Fire Research Note

No. 971

A 5 LITRE PER MINUTE STANDARD FOAM BRANCHPIPE

by

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FIRE
RESEARCH
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SUMMARY

Constructional details of a 5 litre per minute foam branchpipe are given. A recommended procedure is described for its use in a standard laboratory test method for the determination of foam properties.

Note

The investigations leading to the design of this branchpipe, and to the method of determining the 25 per cent drainage time of the foam, have been described in Fire Research Notes Nos. 970 and 972. This report is confined to the constructional details and to a suggested standard operating procedure, in order to make it convenient for those who wish to use it for this purpose.

KEY WORDS: Branchpipe, foam.

DEPARTMENT OF THE ENVIRONMENT AND FIRE OFFICES COMMITTEE

JOINT FIRE RESEARCH ORGANIZATION

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INTRODUCTION

Fire Research Note No.970 described investigations which determined the design details and operational characteristics of a 5 l/min branchpipe. The branchpipe is simple to construct and to use, has good foam-producing characteristics, and can serve as a laboratory reference standard. For those who may wish to use it for this purpose, this report is confined to describing the constructional details, and a recommended standard procedure to be followed for determining the characteristics of a foam liquid. This procedure includes an improved method for measuring the drainage rate of the foam, and the development of this method has been described in Fire Research Note No.972.

Constructional Details

Drawing No.121 gives details of the construction of the branchpipe. Drawing No.125 gives details of the swan-neck outlet which is used to replace the straight outlet when the branchpipe is used for testing foam properties other than by application to an experimental fire. Great care is required in making the downstream orifice to ensure that it is sharp-edged and has the correct diameter. To verify this, the branchpipe should be tested for discharge rate using clean water at 20^{o}C and 690 kPa (100 lbs/in^2). The discharge rate should be between 4.75 and 5.25 l/min. Figure 1 is a picture of the branchpipe, assembled and dismantled.

Arrangement for Use

The branchpipe is arranged on the 12 mm diam. outlet from a container, from which the foam solution, premixed at the required concentration, can be expelled by a controlled air pressure, through the branchpipe. The outlet pipe is provided with a cock so that the flow to the branchpipe can be started and stopped as required.

A 10 litre container is a convenient size for most experiments; and should preferably be made of stainless steel. When the branchpipe is to be used for foam testing, the swan-neck outlet is used, because this allows the collection of samples without splashing. The branchpipe is connected directly to the container outlet with a right angle bend. If the branchpipe is to be used for fire tests the straight outlet is used and the branchpipe is connected to the container by an appropriate length of 12 mm. bore flexible tubing. It is a great convenience to use quick acting couplings[1] to connect the air supply and the branchpipe to the container. The air supply should have a reducing valve and pressure gauge so that the supply to the container can be adjusted to any desired value between 335 and 830 kPa (50-120 lbs/in^2). A pressure release valve is also necessary to prevent the safe working pressure of the container being exceeded. A valve on the air line and a vent with a valve to enable the container to be pressurized or to be reduced to atmospheric pressure, are provided.

Fig.2 shows the branchpipe in use for foam testing and Fig.3 shows it operating with the straight outlet for fire testing.

Operating the Branchpipe for Foam Testing

A number of points must be watched if reliable results are to be obtained. The premixed solution must be made up accurately and a standard procedure should be adopted so that the differences in time between making the premix and making measurements are minimised, since some foam liquids change progressively after they are diluted.

The expansion, drainage rate, and shear stress, are all dependent upon the temperature and therefore some degree of control is

necessary. The effect of temperature is being investigated in some detail and will be reported upon in a subsequent Fire Research Note.

When the branchpipe is operated, the discharge for the first several seconds will have anomalous properties and sample collection during this period must be strictly avoided.

Appendix I provides a set of test instructions which are designed to incorporate all these points. Appendix II is a typical test record.

Reproducibility of Results

The expansion should be measured by weighing samples in a 2 litre plastic beaker.

The shear stress should be measured using a torsional vane viscometer.(2)

The 25 per cent drainage time should be measured using a 20 cm. diam. x 20 cm. deep pan (3) as shown in Fig.4.

Tests in five laboratories, each using a different branchpipe constructed according to Drawings 121 and 125, using the same protein foam liquid, provided the following estimates of the reproducibility of the foam property measurements, when the procedure described in Appendix I was followed.

Table 1. Reproducibility of Foam Property Tests

	Standard Deviation - Per Cent	
	Individual Test in Any One Laboratory	Average of Four Results in Any Laboratory
Expansion	± 1.5	± 3.8
Shear Stress (N/m^2)	± 1.8	± 5.5
25 Per Cent Drainage Time (Min.)	± 3.0	± 4.6

References

(1) Schrader, Walkmill Lane, Bridgtown, Cannock, Staffs.

(2) R.J. French
Foam Viscometer - Journal of Scientific Instruments, Vol.37, August 1960

(3) S.P. Benson, K. Morris and J.G. Corrie
An improved method for measuring the drainage rate of fire fighting foam - Fire Research Note No. February 1973.

APPENDIX I

Branchpipe Foam Properties Test - Instructions

Preparation of solution

Prepare a 9 litre premix as follows:

Almost fill a 9 litre measure with water (domestic supply) and adjust its temperature to give foam close to 20°C - i.e. slightly above 20°C with low air temperatures and slightly below with high air temperatures.

Add the concentrate and note the time - make up the measure to volume, stir gently and transfer to the pressure vessel, connect the branchpipe with swan neck outlet and pressurize to exactly 690 kPa (100 p.s.i.).

Expansion

Allow the branchpipe to operate for a minimum of 5 seconds and fill a 2 litre plastic beaker which has been tared when wet. Scrape the beaker level, wipe any foam or liquid from the sides of the beaker and determine the net weight. Divide the net weight into the weight of water which the beaker holds to determine the expansion. Determine the foam temperature after the first collection using a mercury in glass thermometer, without a protective case, stirring the foam constantly until the thermometer has a constant reading. Note the air temperature.

Make 3 determinations which can all be made from the same premix providing they are completed within 10 minutes from making the premix.

Shear Stress

Allow the branchpipe to operate for a minimum of 5 seconds before collecting the sample in the shear stress measuring pot. Start a stop watch when commencing to fill the pot. Take the shear stress reading at 1 minute from starting the stop watch. Measure the foam temperature in the sample pot after making the first test and note the air temperature.

Make 4 tests which can all be made from the same premix providing they are completed within 10 minutes from making the premix.

25 per cent Drainage Time

Prepare a new 1 gallon premix for each test.

1. Rinse the drainage pan with water and allow to drain.

2. Start the branchpipe - $1\frac{1}{2}$ minutes from making the premix.

3. Start the stop watch.

4. At 5 seconds commence filling the drainage pan.

5. Scrape the top of the pan level and wipe any foam from the sides of the pan and place in the stand.

6. Run off the liquid as it collects in the base of the drainage pan - do not allow it to accumulate in the pan, nor allow foam to run out of the cock. Collect the drainage in 2 x 100 ml cylinders and stop the watch when 25 per cent drainage is obtained. Deduct the 5 seconds pre-run time from the watch reading and record the result.

7. Determine the foam temperature of each sample and record. Make 4 determinations, each on a separate premix.

APPENDIX II

Branchpipe Foam Properties Test

Sample PROTEIN CM 421

Concentration for test 4 % vol/vol.

Pressure for test 100 lb/in^2

5 litre/min branchpipe No. 2

with/without swan-neck outlet.

Location of test FIRE RESEARCH STATION

Expansion

	Test No.	Net Wt.g.	Expansion
Air temp 15 °C	1	263	9.5
Foam temp 23 °C	2	266	9.4
	3	268.5	9.3
	Average		9.4

25% drainage = 168 ml
OF 6,320 ml OF FOAM

Shear Stress

	Test No.	Shear N/m^2
Air temp 15 °C	1	25.5
Foam temp 19.2 °C	2	27.2
	3	30
	4	31
	Average	28.4

25 per cent (20 cm) Drainage Time

Mix No.	25 per cent drainage time min-s	Foam temp °C
1	8-19	19.5
2	8-26	19
3	7-58	19
4	8-30	19
Average	8-18	

Tested by: S.P. BENSON

Date: 8.11.72

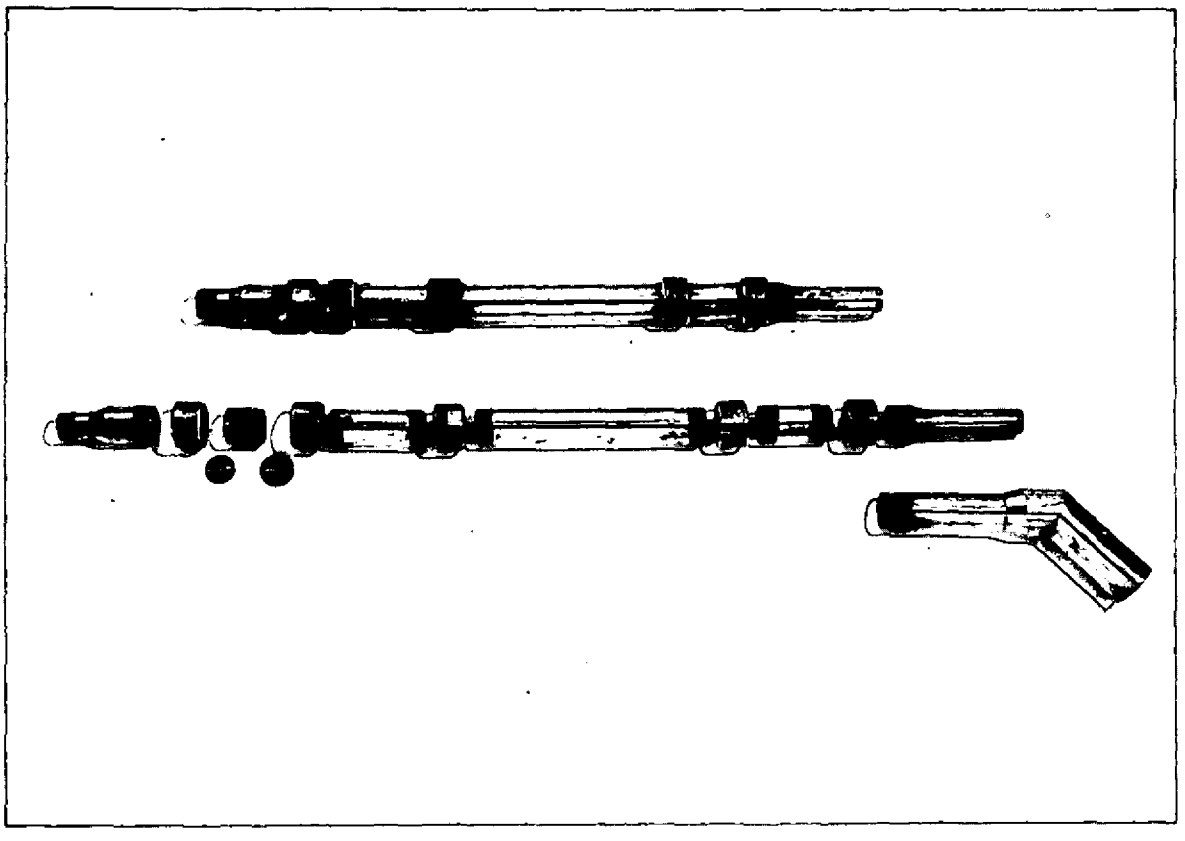


FIG. 1. THE BRANCHPIPE - ASSEMBLED AND DISMANTLED

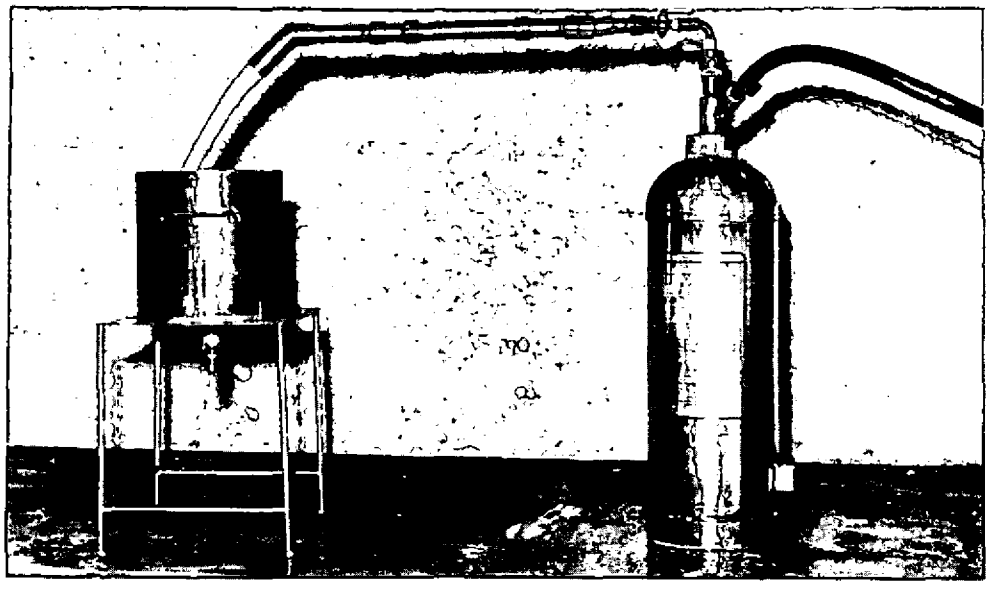


FIG. 2. BRANCHPIPE IN USE FOR FOAM TESTING

FIG. 3. BRANCHPIPE OPERATING WITH STRAIGHT OUTLET FOR FIRE TESTS

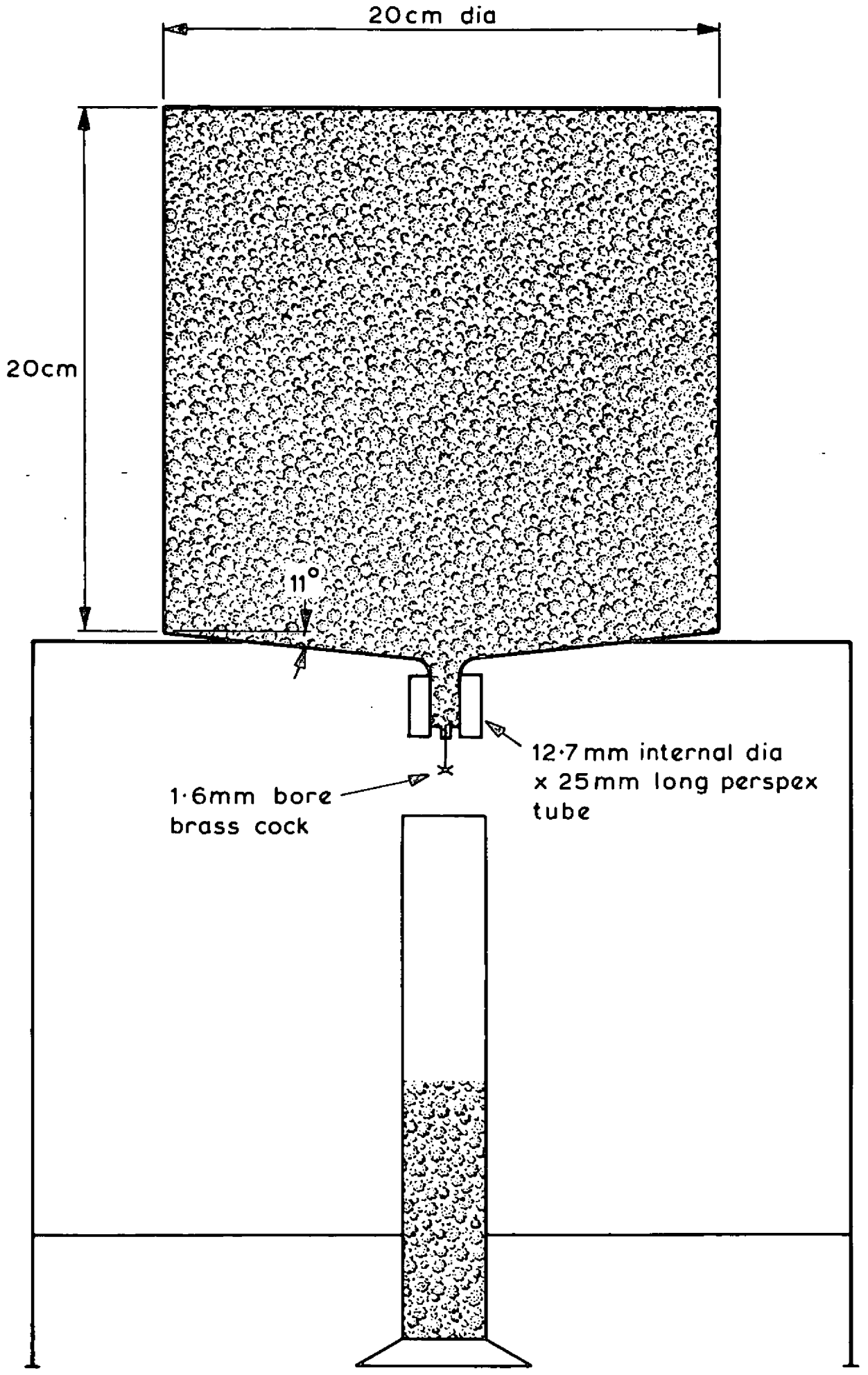
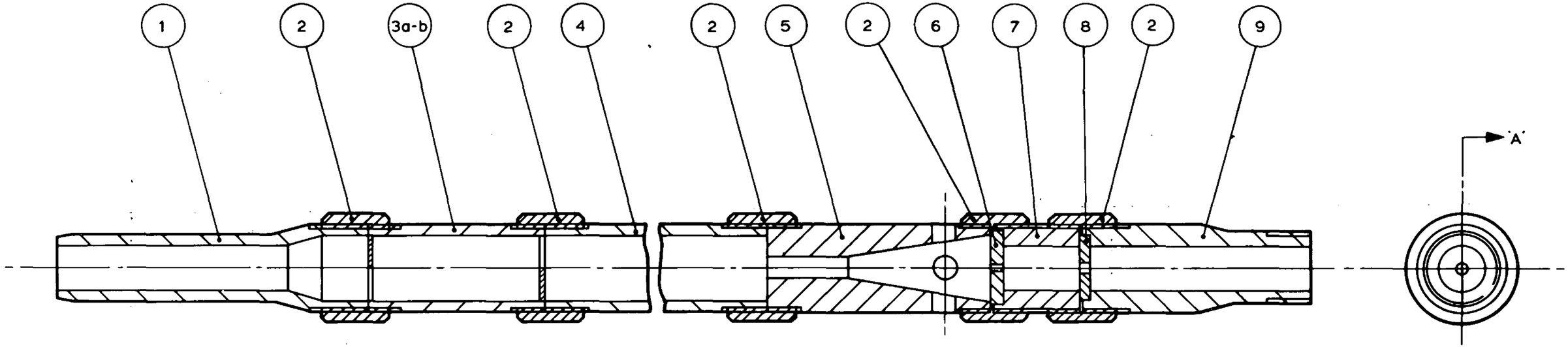


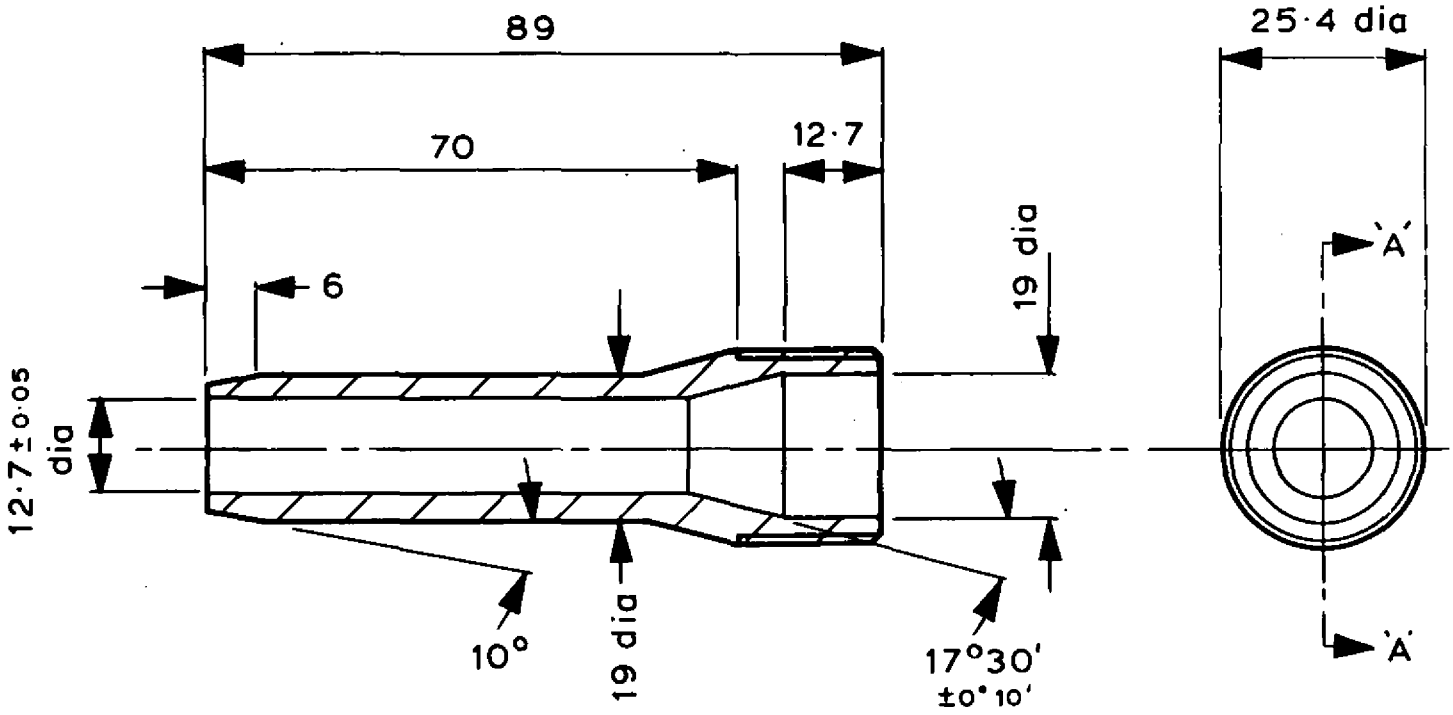
Figure 4 6320ml brass drainage pan and stand



Section 'A-A'

Safety - It is desirable that the crest of each thread is replaced by a small radius

Drg. no. 121a Foam branch pipe - general assembly

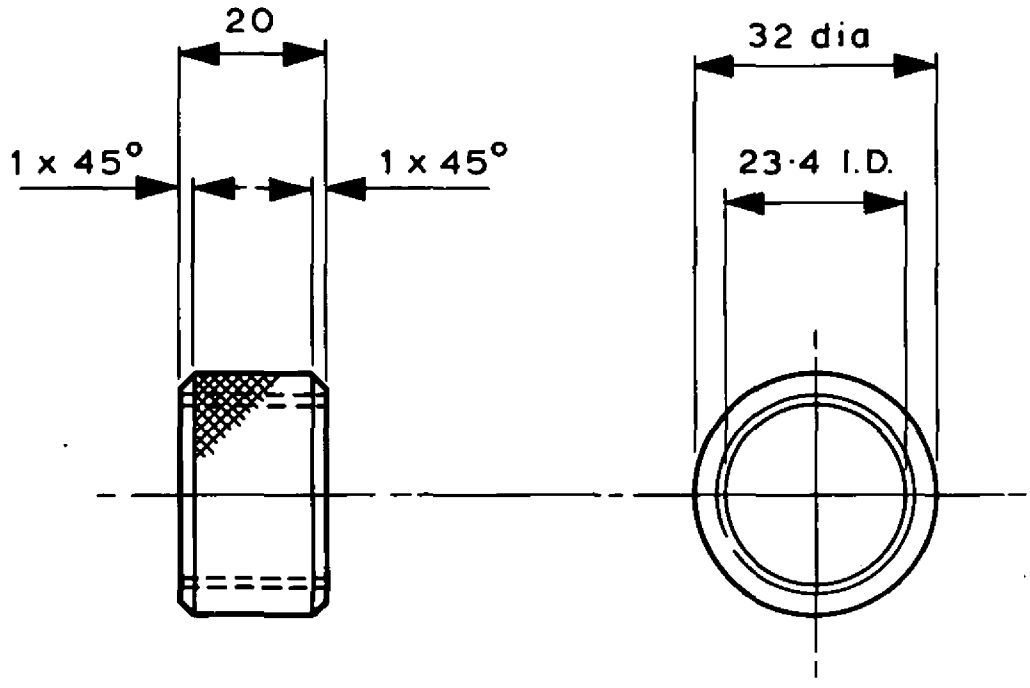


Section 'A'-'A'

Chamfer thread end 1 x 45°
Machine square with axis
Thread - 16 TPI whit form

Full size
All dimensions are in mm
Material – brass
Number required - 1
Tolerance - whole ±0·25
dec. ±0·10

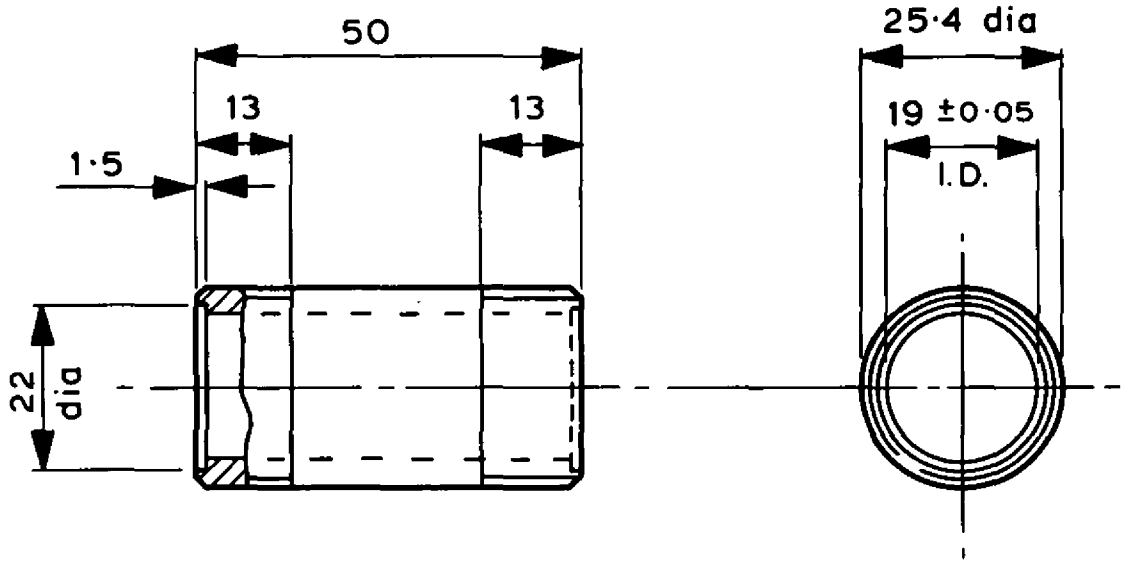
Drg. no. 121b Foam branch pipe - item 1



Chamfer each end internal and external
Thread 16 TPI whit form

Full size
All dimensions are in mm
Material - brass
Number required - 5
Tolerance - whole ±0·25
dec ±0·10

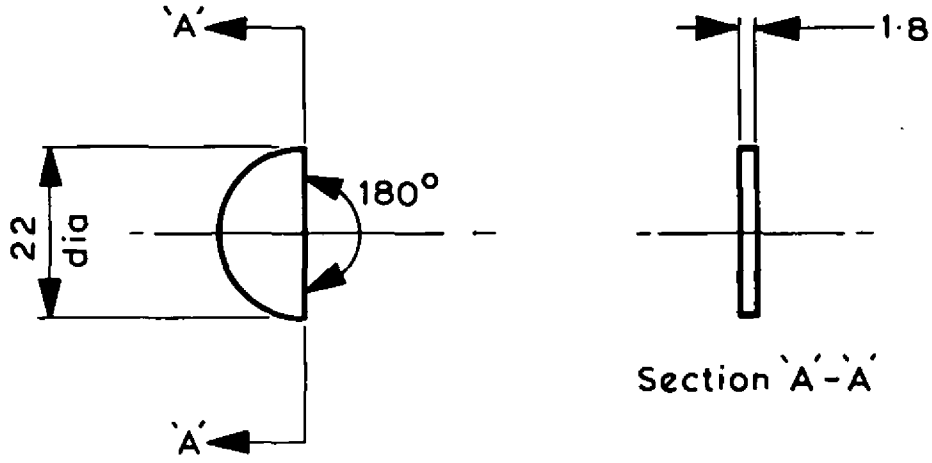
Drg. no. 121c Foam branch pipe - item 2 - collar



Chamfer each end 1 x 45° ext
End faces must be square with axis

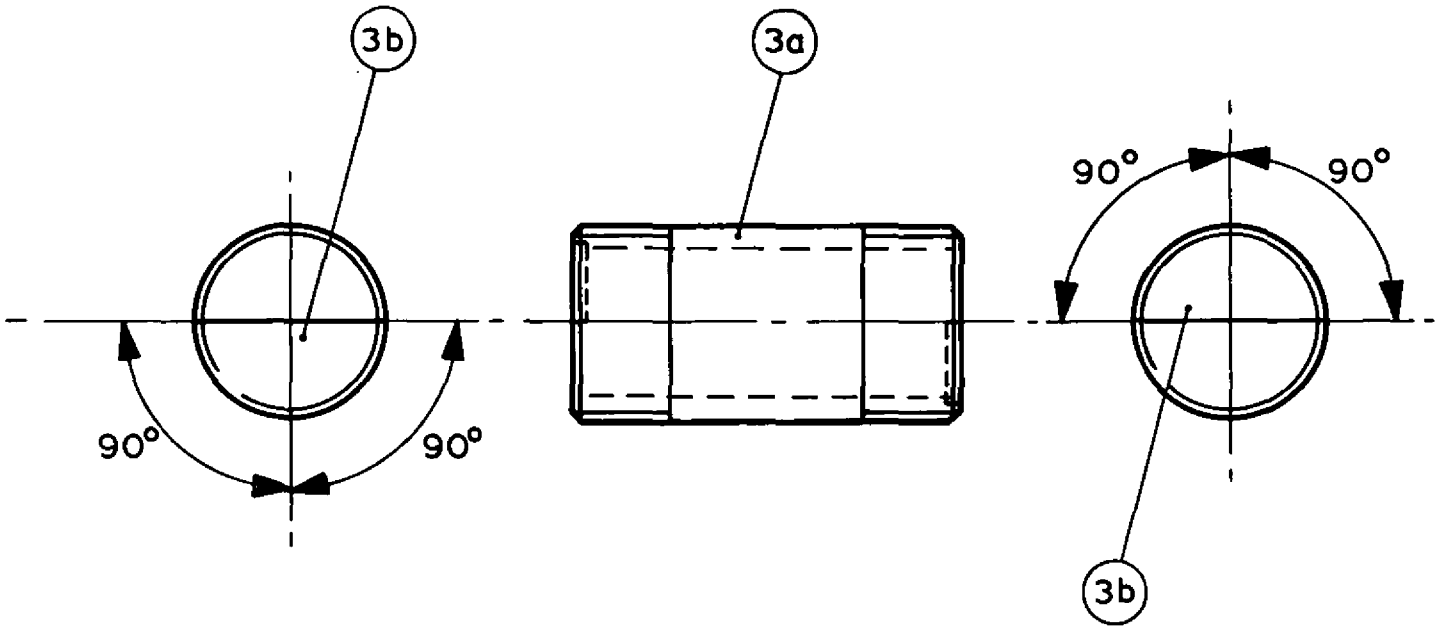
Full size
Dimensions are in mm
Material - brass
Number required - 1
Tolerance - whole ±0·25
dec. ±0·10

Drg. no. 121d Foam branch pipe - item 3a



Full size
All dimensions are in mm
Material - brass
Number required - 2
Tolerance - whole ±0·25
dec ±0·10

Drg. no. 121e Foam branch pipe - item 3b



Items 3b are to be brazed into item 3a as indicated

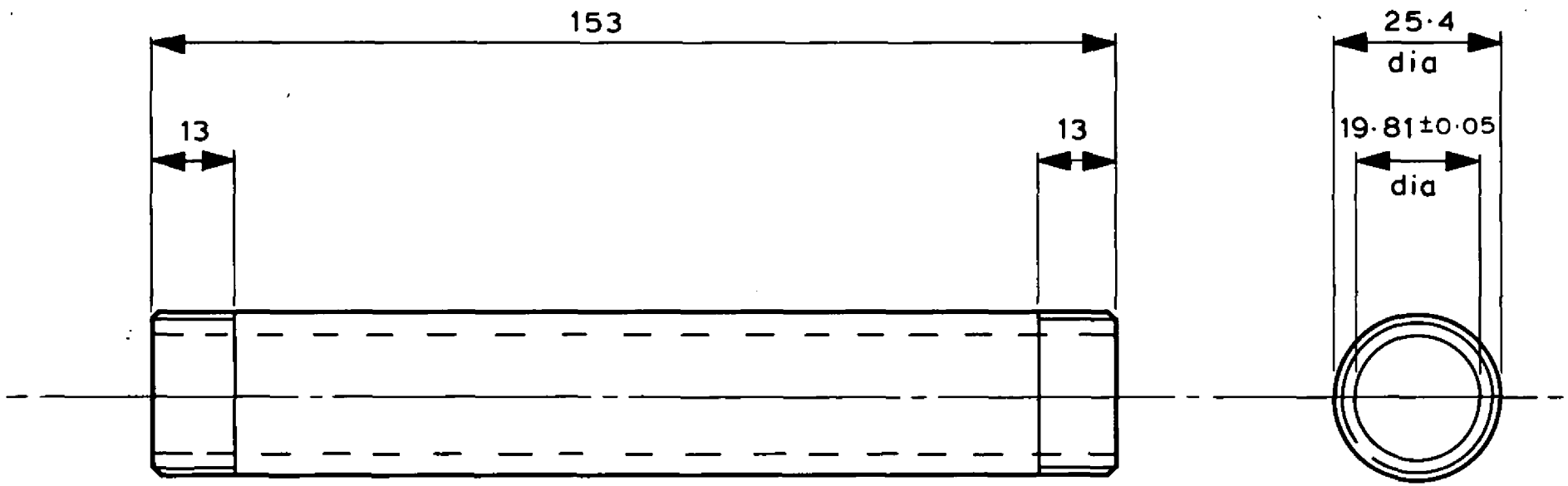
After brazing face square with axis (50mm long)

End faces must be square with axis

Important

The angular position of the opening in one plate relative to the other is 180° ± 0° 30'

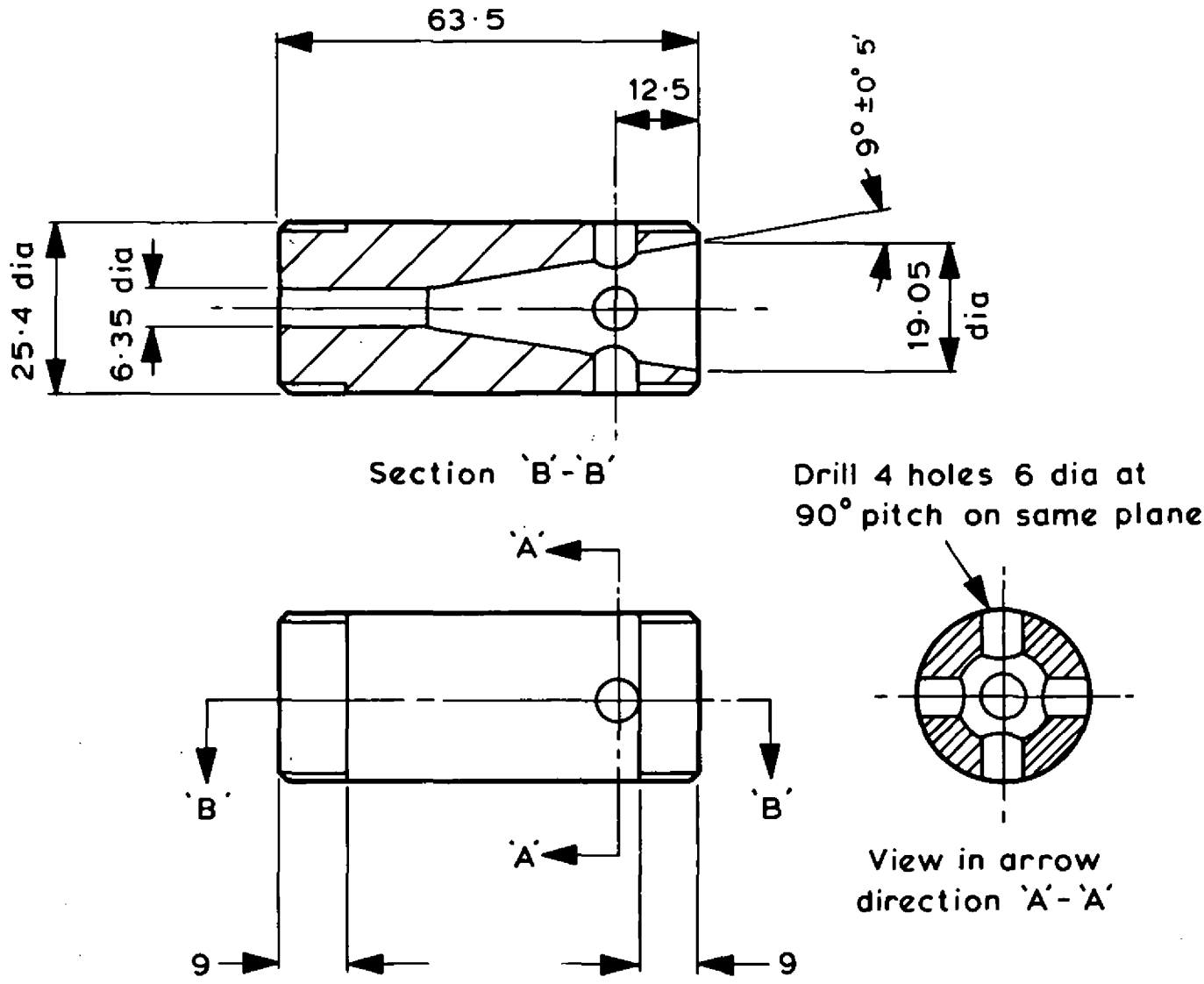
Drg. no. 121f Foam branch pipe - items 3a & b assembly



Full size
All dimensions are in mm
Material - brass
Number required - 1

Thread - 16 TPI whit form
Chamfer each end 1 x 45° external
End faces must be square with axis
Tolerance - whole ±0·25
dec. ±0·10

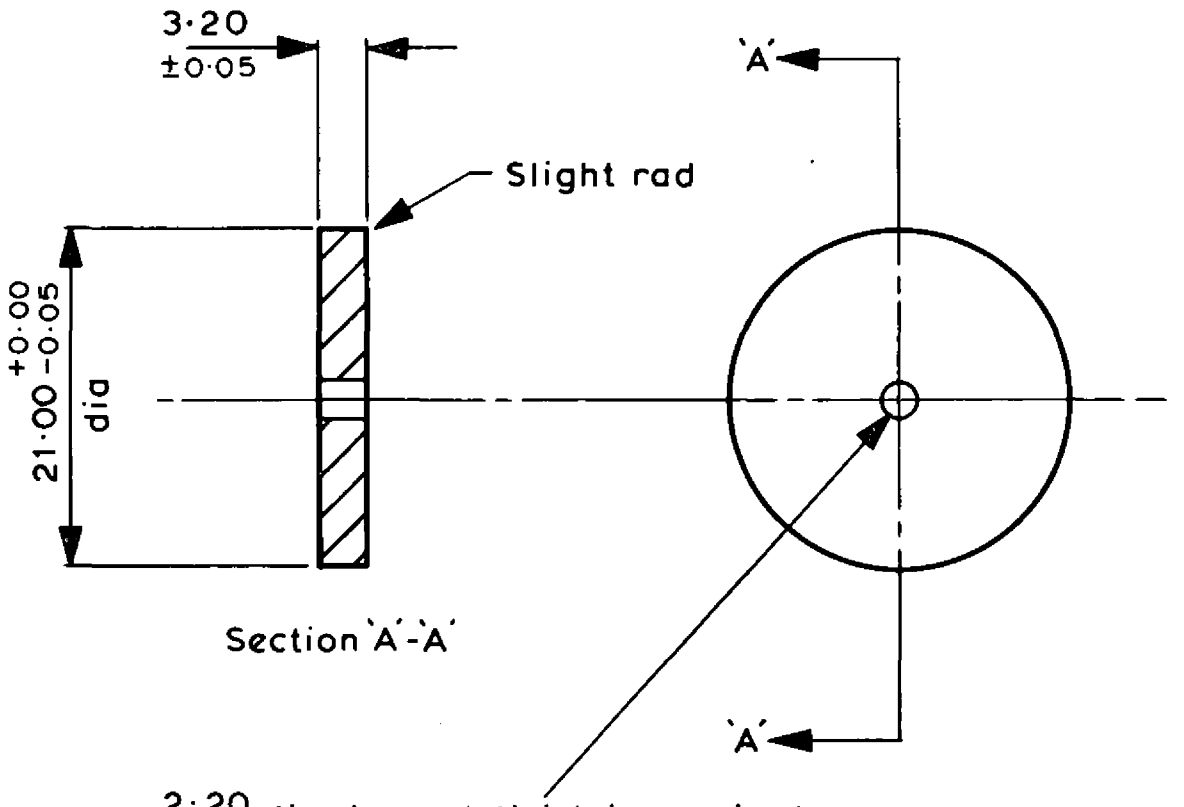
Drg. no. 121g Foam branch pipe - item 4 - tube



6·35 dia hole should be reamed
End face must be square with the axis
Chamfer both ends 1 x 45°
Thread - 16 TPI whit form

Full size
All dimensions are in mm
Material - brass
Number required - 1
Tolerance - whole ±0·25
dec ±0·10

Drg no. 121h Foam branch pipe - item 5



2 x full size

All dimensions are in mm

Material - stainless steel - BS type 316516

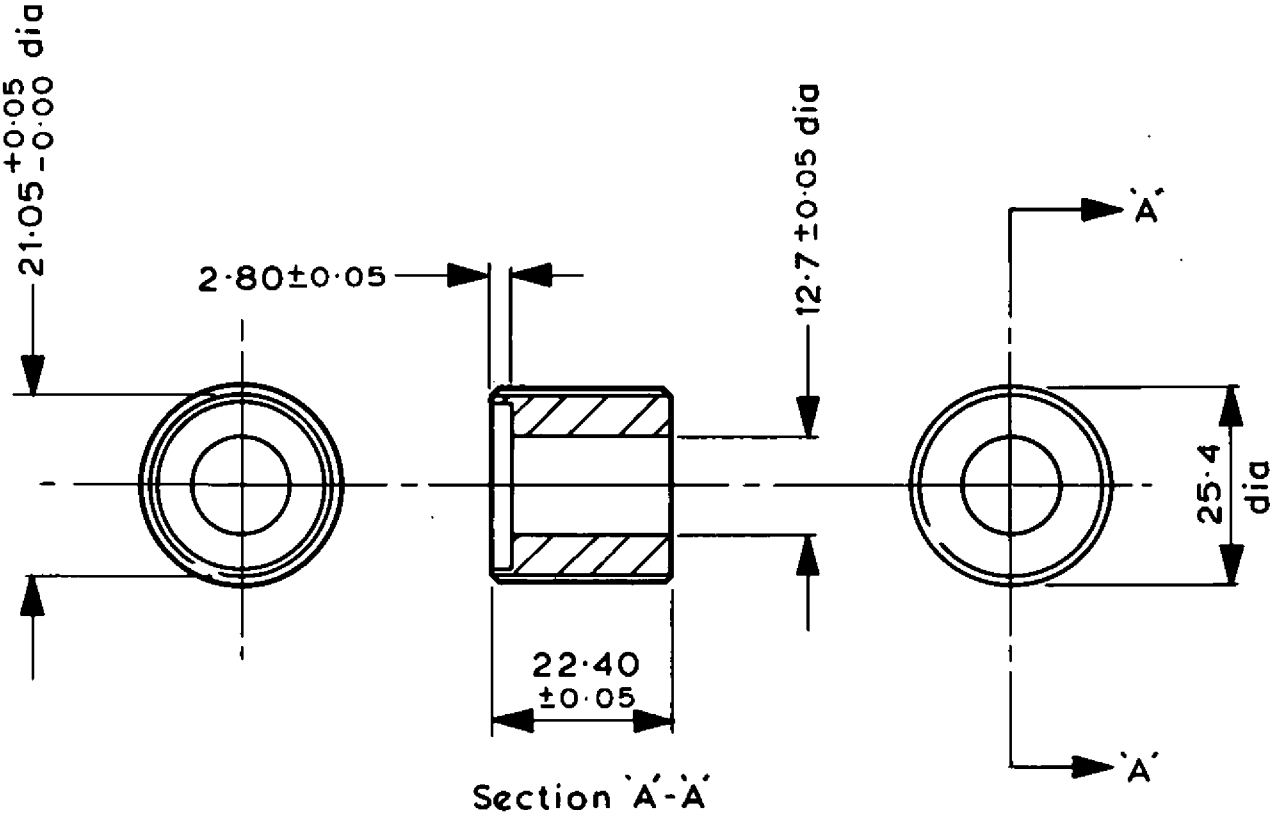
Number required - 1

Important

Tolerances

1. Faces must be parallel to within 0·05
2. Bore must be concentric with O.D. to within 0·05
3. Bore must be square with either face to within 0·05

Drg. no. 121j Foam branch pipe - item 6



Section 'A'-'A'

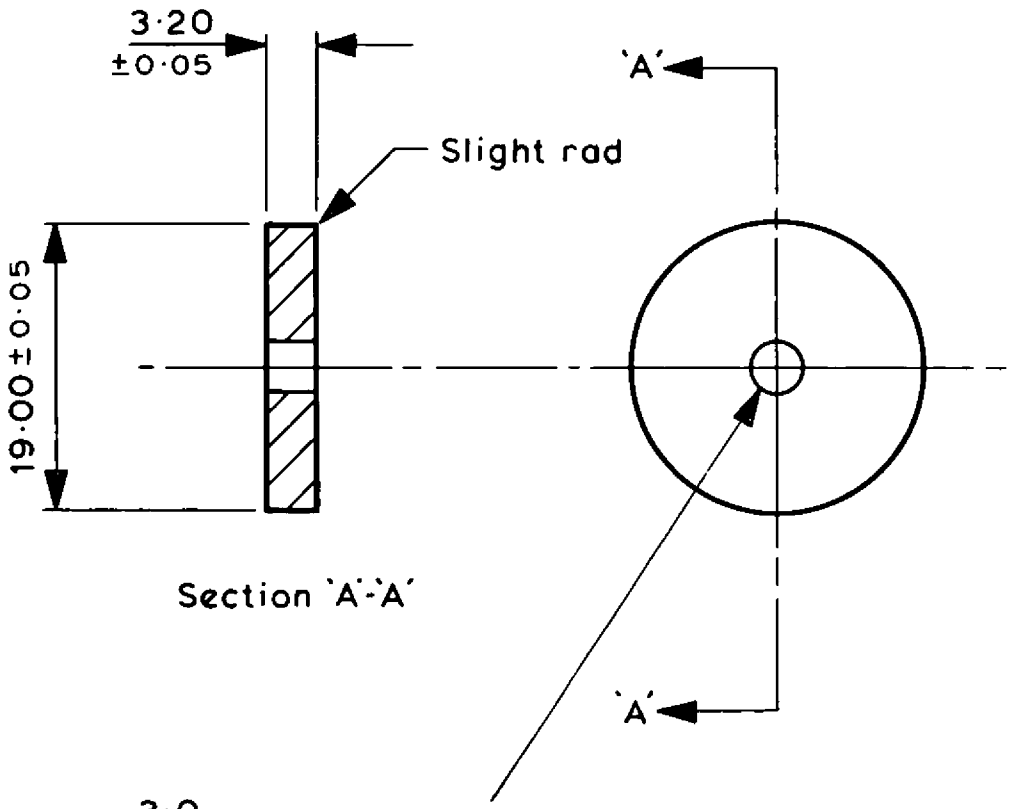
Full size
All dimensions are in mm
Material - brass
Number required - 1

Chamfer thread edges 1 x 45° leave rest sharp
Thead – 16 TPI whit form

Important
Tolerances

1. Bore must be conc. with c'bore and O.D. to within 0·05
2. C'bores must be parallel to end face to within 0·05
3. End and c'bore faces must be square with axis to within 0·05

Drg. no. 121k Foam branch pipe - item 7



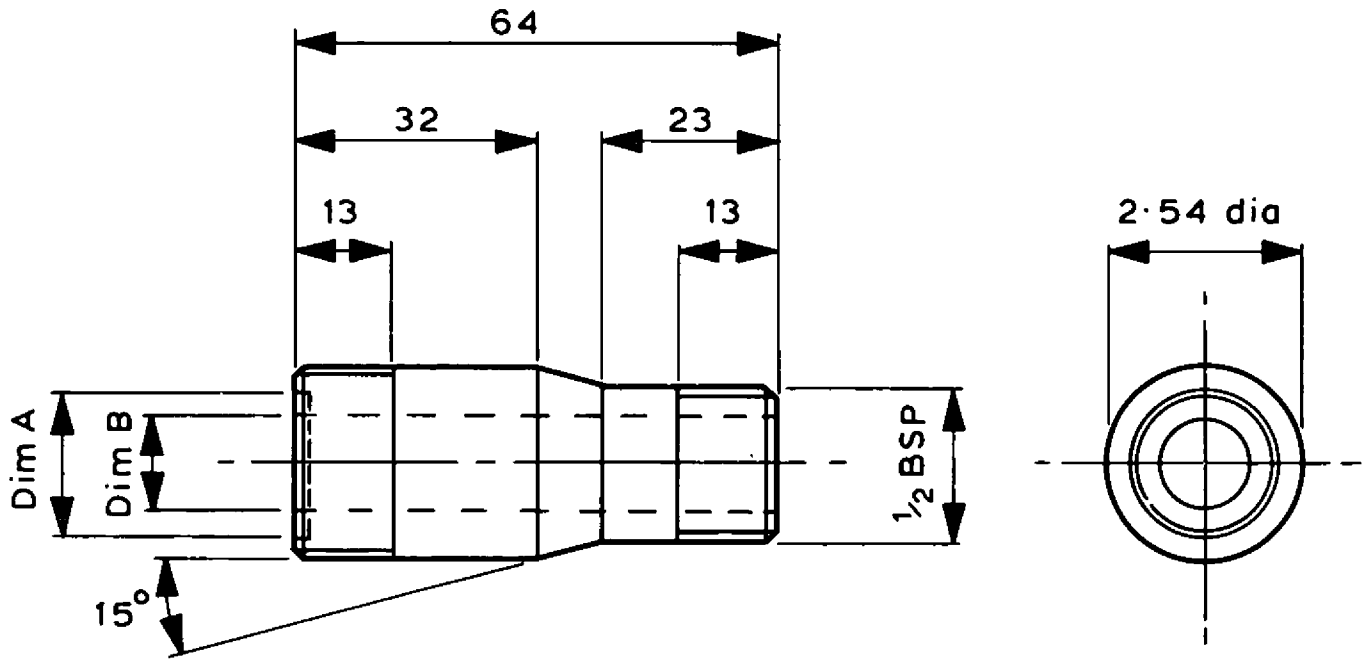
2 x full size
Material - stainless steel - BS type 316516
All dimensions are in mm
Number required - 1

Important

Tolerances

1. Faces must be parallel to within 0·05
2. Bore must be concentric with O.D. to within 0·05
3. Bore must be square with either face to within 0·05

Drg. no. 121m Foam branch pipe - item 8



Dim A C'bore face 19·05 $^{+0·05}_{-0·00}$ dia by 2·80 ±0·05 deep conc. to to bore and O.D. to within 0·05

Dim B Bore 12·70 ±0·05 dia through

Face of large diameter end must be square with axis

Chamfer both ends 1 x 45°

Thread - 16 TPI whit form

Full size

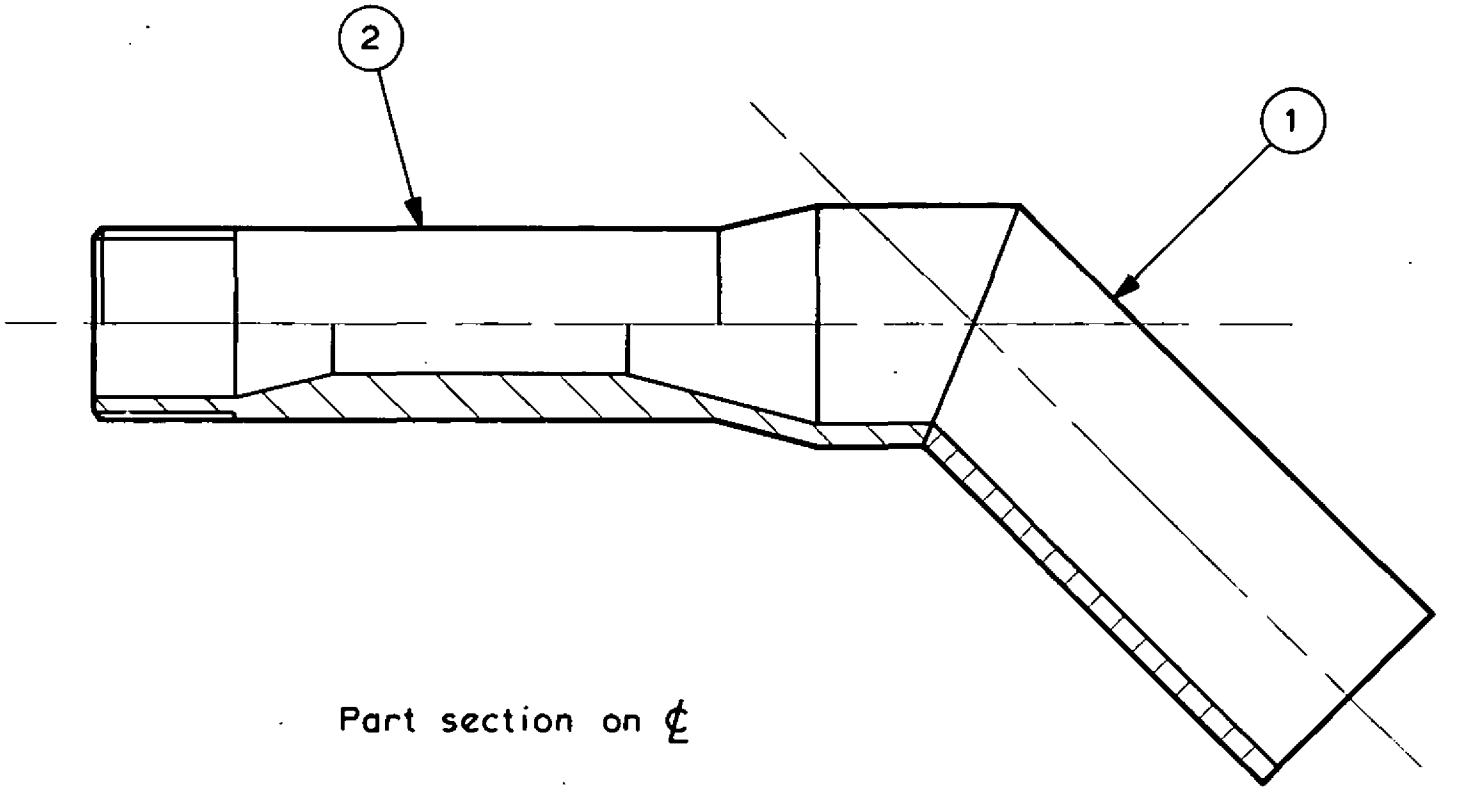
All dimensions are in mm

Material - brass

Number required - 1

Tolerance - whole ±0·25
dec. ±0·10

Drg. no. 121n Foam branch pipe - item 9



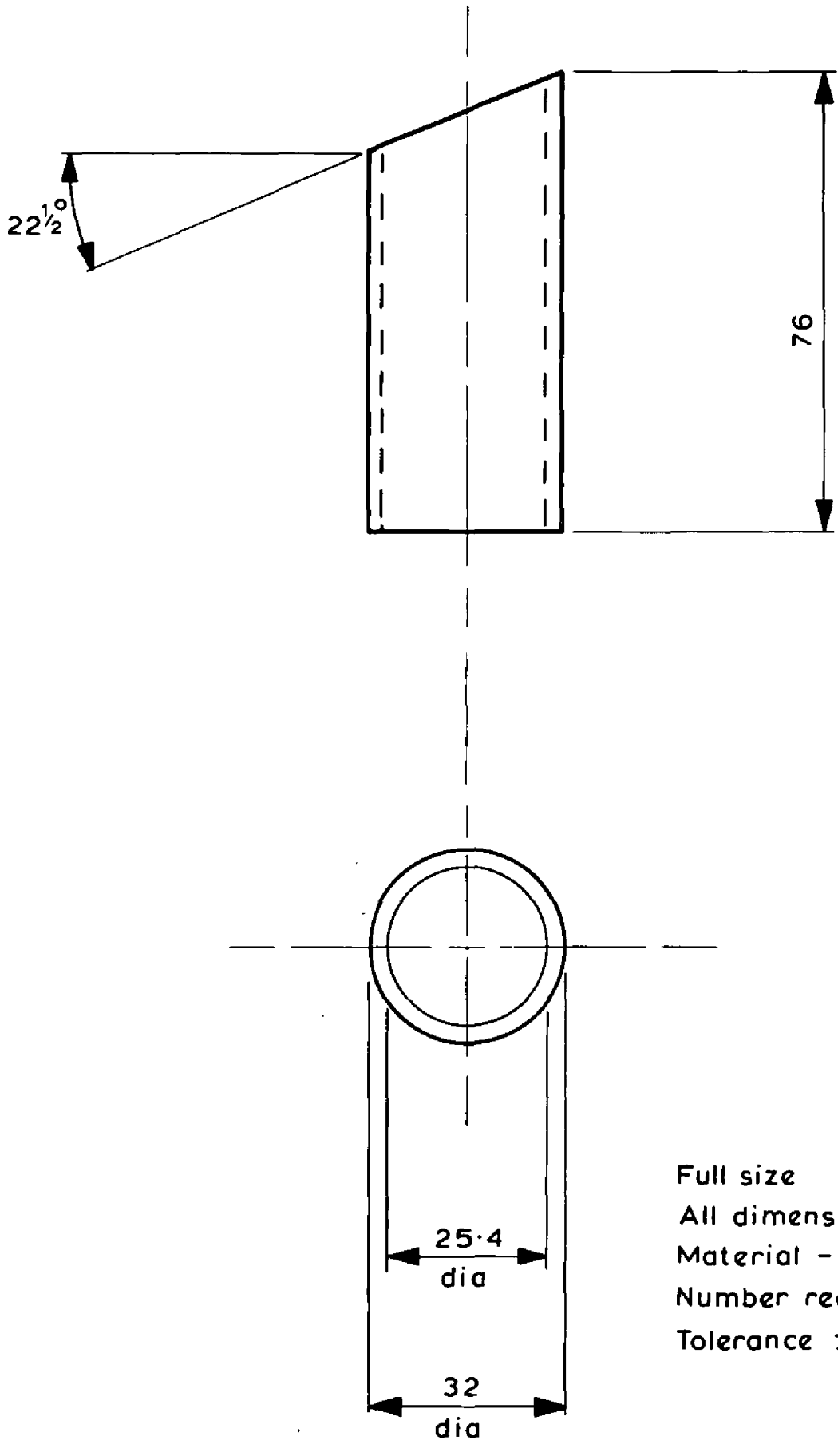
Part section on ℄

Full size
Number required - 1

Notes

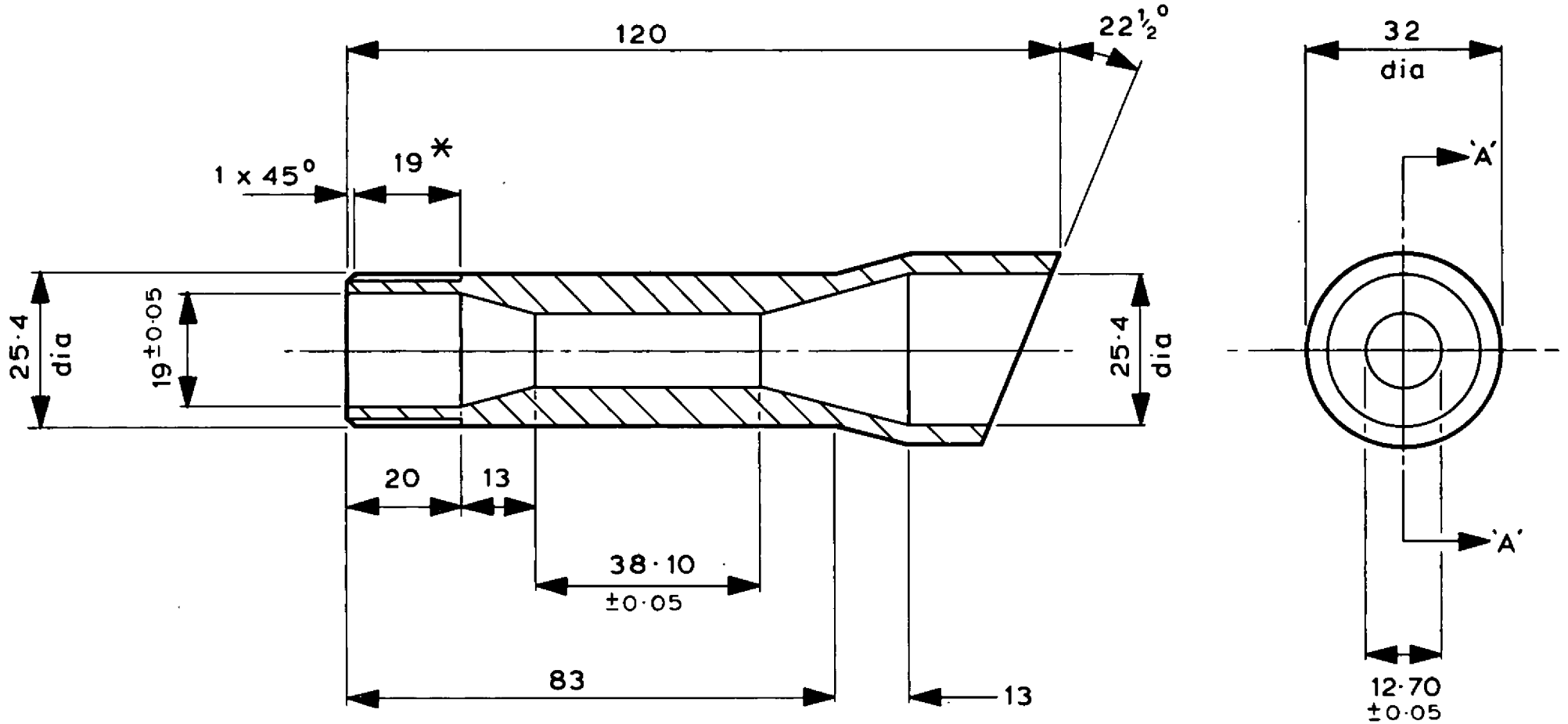
1. Items 1 and 2 are to be silver soldered together as shown on G.A.
2. A small chamfer may be introduced around the mating faces
3. Care should be exercised to ensure an angle of 45° inclusive is obtained
4. The inside of the joint should be cleaned as adequately as possible
5. Outlet is to replace existing one on model foam branchpipe
6. Remove sharp crest of thread for safety

Drg. 125a Foam branch pipe outlet - general assembly



Full size
All dimensions in mm
Material - Brass
Number required - 1
Tolerance ±0·30

Drg.no. 125 b Foam branch pipe outlet - item 1



Section 'A'-'A'

Notes

1. * thread to be 16 T.P.I. whit form
2. Datum face should be square with ℄
3. All unmarked angles are 15° (approx)

Full size
All dimensions are in mm
Material – brass
Number required – 1
Tolerance ±0·30

Drg. no. 125c Foam branch pipe outlet - item 2