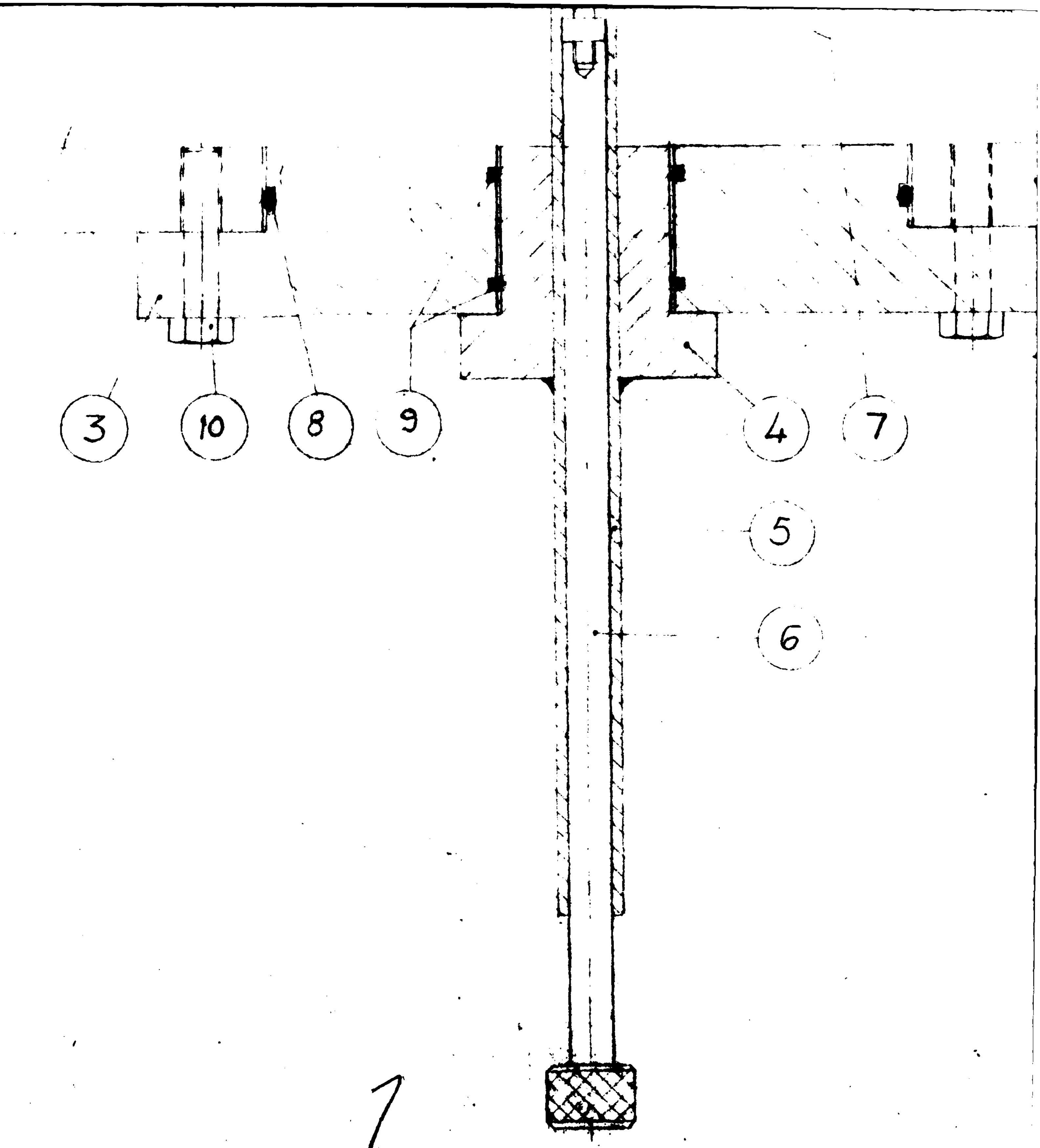

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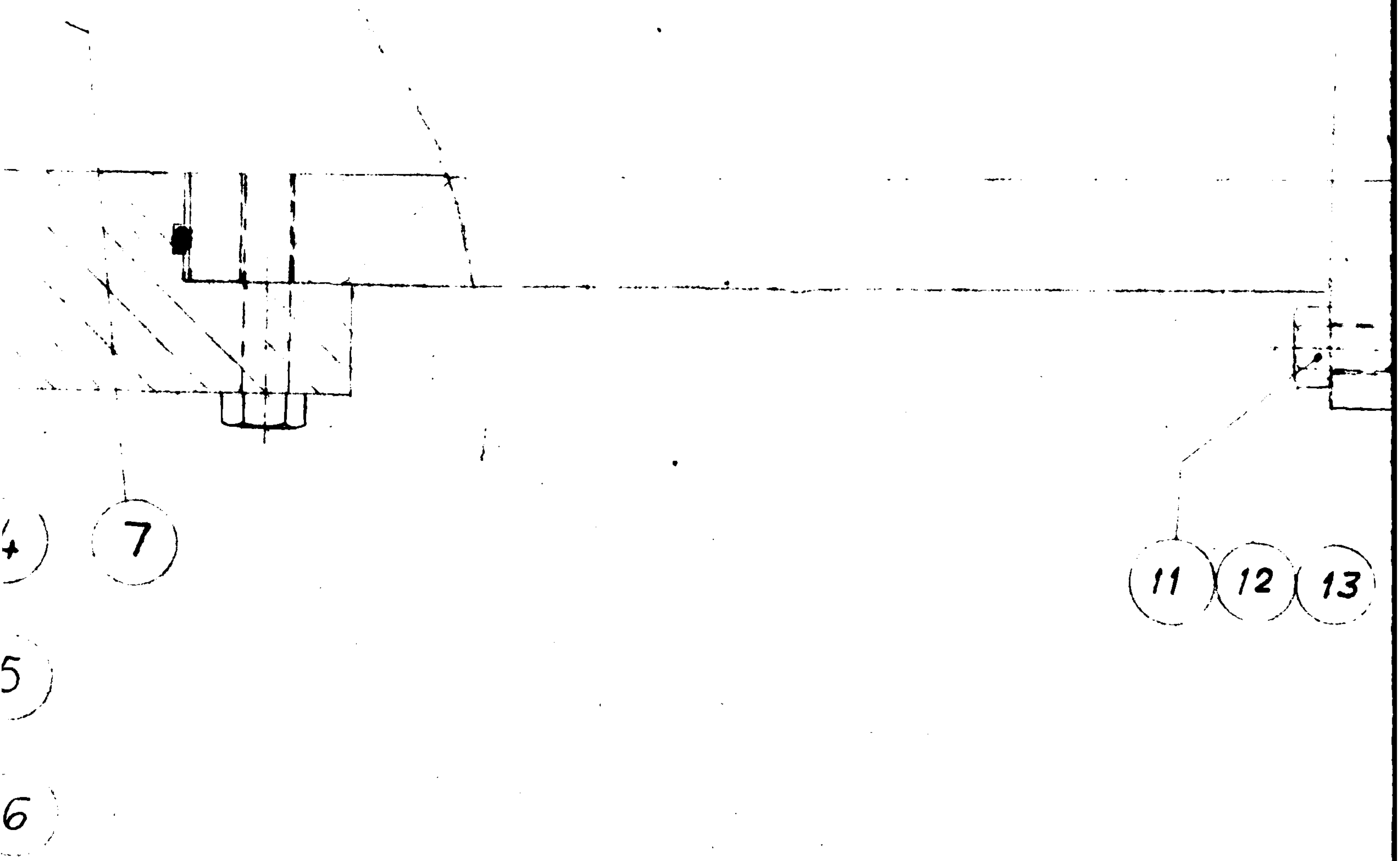
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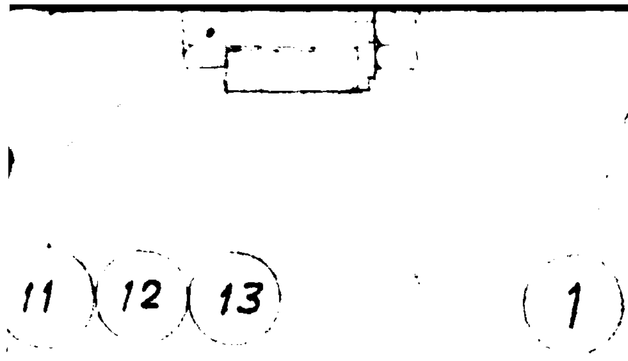
7
5
6
11
12
13

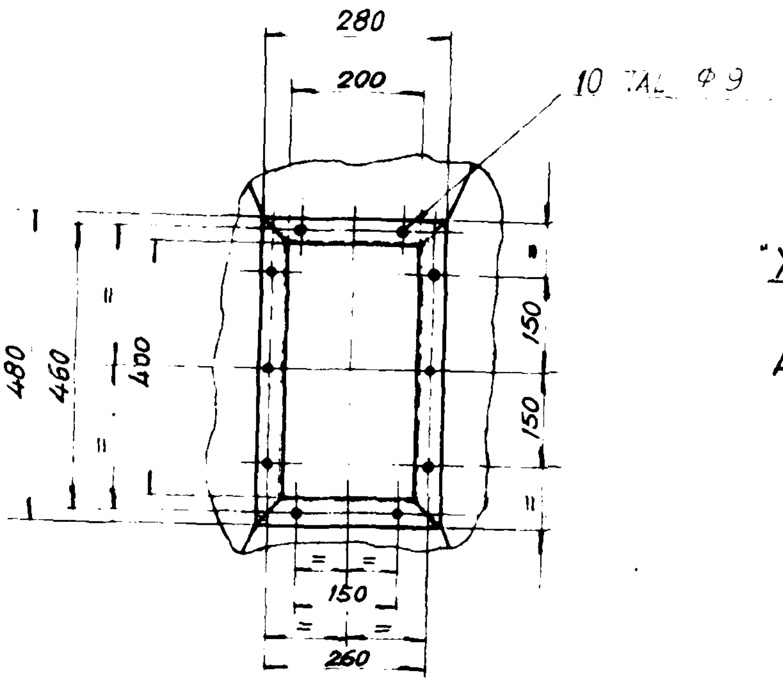


TUNEL FORMACION HIELO

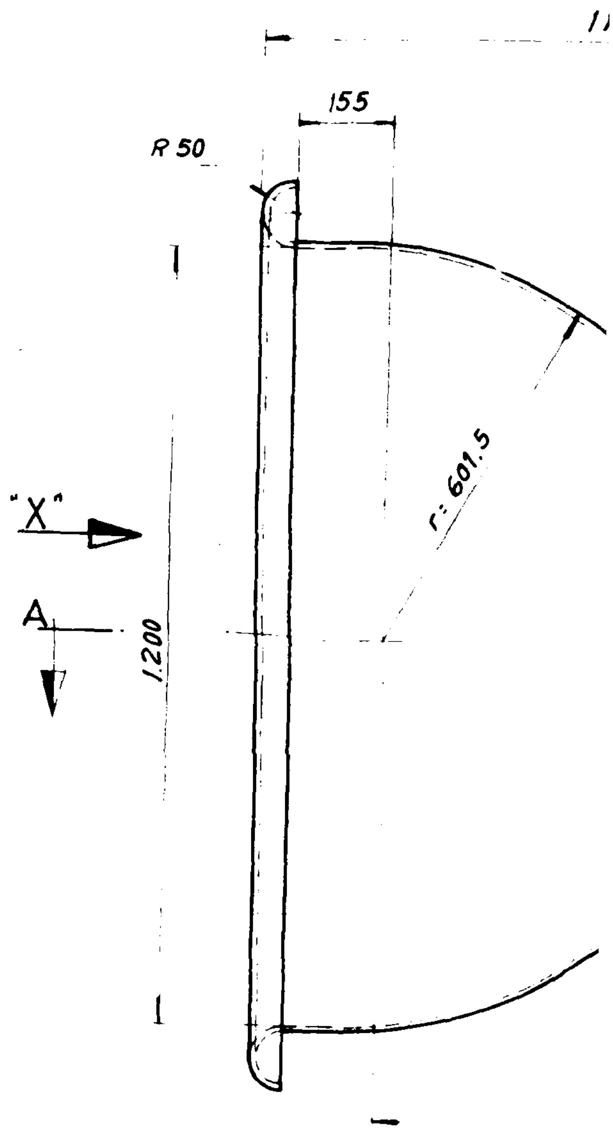
Escala. 1:1

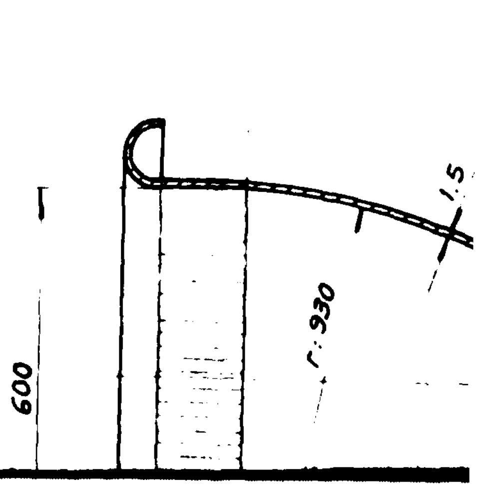
Nº PLANO: 84-023-A

9


280
200
10 TAL. Φ 9
480
460
400
150
150
150
260

VISTA POR "Y"


155
R 50
r: 601,5
"X"
A
1.200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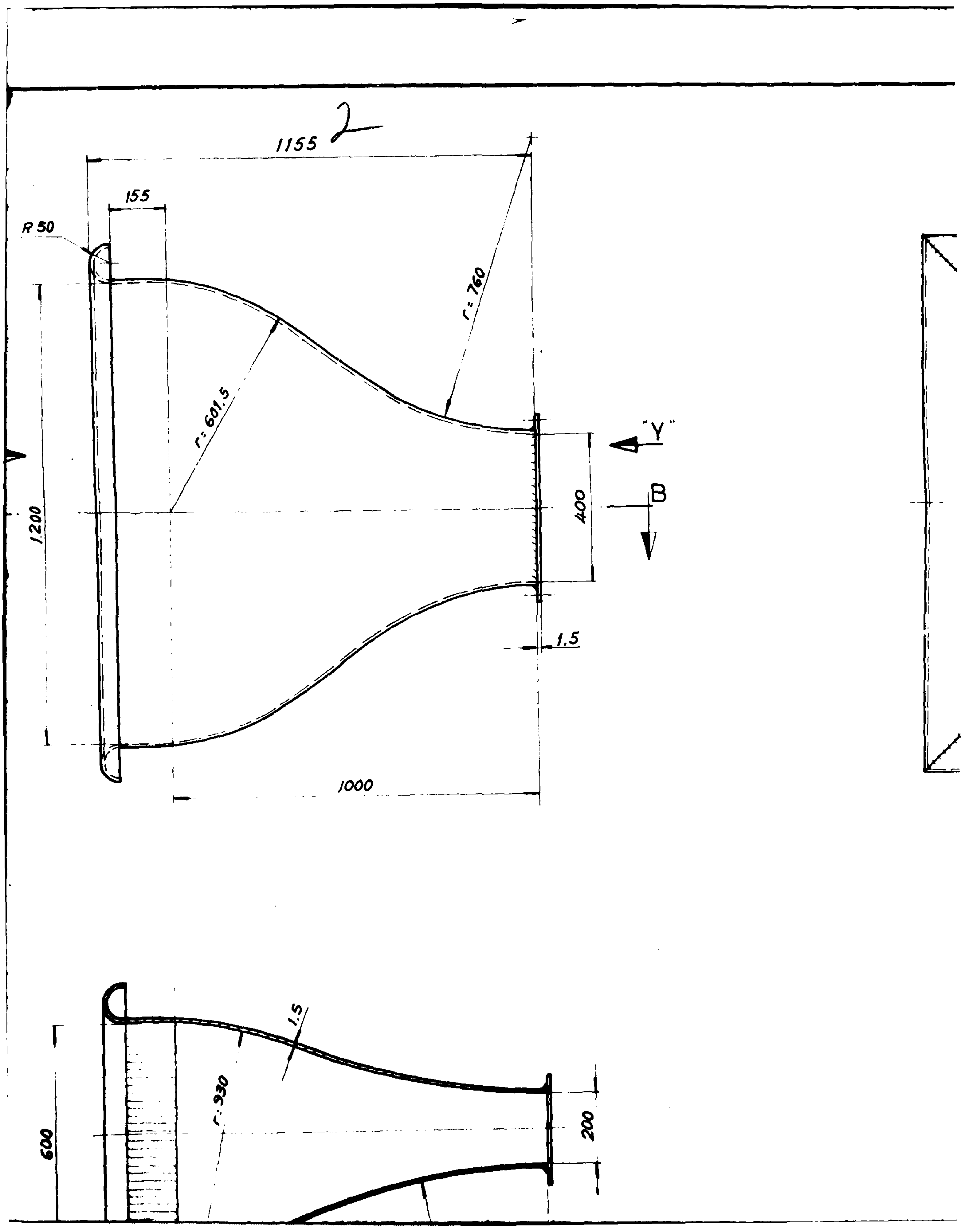
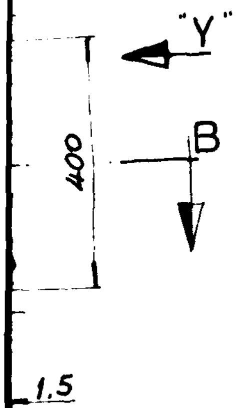
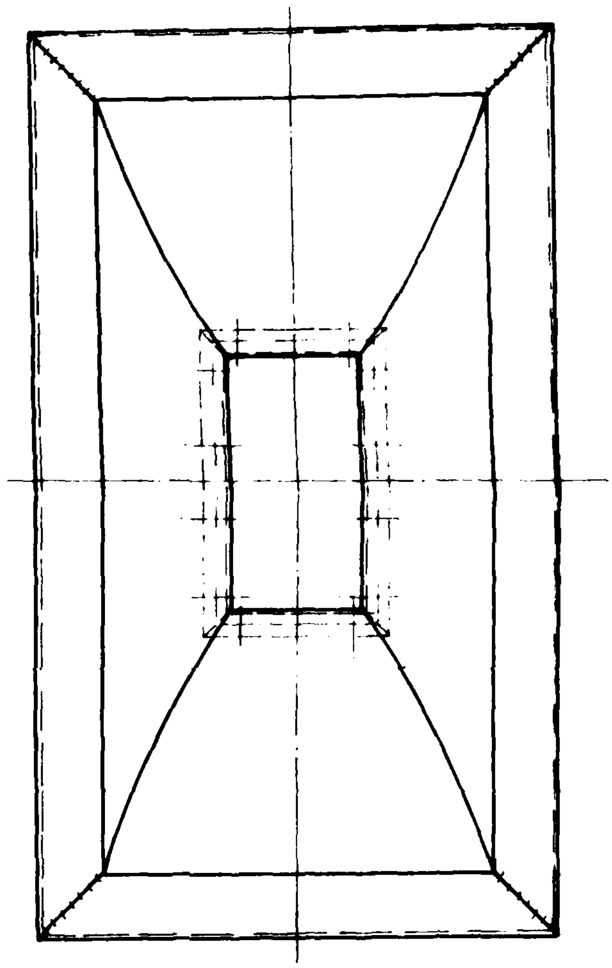

2
1155
155
R 50
r: 760
r: 601,5
1.200
400
"Y"
B
1,5
1000
1.5
r: 930
600
200





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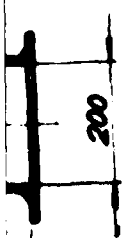
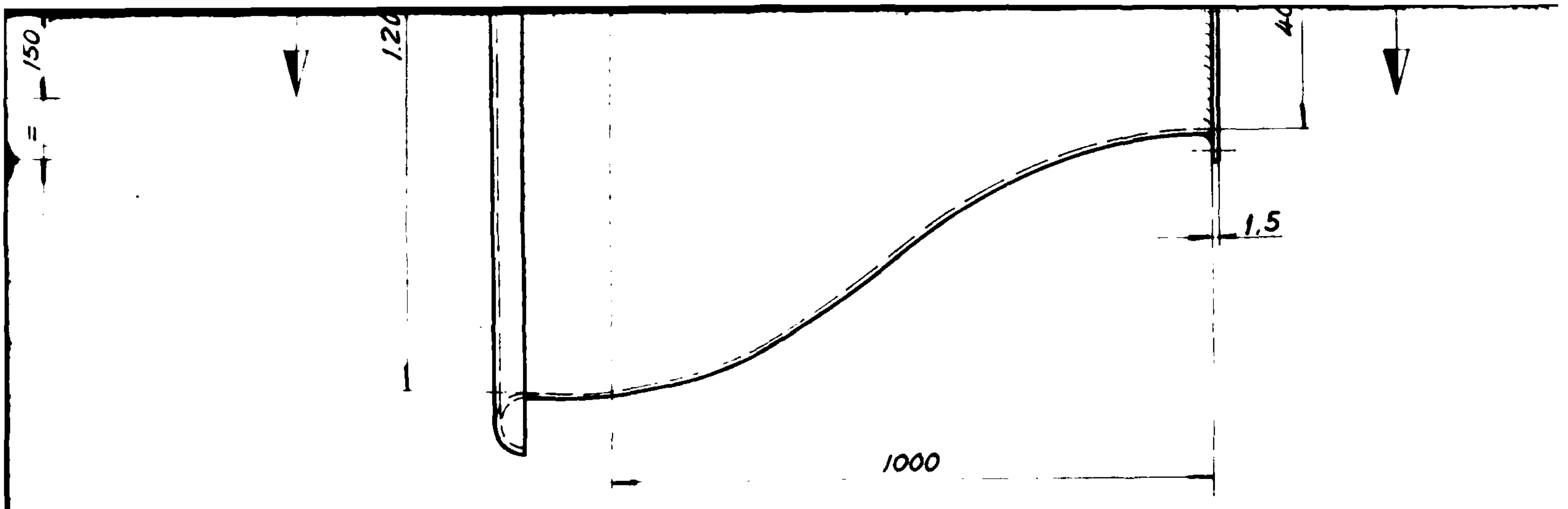
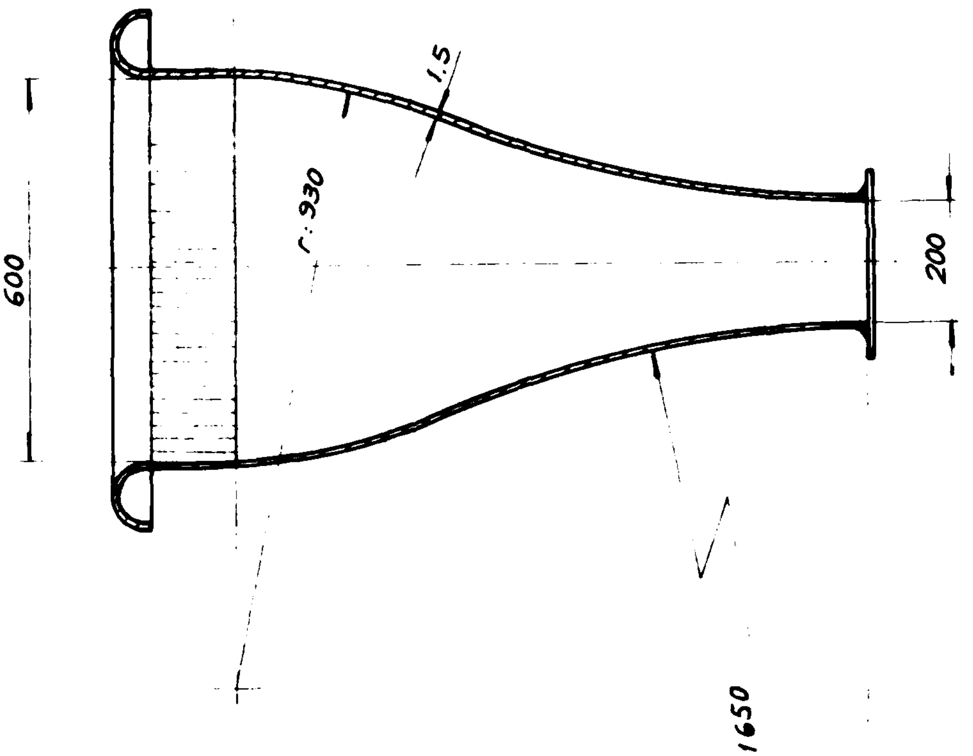
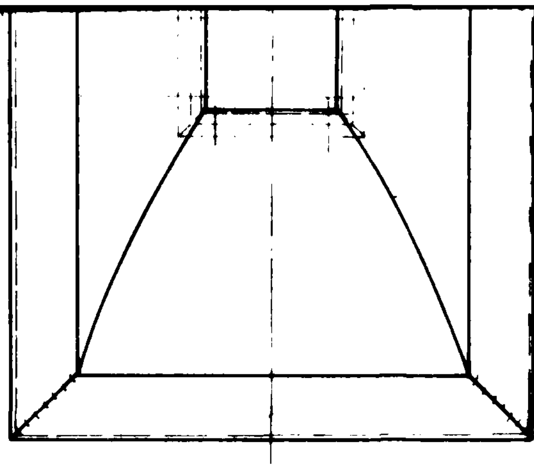






SECCION A-B

4



VISTA POR "X"

Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO
1	COLECTOR	1	A. INOX. F-314

Conjunto: TUNEL FORMACION HIELO

Escalas: 1:10

INTA
TALLERES GENERALES
PROYECTOS

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 350	− 0,60	+ 0,60	± 0,60
350 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
A partir 800	− ½ %	+ ½ %	± ½ %

Todos los cantos sin indicación redondeados con 0,2 mm.
Calidad de rosca «media»

~ Superficie en bruto
▽ » basta
▽▽ » fina
▽▽▽ » muy fina
▽▽▽▽ » lapeada

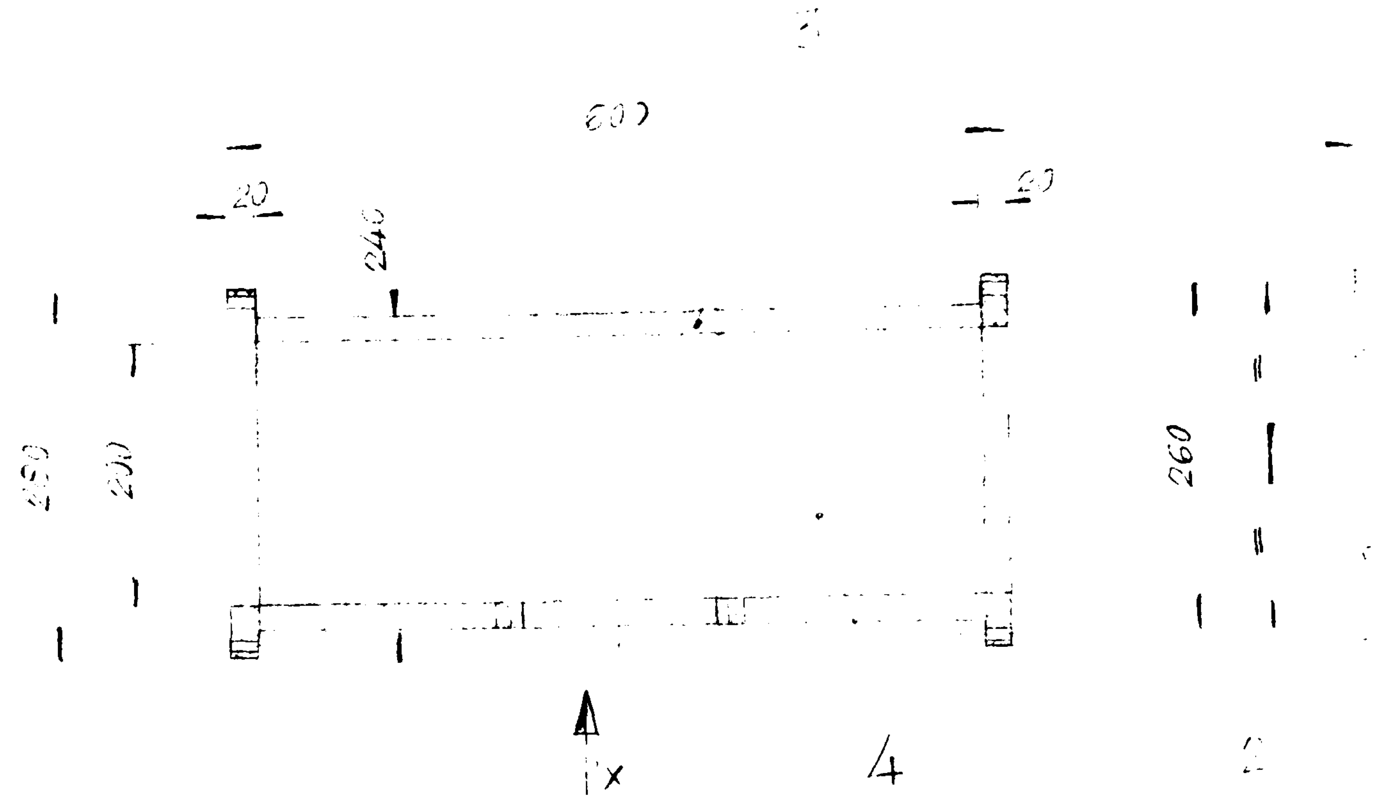
	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

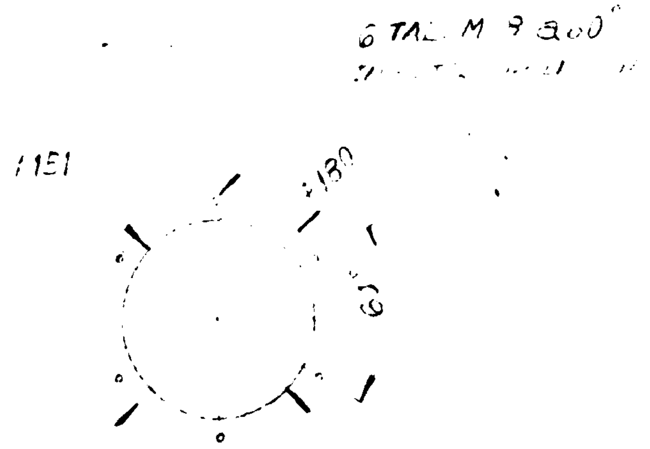
Núm. del plano Talleres

Peticionario

Núm. del plano 54-23 A 4

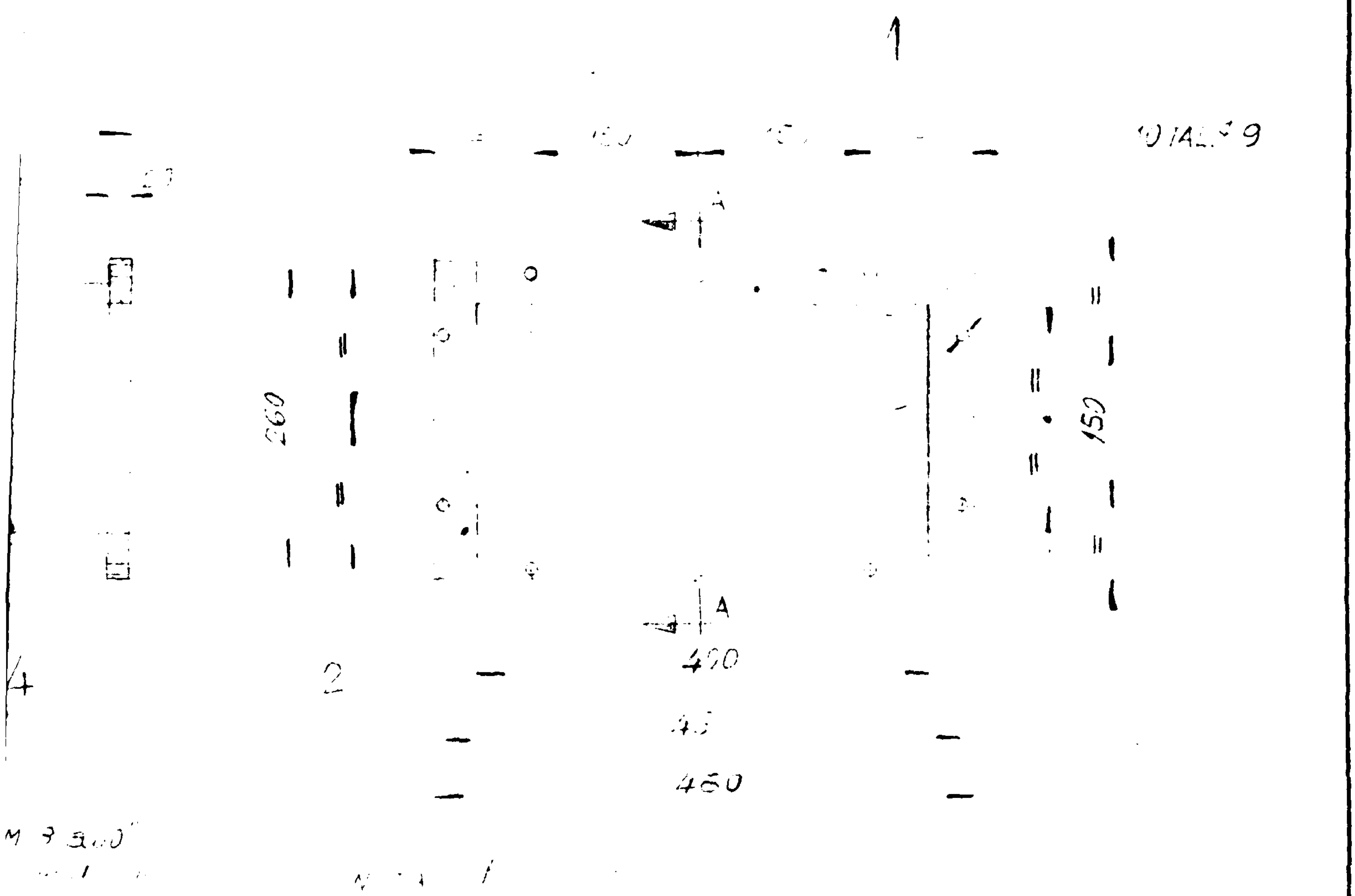
5





VISTA POR "X"

Marca	
Tolerancias sin indica... trabaj...	
Sectores de medidas	
1 – 3	
3 – 10	
10 – 30	
30 – 80	
80 – 180	
180 – 350	
350 – 500	
500 – 800	
A partir 800	



2			
Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	- 0,15	0,15	± 0,15
3 ÷ 10	- 0,25	0,25	± 0,25
10 ÷ 30	- 0,30	0,30	± 0,30
30 ÷ 80	- 0,40	0,40	± 0,40
80 ÷ 180	- 0,50	0,50	± 0,50
180 ÷ 350	- 0,60	0,60	± 0,60
350 ÷ 500	- 0,80	0,80	± 0,80
500 ÷ 800	- 1,0	1,0	± 1,0
A partir 800	- 1/2 %	+ 1/2 %	± 1/2 %

Conjunto

Todos los cantos sin indicación redondeados con 0,2 mm. Calidad de rosca ....

Superficie	
~	Superficie en bruto
▽	» basta
▽▽	» fina
▽▽▽	» muy fina
▽▽▽▽	» lapeada

	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

Escalas

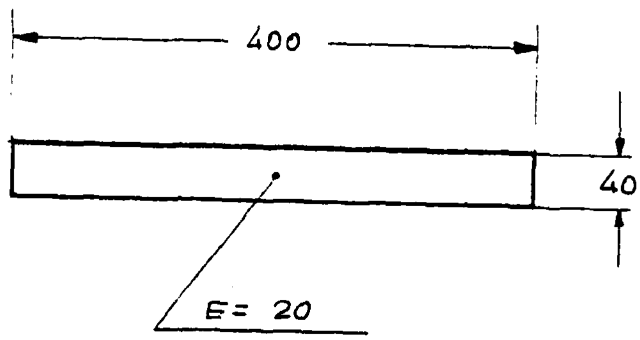
INTA
TALLERES GENERALES
PROYECTOS

Núm. del plano Talleres

Peticionario

Núm. del plano
24 23 A 1

2

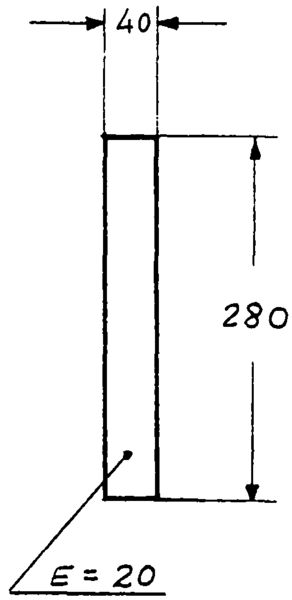


TRANSVERSAL

Plano nº 84-023-A/2-1

Metacrilato transparente

4 piezas

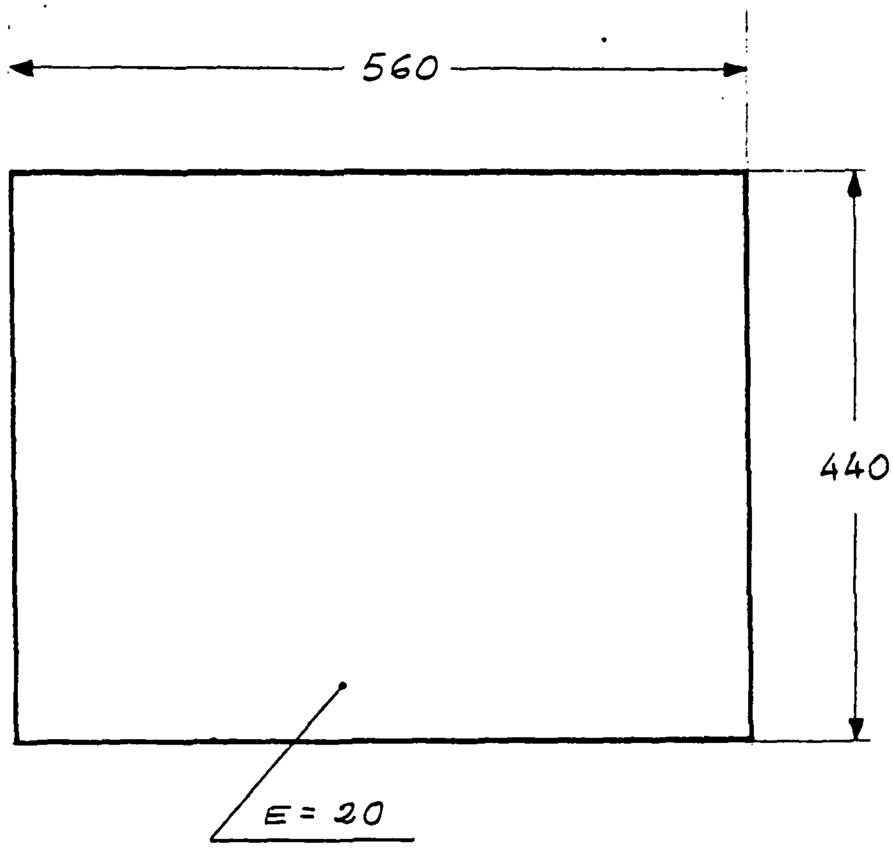


LATERAL

Plano nº 84-023-A/2-2

Metacrilato transparente

4 piezas

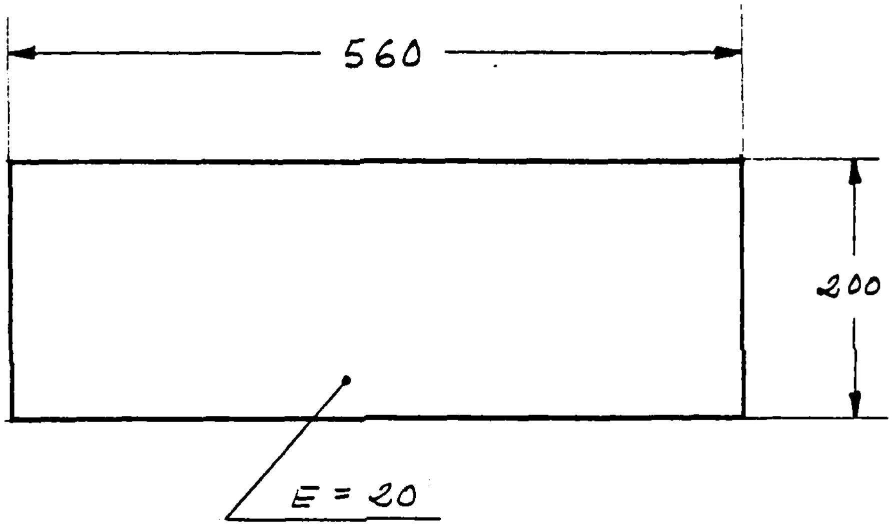


TAPA TRANSVERSAL

Plano nº 84-023-A/2-3

Metacrilato transparente

2 piezas

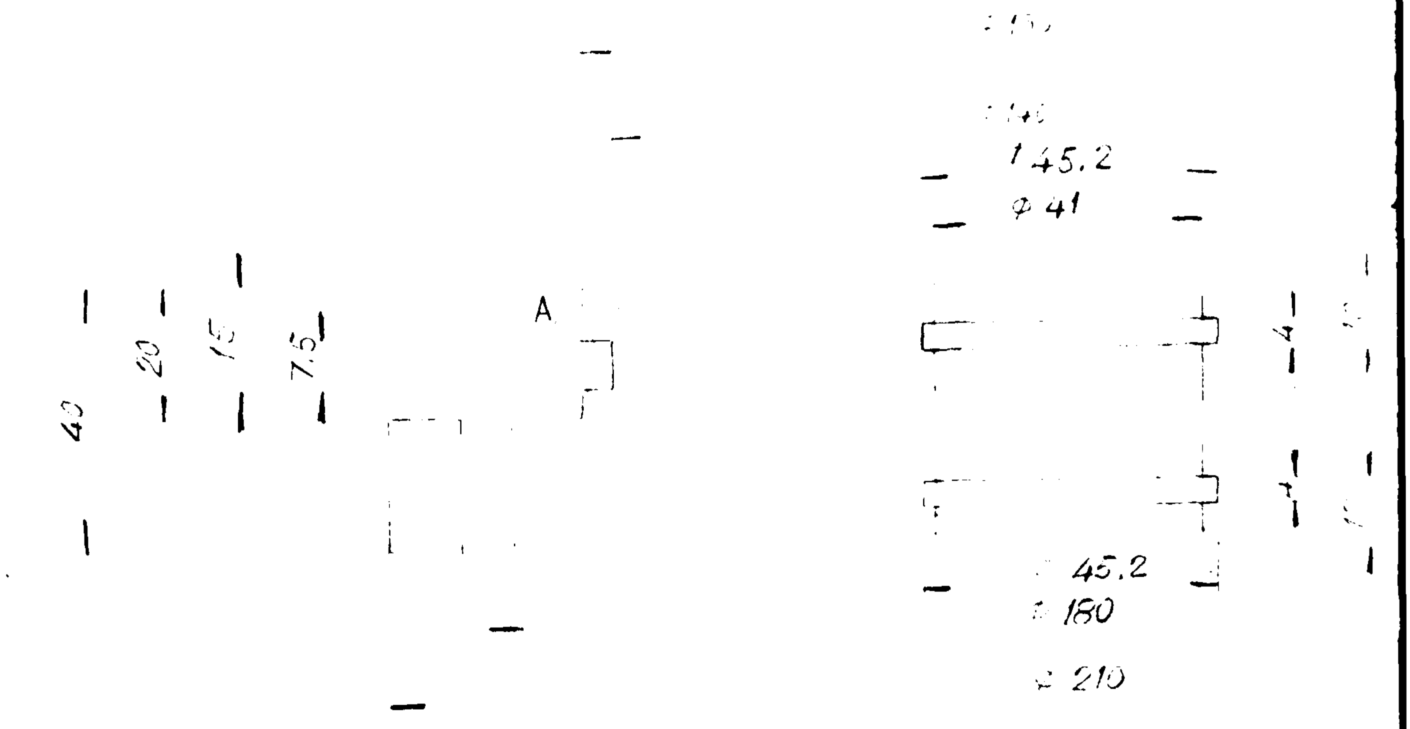


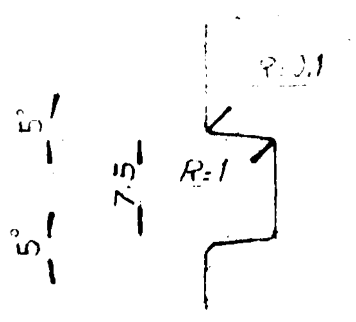
TAPA LATERAL

Plano nº 84-023-A/2-4

Metacrilato transparente

2 piezas.



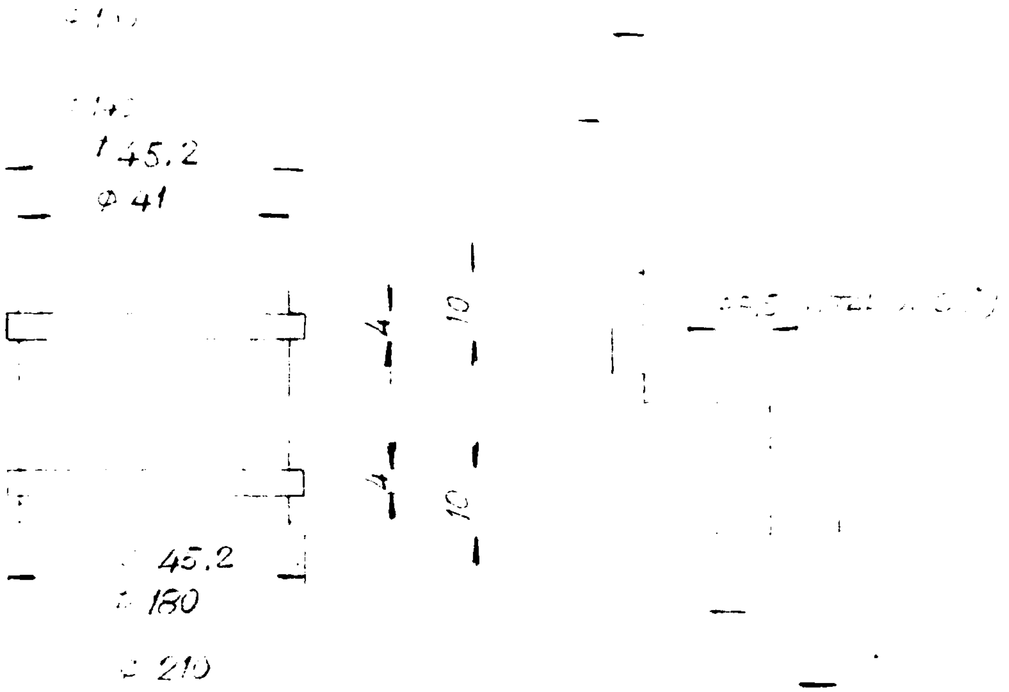


DETALLE A

2	5
Marca	

Tolerancias admi
sin indicación d
trabajos arr

Sectores de medidas	Tolerancia exteriores
1 ÷ 3	– 0,15
3 ÷ 10	– 0,25
10 ÷ 30	– 0,30
30 ÷ 80	– 0,40
80 ÷ 180	– 0,50
180 ÷ 350	– 0,60
350 ÷ 500	– 0,80
500 ÷ 800	– 1,0
A partir 800	– ¹/₈ %



Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO
3	[illegible]	1	[illegible] TRANSPARENTE

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 250	− 0,60	+ 0,60	± 0,60
250 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
A partir 800	− ¹/₈ %	+ ¹/₈ %	± ¹/₈ %

Conjunto: TUNEL FORMACION HIELO

Escalas: 1:1, 2:1

[I]NTA
TALLERES GENERALES
PROYECTOS

Todos los cantos sin indicación redondeados con 0,2 mm. Calidad de roscas «medias»

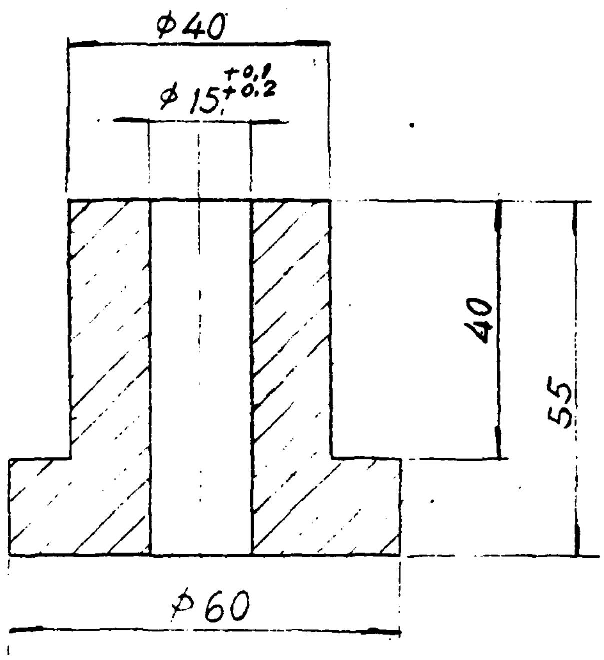
	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

~ Superficie en bruto
▽ » basta
▽▽ » fina
▽▽▽ » muy fina
▽▽▽▽ » lapeada

Núm. del plano Talleres

Peticionario

Núm. del plano: 84-023-A/3



4	SOPORTE SONDA	1	Acero Inox.
Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 350	− 0,60	+ 0,60	± 0,60
350 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
A partir 800	− ¹/₈ %	+ ¹/₈ %	± ¹/₈ %

Conjunto: TUNEL FORMACION HIELO

Escalas: 1:1, 3:1

INTA
TALLERES GENERALES
PROYECTOS

Todas las cotas sin indicación [illegible] 0,2 mm. Calidad de rosca [illegible]

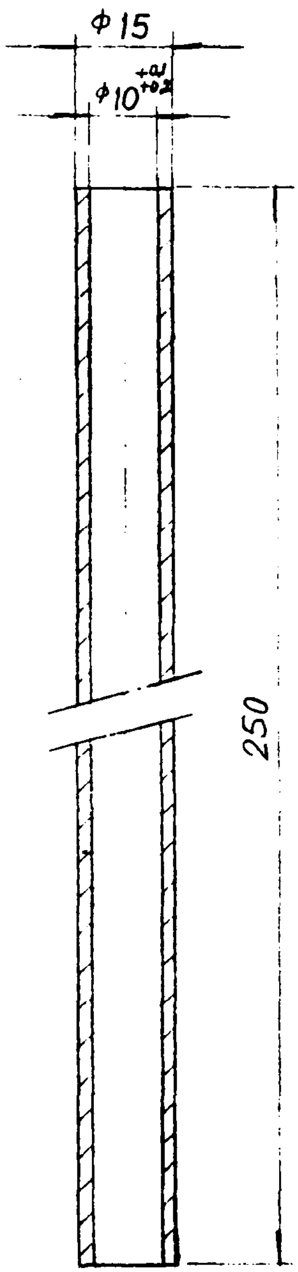
Símbolo	Superficie
~	Superficie en bruto
▽	» basta
▽▽	» fina
▽▽▽	» muy fina
▽▽▽▽	» lapeada

	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

Núm. del plano Talleres

Peticionario

Núm. del plano: 84-023-A/4



Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO
5	GUIA SONDA	1	Acero Inox.

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 250	− 0,60	+ 0,60	± 0,60
350 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
A partir 800	− ½ %	+ ½ %	± ½ %

Conjunto: TUNEL FORMACION HIELO

Escalas

INTA
TALLERES GENERALES
PROYECTOS

Todos los cantos sin indicación redondeados con 0,2 mm. Calidad de rosca mediana

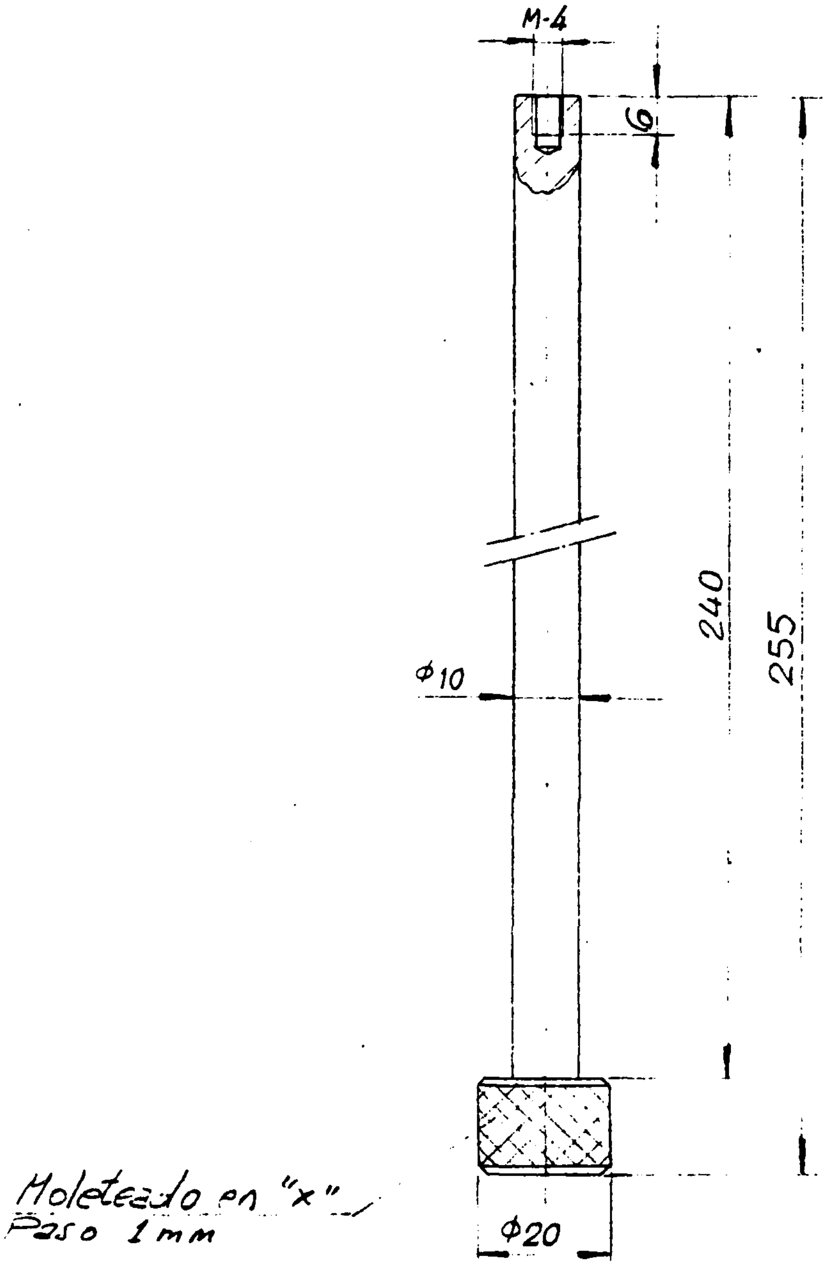
	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

Símbolo	Superficie
~	Superficie en bruto
▽	» basta
▽▽	» fina
▽▽▽	» muy fina
▽▽▽▽	» lapeada

Núm. del plano Talleres

Peticionario

Núm. del plano 84-023-A/5



Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO
6	EJE SONDA	1	Acero Inox.

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 350	− 0,60	+ 0,60	± 0,60
350 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
à partir 800	− 1/2 %	+ 1/2 %	± 1/2 %

Conjunto: TUNEL FORMACION HIELO

Escalas: 1:1

INTA
TALLERES GENERALES
PROYECTOS

Todas las cotas sin indicación redondeadas con 0,2 mm. Calidad de rosca media

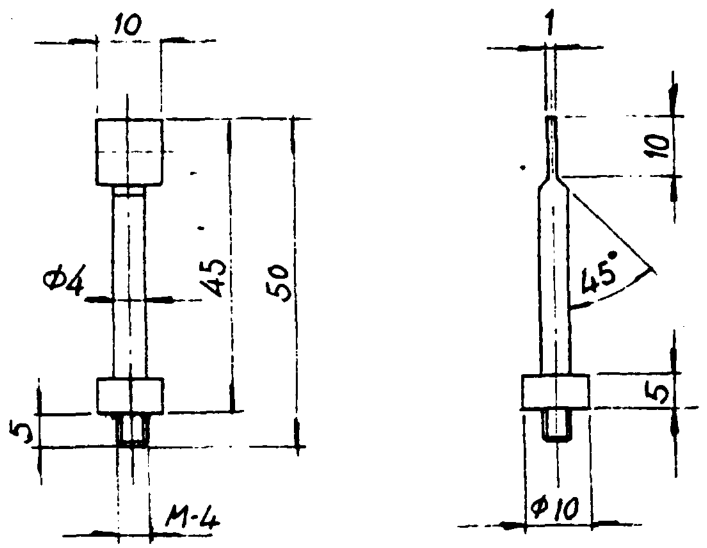
Símbolo	Superficie
~	Superficie en bruto
▽	» basta
▽▽	» fina
▽▽▽	» muy fina
▽▽▽▽	» lapeada

	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

Núm. del plano Talleres

Peticionario

Núm. del plano: 84-023-A/6



7	TERMINAL SONDA	3	Acero inox.
Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 350	− 0,60	+ 0,60	± 0,60
350 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
a partir 800	− 1/8 %	+ 1/8 %	± 1/8 %

Conjunto: TUNEL FORMACION HIELO

Escalas: 1:1

INTA
TALLERES GENERALES
PROYECTOS

Todas las aristas sin indicación redondeadas con 0,2 mm. Calidad de rayas amolado

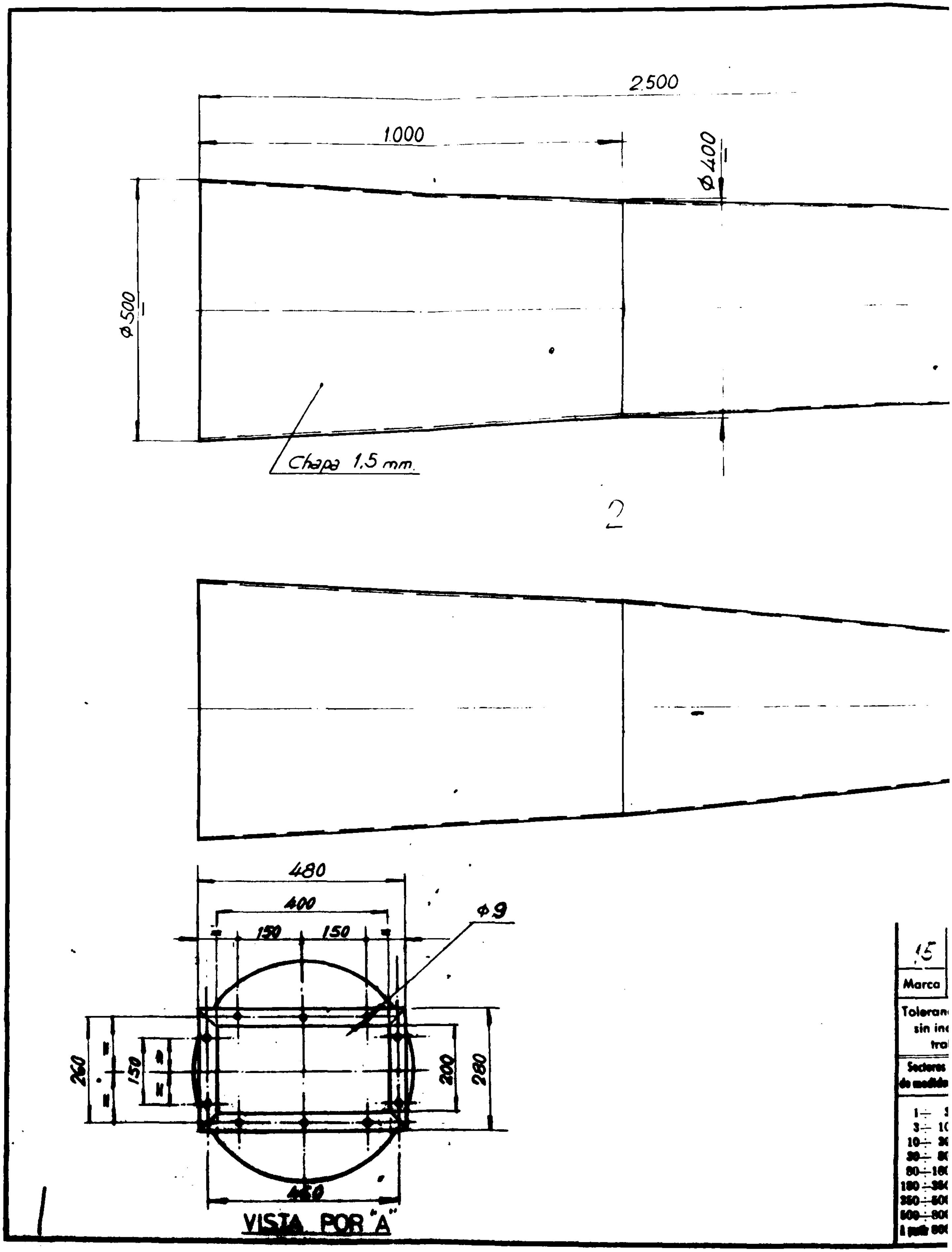
~ Superficie en bruto
▽ » basta
▽▽ » fina
▽▽▽ » muy fina
▽▽▽▽ » lapeada

	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

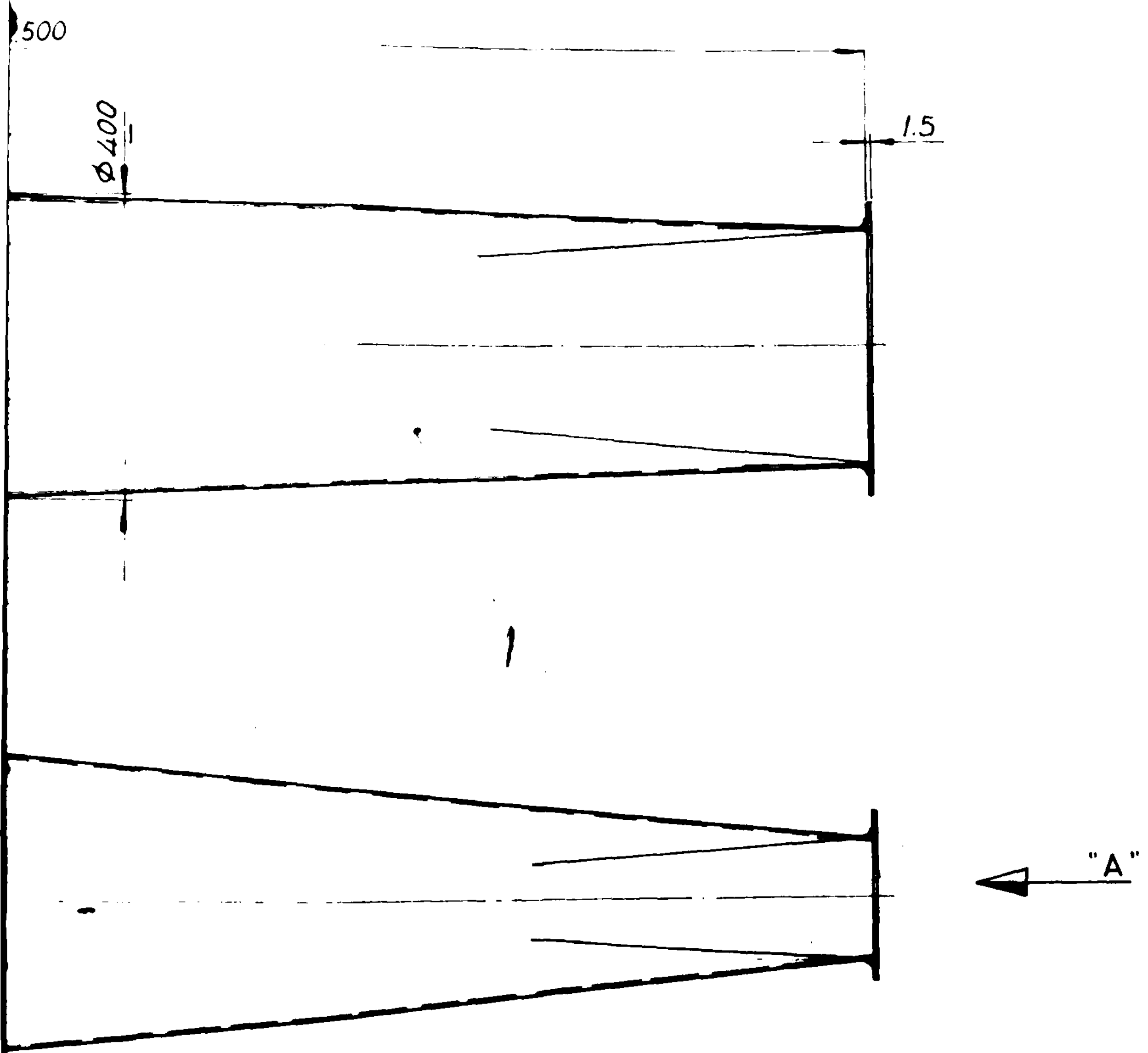
Núm. del plano Talleres

Peticionario

Núm. del plano: 84-023-A/7



2.500
1.000
Φ400
Φ500
Chapa 1,5 mm.
2
480
400
150
150
Φ9
260
150
200
280
460
VISTA POR "A"
15
Marca



Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO
15	DIFUSOR	1	Acero Inox.

Conjunto: TUNEL FORMACION HIELO

Escalas: 1:10

INTA
TALLERES GENERALES
PROYECTOS

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1÷3	−0,15	+0,15	±0,15
3÷10	−0,25	+0,25	±0,25
10÷30	−0,30	+0,30	±0,30
30÷80	−0,40	+0,40	±0,40
80÷180	−0,50	+0,50	±0,50
180÷250	−0,60	+0,60	±0,60
250÷500	−0,80	+0,80	±0,80
500÷800	−1,0	+1,0	±1,0
A partir 800	−½ %	+½ %	±½ %

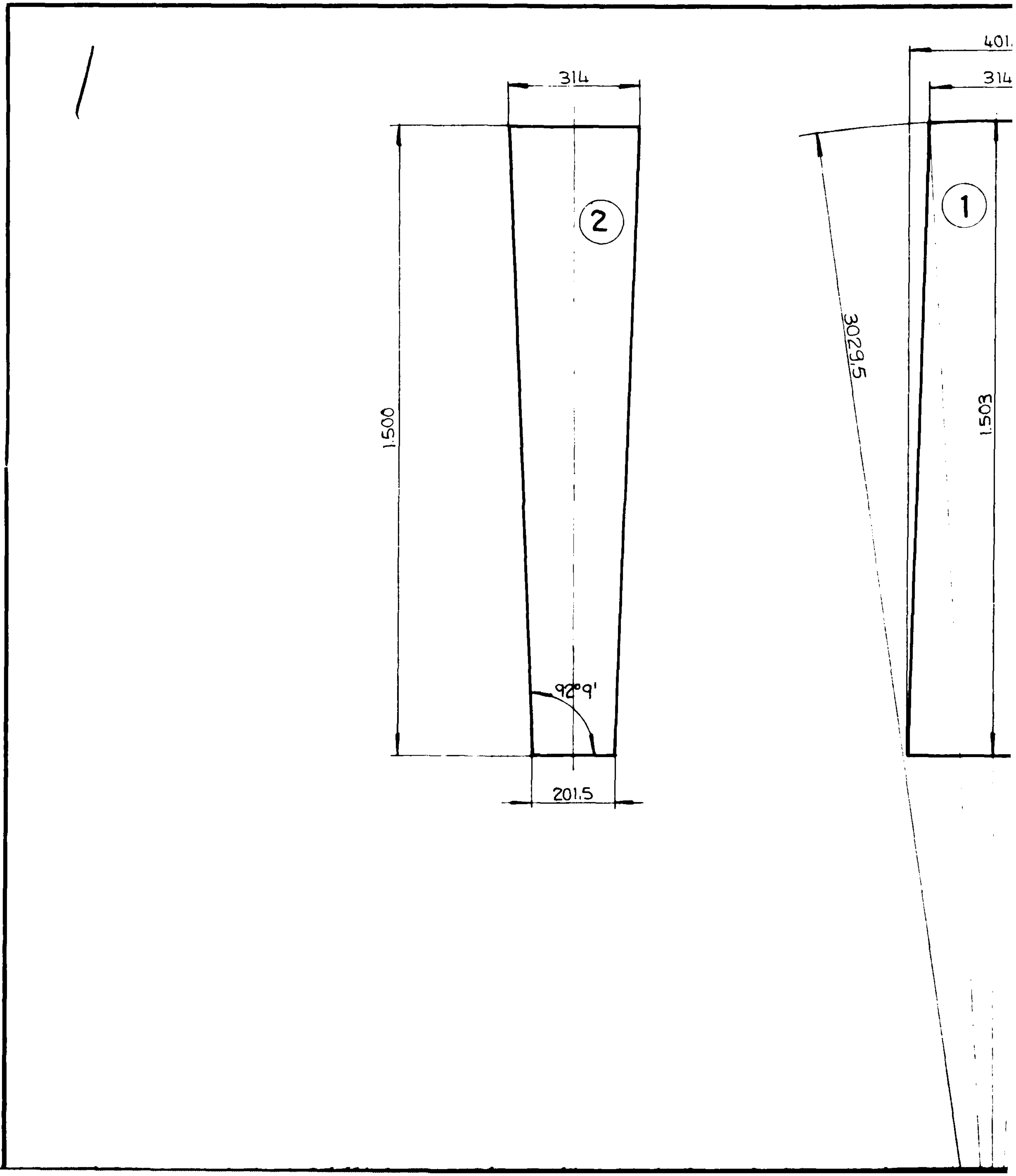
~ Superficie en bruto
▼ » basta
▼▼ » fina
▼▼▼ » muy fina
▼▼▼▼ » lapeada

	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

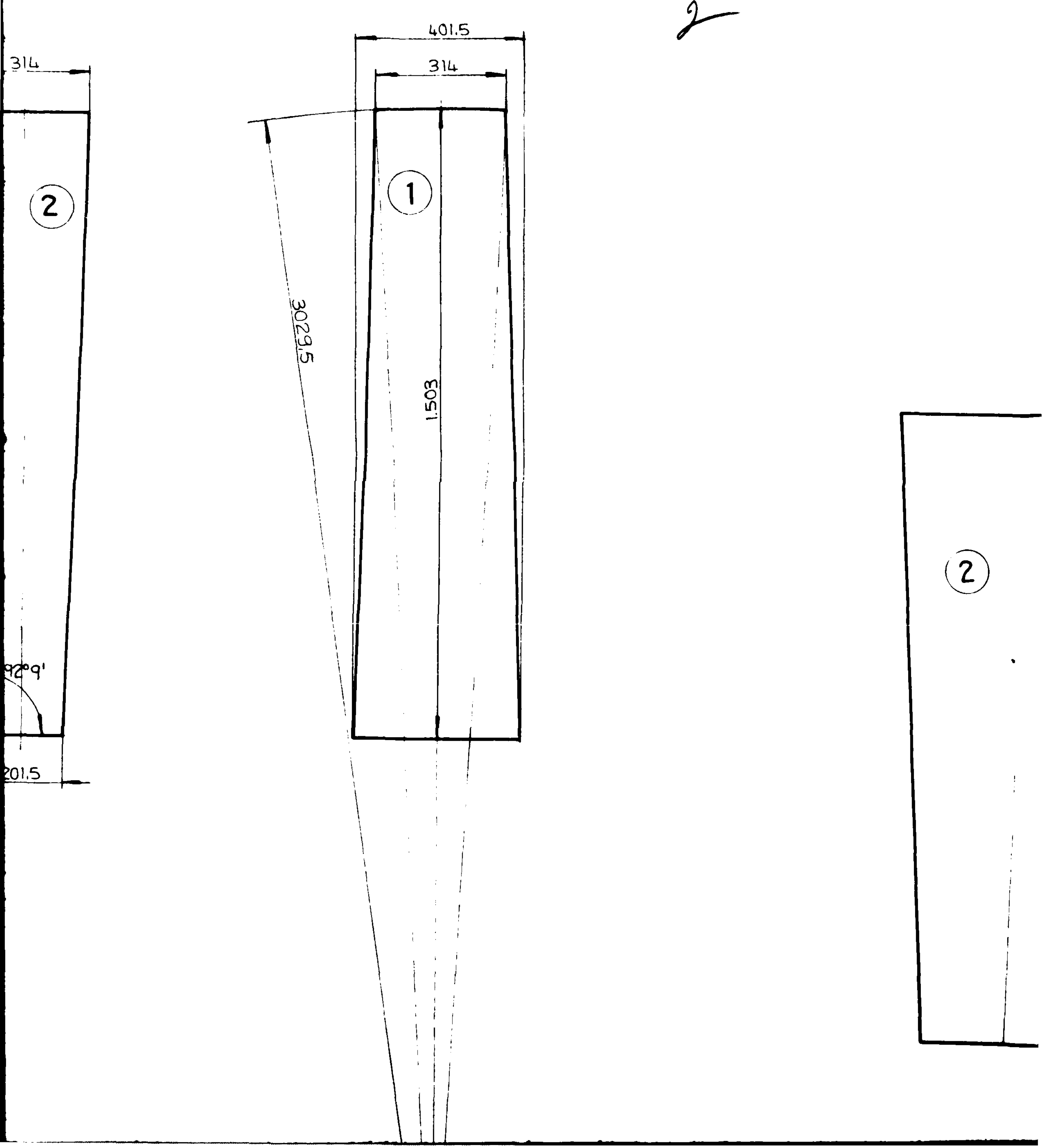
Núm. del plano Talleres

Peticionario

Núm. del plano: 84-023-A/14

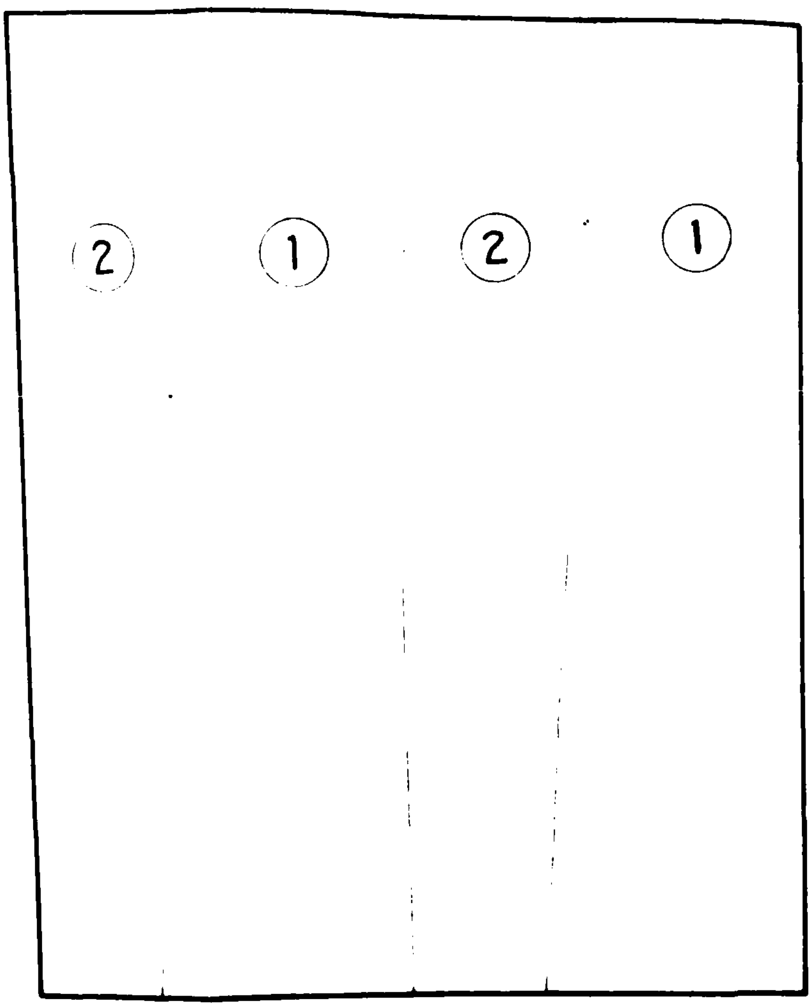


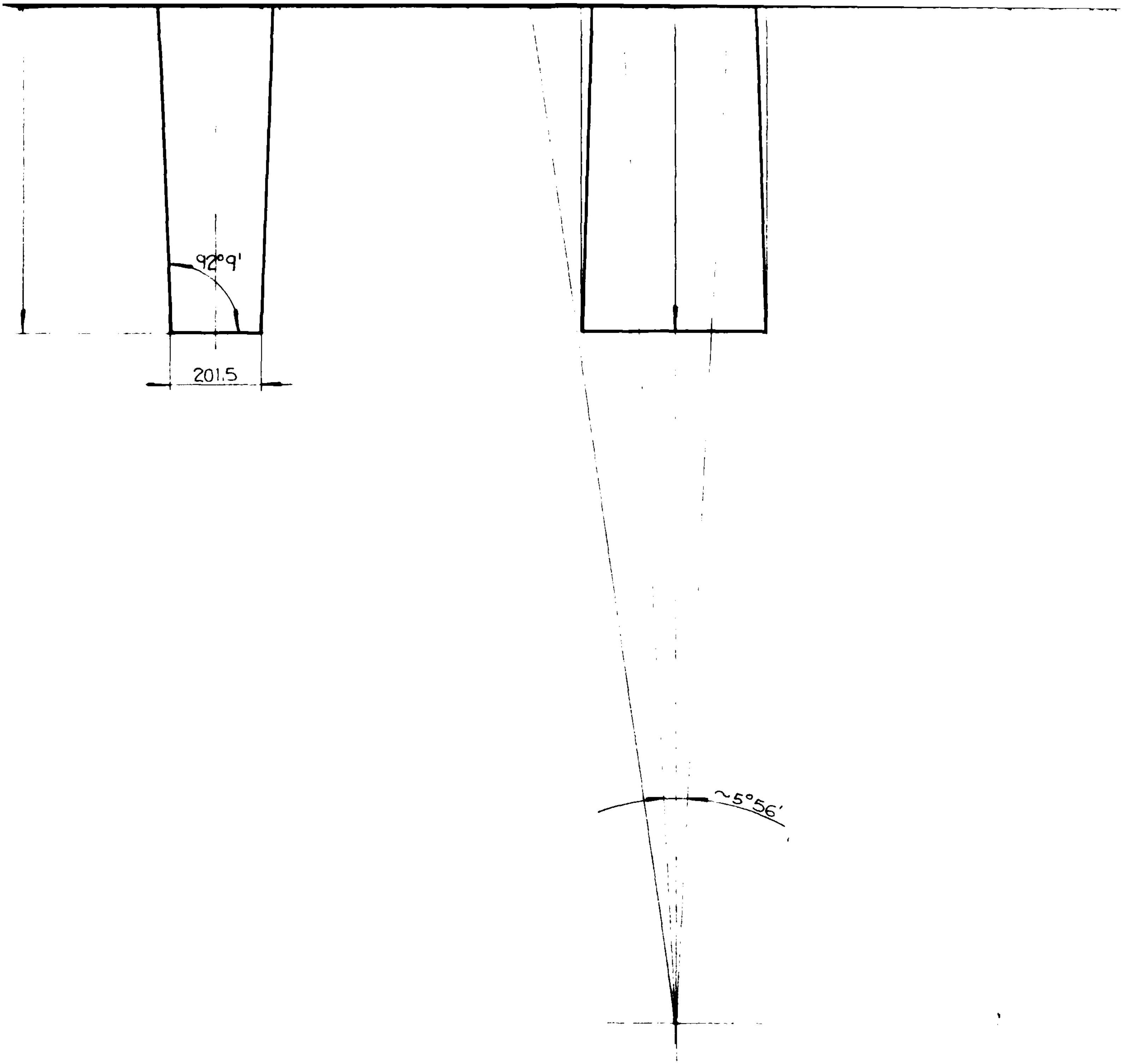
314
1.500
2
92°9'
201,5
401.
314
3029,5
1
1.503



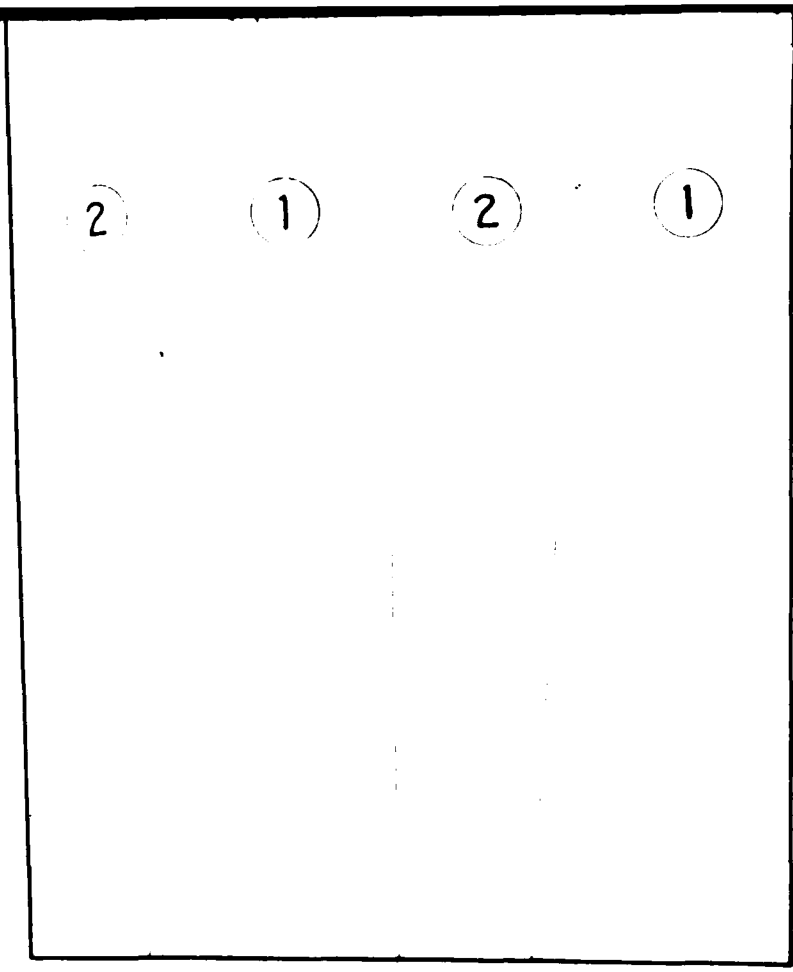
2
401.5
314
314
1
2
3029,5
1.503
92°9'
201.5
2

3





5



Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO
A-15/1	DESARROLLO DIFUSOR 1	1	Acero Inox.

Conjunto

TUNEL FORMACION HIELO

INTA
TALLERES GENERALES
PROYECTOS

Escalas

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 360	− 0,60	+ 0,60	± 0,60
360 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
à partir 800	− 1/2 %	+ 1/2 %	± 1/2 %

Todas las cantos sin indicación redondeados con 0,2 mm. Calidad de rosca «media»

Símbolo		Superficie
~		Superficie en bruto
▽	»	basta
▽▽	»	fina
▽▽▽	»	muy fina
▽▽▽▽	»	lapeada

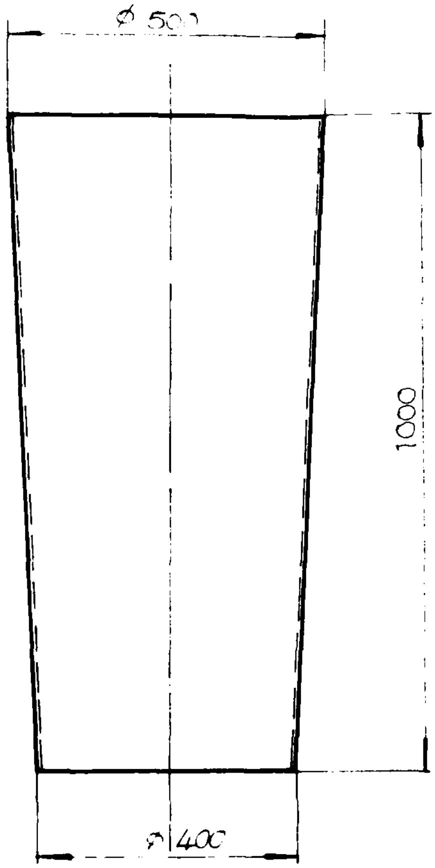
	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

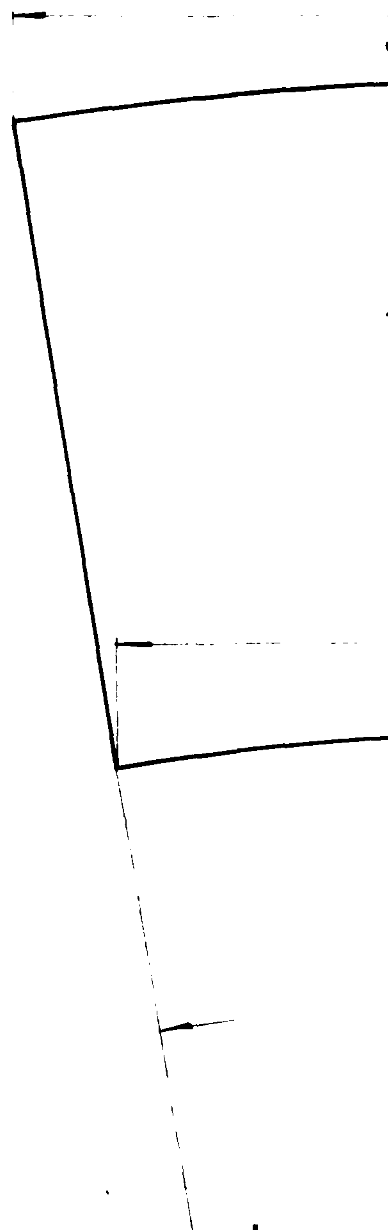
Núm. del plano Talleres

Peticionario

Núm. del plano
84-023-A-14/1

6



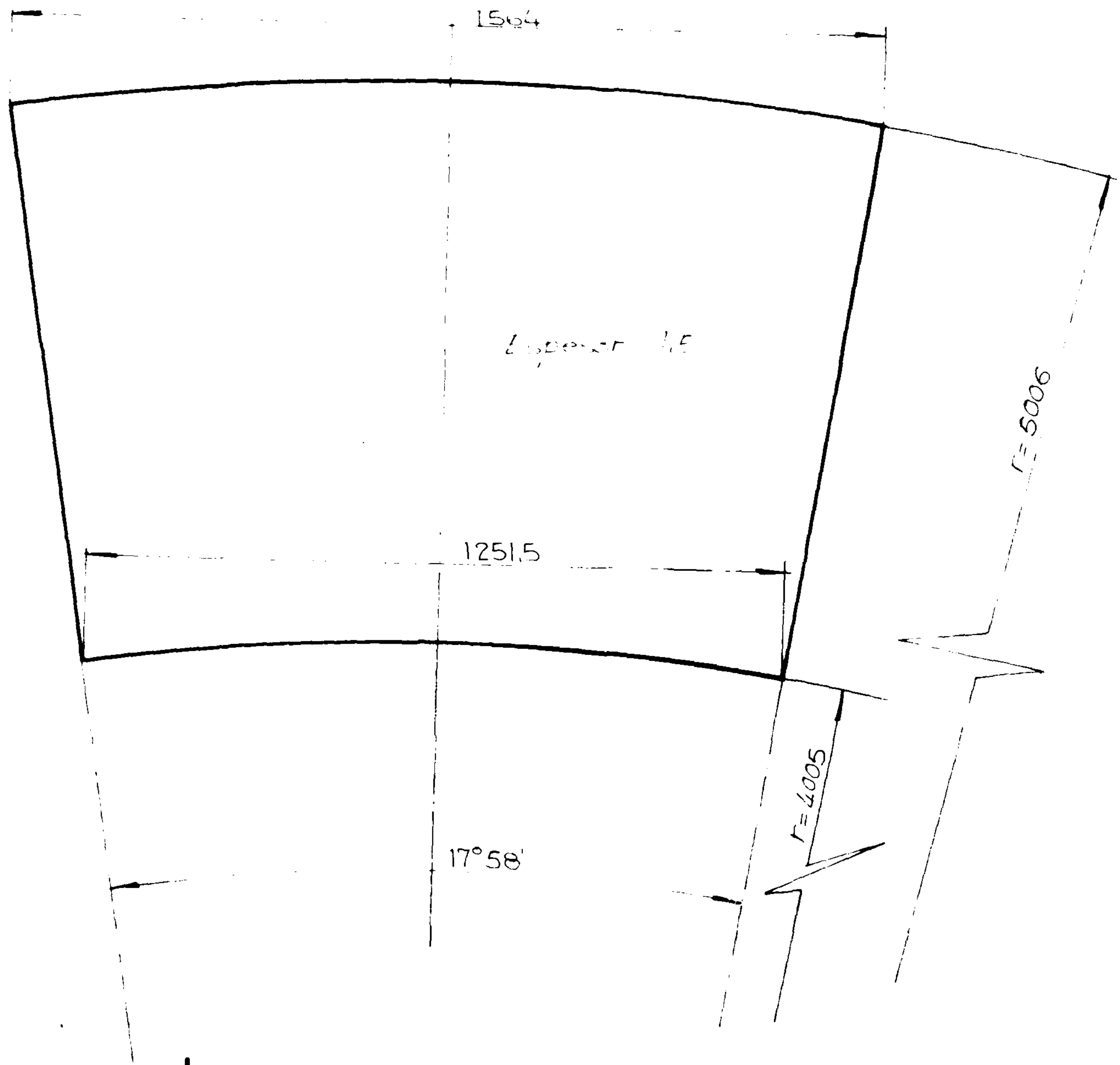


A 15 ...

Marca

Tolerancias a...
sin indicaci...
trabajos ...

Sectores de medidas	Toler... exte...
1 ÷ 3	– ...
3 ÷ 10	– ...
10 ÷ 30	– ...
30 ÷ 80	– ...
80 ÷ 180	– ...
180 ÷ 350	– ...
350 ÷ 500	– ...
500 ÷ 800	– ...
a partir 800	– ...



A-15-2	[illegible] 2	1	Acero Inox
Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 350	− 0,60	+ 0,60	± 0,60
350 ÷ 600	− 0,80	+ 0,80	± 0,80
600 ÷ 800	− 1,0	+ 1,0	± 1,0
a partir 800	− 1/8 %	+ 1/8 %	± 1/8 %

Conjunto

TUNEL FORMACION HIELO

Escalas

INTA
TALLERES GENERALES
PROYECTOS

Todas las cantos sin indicación redondeados con 0,2 mm. Calidad de superficies

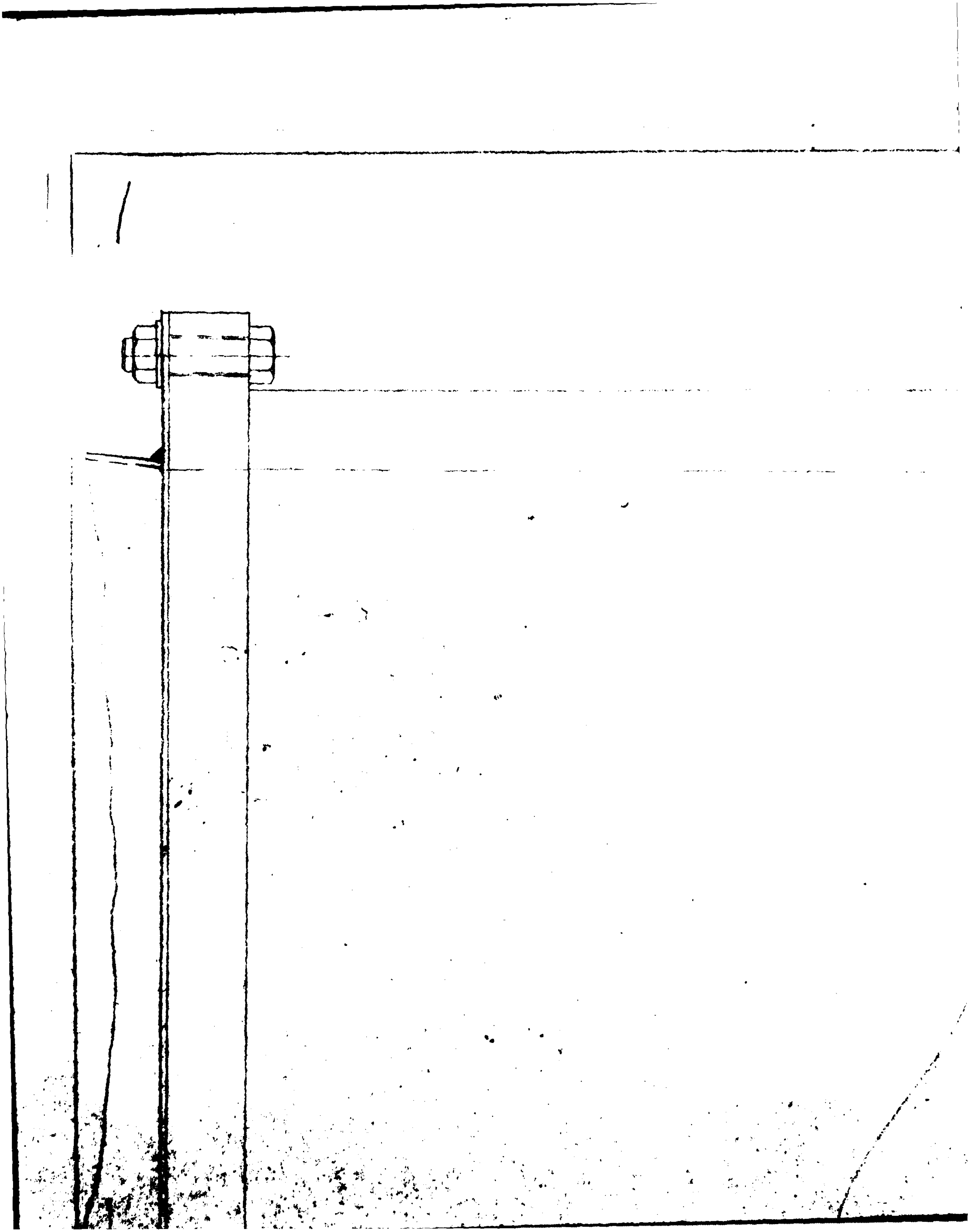
	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

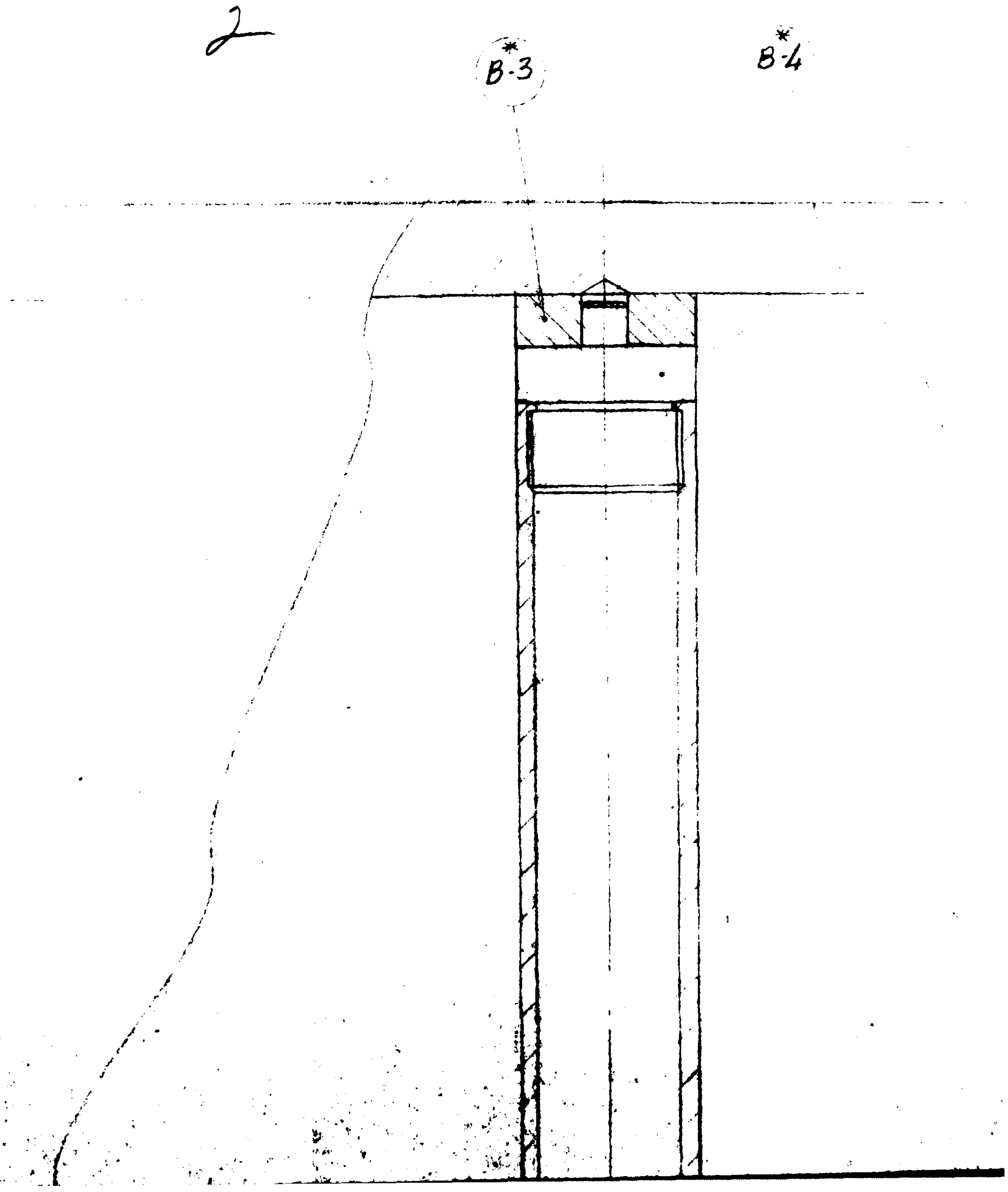
~ Superficie en bruto
▽ » basta
▽▽ » fina
▽▽▽ » muy fina
▽▽▽▽ » lapeada

Núm. del plano Talleres

Peticionario

Núm. del plano
84 023-A-14/2

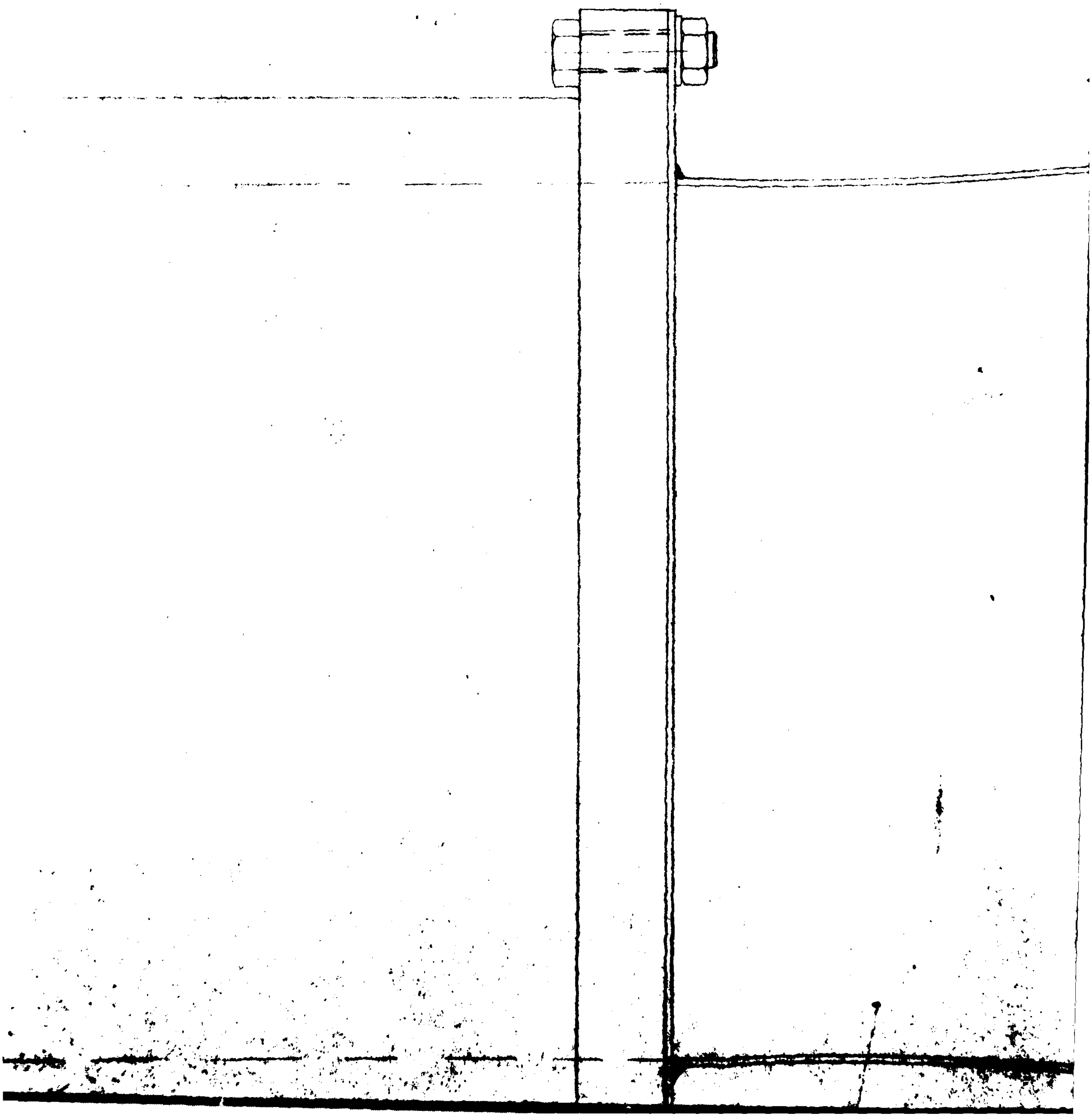


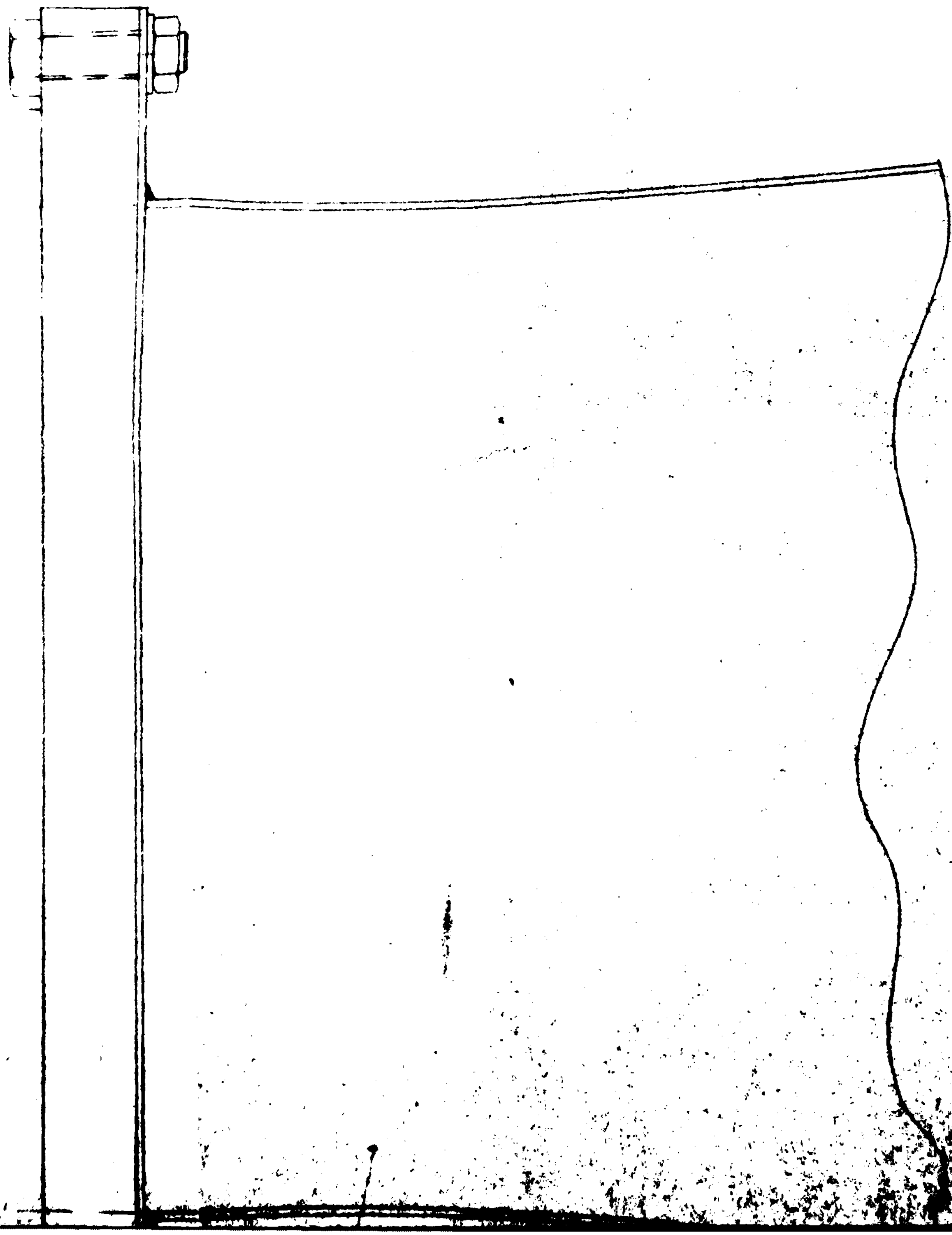


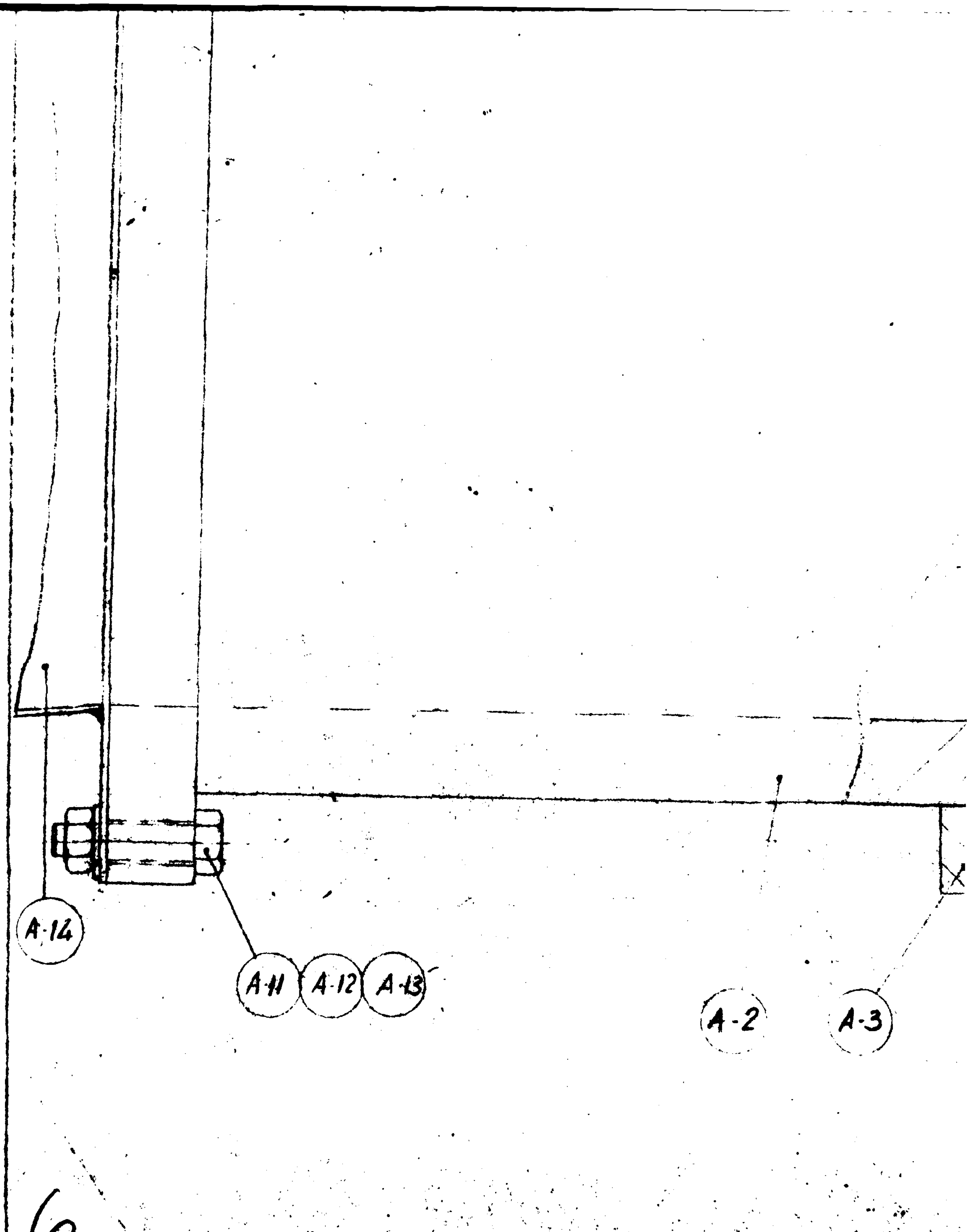
2
B-3
B-4

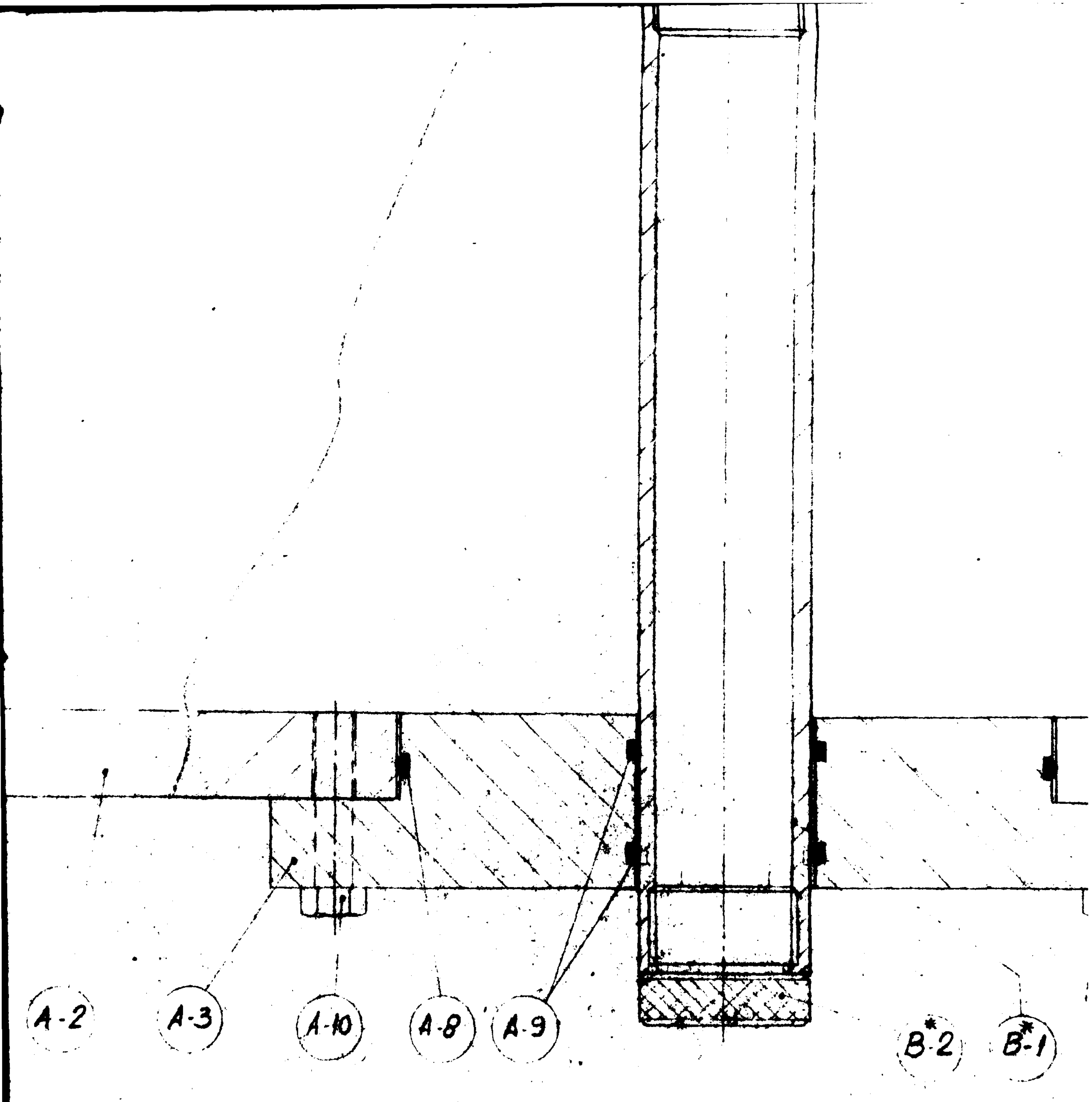
*-4

3

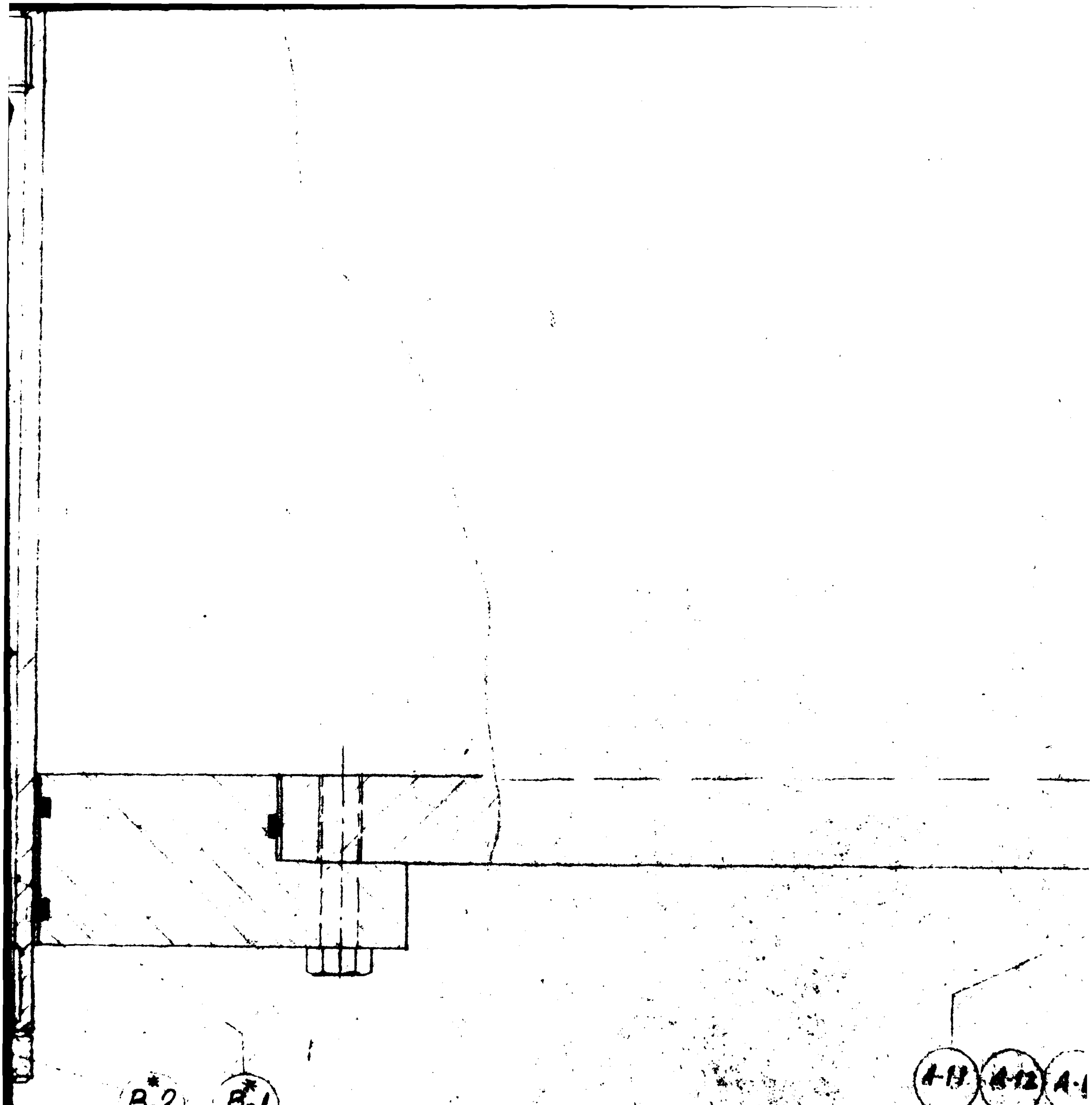





A-14
A-11
A-12
A-13
A-2
A-3

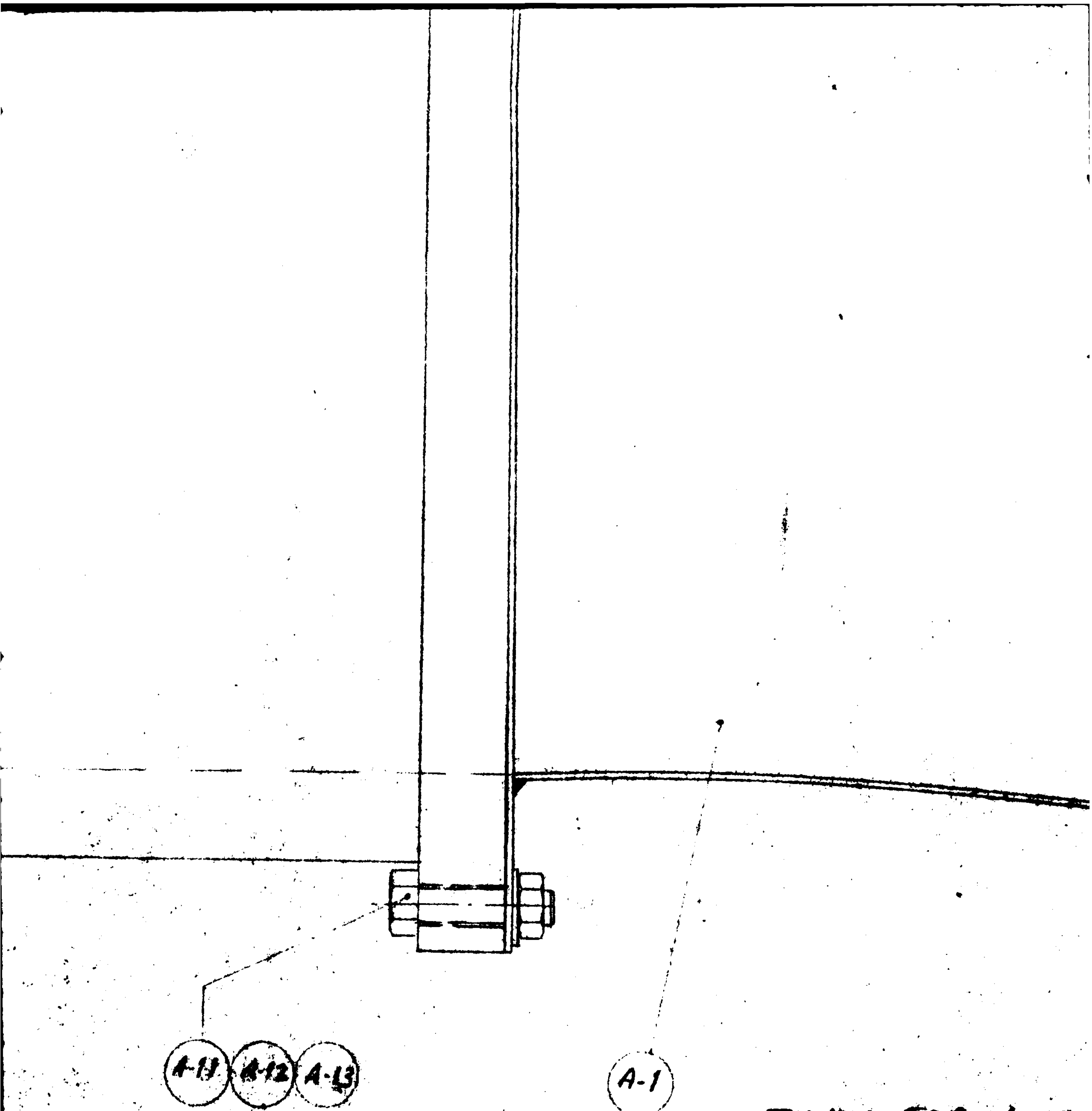


A-2
A-3
A-10
A-8
A-9
B*2
B*1



* En este plano solo se fabricarán las piezas "B".
La pieza B-3, se [illegible] con [illegible] a la pieza A-2.

8



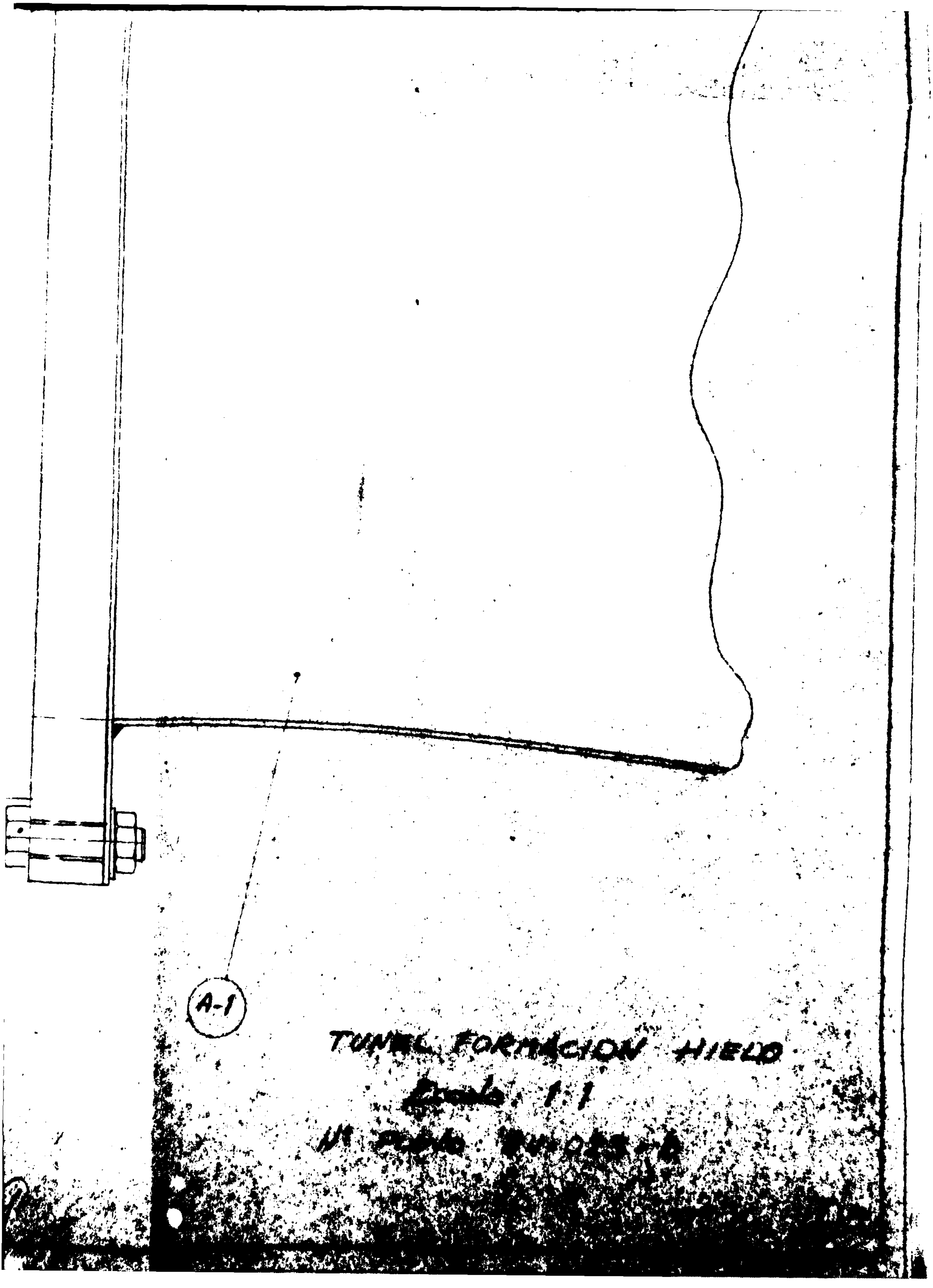
se fabricarán

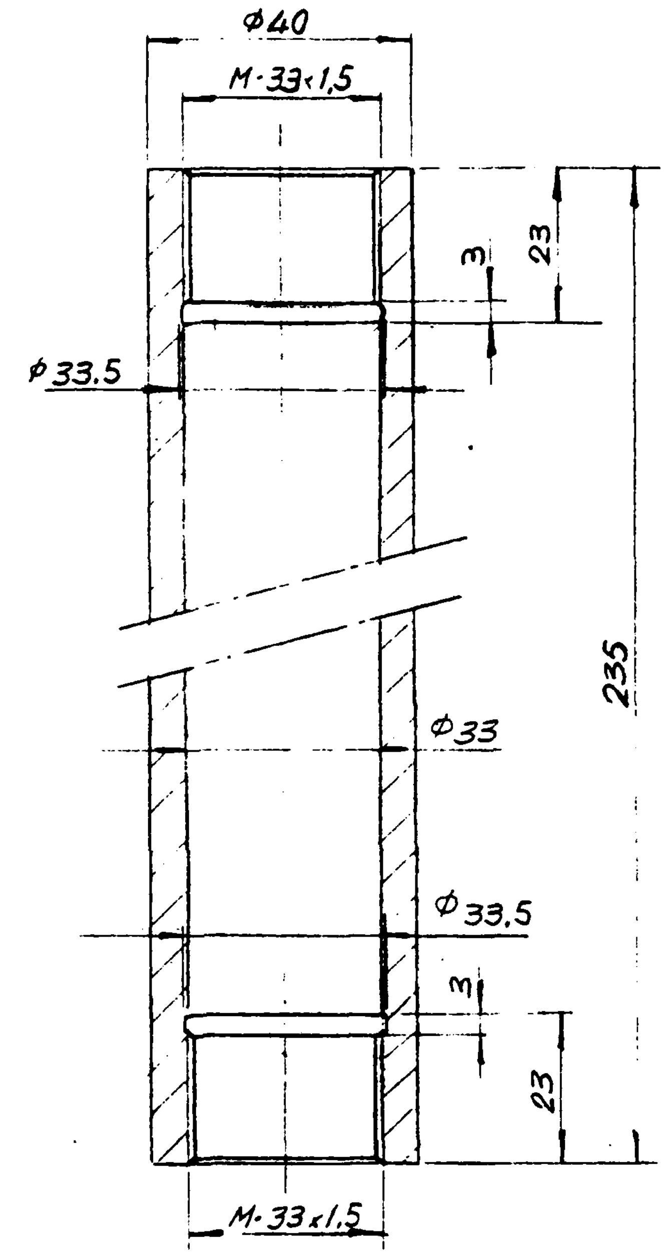
...ado con pagamento

TUNEL FORMACION...

Escala: 1:1

Nº PLANO: 84-023...


A-1
TUNEL FORMACION HIELO
1:1



B-1	MODELO	3	DURAL ANODIZADO.
Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 350	− 0,60	+ 0,60	± 0,60
350 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
A partir 800	− 1/2 %	+ 1/2 %	± 1/2 %

Conjunto

TUNEL FORMACION HIELO

Escalas: 1:1, 3:1

INTA
TALLERES GENERALES
PROYECTOS

Todas las cotas sin indicación redondeadas con 0,2 mm. Calidad de rosca mediana

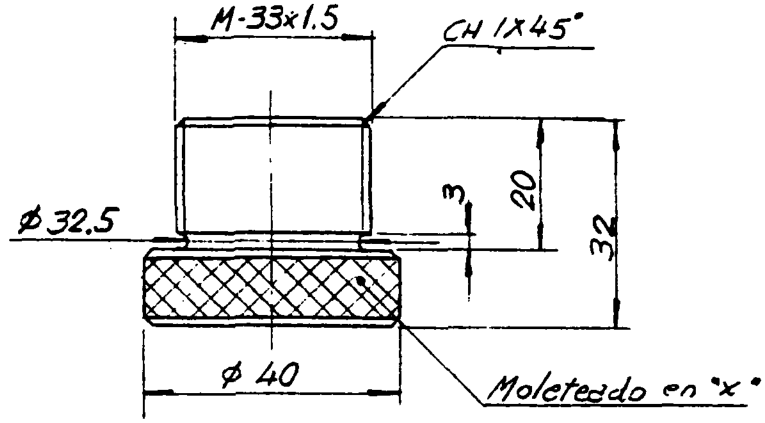
~ Superficie en bruto
▽ » basta
▽▽ » fina
▽▽▽ » muy fina
▽▽▽▽ » lapeada

	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

Núm. del plano Talleres

Peticionario

Núm. del plano
84-023-B/1



Marca	Designación	Cantidad	Material y tratamiento
B-2	TAPA INFERIOR MODELO	3	DURAL ANODIZADO

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 350	− 0,60	+ 0,60	± 0,60
350 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
a partir 800	− 1/2 %	+ 1/2 %	± 1/2 %

Conjunto: TUNEL FORMACION HIELO

Escalas

INTA
TALLERES GENERALES
PROYECTOS

Todos los cantos sin indicación redondeados con 0,2 mm.
Calidad de rosca [illegible]

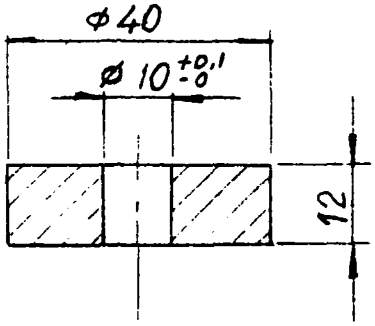
Símbolo	Superficie
∼	Superficie en bruto
▽	» basta
▽▽	» fina
▽▽▽	» muy fina
▽▽▽▽	» lapeada

	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

Núm. del plano Talleres

Peticionario

Núm. del plano BV-A28-B/2



B-3	FIJACION MODELO	1	METACRILATO TRANSPARENTE
Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 350	− 0,60	+ 0,60	± 0,60
350 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
A partir 800	− ½ %	+ ½ %	± ½ %

Conjunto: TUNEL FORMACION HIELO

Escalas: 1:1

INTA
TALLERES GENERALES
PROYECTOS

Todas las cotas sin indicación redondeadas con 0,2 mm. Calidad de rosca [illegible]

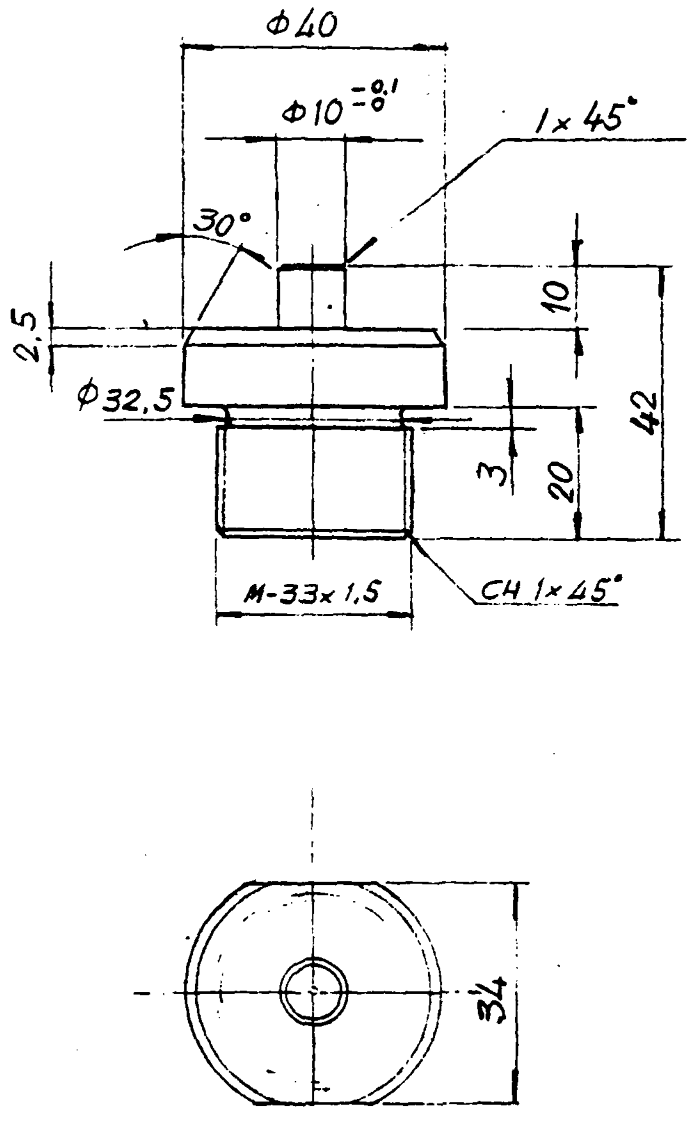
Símbolo		
~	Superficie en bruto	
▽	»	basta
▽▽	»	fina
▽▽▽	»	muy fina
▽▽▽▽	»	lapeada

	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

Núm. del plano Talleres

Peticionario

Núm. del plano: 84-023/B-3



B-4	TAPA SUPERIOR MODELO	3	DURAL ANODIZADO
Marca	DESIGNACION	Cantidad	MATERIAL Y TRATAMIENTO

Tolerancias admitidas en dimensiones sin indicación de tolerancia, para trabajos arrancando virutas

Sectores de medidas	Tolerancia exteriores	Tolerancia interiores	Tolerancia
1 ÷ 3	− 0,15	+ 0,15	± 0,15
3 ÷ 10	− 0,25	+ 0,25	± 0,25
10 ÷ 30	− 0,30	+ 0,30	± 0,30
30 ÷ 80	− 0,40	+ 0,40	± 0,40
80 ÷ 180	− 0,50	+ 0,50	± 0,50
180 ÷ 350	− 0,60	+ 0,60	± 0,60
350 ÷ 500	− 0,80	+ 0,80	± 0,80
500 ÷ 800	− 1,0	+ 1,0	± 1,0
A partir 800	− 1/2 %	+ 1/2 %	± 1/2 %

Conjunto: TUNEL FORMACION HIELO

Escalas: 1:1

INTA
TALLERES GENERALES
PROYECTOS

Todos los cantos sin indicación redondeados con 0,2 mm.
Calidad de [illegible]

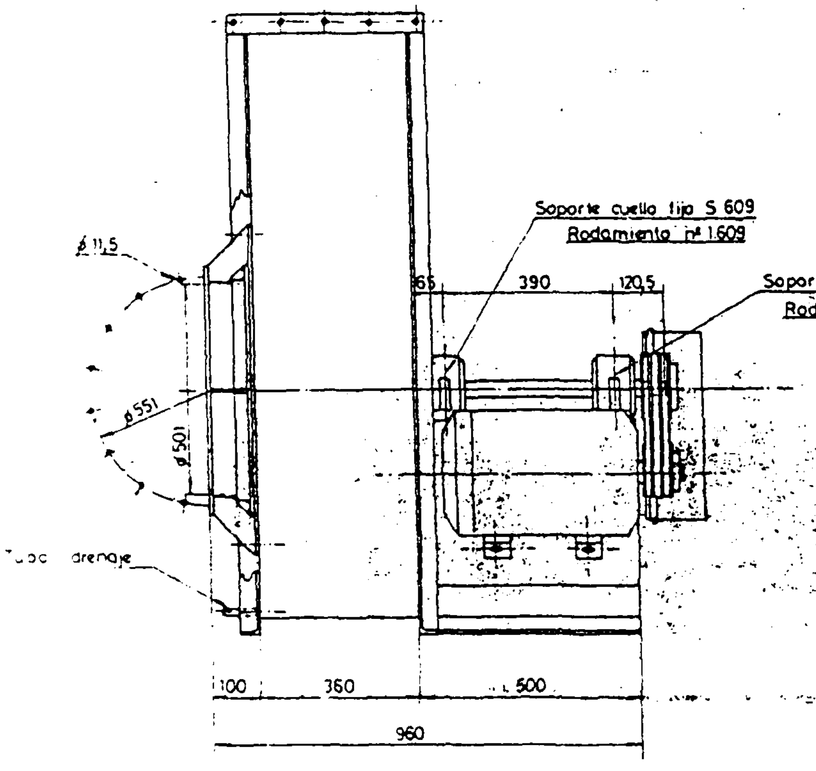
~	Superficie en bruto
▽	» basta
▽▽	» fina
▽▽▽	» muy fina
▽▽▽▽	» lapeada

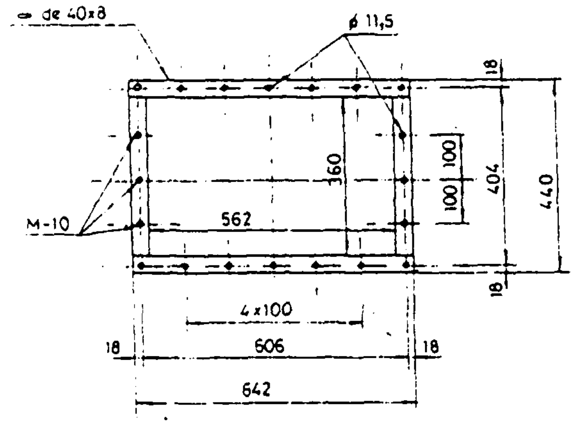
	Fecha	Nombre
Dibujado		
Calcado		
Verificado		

Núm. del plano Talleres

Peticionario

Núm. del plano: 84-023-B/4



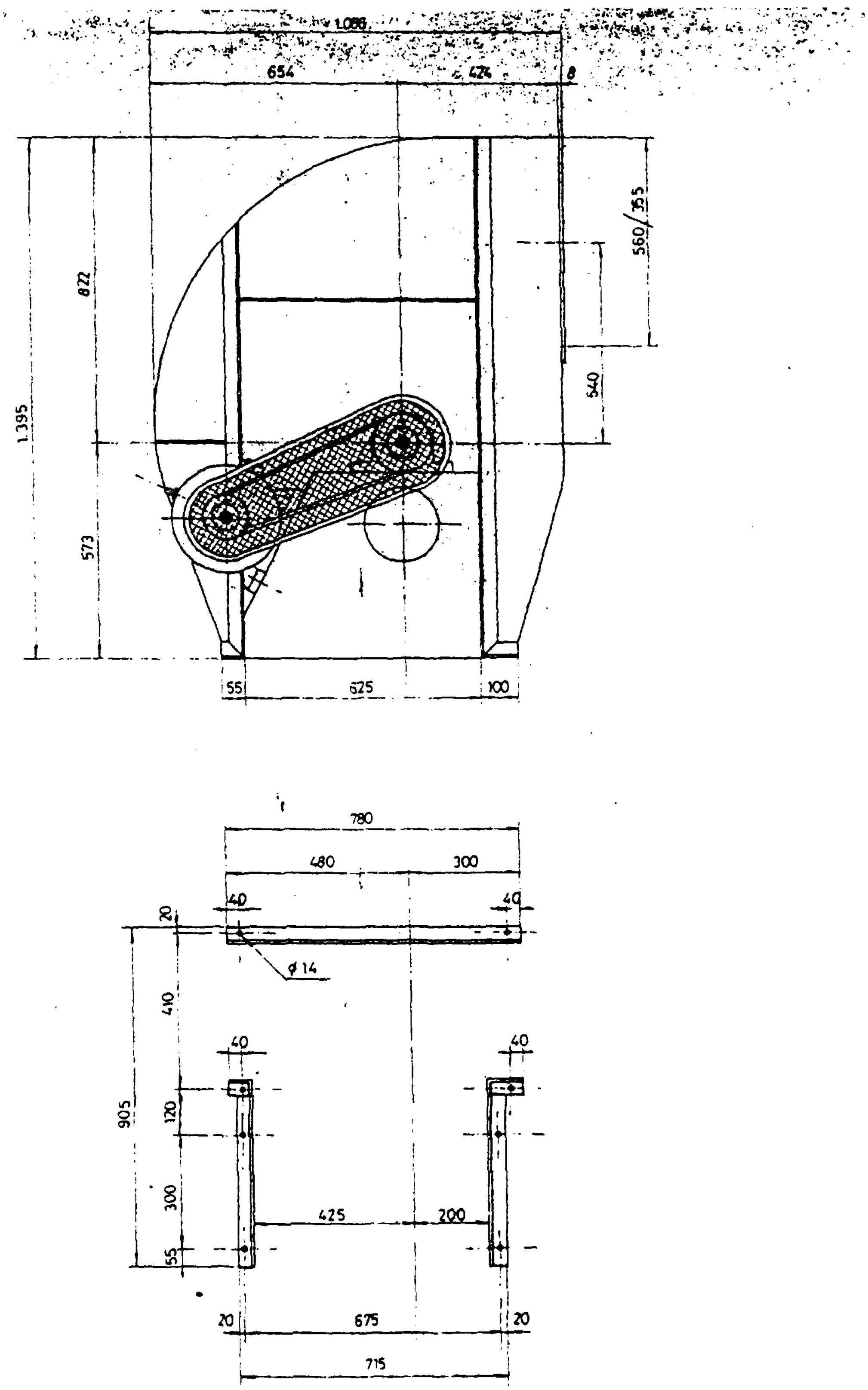


P/41.561

HOJA 1/2

Material		Dibujado	15-10-84	TALLERES IBARRETA, S. A.
		Comprob.		
Escala 1:10	VENTILADOR HN/RU-500-Rs GR-90° CONJUNTO			28.822
				Anula el / Anulado por

REDUCED COPY



HOJA 2/2

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ANNEX III

A-1/002.3 Imprenta del INTA

AD-A160 414 STUDY OF AEROSPACE MATERIALS COATINGS ADHESIONS AND PROCESSES AIRCRAFT IC..(U) INSTITUTO NACIONAL DE TECNICA AEROESPACIAL MADRID (SPAIN) E M RODRIGUEZ 2/2

UNCLASSIFIED 14 SEP 84 EOARD-TR-85-09(B) AFOSR-83-0340 F/G 8/12 NL

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DATE
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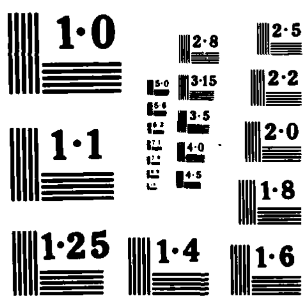
1·0
2·8
2·5
3·15
2·2
3·5
2·0
1·1
4·0
4·5
1·8
1·25
1·4
1·6

CALIBRATION TEST PROBES REPORT

A-1/002.3 Imprenta del INTA

INTRODUCCION

A petición de la Sección de Instrumentos de a bordo del Departamento de Aerodinamica y Navegabilidad y con cargo al contrato de formación de hielo HIA - 50 - 1119, se ha realizado la calibración de diversas sondas de anemometría térmica, con la instrumentación de dicha técnica existente en el Laboratorio de Ensayos Aerodinámicos del mismo Departamento.

La instrumentación utilizada a tal efecto estuvo compuesta por los siguientes equipos:

a) Unidad calibradora T.S.I. modelo 1125
b) Unidad de alimentación y monitora T.S.I. modelo 1051 2D41/2B-BCD
c) Unidad acondicionadora T.S.I. modelo 1057.
d) Unidad promediadora T.S.I. modelo 1047
e) Unidad anemométrica de temperatura constante T.S.I. modelo 1051.
f) Generador de funciones TRIO modelo FG-271
g) Osciloscopio HP - modelo 1150
i) cable de sondas T.S.I. modelo 10110 de 5 m.

Se han realizado cinco calibraciones gráficas y analíticas para el uso de diversas sondas de hilo y película en aire, operando estas sondas en todo momento en el modo de temperatura constante. Las presentes calibraciones permitirán la medición de velocidades medidas y de determinados parámetros turbulentos en una corriente de aire con velocidades comprendidas entre aproximadamente 0 y 70 m/seg. (0 y 280 mm H_2O).

Las sondas que se calibraron fueron las siguientes:

a) sondas de película caliente cilíndricas rectas a 90°con respecto al eje de la sonda medidos:

T.S.I. 1210-20/43092/121014

A-1002.3 Imprenta del INTA

- T.S.I. 1210-20/43093/121014
- T.S.I. 1210-20/43099/121014

b) Sondas de hilo caliente cilindricos rectos a 90°con respecto al eje de la sonda modelos:

- T.S.I. 1210-T1.5/41266/121002
- T.S.I. 1210-%1.5/41268/121002

El límite superior de frecuencias y las constantes de tiempo se han obtenido a una velocidad de aproximadamente 100 m/seg, sometiendo a los distintos sensores a una onda cuadrada de 1 Khz y 2 voltios de frecuencia y amplitud respectivamente.

La temperatura de funcionamiento de los distintos sensores se computó por el método de las resistencias de operación, a partir de los datos suministrados por el fabricante.

La ley elegida para simular el comportameinto real de la transferencia de calor desde los traductores fué la Ley de King, por lo que el tratamiento analítico se realizó confrontando los valores de la tensión DC de salida del anemómetro reducida por los efectos térmicos, esto es $E^2/(T_s-T)$, con el flujo másico incidente sobre el sensor. De este modo se obtuvieron curvas de calibración universales respecto a la temperatura fluída y al flujo másico. Se consideró tanto a la viscosidad dinámica como a la conductividad térmica del aire constantes e independientes de la temperatura a lo largo de las calibraciones.

La determinación de las constantes de calibración A, B y n se realizó mediante el programa Fortran "AJUSTE" que hace uso de las ecuaciones de gobierno de los distintos tramos del calibrador T.S.I. modelo 1125 y del método de obtención de solución por mínimos cuadrados.

A-1/0002.3 Imprenta del INTA

SECCION I

CALIBRACION DEL SENSOR DE HILO CALIENTE RECTO A 90° CON RESPECTO AL EJE DE LA SONDA T.S.I. MODELO 1210-T1.5/41266/121002

A-4/88.3 Imprenta del INTA

DATOS TECNICOS

- Fecha de calibración: 25 de Octubre de 1984
- Características del sensor: Sensor de hilo caliente cilíndrico recto a 90°con respecto al eje de la sonda, con una longitud de area sensible de 1.25 mm y un diámetro de 4 micras (razón de forma de aproximadamente 312.5), con distancia entre los soportes de 1.5 mm., compuesto de Tungsteno y laminado de Platino).
- Utilidad del sensor: Para determinar la velocidad media e intensidad de la turbulencia en la dirección del eje de la sonda.

DATOS ELECTRICOS

$R_{interna} = 0.26\ \Omega$

$R(°C) = 5.35\ \Omega$

$R(22°C) = 5.93\ \Omega$

$R(100°C) = 7.43\ \Omega$

$R_{operación} = 10.81\ \Omega$

Obteniendose a aproximadamente 100 m/seg. una constante de tiempo $\tau = 5\mu s$ lo que comporta un límite superior de frecuencias de hasta 154 Khz (maximo posible de 600 Hkz).

CONSTANTES DE CALIBRACION

La sonda se calibró según la ley de King en la forma:

$$\frac{E^2}{T_s - T} = A + B(\rho V)^n$$

donde E es la tensión DC de salida del anemómetro, Ts la temperatura de funcionamiento del sensor, T la temperatura ambiente, ρ la densidad y V la velocidad. A, B y n son las constantes de calibración propias del sensor.

A-4088.3 Imprenta del INTA

La temperatura de funcionamiento se determinó por la expresión:

$$T_s = 273.159 + 100 \frac{R_s - R_o}{R_{100} - R_o}$$

Los valores de las constantes de calibración fueron:

$n = 0.458$
$A = 0.0158$ Voltios^2/°K
$B = 0.0070$ Voltios^2/°K (Kg/seg m^2)^n
$T_s = 535.659$ °K

siendo el ajuste de tensiones de 0.00189 voltios.

La velocidad máxima de utilización es de 200 m/seg, la velocidad mínima de 0.15 m/seg. La temperatura ambiente máxima en la que se puede emplear es de 150°C.

A-4002.3 Imprenta del INTA

INTA	N.°	Pág.

DATOS DE CALIBRACION

PRESION ATMOSFERICA P_a = 709.5 mm HG
NUMERO DE DATOS N = 50

D mm	ΔP mmH_2O	T °F	E volt.	E_{RMS} mVolt.
16.51	0	72.0	1.981	
16.51	0.2	72.2	2.451	
16.51	0.4	"	2.514	
16.51	0.6	"	2.580	
16.51	0.8	"	2.627	
16.51	1	"	2.671	
16.51	1.5	"	2.729	
16.51	2	"	2.786	
16.51	2.5	"	2.821	
16.51	3	"	2.858	
16.51	4	"	2.913	
16.51	5	"	2.954	
16.51	6	"	2.986	
16.51	7	"	3.019	
16.51	8	"	3.038	
3.81	9	71.0	3.083	
3.81	10	"	3.105	
3.81	12	"	3147	
3.81	14	"	3.180	
3.81	16	"	3.212	
3.81	18	"	3.241	
3.81	20	"	3.264	
3.81	25	"	3.318	
3.81	30	"	3.364	
3.81	35	"	3.403	

D mm	ΔP mmH_2O	T °F	E volt.	E_{RMS} mVolt.
3.81	40	71.0	3.438	
3.81	45	"	3.469	
3.81	50	71.1	3.497	
3.81	55	"	3.524	
3.81	60	"	3.548	
3.81	65	"	3.570	
3.81	70	"	3.591	
3.81	80	"	3.629	
3.81	90	"	3.664	
3.81	100	"	3.695	
3.81	110	"	3.723	
3.81	120	"	3.750	
3.81	130	"	3.775	
3.81	140	"	3.798	
3.81	150	"	3.820	
3.81	160	"	3.840	
3.81	170	"	3.859	
3.81	180	"	3.877	
3.81	190	"	3.895	
3.81	200	"	3.911	
3.81	210	"	3.927	
3.81	230	"	3.957	
3.81	250	71.2	3.985	
3.81	270	"	4.011	
3.81	280	"	4.024	

OBSERVACIONES

A-4088.3 Imprenta del INTA

PRESION (MM.HG)	TEMPERATURA (K)	FLUJO MASICO (KG./SEG.M2)	TENSION MEDIA (VOLTIOS)
708.500	295.382	0.0	1.981
708.515	295.493	2.089	2.451
708.529	295.493	2.954	2.514
708.544	295.493	3.618	2.580
708.559	295.493	4.186	2.627
708.573	295.493	4.678	2.671
708.610	295.493	5.733	2.729
708.647	295.493	6.616	2.786
708.684	295.493	7.399	2.821
708.721	295.493	8.107	2.858
708.794	295.493	9.360	2.913
708.868	295.493	10.464	2.954
708.941	295.493	11.465	2.986
709.015	295.493	12.383	3.018
709.089	295.493	13.240	3.038
709.162	294.748	14.037	3.083
709.236	294.739	14.797	3.105
709.383	294.721	16.209	3.147
709.530	294.704	17.508	3.180
709.677	294.687	18.717	3.212
709.824	294.669	19.853	3.241
709.971	294.652	20.925	3.264
710.339	294.608	23.395	3.318
710.707	294.564	25.628	3.364
711.075	294.521	27.681	3.403
711.443	294.477	29.592	3.438
711.811	294.434	31.387	3.469
712.179	294.446	33.081	3.497
712.547	294.403	34.695	3.524
712.915	294.359	36.237	3.548
713.283	294.316	37.716	3.570
713.651	294.272	39.139	3.591
714.386	294.186	41.840	3.629
715.122	294.099	44.376	3.664
715.858	294.013	46.775	3.695
716.594	293.927	49.057	3.723
717.330	293.840	51.236	3.750
718.066	293.754	53.326	3.775
718.802	293.668	55.338	3.798
719.537	293.583	57.277	3.820
720.273	293.497	59.154	3.840
721.009	293.411	60.972	3.859
721.745	293.326	62.738	3.877
722.481	293.240	64.454	3.895
723.217	293.155	66.126	3.911
723.952	293.070	67.757	3.927
725.424	292.900	70.905	3.957
726.896	292.785	73.911	3.985
728.367	292.616	76.805	4.011
729.103	292.532	78.211	4.024

TEMPERATURA FLUIDA (K)	TENSION EXPERIMENTAL REDUCIDA (VOLTIOS)2/K	TENSION TEORICA REDUCIDA (VOLTIOS)2/K	FLUJO MASICO REDUCIDO (KG/SEG.M2)N
295.382	0.0163	0.0158	0.0
295.493	0.0250	0.0256	1.401
295.493	0.0263	0.0273	1.642
295.493	0.0277	0.0284	1.802
295.493	0.0287	0.0293	1.927
295.493	0.0297	0.0300	2.027
295.493	0.0310	0.0313	2.225
295.493	0.0323	0.0324	2.376
295.493	0.0331	0.0333	2.501
295.493	0.0340	0.0340	2.608
295.493	0.0353	0.0352	2.785
295.493	0.0363	0.0363	2.931
295.493	0.0371	0.0371	3.056
295.493	0.0379	0.0379	3.166
295.493	0.0384	0.0386	3.265
294.748	0.0395	0.0392	3.353
294.739	0.0400	0.0398	3.435
294.721	0.0411	0.0408	3.581
294.704	0.0420	0.0417	3.710
294.687	0.0428	0.0425	3.825
294.669	0.0436	0.0432	3.930
294.652	0.0442	0.0439	4.026
294.608	0.0457	0.0453	4.237
294.564	0.0469	0.0466	4.418
294.521	0.0480	0.0477	4.576
294.477	0.0490	0.0487	4.718
294.434	0.0499	0.0496	4.847
294.446	0.0507	0.0504	4.966
294.403	0.0515	0.0512	5.075
294.359	0.0522	0.0519	5.177
294.316	0.0528	0.0526	5.273
294.272	0.0534	0.0532	5.363
294.186	0.0545	0.0543	5.530
294.099	0.0556	0.0554	5.681
294.013	0.0565	0.0564	5.819
293.927	0.0573	0.0573	5.948
293.840	0.0582	0.0581	6.067
293.754	0.0589	0.0589	6.179
293.668	0.0596	0.0596	6.285
293.583	0.0603	0.0603	6.385
293.497	0.0609	0.0610	6.480
293.411	0.0615	0.0616	6.570
293.326	0.0620	0.0622	6.657
293.240	0.0626	0.0628	6.740
293.155	0.0631	0.0633	6.819
293.070	0.0636	0.0639	6.896
292.900	0.0645	0.0649	7.041
292.785	0.0654	0.0658	7.176
292.616	0.0662	0.0667	7.303
292.532	0.0666	0.0671	7.364

A-4000 I. Imprenta del INTA

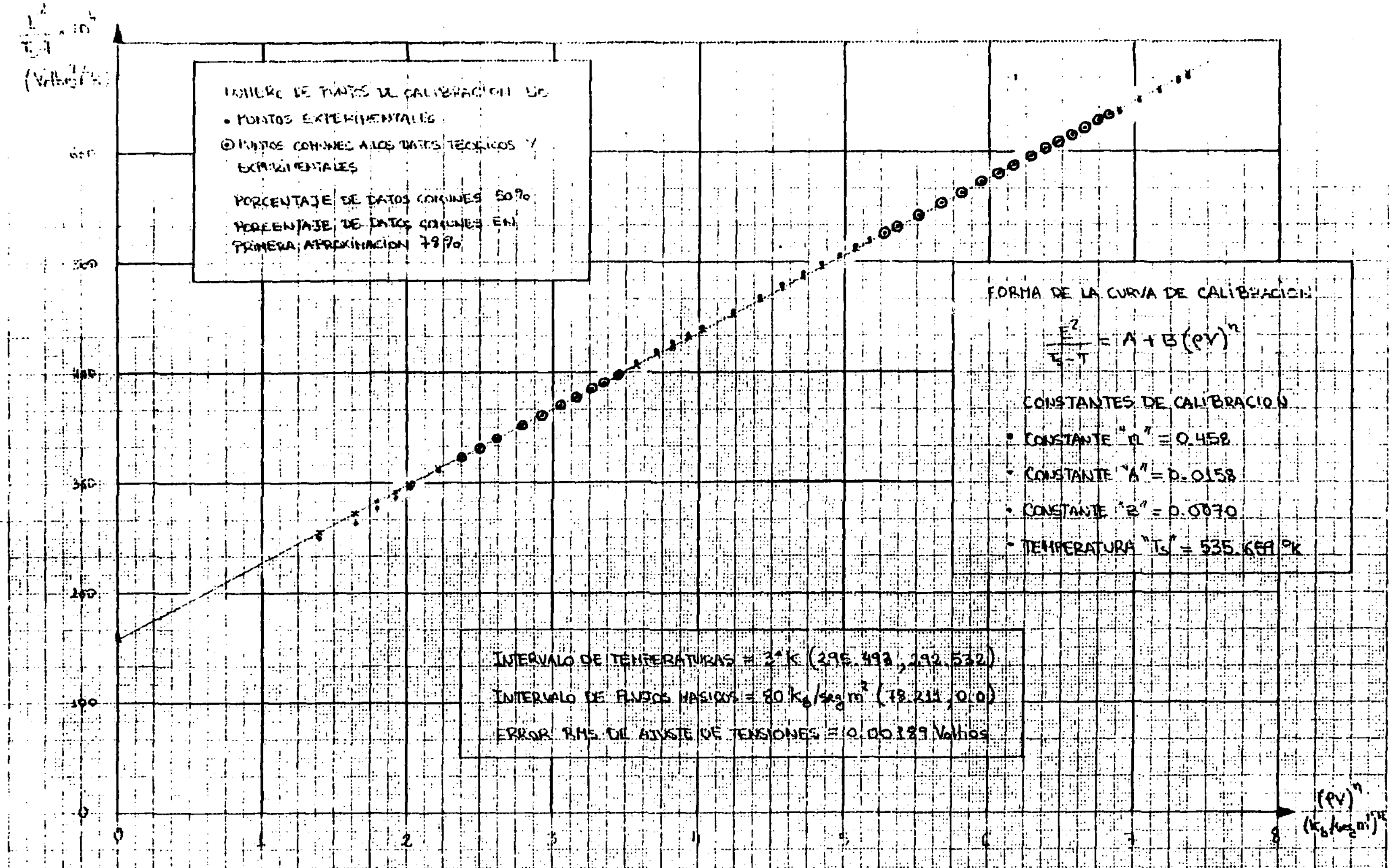

FIGURA 1: CALIBRACION EN AIRE DEL SENSOR T.S.I DE HILO CALIENTE MODELO 1210-T1.5/41266/121002

SECCION II

CALIBRACION DEL SENSOR DE HILO CALIENTE RECTO A 90°CON RESPECTO AL EJE DE LA SONDA T.S.I. MODELO 1210-T1-5/41268/121002

A-1/002.3 Imprenta del INTA

DATOS TECNICOS

- Fecha de calibración: 29 de Octubre de 1984
- Características del sensor: Sensor de hilo caliente cilíndrico recto a 90° con respecto al eje de la sonda, con una longitud de area sensible de 1.25 mm. y un diámetro de 4 micras (razón de forma de aproximadamente 312.5), con una distancia entre los soportes de 1.5 mm., compuesto de Tungsteno y laminado de Platino.
- Utilidad del sensor: Para determinar la velocidad media e intensidad de la turbulencia en la dirección del aje de la sonda

DATOS ELECTRICOS

$R_{interna} = 0.26\ \Omega$

$R(0°C) = 5.19\ \Omega$
$R(22°C) = 5.73\ \Omega$
$R(100°C) = 7.21\ \Omega$
$R_{operación} = 10.50\ \Omega$

Obteniéndose a aproximadamente 100 m/seg. una constante de tiempo $\tau = 5\mu s$ lo que comporta un límite superior de frecuencias de hasta 154 Khz (máximo posible 600 Khz).

CONSTANTES DE CALIBRACION

La sonda se calibró según la ley de King en la forma:

$$\frac{E^2}{T_s - T} = A + B\ (\rho V)^n$$

donde E es la salida DC del anemómetro, T_s la temperatura de funcionamiento del sensor, T la temperatura ambiente, ρ la densidad y v la velocidad. A, B y n son las constantes de calibración propias del sensor.

A-1/882-B Imprenta del INTA

La temperatura de funcionamiento se determinó por la expresión

$$T_s = 273.159 + 100\,\frac{R_s - R_o}{R_{100} - R_o}$$

Los valores de las constantes de calibración fueron:

$n = 0.456$
$A = 0.0163$ Voltios^2/°K
$B = 0.0073$ Voltios^2/°K (Kg/seg. m^2)^n
$T_s = 536.030$ °K

siendo el ajuste de tensiones de 0.00219 voltios.

La velocidad máxima en la que se puede emplear es de 200 m/seg. y la mínima de 0.15 m/seg. La máxima temperatura ambiente es de 150°C.

A-4002.3 Imprenta del INTA

INTA	N.°	Pág.

DATOS DE CALIBRACION

PRESION ATMOSFERICA P_a = 715.5 mm HG
NUMERO DE DATOS N = 50

D mm	ΔP mmH_2O	T °F	E volt.	E_{RMS} mVolt.
16.51	0	70.6	2.018	
16.51	0.2	70.8	2.468	
16.51	0.4	"	2.575	
16.51	0.6	"	2.627	
16.51	0.8	"	2.673	
16.51	1	70.9	2.720	
16.51	1.5	"	2.787	
16.51	2	"	2.839	
16.51	2.5	"	2.878	
16.51	3	71.0	2.916	
16.51	4	"	2.972	
16.51	5	"	3.015	
16.51	6	"	3.049	
16.51	7	"	3.080	
16.51	8	"	3.110	
3.81	9	69.7	3.142	
3.81	10	669.8	3.167	
3.81	12	69.9	3.209	
3.81	14	"	3.244	
3.81	16	"	3.274	
3.81	18	"	3.303	
3.81	20	"	3.327	
3.81	25	"	3.382	
3.81	30	"	3.429	
3.81	35	"	3.468	

D mm	ΔP mmH_2O	T °F	E volt.	E_{RMS} mVolt.
3.81	40	69.9	3.506	
3.81	45	"	3.538	
3.81	50	"	3.566	
3.81	55	"	3.593	
3.81	60	"	3.617	
3.81	65	"	3.639	
3.81	70	"	3.661	
3.81	80	70.0	3.700	
3.81	90	"	3.734	
3.81	100	"	3.766	
3.81	110	"	3.795	
3.81	120	"	3.822	
3.81	130	"	3.848	
3.81	140	"	3.872	
3.81	150	70.1	3.894	
3.81	160	"	3.915	
3.81	170	"	3.933	
3.81	180	"	3.951	
3.81	190	"	3.968	
3.81	200	"	3.985	
3.81	210	"	4.002	
3.81	230	70.2	4.032	
3.81	250	"	4.060	
3.81	270	"	4.086	
3.81	280	"	4.098	

OBSERVACIONES

A-4068.8 Imprenta del INTA

PRESION (MM.HG)	TEMPERATURA (K)	FLUJO MASICO (KG./SEG.M2)	TENSION MEDIA (VOLTIOS)
715.500	294.604	0.0	2.018
715.515	294.715	2.102	2.468
715.529	294.715	2.972	2.575
715.544	294.715	3.640	2.627
715.559	294.715	4.212	2.673
715.573	294.771	4.707	2.720
715.610	294.771	5.768	2.787
715.647	294.771	6.657	2.839
715.684	294.771	7.445	2.878
715.721	294.826	8.156	2.916
715.794	294.826	9.417	2.972
715.868	294.826	10.527	3.015
715.941	294.826	11.535	3.049
716.015	294.826	12.458	3.080
716.089	294.826	13.320	3.110
716.162	294.026	14.124	3.142
716.236	294.073	14.886	3.167
716.383	294.112	16.306	3.209
716.530	294.094	17.612	3.244
716.677	294.077	18.829	3.274
716.824	294.060	19.972	3.303
716.971	294.042	21.050	3.327
717.339	294.000	23.535	3.382
717.707	293.956	25.781	3.429
718.075	293.913	27.847	3.468
718.443	293.870	29.769	3.506
718.811	293.827	31.574	3.538
719.179	293.784	33.282	3.566
719.547	293.741	34.905	3.593
719.915	293.698	36.457	3.617
720.283	293.656	37.945	3.639
720.651	293.613	39.377	3.661
721.386	293.583	42.090	3.700
722.122	293.497	44.642	3.734
722.858	293.412	47.055	3.766
723.594	293.327	49.350	3.795
724.330	293.241	51.543	3.822
725.066	293.156	53.645	3.848
725.802	293.072	55.668	3.872
726.537	293.042	57.614	3.894
727.273	292.957	59.502	3.915
728.009	292.872	61.331	3.933
728.745	292.788	63.107	3.951
729.481	292.703	64.834	3.968
730.217	292.619	66.515	3.985
730.952	292.535	68.155	4.002
732.424	292.422	71.315	4.032
733.896	292.255	74.346	4.060
735.367	292.087	77.257	4.086
736.103	292.004	78.672	4.098

INTA	N.°	Pág.

TEMPERATURA FLUIDA (K)	TENSION EXPERIMENTAL REDUCIDA (VOLTIOS)2/K	TENSION TEORICA REDUCIDA (VOLTIOS)2/K	FLUJO MASICO REDUCIDO (KG/SEG.M2)N
294.604	0.0169	0.0163	0.0
294.715	0.0252	0.0265	1.403
294.715	0.0275	0.0282	1.643
294.715	0.0286	0.0294	1.802
294.715	0.0296	0.0303	1.927
294.771	0.0307	0.0310	2.027
294.771	0.0322	0.0324	2.223
294.771	0.0334	0.0335	2.374
294.771	0.0343	0.0344	2.498
294.826	0.0353	0.0352	2.609
294.826	0.0366	0.0365	2.780
294.826	0.0377	0.0375	2.925
294.826	0.0385	0.0384	3.050
294.826	0.0393	0.0392	3.159
294.826	0.0401	0.0399	3.257
294.026	0.0408	0.0406	3.345
294.073	0.0415	0.0412	3.426
294.112	0.0426	0.0422	3.571
294.094	0.0435	0.0431	3.699
294.077	0.0443	0.0440	3.819
294.060	0.0451	0.0447	3.917
294.042	0.0457	0.0454	4.012
294.000	0.0473	0.0469	4.222
293.956	0.0486	0.0482	4.401
293.913	0.0497	0.0494	4.558
293.870	0.0508	0.0504	4.699
293.827	0.0517	0.0513	4.827
293.784	0.0525	0.0522	4.945
293.741	0.0533	0.0530	5.053
293.698	0.0540	0.0537	5.154
293.656	0.0546	0.0544	5.249
293.613	0.0553	0.0550	5.339
293.583	0.0565	0.0562	5.503
293.497	0.0575	0.0573	5.653
293.412	0.0585	0.0583	5.790
293.327	0.0593	0.0593	5.918
293.241	0.0602	0.0601	6.036
293.156	0.0610	0.0609	6.147
293.072	0.0617	0.0617	6.252
293.042	0.0624	0.0624	6.350
292.957	0.0631	0.0631	6.444
292.872	0.0636	0.0637	6.534
292.788	0.0642	0.0643	6.620
292.703	0.0647	0.0649	6.702
292.619	0.0652	0.0655	6.780
292.535	0.0658	0.0661	6.856
292.422	0.0667	0.0671	6.999
292.255	0.0676	0.0681	7.133
292.087	0.0684	0.0690	7.259
292.004	0.0688	0.0694	7.320

A-40013. Imprenta del INTA

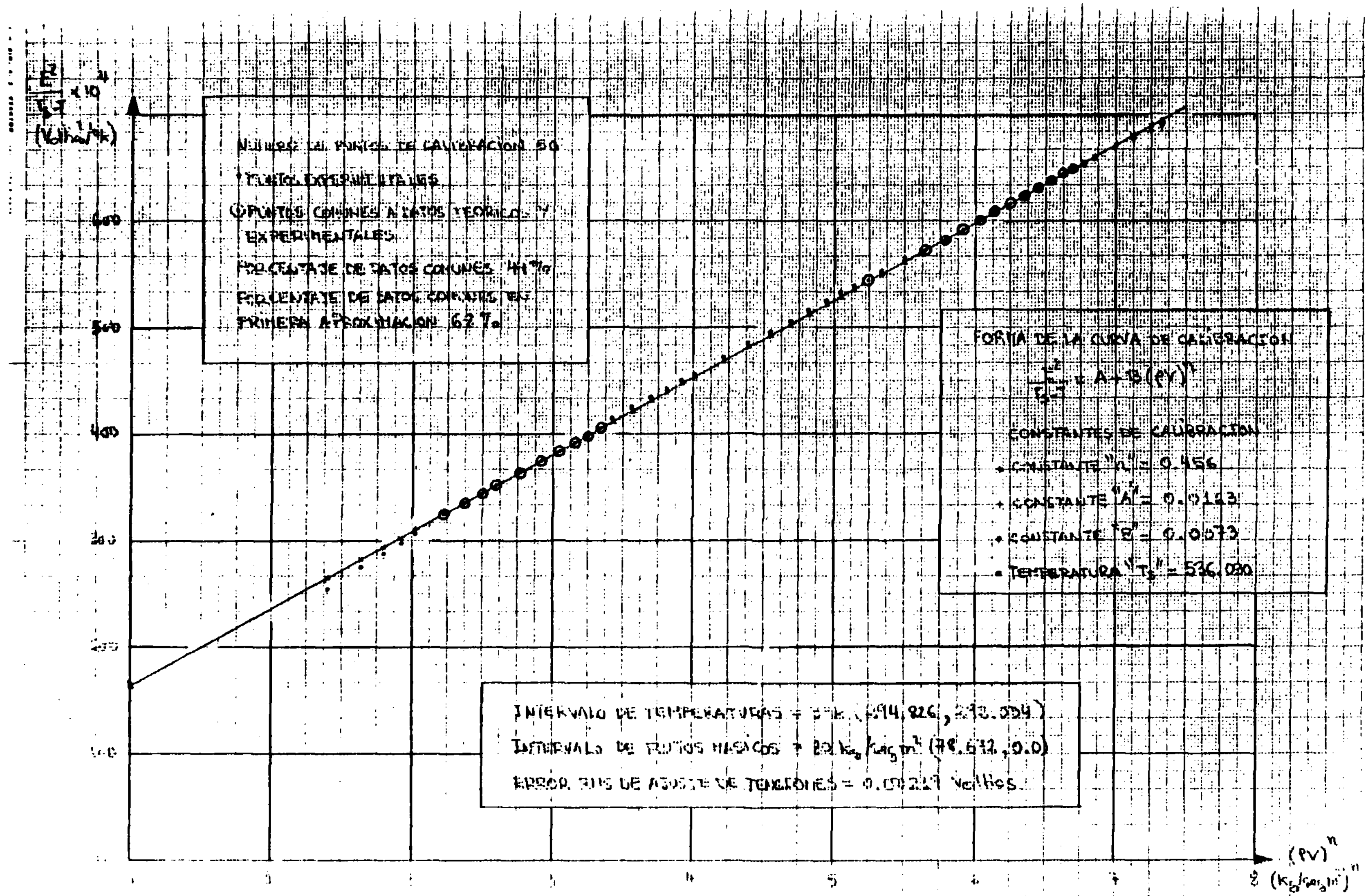

Figura 2: Calibración en aire del sensor T.S.I de hilo caliente modelo 1210-T1.5/41268/121602.

SECCION III

CALIBRACION DEL SENSOR DE PELICULA CALIENTE RECTA A 90° CON RESPECTO AL EJE DE LA SONDA TSI MODELO 1210-20/43092/121014

A-4888.3 Imprenta del INTA

DATOS TECNICOS

- Fecha de calibracion: 17 de Octubre de 1984
- Características del sensor: Sensor de película caliente cilíndrica recta a 90°con respecto al eje de la sonda, con una longitud de area sensible de 1.0 mm. y un diámetro de 54 μm. (razon de forma de aproximadamente 19.6), con distancia entre los soportes de 1.67 mm., compuesto de platino sobre un substrato de cuarzo.
- Utilidad del sensor: Para determinar la velocidad media e intensidad de la turbulencia en la dirección del eje de la sonda.

DATOS ELECTRICOS

$R_{interna} = 0.20\ \Omega$
$R_{(°0C)} = 7.00\ \Omega$
$R_{(22.8°C)} = 7.35\ \Omega$
$R_{(100°C)} = 7.97\ \Omega$
$R_{operación} = 9.50\ \Omega$

obteniendose a aproximadamente 100 m/seg una constante de tiempos $\tau = 10\ \mu s$ lo que comporta un límite superior de frecuencias de hasta 100 Khz (maximo posible de 250 Khz).

CONSTANTES DE CALIBRACION

La sonda se calibró según la Ley de King en la forma:

$$\frac{E^2}{T_s - T} + A + B\ (\rho V)^n$$

A-4008.3 Imprenta del INTA

donde E es la tensión DC de salida del anemómetro, T_s la temperatura de funcionamiento del sensor, T la temperatura ambiente, ρ la densidad y V la velocidad. A, B y n son las constantes de calibración propias del sensor.

La temperatura de funcionamiento se determinó por la expresión

$$T_s = 273.159 + 100 \frac{R_s - R_o}{R_{100} - R_o}$$

Los valores de las constantes de calibración fueron:

$n = 0.522$
$A = 0.0350$ Voltios^2/°K
$B = 0.0191$ Voltios^2/°K (Kg/seg m^2)^n
$T_s = 530.891$°K

siendo el ajuste de tensiones de 0.00294 voltios.

La velocidad máxima en la que se puede emplear es de 350 m/seg. y la mínima de 0.15 m/seg. La máxima temperatura ambiente es de 150°C.

A-4008.3 Imprenta del INTA

INTA	N.°	Pág.

DATOS DE CALIBRACION

PRESION ATMOSFERICA Pa = 716 mm HG
NUMERO DE DATOS N = 50

D mm	ΔP mmH_2O	T °F	E volt.	E_{RMS} mVolt.
16.51	0	73.5	2.898	
16.51	0.2	"	3.780	
16.51	0.4	"	3.961	
16.51	0.6	"	4.080	
16.51	0.8	"	4.170	
16.51	1	"	4.289	
16.51	1.5	"	4.404	
16.51	2	"	4.521	
16.51	2.5	"	4.602	
16.51	3	"	4.677	
16.51	4	"	4.787	
16.51	5	"	4.871	
16.51	6	"	4.947	
16.51	7	"	5.008	
16.51	8	"	5.064	
3.81	9	72.5	5.147	
3.81	10	"	5.192	
3.81	12	"	5.267	
3.81	14	"	5.333	
3.81	16	"	5.390	
3.81	18	"	5.443	
3.81	20	"	5.497	
3.81	25	"	5.608	
3.81	30	72.4	5.698	
3.81	35	"	5.790	
3.81	40	72.4	5.871	
3.81	45	"	5.950	
3.81	50	"	6.014	
3.81	55	"	6.074	
3.81	60	"	6.128	
3.81	65	"	6.178	
3.81	70	"	6.227	
3.81	80	"	6.317	
3.81	90	"	6.400	
3.81	100	"	6.478	
3.81	110	"	6.545	
3.81	120	"	6.610	
3.81	130	"	6.669	
3.81	140	73.0	6.713	
3.81	150	"	6.766	
3.81	160	"	6.815	
3.81	170	"	6.858	
3.81	180	"	6.896	
3.81	190	73.5	6.932	
3.81	200	"	6.968	
3.81	210	"	7.004	
3.81	230	"	7.077	
3.81	250	"	7.149	
3.81	270	"	7.212	
3.81	280	"	7.247	

OBSERVACIONES

A-4083.3 Imprenta del INTA

PRESION (MM.HG)	TEMPERATURA (K)	FLUJO MASICO (KG./SEG.M2)	TENSION MEDIA (VOLTIOS)
716.000	296.215	0.0	2.898
716.015	296.215	2.097	3.780
716.029	296.215	2.966	3.961
716.044	296.215	3.632	4.080
716.059	296.215	4.203	4.170
716.073	296.215	4.697	4.289
716.110	296.215	5.756	4.404
716.147	296.215	6.643	4.521
716.184	296.215	7.429	4.602
716.221	296.215	8.140	4.677
716.294	296.215	9.398	4.787
716.368	296.215	10.506	4.871
716.441	296.215	11.512	4.947
716.515	296.215	12.433	5.008
716.589	296.215	13.293	5.064
716.662	295.582	14.091	5.147
716.736	295.573	14.854	5.192
716.883	295.556	16.272	5.267
717.030	295.538	17.576	5.333
717.177	295.521	18.789	5.390
717.324	295.504	19.930	5.443
717.471	295.486	21.006	5.497
717.839	295.443	23.486	5.608
718.207	295.344	25.729	5.698
718.575	295.301	27.791	5.790
718.943	295.258	29.709	5.871
719.311	295.215	31.511	5.950
719.679	295.172	33.215	6.014
720.047	295.128	34.835	6.074
720.415	295.085	36.384	6.128
720.783	295.042	37.869	6.178
721.151	294.999	39.298	6.227
721.886	294.913	42.010	6.317
722.622	294.828	44.557	6.400
723.358	294.742	46.965	6.478
724.094	294.656	49.256	6.545
724.830	294.571	51.444	6.610
725.566	294.485	53.543	6.669
726.302	294.732	55.531	6.713
727.037	294.647	57.477	6.766
727.773	294.562	59.361	6.815
728.509	294.477	61.185	6.858
729.245	294.392	62.957	6.896
729.981	294.583	64.649	6.932
730.717	294.498	66.326	6.968
731.452	294.414	67.962	7.004
732.924	294.245	71.119	7.077
734.396	294.076	74.141	7.149
735.867	293.908	77.044	7.212
736.603	293.824	78.455	7.247

A-4002 Imprenta del INTA

TEMPERATURA FLUIDA (K)	TENSION EXPERIMENTAL REDUCIDA (VOLTIOS)2/K	TENSION TEORICA REDUCIDA (VOLTIOS)2/K	FLUJO MASICO REDUCIDO (KG/SEG.M2)N
296.215	0.0358	0.0350	0.0
296.215	0.0609	0.0631	1.472
296.215	0.0669	0.0687	1.764
296.215	0.0709	0.0725	1.961
296.215	0.0741	0.0754	2.116
296.215	0.0784	0.0778	2.242
296.215	0.0826	0.0826	2.493
296.215	0.0871	0.0863	2.687
296.215	0.0902	0.0894	2.849
296.215	0.0932	0.0921	2.988
296.215	0.0976	0.0965	3.220
296.215	0.1011	0.1002	3.413
296.215	0.1043	0.1034	3.580
296.215	0.1069	0.1062	3.727
296.215	0.1093	0.1087	3.860
295.582	0.1126	0.1110	3.979
295.573	0.1146	0.1131	4.090
295.556	0.1179	0.1170	4.289
295.538	0.1208	0.1203	4.465
295.521	0.1234	0.1233	4.624
295.504	0.1259	0.1261	4.768
295.486	0.1284	0.1286	4.901
295.443	0.1336	0.1343	5.195
295.344	0.1378	0.1391	5.448
295.301	0.1423	0.1434	5.672
295.258	0.1463	0.1472	5.873
295.215	0.1502	0.1507	6.056
295.172	0.1534	0.1539	6.225
295.128	0.1565	0.1569	6.382
295.085	0.1593	0.1597	6.528
295.042	0.1618	0.1624	6.666
294.999	0.1644	0.1648	6.796
294.913	0.1691	0.1694	7.037
294.828	0.1735	0.1736	7.257
294.742	0.1777	0.1775	7.459
294.656	0.1813	0.1811	7.647
294.571	0.1849	0.1844	7.822
294.485	0.1881	0.1876	7.987
294.732	0.1908	0.1905	8.140
294.647	0.1938	0.1934	8.288
294.562	0.1965	0.1960	8.429
294.477	0.1989	0.1986	8.563
294.392	0.2011	0.2011	8.692
294.583	0.2033	0.2034	8.813
294.498	0.2054	0.2056	8.931
294.414	0.2074	0.2078	9.046
294.245	0.2116	0.2120	9.263
294.076	0.2158	0.2159	9.466
293.908	0.2195	0.2195	9.658
293.824	0.2215	0.2213	9.750

A-4000 S. Imprenta del INTA

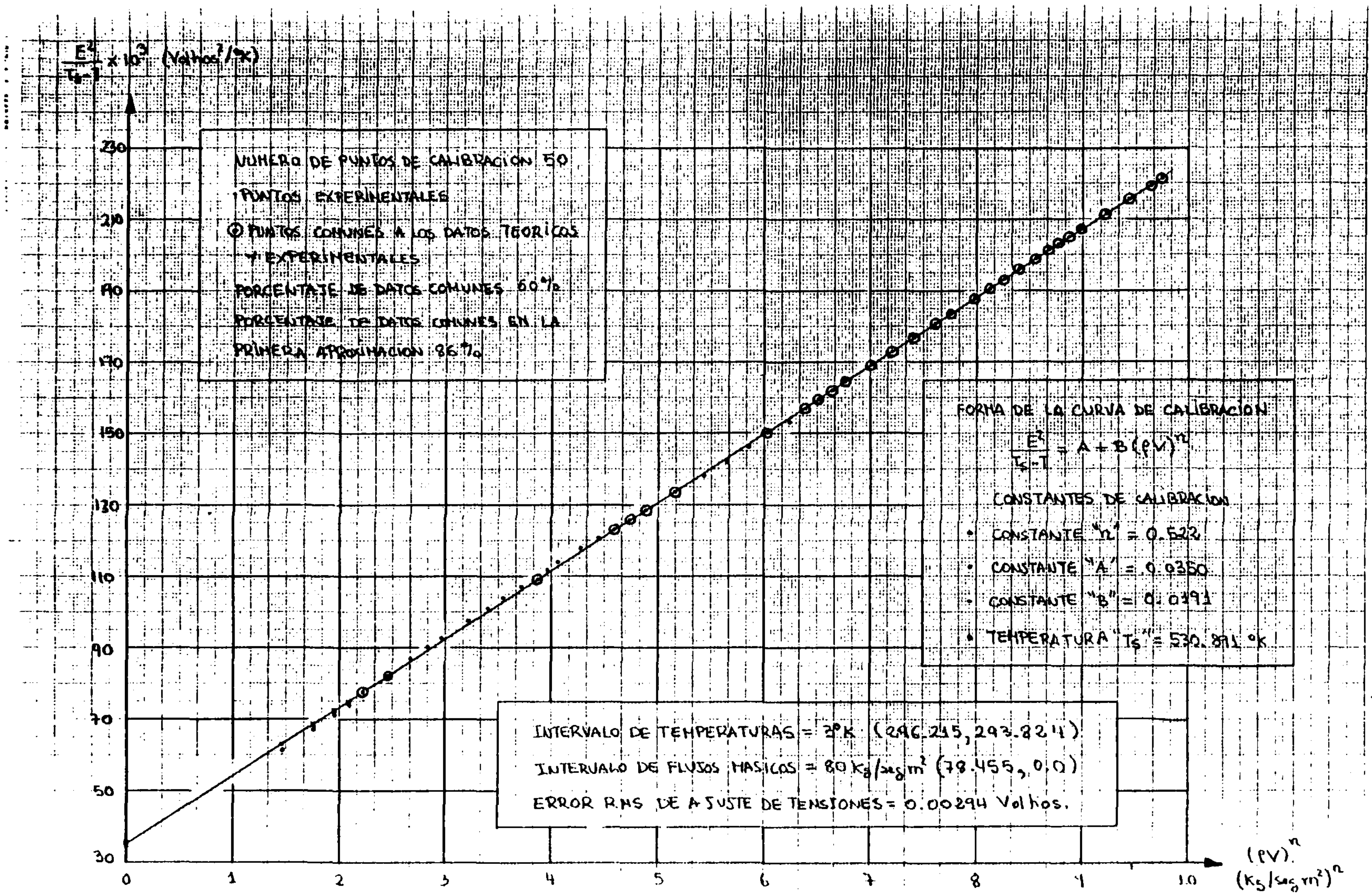

FIGURA 3: CALIBRACION EN AIRE DEL SENSOR T.S.I DE PELICULA CALIENTE MODELO 1210-20/43092/121014

SECCION IV

CALIBRACION DEL SENSOR DE PELICULA CALIENTE RECTA A 90° CON RESPECTO AL EJE DE LA SONDA T.S.I. MODELO 1210-20/ 43093/121014

A-1/002.8 Imprenta del INTA

DATOS TECNICOS

- Fecha de calibración: 18 de Octubre de 1984
- Características del sensor; Sensor de película caliente cilindrica recta a 90° con respecto al eje de la sonda, con una longitud de área sensible de 1.0 mm y un diámetro de 51μ (razón de forma de aproximadamente 19.6), con distancia entre los soportes de aproximadamente 1.67 mm., compuesto de platino sobre un substrato de cuarzo.
- Utilidad del sensor: Para determinar la velocidad media e intensidad de la turbulencia en la dirección del aje de la sonda.

DATOS ELECTRICOS

$R_{interna} = 0.20\ \Omega$

$R(°0\ C) = 6.44\ \Omega$

$R(23°C) = 6.82\ \Omega$

$R(100°C) = 7.34\ \Omega$

$R_{operación} = 8.89\ \Omega$

Obteniéndose a aproximadamente 100 m/seg. una constante de tiempos $\tau = 6\mu s$ lo que comporta un límite superior de frecuencias de hasta 166 Khz (máximo posible de 250 Khz.)

CONSTANTES DE CALIBRACION

La sonda se calibró según la Ley de King en la forma:

$$\frac{E^2}{T_s - T} = A + B\,(\rho V)^n$$

donde E es la tensión DC de salida del anemómetro, T_s la temperatura de funcionamiento del sensor, T la temperatura ambiente ρ la densidad y V la velocidad. A, B y n son las constantes de calibración propias del sensor.

A-1/002.3 Imprenta del INTA

La temperatura de funcionamiento se determinó por la expresión:

$$T_s = 273.159 + 100 \frac{R_s - R_o}{R_{100} - R_o}$$

Los valores de las constantes de calibración fueron:

$n = 0.511$
$A = 0.0335$ Voltios^2/°K
$B = 0.0188$ Voltios^2/°K (Kg/seg m^2)^n
$T_s = 545.381$°K

siendo el ajuste de tensiones de 0.00391 Voltios.

La velocidad máxima-en la que se puede emplear es de 350 m/seg y la mínima de 0.15 m/seg. La máxima temperatura ambiente es de 150°C.

A-4088.8 Imprenta del INTA

INTA	N.°	Pág.

DATOS DE CALIBRACION

PRESION ATMOSFERICA P_a = 709.5 mm HG
NUMERO DE DATOS N = 50

D mm	ΔP mmH_2O	T °F	E volt.	E_{RMS} mVolt.
16.51	0	73.0	2.938	
16.51	0.2	73.3	3.785	
16.51	0.4	"	3.976	
16.51	0.6	"	4.115	
16.51	0.8	"	4.212	
16.51	1	"	4.324	
16.51	1.5	"	4.457	
16.51	2	"	4.577	
16.51	2.5	"	4.649	
16.51	3	"	4.726	
16.51	4	"	4.837	
16.51	5	"	4.926	
16.51	6	"	4.995	
16.51	7	"	5.056	
16.51	8	"	5.104	
3.81	9	72.5	5.176	
3.81	10	"	5.222	
3.81	12	"	5.303	
3.81	14	"	5.374	
3.81	16	"	5.434	
3.81	18	"	5.487	
3.81	20	"	5.540	
3.81	25	"	5.645	
3.81	30	"	5.737	
3.81	35	"	5.817	

D mm	ΔP mmH_2O	T °F	E volt.	E_{RMS} mVolt.
3.81	40	72.5	5.899	
3.81	45	"	5.968	
3.81	50	"	6.031	
3.81	55	"	6.091	
3.81	60	"	6.144	
3.81	65	"	6.195	
3.81	70	"	6.242	
3.81	80	"	6.329	
3.81	90	"	6.407	
3.81	100	72.7	6.479	
3.81	110	"	6.546	
3.81	120	"	6.609	
3.81	130	"	6.668	
3.81	140	"	6.721	
3.81	150	"	6.772	
3.81	160	"	6.818	
3.81	170	"	6.862	
3.81	180	"	6.902	
3.81	190	"	6.942	
3.81	200	"	6.979	
3.81	210	"	7.016	
3.81	230	73.0	7.086	
3.81	250	"	7.149	
3.81	270	"	7.207	
3.81	280	"	7.236	

OBSERVACIONES

A-4002.3 Imprenta del INTA

PRESION (MM.HG)	TEMPERATURA (K)	FLUJO MASICO (KG./SEG.M2)	TENSION MEDIA (VOLTIOS)
709.500	295.938	0.0	2.938
709.515	296.104	2.088	3.785
709.529	296.104	2.953	3.976
709.544	296.104	3.616	4.115
709.559	296.104	4.185	4.212
709.573	296.104	4.677	4.324
709.610	296.104	5.731	4.457
709.647	296.104	6.614	4.577
709.684	296.104	7.397	4.649
709.721	296.104	8.104	4.726
709.794	296.104	9.357	4.837
709.868	296.104	10.460	4.926
709.941	296.104	11.461	4.995
710.015	296.104	12.379	5.056
710.089	296.104	13.235	5.104
710.162	295.581	14.028	5.176
710.236	295.572	14.786	5.222
710.383	295.555	16.198	5.303
710.530	295.537	17.496	5.374
710.677	295.520	18.704	5.434
710.824	295.502	19.839	5.487
710.971	295.485	20.911	5.540
711.339	295.441	23.378	5.645
711.707	295.397	25.610	5.737
712.075	295.354	27.662	5.817
712.443	295.310	29.571	5.899
712.811	295.267	31.364	5.968
713.179	295.223	33.061	6.031
713.547	295.180	34.674	6.091
713.915	295.136	36.215	6.144
714.283	295.093	37.693	6.195
714.651	295.049	39.115	6.242
715.386	294.963	41.814	6.329
716.122	294.876	44.350	6.407
716.858	294.900	46.738	6.479
717.594	294.814	49.018	6.546
718.330	294.728	51.195	6.609
719.066	294.641	53.284	6.668
719.802	294.555	55.293	6.721
720.537	294.469	57.232	6.772
721.273	294.383	59.107	6.818
722.009	294.298	60.924	6.862
722.745	294.212	62.688	6.902
723.481	294.126	64.403	6.942
724.217	294.041	66.074	6.979
724.952	293.956	67.703	7.016
726.424	293.951	70.828	7.086
727.896	293.781	73.838	7.149
729.367	293.611	76.729	7.207
730.103	293.527	78.134	7.236

A-4008-G. Imprenta del INTA

INTA	N.°	Pág.

TEMPERATURA FLUIDA (K)	TENSION EXPERIMENTAL REDUCIDA (VOLTIOS)2/K	TENSION TEORICA REDUCIDA (VOLTIOS)2/K	FLUJO MASICO REDUCIDO (KG/SEG.M2)N
295.938	0.0346	0.0335	0.0
296.104	0.0575	0.0609	1.457
296.104	0.0634	0.0662	1.739
296.104	0.0679	0.0698	1.929
296.104	0.0712	0.0726	2.078
296.104	0.0750	0.0749	2.200
296.104	0.0797	0.0794	2.440
296.104	0.0840	0.0829	2.626
296.104	0.0867	0.0858	2.780
296.104	0.0896	0.0883	2.913
296.104	0.0939	0.0925	3.135
296.104	0.0973	0.0960	3.319
296.104	0.1001	0.0990	3.478
296.104	0.1025	0.1016	3.617
296.104	0.1045	0.1040	3.743
295.581	0.1072	0.1061	3.856
295.572	0.1092	0.1081	3.961
295.555	0.1126	0.1116	4.150
295.537	0.1156	0.1148	4.317
295.520	0.1182	0.1176	4.466
295.502	0.1205	0.1202	4.603
295.485	0.1228	0.1225	4.728
295.441	0.1275	0.1278	5.006
295.397	0.1317	0.1323	5.244
295.354	0.1353	0.1362	5.455
295.310	0.1392	0.1398	5.644
295.267	0.1424	0.1430	5.817
295.223	0.1454	0.1460	5.975
295.180	0.1483	0.1488	6.123
295.136	0.1508	0.1514	6.260
295.093	0.1533	0.1538	6.390
295.049	0.1556	0.1561	6.512
294.963	0.1600	0.1604	6.737
294.876	0.1639	0.1643	6.943
294.900	0.1676	0.1678	7.132
294.814	0.1710	0.1711	7.308
294.728	0.1743	0.1742	7.472
294.641	0.1773	0.1771	7.626
294.555	0.1801	0.1799	7.772
294.469	0.1828	0.1825	7.910
294.383	0.1852	0.1849	8.041
294.298	0.1875	0.1873	8.166
294.212	0.1897	0.1896	8.286
294.126	0.1918	0.1917	8.401
294.041	0.1938	0.1938	8.512
293.956	0.1958	0.1958	8.619
293.951	0.1997	0.1996	8.820
293.781	0.2031	0.2032	9.009
293.611	0.2063	0.2065	9.188
293.527	0.2079	0.2082	9.273

A-4002.3. Imprenta del INTA

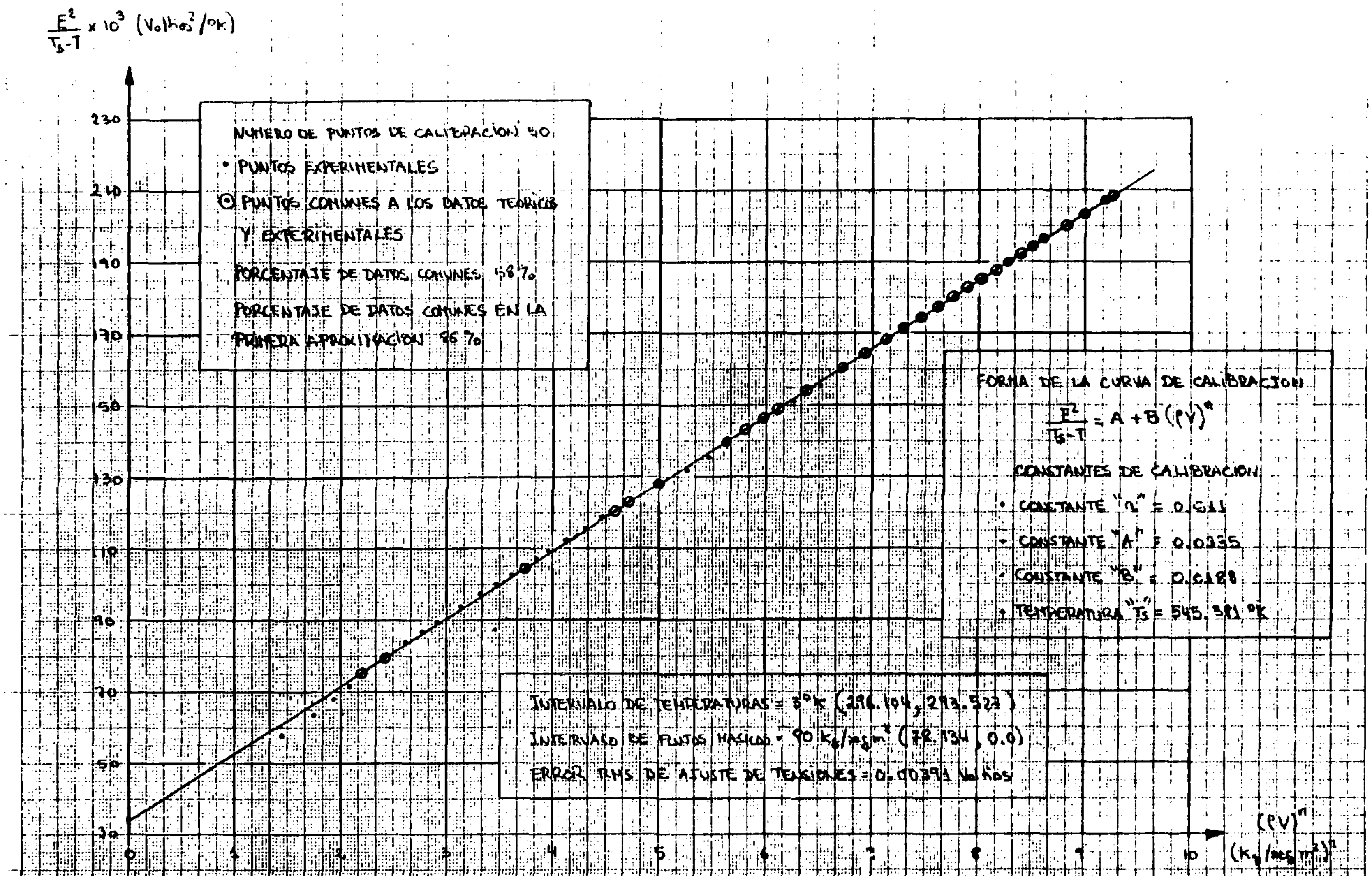

FIGURA 4: CALIBRACION EN AIRE DEL SENSOR T.S.I DE PELICULA CALIENTE MODELO 1210-20/43093/121014

SECCION V

CALIBRACION DEL SENSOR DE PELICULA CALIENTE RECTA A 90° CON RESPECTO AL EJE DE LA SONDA T.S.I MODELO 1210-20/43099/121014

A-4088.8 Imprenta del INTA

DATOS TECNICOS

- Fecha de calibración: 23 de Octubre de 1984
- Características del sensor: Sensor de película caliente - cilíndrica recta a 90° con respecto al eje de la sonda, con una longitud de área sensible de 1.0 mm. y un diámetro de 51 μm. (razón del forma de aproximadamente 19.6), con distancia entre los soportes de aproximadamente 1.67 mm., compuesto de platino depositado sobre un substrato de cuarzo.
- Utilidad del sensor: Para determinar la velocidad media e intensidad de la turbulencia en la dirección del eje de la sonda

DATOS ELECTRICOS

$R_{interna} = 0.20\ \Omega$

$R(0°C) = 7.01\ \Omega$

$R(21.5°C) = 7.33\ \Omega$

$R(100°C) = 8.03\ \Omega$

$R_{operación} = 9.76\ \Omega$

Obteniéndose a aproximadamente 100 m/seg. una constante de tiempos de $\tau = 8.5\ \mu s$ lo que comporta un límite superior de frecuencias de hasta 117 Khz (máximo posible de 250 Khz)

CONSTANTES DE CALIBRACION

La sonda se calibró según la Ley de King en la forma:

$$\frac{E^2}{T_s - T} = A + B\ (\rho V)^n$$

A-4/065.3 Imprenta del INTA

donde E es la tension DC de salida del anemómetro, T_s la temperatura de funcionamiento del sensor, T la temperatura ambiente, ρ la densidad y V la velocidad. A, B y n son las constantes de calibración propias del sensor.

La temperatura de las constantes de calibración fueron:

n = 0.531
A = 0.0341 $Voltios^2/°K$
B = 0.0174 $Voltios^2/°K\ (Kg/seg\ m^2)^n$
T_s = 542.767 °K

siendo el ajuste de tensiones de 0.00323 voltios.

La velocidad máxima en la que se puede emplear es de 350 m/seg y la mínima de 0.15 m/seg. La máxima temperatura ambiente a la que se puede exponer el sensor es de 150°C.

A-4088.8 Imprenta del INTA

INTA	N.°	Pág.

DATOS DE CALIBRACION

PRESION ATMOSFERICA P_a = 714.5 mm HG
NUMERO DE DATOS N = 50

D mm	ΔP mmH$_2$O	T °F	E volt.	E_{RMS} mVolt.
16.51	0	71	2.914	
16.51	0.2	"	3.810	
16.51	0.4	"	3.990	
16.51	0.6	"	4.092	
16.51	0.8	"	4.178	
16.51	1	71.2	4.310	
16.51	1.5	"	4.432	
16.51	2	"	4.541	
16.51	2.5	"	4.610	
16.51	3	"	4.693	
16.51	4	71.3	4.798	
16.51	5	"	4.885	
16.51	6	"	4.953	
16.51	7	"	5.015	
16.51	8	"	5.074	
3.81	9	70.5	5.127	
3.81	10	"	5.174	
3.81	12	"	5.255	
3.81	14	"	5.324	
3.81	16	"	5.383	
3.81	18	"	5.427	
3.81	20	"	5.485	
3.81	25	"	5.598	
3.81	30	"	5.691	
3.81	35	"	5.780	

D mm	ΔP mmH$_2$O	T °F	E volt.	E_{RMS} mVolt.
3.81	40	70.7	5.865	
3.81	45	"	5.942	
3.81	50	"	6.006	
3.81	55	"	6.066	
3.81	60	"	6.120	
3.81	65	"	6.172	
3.81	70	"	6.221	
3.81	80	"	6.317	
3.81	90	"	6.401	
3.81	100	"	6.479	
3.81	110	70.8	6.543	
3.81	120	"	6.620	
3.81	130	"	6.677	
3.81	140	"	6.735	
3.81	150	"	6.788	
3.81	160	"	6.841	
3.81	170	"	6.888	
3.81	180	"	6.930	
3.81	190	"	6.971	
3.81	200	71.0	7.011	
3.81	210	"	7.047	
3.81	230	"	7.111	
3.81	250	"	7.174	
3.81	270	"	7.235	
3.81	280	"	7.265	

OBSERVACIONES

PRESION (MM.HG)	TEMPERATURA (K)	FLUJO MASICO (KG./SEG.M2)	TENSION MEDIA (VOLTIOS)
714.500	294.826	0.0	2.914
714.515	294.826	2.100	3.810
714.529	294.826	2.970	3.990
714.544	294.826	3.637	4.092
714.559	294.826	4.208	4.178
714.573	294.938	4.702	4.310
714.610	294.938	5.762	4.432
714.647	294.938	6.650	4.541
714.684	294.938	7.437	4.610
714.721	294.938	8.149	4.693
714.794	294.993	9.408	4.798
714.868	294.993	10.517	4.885
714.941	294.993	11.523	4.953
715.015	294.993	12.446	5.015
715.089	294.993	13.307	5.074
715.162	294.470	14.103	5.127
715.236	294.462	14.866	5.174
715.383	294.445	16.285	5.255
715.530	294.427	17.590	5.324
715.677	294.410	18.806	5.383
715.824	294.393	19.946	5.427
715.971	294.375	21.024	5.485
716.339	294.332	23.506	5.598
716.707	294.289	25.748	5.691
717.075	294.246	27.811	5.780
717.443	294.314	29.726	5.865
717.811	294.271	31.528	5.942
718.179	294.228	33.233	6.006
718.547	294.184	34.855	6.066
718.915	294.141	36.404	6.120
719.283	294.098	37.890	6.172
719.651	294.055	39.320	6.221
720.386	293.969	42.033	6.317
721.122	293.884	44.581	6.401
721.858	293.798	46.991	6.479
722.594	293.768	49.278	6.543
723.330	293.683	51.467	6.620
724.066	293.597	53.567	6.677
724.802	293.512	55.587	6.735
725.537	293.427	57.536	6.788
726.273	293.342	59.421	6.841
727.009	293.257	61.248	6.888
727.745	293.173	63.021	6.930
728.481	293.088	64.745	6.971
729.217	293.114	66.413	7.011
729.952	293.030	68.050	7.047
731.424	292.861	71.212	7.111
732.896	292.693	74.238	7.174
734.367	292.525	77.145	7.235
735.103	292.441	78.558	7.265

TEMPERATURA FLUIDA (K)	TENSION EXPERIMENTAL REDUCIDA (VOLTIOS)2/K	TENSION TEORICA REDUCIDA (VOLTIOS)2/K	FLUJO MASICO REDUCIDO (KG/SEG.M2)N
294.826	0.0342	0.0341	0.0
294.826	0.0585	0.0600	1.483
294.826	0.0642	0.0652	1.782
294.826	0.0675	0.0687	1.985
294.826	0.0704	0.0715	2.145
294.938	0.0750	0.0738	2.275
294.938	0.0793	0.0783	2.534
294.938	0.0832	0.0818	2.735
294.938	0.0858	0.0847	2.902
294.938	0.0889	0.0872	3.046
294.993	0.0929	0.0915	3.288
294.993	0.0963	0.0950	3.488
294.993	0.0990	0.0980	3.662
294.993	0.1015	0.1006	3.815
294.993	0.1039	0.1030	3.953
294.470	0.1059	0.1052	4.076
294.462	0.1078	0.1072	4.192
294.445	0.1112	0.1109	4.400
294.427	0.1141	0.1141	4.584
294.410	0.1167	0.1169	4.749
294.393	0.1186	0.1196	4.900
294.375	0.1211	0.1220	5.039
294.332	0.1261	0.1274	5.347
294.289	0.1303	0.1320	5.612
294.246	0.1344	0.1361	5.846
294.314	0.1384	0.1397	6.057
294.271	0.1421	0.1431	6.249
294.228	0.1451	0.1462	6.426
294.184	0.1480	0.1491	6.591
294.141	0.1506	0.1517	6.745
294.098	0.1532	0.1543	6.890
294.055	0.1556	0.1567	7.026
293.969	0.1604	0.1611	7.280
293.884	0.1646	0.1651	7.511
293.798	0.1686	0.1688	7.724
293.768	0.1719	0.1723	7.921
293.683	0.1759	0.1755	8.106
293.597	0.1789	0.1785	8.280
293.512	0.1820	0.1814	8.445
293.427	0.1848	0.1841	8.601
293.342	0.1876	0.1867	8.749
293.257	0.1902	0.1892	8.891
293.173	0.1924	0.1915	9.027
293.088	0.1946	0.1938	9.157
293.114	0.1969	0.1960	9.281
293.030	0.1988	0.1981	9.402
292.861	0.2023	0.2021	9.632
292.693	0.2058	0.2058	9.847
292.525	0.2092	0.2094	10.050
292.441	0.2108	0.2111	10.147

A-40001 S. Imprenta del INTA

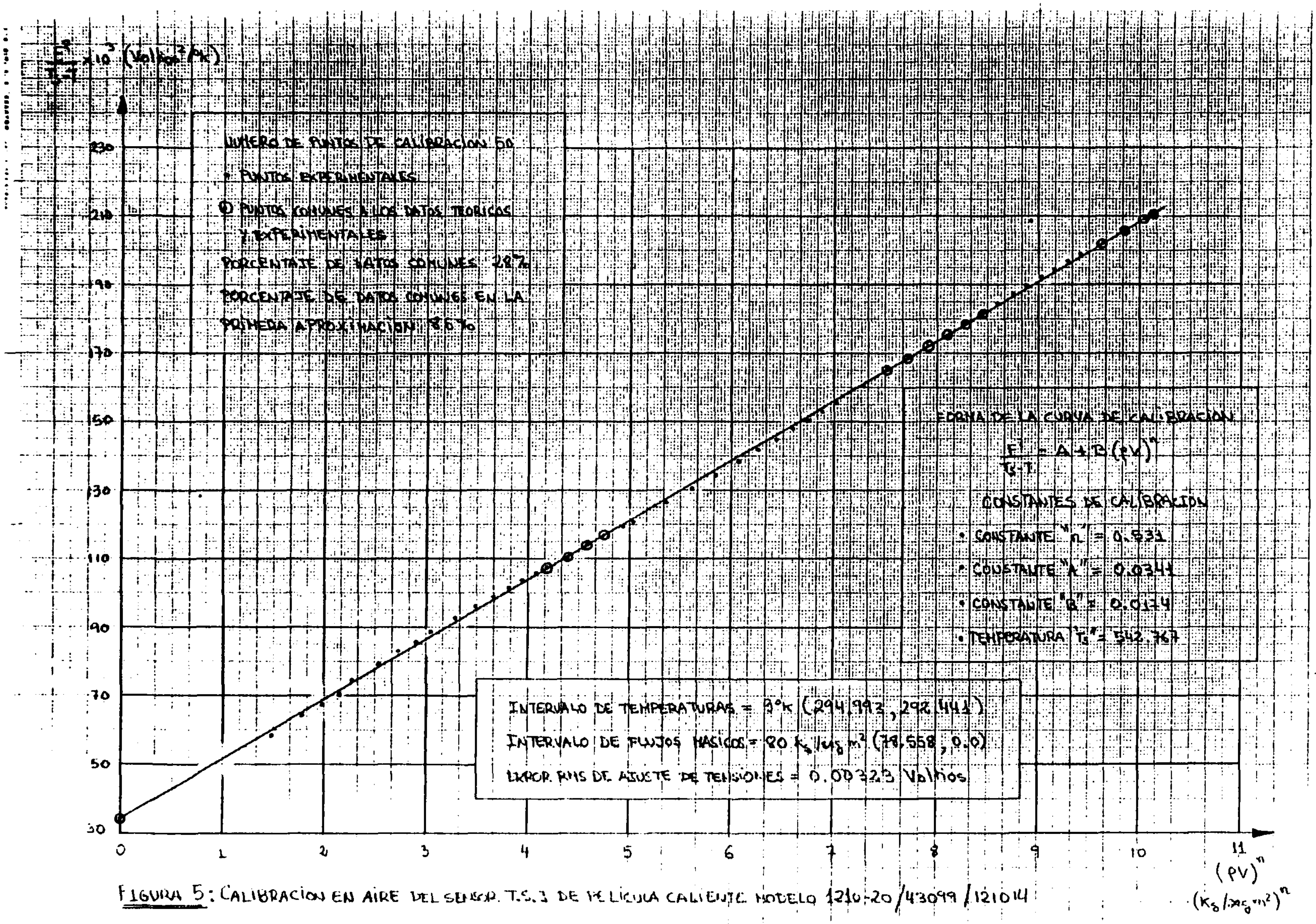

FIGURA 5: CALIBRACION EN AIRE DEL SENSOR T.S.3 DE PELICULA CALIENTE MODELO 1210-20/43099/121014

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