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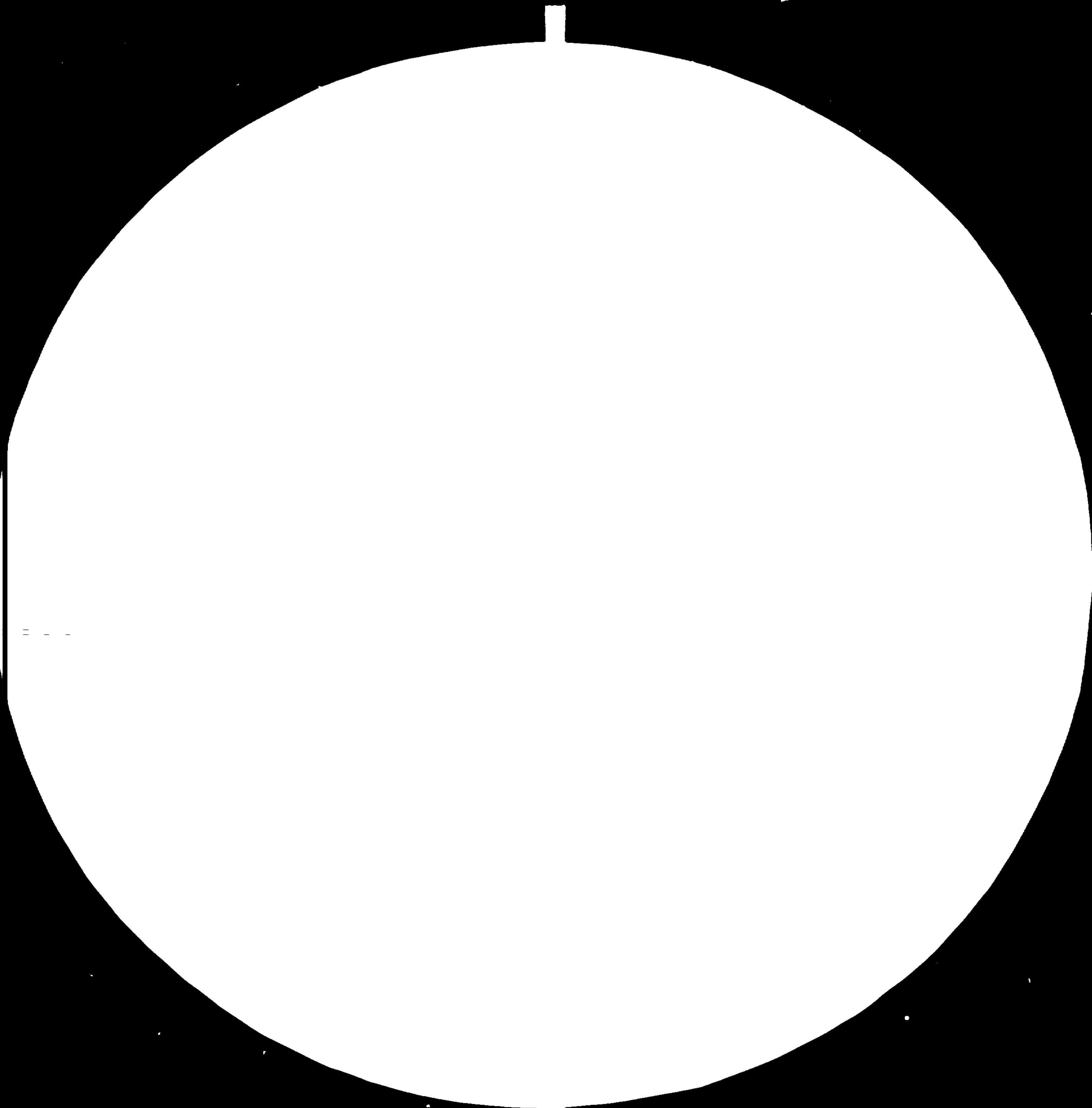

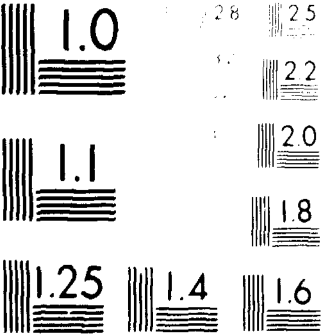
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PILOT PROJECT ON PRODUCT ADAPTATION
DP/ROK/72/023
REPUBLIC OF KOREA

Technical report: The production of seats for vehicles

Prepared for the Government of the Republic of Korea by the United Nations Industrial Development Organization, acting as executing agency for the United Nations Development Programme

Based on the work of Ignaz Vogel, vehicle seat specialist

United Nations Industrial Development Organization
Vienna

This document has been translated from an unedited original.

80-46459

The travel schedule was prepared by the Korea Trade Promotion Corporation (KOTRA), the organization to which I was attached during my stay in Korea.

I visited 8 vehicle seat factories. Thanks to a thorough inspection of their production departments I was able to observe the various production processes and the flow of material very closely. I found it a very good idea after inspecting a factory to explain its particular production problems in a classroom. The chairman of each individual factory selected those attending my lectures.

Those concerned in the inspections and attending my lectures were as follows:

6 chairmen
5 vicechairmen
4 executive directors
1 commercial manager
2 works managers
1 senior technical executive
2 technical managers
3 head managers, production
10 managers, production
7 technicians, production
3 senior production assistants
2 development managers
2 development designers
1 chief development designer
1 assistant development chief
1 chief designer of seats for private motor vehicles
4 designers of truck seats
1 designer of bus seats

2 chief engineers
4 quality control chiefs
1 materials chief
3 materials managers
2 materials employees
1 construction manager
3 seat managers
2 spring managers
1 roller manager
1 test manager
1 project manager
1 equipment manager
1 chemical manager
1 foreman
1 motive power technician
1 chemical technician
1 frame technician
2 heads of personnel
1 assistant head of personnel

The total of 76 decision makers were informed about the technological level of their seat construction, technological improvements and improvements in production engineering and the production process.

For private reasons I could not be away for longer than 4 weeks from my firm, and so UNIDO subdivided my mission into three parts.

The global aim of the project is to improve seats in passenger vehicles used in road, rail and water transport.

PART I

This deals with the examination of existing products and production methods. The report deals with this now finished Part I. In none of the firms visited are the technologically important seat parts, most of which are invisible to the user, up to modern engineering standards. Quite fankly, the attitude of every firm visited is that the external appearance of the completely finished seat serves as the yardstick of quality, whereas the technological parts important for operation and stabilization are regarded purely as a necessary evil. However, these partly visible steel structures, such as tubular frames, metal parts and so on, are crucial items, as I shall show later on.

Not enough importance is given to accident research, flame retardance, the anatomical design of vehicle seats, operator seating in factories and ergonomics. These areas and production engineering are the weakest links in the production chain.

In the light of my observations of manufacturing processes in most of the factories visited, I would comment as follows:

I. TUBING

(A) Findings

Except in two cases steel tubing is stored either in the open or under a roof. By the time it comes to be used the tube is badly rusted both externally and internally. The tube is cropped on an eccentric press. The parted-off lengths are inaccurate and it is impossible to reinforce the tube internally. Not one inner tube was found which fitted accurately.

(B) Requirements

The material for squab and back frames should be bright annealed precision steel tube of a strength of 37 kg/mm^2 and an elongation of more than 25% to German Industrial Standard (DIN) 2394.

Tube stock must be stored in enclosed dry premises to prevent rusting.

Internal rust (Figure 1) is much more dangerous than external rust since it rapidly weakens the tube from the inside and the complete tube structure loses its calculated rigidity. This is an important point which can provide a fundamental improvement in quality and automatically contribute to accident safety.

Parting-off of tube stock (Figure 2)

The current method of cropping is very inaccurate and makes it impossible to produce a reinforced structure using a properly fitting inner tube.

Tubing must be cut either with a metal circular saw or with a rapid cut-off machine or on long runs with an automatic tube cutter and never in any other way.

Deburring of tubing (Figures 3 and 3A)

Internal burring is essential so that fracture-prone parts of the tube can be strengthened with a reinforcing tube. Weld burrs on the inside must be uniform and at most 0.5mm high. The inner reinforcing tube must be a good fit and must not shift during bending.

Mitering of tubing (Figure 4)

Mitering must not alter the tube cross-section, thus ensuring that the strength of the weld is not affected.

Bending (Figure 5)

(a) Findings

Bending techniques were unsatisfactory in all factories inspected. The usual practice is to use 2 operators for tube bending. In some cases tubes were bent over 2 rollers by the use of brute force and in other cases a completely obsolete hydraulic bender was used to draw the tubing. The quality of the work was very poor in all cases.

(b) Requirements

For economic tube bending using just a single operator, I recommended firms to have a look round the tube bender market. In my view all manufacturers badly need to acquire a modern tube bender. Machines tailored to any output and suitable for long and short runs are commercially available. I would recommend a dead bender or for long runs an automatic bender (in my lectures I discussed dead bending in some detail). At one factory extensive corrections were necessary because the bender delivered the finish-bent frame askew. Modern benders make any such corrections unnecessary.

II. PRESS SHOP

(A) Findings

People working with gloves
Floors of press shops often very unsatisfactory
Complicated conveyance of material
Flow of work good in some cases
Pressing very good in some cases
Room for improvement in tools

(B) Requirements

Working on eccentric presses with gloves greatly increases the risk of accident since it is all too easy for a glove to stick to steel parts for too long and the presses I found in use have one-hand control - i.e., when the right hand operates the press, the left hand can still be inserting the work, and the glove may then cause an accident if it sticks and the operator cannot move his hand away fast enough.

Recommendations

Two-handed operation of presses, elimination of gloves.

If floors could be improved, home-made trucks or trolleys of a working height of from 60 to 80 cm could be used to convey material between presses with a reduction in labour and costs. Alternatively, a system using pallets and lift trucks might be worth considering (see Figure 6).

This is an individual decision for each factory.

Pressing and stamping tools often need an ejector so that the pressing does not have to be lifted out manually. Manual release of the work damages the tools themselves (tool edge life) and unnecessarily increases the time taken to press individual components.

III. WELDING

(A) Findings

There are some CO_2 welding plants, but electric welding equipment with electrodes is also in use.

Welding facilities are unsatisfactory.

(B) Requirements

The modern view is that items of this nature should be welded by inert gas welding plant connected to a central works gas supply. There is then no need to strike off the scale, nor is welding material wasted by electrode stumps having to be discarded, with the factory leaving it up to the individual welder to decide on the discard length of his stump.

Welding facilities are all far too small.

As a rule of thumb, the thickness of the welding material times equals the thickness of the material of the welding plant.

Welding tables

(a) Findings

Some too small, electrode holders wrong, supply cable kinked (see Figure 7). Material drops on the welding table and burns so that the workpiece is supported unevenly.

(b) Requirements

Electrode holders should be hung up properly as shown in Figure 7 to cut down rejects.

Welding table surfaces should be in the form of a grating through which material can drop, so that the support surface of the apparatus is always clean.

Also, welding tables could have an extractor (there are specialist firms which can supply welding tables of this kind).

IV. FINISHING (SURFACE TREATMENT)

(A) Findings

2 firms had serviceable finishing facilities
Surface treatment in all other firms was unsatisfactory
Paintwork generally poor
Paint fails to stick, indicating inadequate corrosion protection
Dilution of paint observed

In all the firms visited, including the two having automatic continuous immersion finishing plants, too little attention is paid to proper choice of paint.

(A.1) In a company having an automatic continuous immersion finishing plant, it was found that after finishing and before stoving the paint dripped off the painted part, which looked streaky and only half painted.

Since no detailed information about the composition of the paint was forthcoming, this failure cannot at present be fully diagnosed.

(B) Requirements (A.1)

In this particular case the necessary improvement would be immediately forthcoming if the cleaning bath preceding the finishing operation was to have its cleaning liquid renewed on the basis not of days of use but of the number of articles treated.

Another item which should be looked at is the suspension device for the articles to be painted and the suspension of the finished articles themselves.

The finished articles, e.g., tubes, should in theory all be so dipped into the cleaning bath and the finishing bath that the open tube ends hang down, to ensure that cleaning agent is not transferred to the finishing bath.

It may well be that in the facility just described the paint is diluted too much and too soon by the cleaning agent.

Also, stoving times and temperatures should be checked in co-operation with the paint manufacturer with reference to specimens of paint on finished items.

If these suggestions bring about no improvement, the fault must lie in the paint itself and the maker's co-operation will have to be sought to improve matters by changing the composition of the paint.

The other factories visited where there are no automatic continuous immersion finishing plants have the same problems with the paint they use, plus the difficulty of deciding which modern finishing system to invest in.

(B.1) Requirements

To achieve an appropriate quality standard using modern economic methods, the decision-makers of all the factories will inevitably come round to considering the virtues of electrostatic powder coating. There is a wide range of equipment providing a wide variety of outputs and first costs are low for the quality obtainable.

In equipment of this kind epoxy resin powder is sprayed on the workpiece electrostatically by a special spray gun and the sprayed article is then stoved at from 180 to 200°C for from 15 to 20 minutes, the stoving times and temperatures depending upon the nature of the powder and the thickness of the coating. The sprayed powder fuses to give a very clean finish. Egg shell and gloss finishes can be provided and some control of coat thickness is possible.

(B.2) Particular advantages of electrostatic powder coating

1. A finish of uniform thickness can be provided over the whole of the work.
2. A coat thickness of 100 μ = 0.1 mm or more can readily be provided.
3. Mar resistance is very high.
4. Corrosion protection of the material (remember the section on rust and accident safety) is cheap and excellent results are obtainable with modern facilities.
5. A fully automatic plant using one or more spray guns is a viable proposition for long runs.

V. PRODUCTION OF FOAM MATERIAL

(A) Findings

Each maker I visited foams his own mouldings.
The foam is frequently too soft.
The foam is of uneven density.
Quality testing is almost non-existent.
Some of the facilities are totally obsolete (I did see one modern plant but it had only just been delivered and was not operating).
The beaker mixing method does not give accurate quantity proportions.

(B) Requirements

Main requirement in the manufacture of polyurethane foam

The basis of the process for producing polyurethane upholstery foam is that the basic raw materials, viz. polyol, isocyanate and water, be mixed very intimately but in very accurate quantity relationships in a mixing chamber in which specific physical conditions exist. This step initiates a double reaction.

One reaction occurs between the polyol and a proportion of the isocyanate and leads to the formation of the urethane polymer which constitutes the cell walls of the subsequent foam.

The second reaction occurs between another proportion of the isocyanate and the water and leads to the formation of CO_2, the gas which expands the foam.

The two reactions combine to produce an expanding process which should be so controlled that the expanding gas collecting in voids can always expand, but not destroy, the continuously solidifying polymer structure.

Obviously, quantity relationships are crucial. For as long as the old facilities continue to be used, accurate mixing of basic materials is essential if there is to be any immediate improvement in the end products. The weighing machines used to weigh the basic materials must be kept clinically clean and cleaned daily, as must also the mixing vessels.

Quality of foam

None of the factories visited had any equipment for foam quality control, and so I particularly emphasized quality control methods in my factory lectures.

Figures 8 to 12 show the most important and relatively simple methods of foam testing. It is considered that every company can produce small test rigs of this kind in their own factories without special expenditure.

When measured results of this kind are available, designers can adapt the future seat to the vehicle and its vibrations individually both at the drawing board stage and in practical experiments.

What is measured?

Determination of density to DIN 53420 (Figure 8)

Example

The 100 cm^3 sample to DIN 53420 has, for instance, a foam density of 35 and a weight of 3.5 g.

Determination of the weight at the specified accuracy of ± 5% gives an end product accuracy of ± 0.5%.

Determination of hardness index and compression index (Figure 9)

Determination of spot hardness - i.e., hardness defined by a single index or coefficient - is determined by two different processes, one for the hardness index and one for the compression index. In both processes the sample is compressed three times, then subjected to a fourth and predetermined deformation from which the measured value is determined. Hardness index testing gives information about the restoring force exerted by the specimen on a test prod impinging on it and is measured in Newtons (N).

Determination of compression index to DIN 53572 (Figure 10)

The compression index, defined as the permanent deformation of a specimen subjected to a predetermined mechanical and climatic stressing, is particularly informative about the long-term behaviour of a foam material.

Determination of rebound resilience (Figure 11)

Rebound resilience is determined by a pendulum hammer, a method which is familiar in materials testing; the hammer drops through an angle of 90° from a horizontal position of rest, strikes a sample horizontally with a predetermined energy and rebounds. The rebound height in relation to the drop height is the measured value.

Low-rebound foam materials are tiring.

Fatigue testing to DIN 53574 (Figure 12)

In addition to testing of the dynamic behaviour of articles of foam material in specially programmed hydraulic pulsators, fatigue testing as generally defined and carried out in the conditions shown in Figure 12 and evaluated as the loss in height and hardness of the sample gives decisive information about the long-term performance of a foam material subjected to pulsating loads.

Upholstery technique

(A) Findings

Upholstery departments are in all cases technically satisfactory. The machines used vary from good to in some cases very modern. Sewing and stitching operatives are very good and even outstanding and I envy Korean upholstery makers. The skill and manual dexterity of their seamstresses are outstanding.

(B) Requirements

One factory tried to reduce the cost of the movement of material between machines by installing conveyors. Other factories should consider this feature very carefully. The idea is to convey the material at working height.

The working environment should be given very careful thought. If operator seating was better adapted in height to sewing machine tables, the output per 8-hour shift would improve. The frequent use of seat cushions may be an indication that the height and inclination of the existing seating is wrong. This point and the lighting of individual operator stations needs closer study.

Seat construction

In all the seat-manufacturing works visited, the seat types in production were designed by the vehicle manufacturers. This form of production may be better suited to the car industry (even in Germany), subject to close collaboration.

It might be better if the seat manufacturer was to endeavour to improve seat design, construction and materials, carry out development work in his own concern, then offer the vehicle manufacturer the seats he has developed; the connection measurements must agree with the type of car intended.

S U M M A R Y

In this first phase of my mission I was able to obtain a broad general view of seat construction in Korea. My four-week stay was of course not long enough to bring about substantial and immediate changes and improvements, but I feel sure that the very thorough lectures I gave will bear fruit.

The great interest shown by Korean managements, engineers and technicians in learning as much as possible was a great stimulation to make my lectures vivid and understandable.

The foundations for modern seat construction exist in the factories I visited. Each individual factory has been given advice and suggestions for improving its product and the next thing is for all this new knowledge to be put into practice before my next visit, when it will become apparent which seat manufacturers will gain in significance in the near future and be able to provide good safe seats for Korean vehicles for export.

Management throughout the Korean motor vehicle associations and motor vehicle industry realizes that accident rates and vehicle accident injuries in Korea are very high.

It is one of the jobs of the seat designer and seat manufacturer to try to improve these statistics.

A positive start was made with the Ponny car within a few days of my visit. Its driver's seat was so altered by simple means not involving investment but merely a minor design alteration that it can now absorb vehicle vibrations, while the seat back supports the spine properly.

This is a contribution to safety, for the better the seat, the greater the driver's concentration on the traffic.

As stated on page 3 of this report, accident research, flame retardance, the anatomical design of vehicle seats, operator seating in factories and ergonomics, plus the use of lightweight and safe materials, are key points which have so far received no attention at all and must now be dealt with as a matter of urgency.

If by design action the weight of the seat and other components of the Ponny car could be reduced by 1 kg and the weight of buses and trucks by 5 kg, the effect might be something as follows:

Example

A bus or truck in Seoul City averages 200 km a day, and so 4 000 vehicles cover 800 000 km daily.

A weight saving of 5kg/vehicle corresponds to an overall weight saving 20 000 kg.

If 2 000 taxis with a weight saving of 1 kg for each are included, 2 000 kg are saved.

Taxis cover at least 100 km/day, and so 2 000 taxis cover 200 000 km/day.

The figures for this example are therefore as follows:

Buses and trucks	Taxis	
800 000	200 000	= 1 000 000 km/day
		= 30 million km/month
		= 365 million km/year

Savings

Buses and trucks	Taxis	
20 000	2 000	= 22 000 kg/day
		= 660 000 kg/month
		= 8 030 000 kg/year

Result

4 CCC trucks plus buses each 5 kg lighter

2 CCC taxis each 1 kg lighter

For a total annual distance of 365 million km there is an annual weight saving of 8 C3C CCC kg.

We leave it to readers to consider what this means in terms of fuel saving.

"It is worthwhile thinking things out carefully and leaving nothing to chance".

In conclusion I should like to thank the chairman and all those working in KOTRA and UNIDO, my interpreter, Mr. Yu and everybody I met.

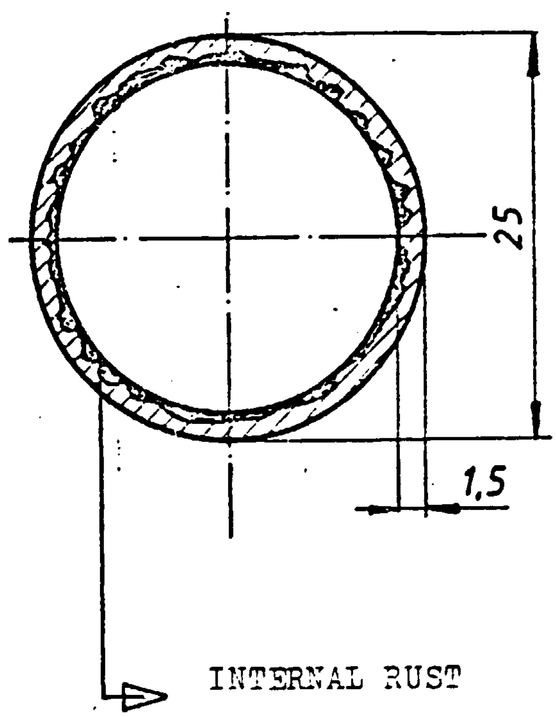


FIGURE 1

CROPPED TUBE

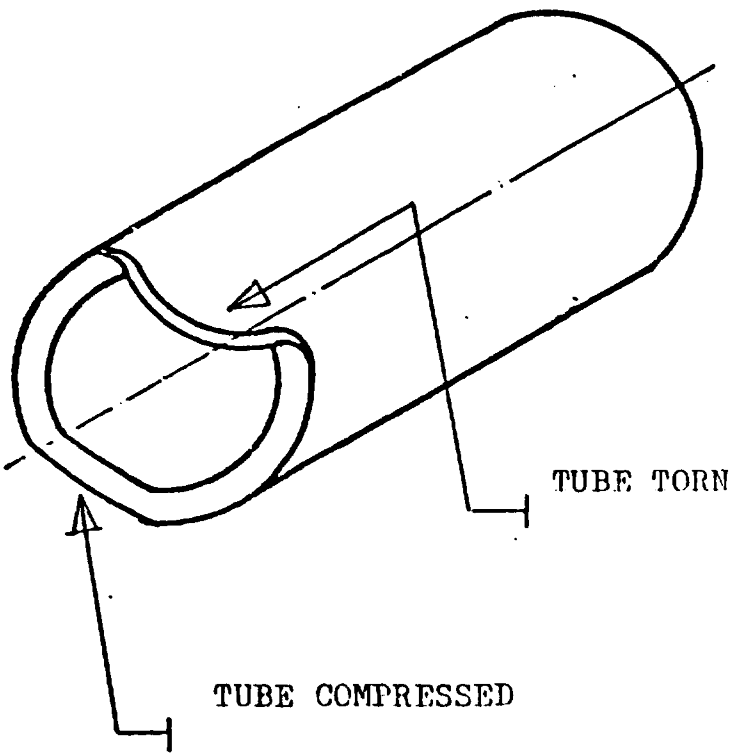
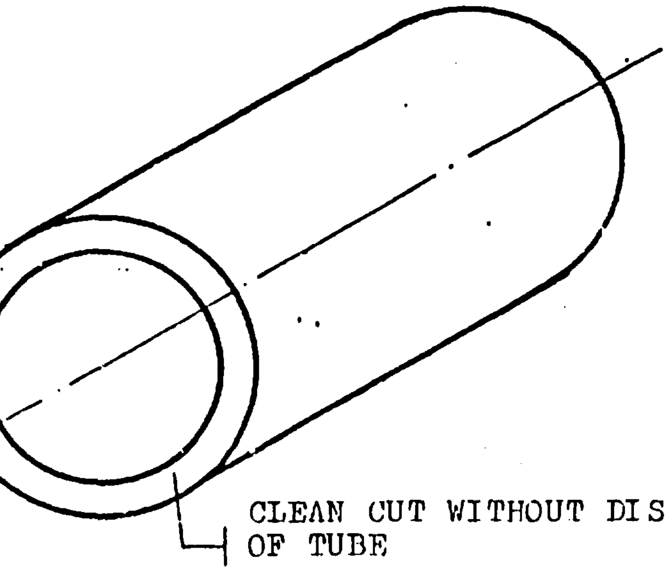


FIGURE 2

SAWN TUBE



DEBURRING OF TUBING

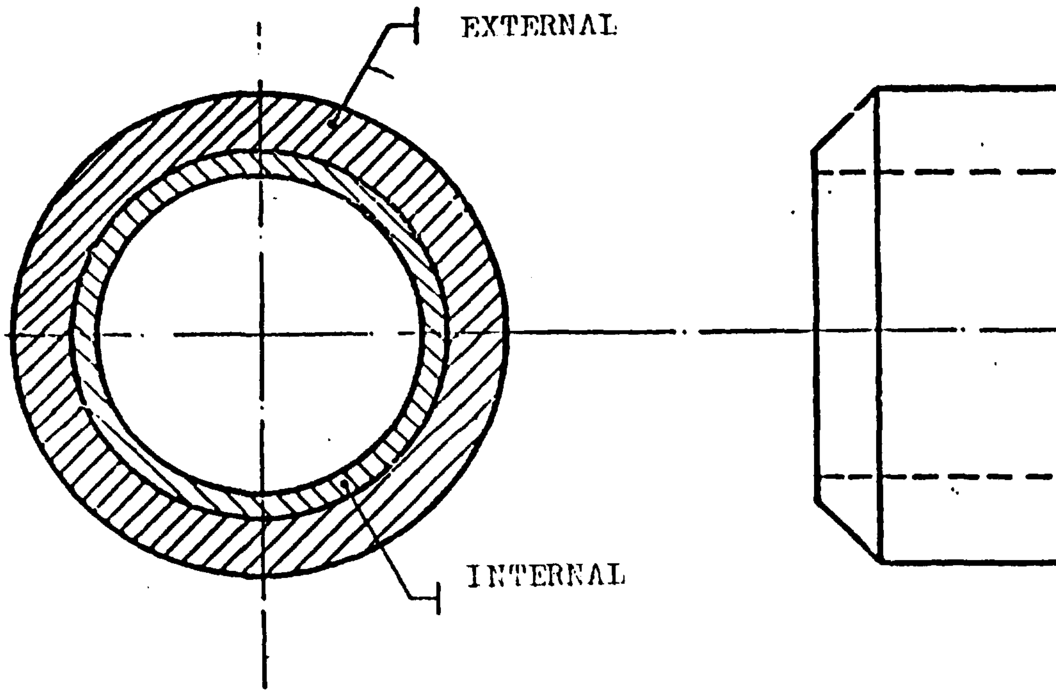
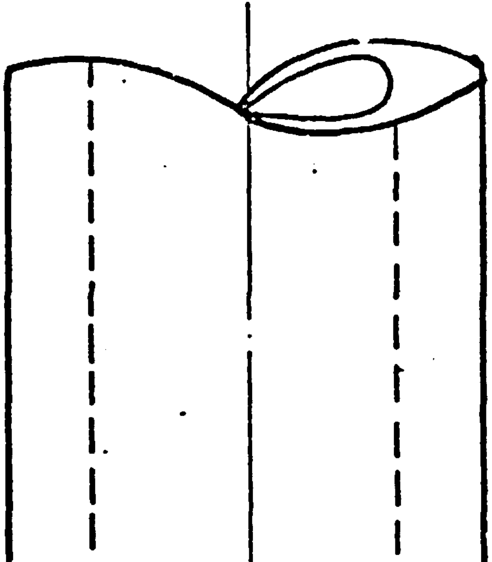
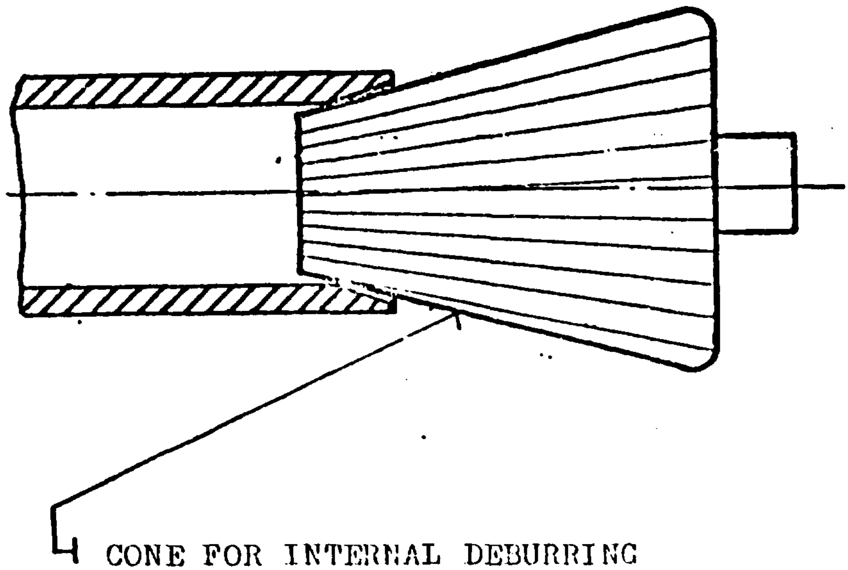
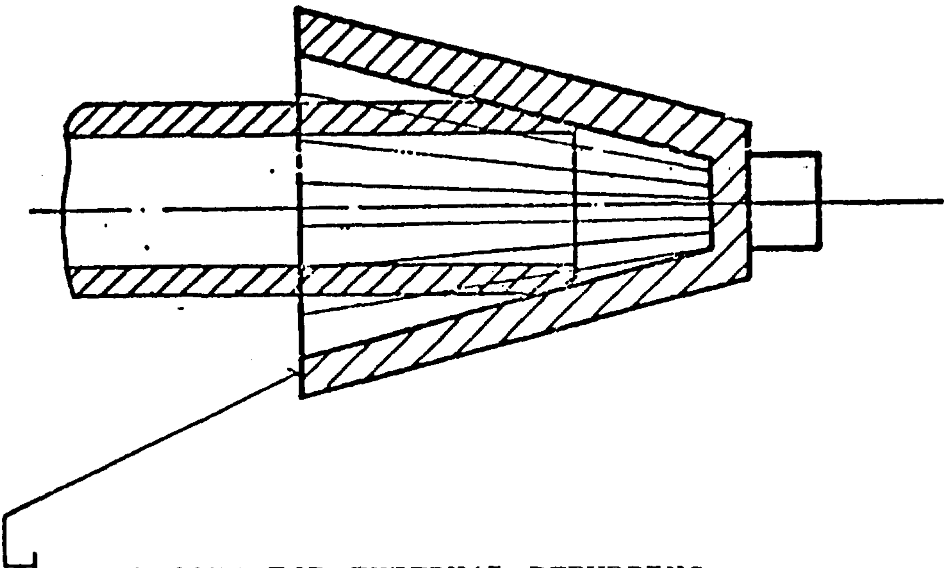


FIGURE 3





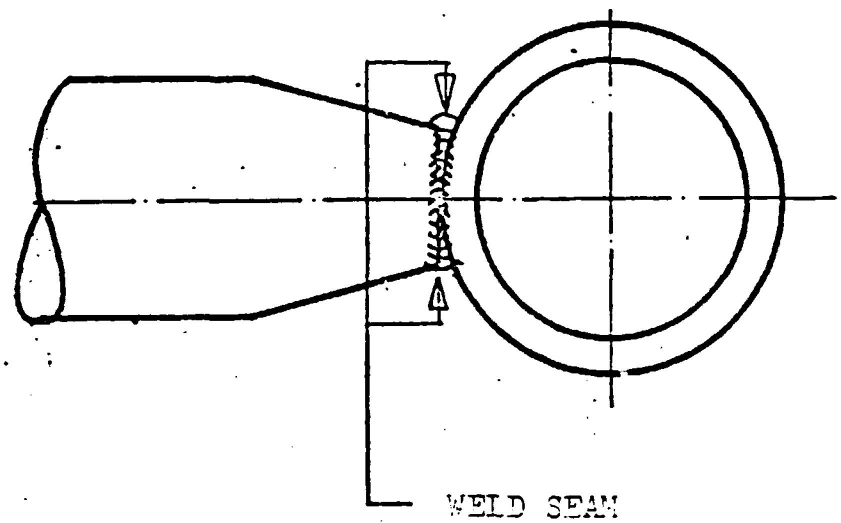
FIGURE



INNER CONE FOR EXTERNAL DEBURRING

3a

OLD METHOD - SQUEEZING



NEW METHOD - MITERING

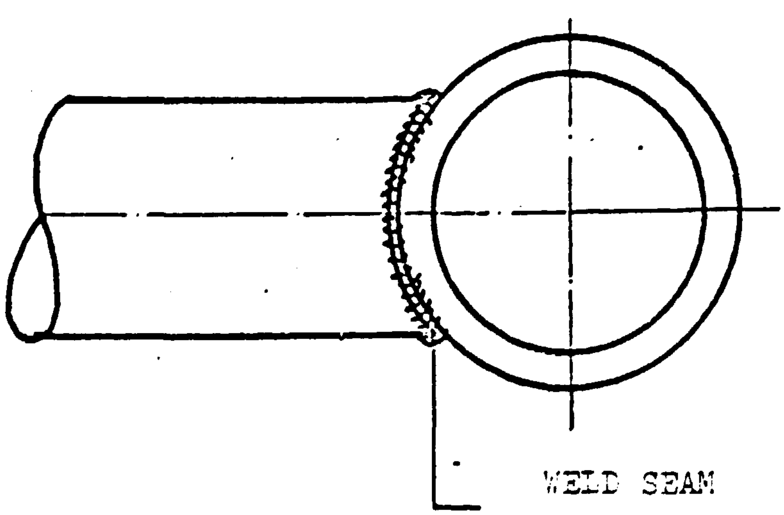
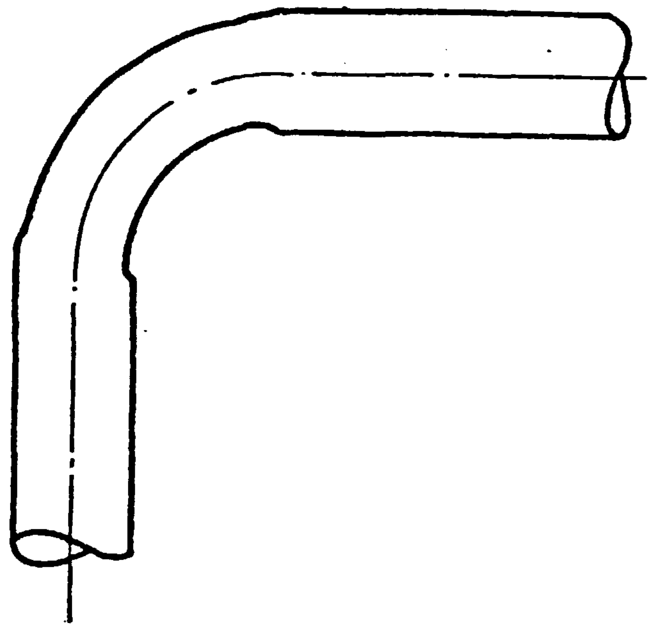


FIGURE 4

TUBE BENDING

BY CURRENT METHOD



TUBE BEND SHOULD LOOK LIKE THIS

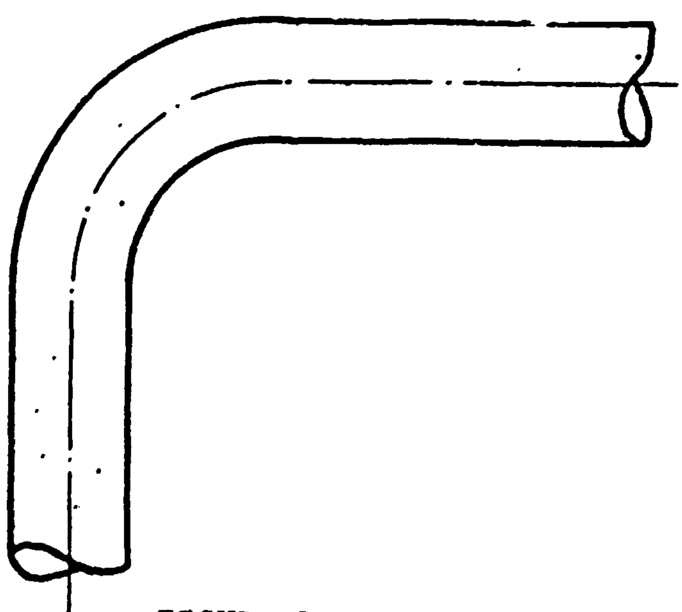


FIGURE 5

TROLLEY WITH METAL OR WOODEN BOX

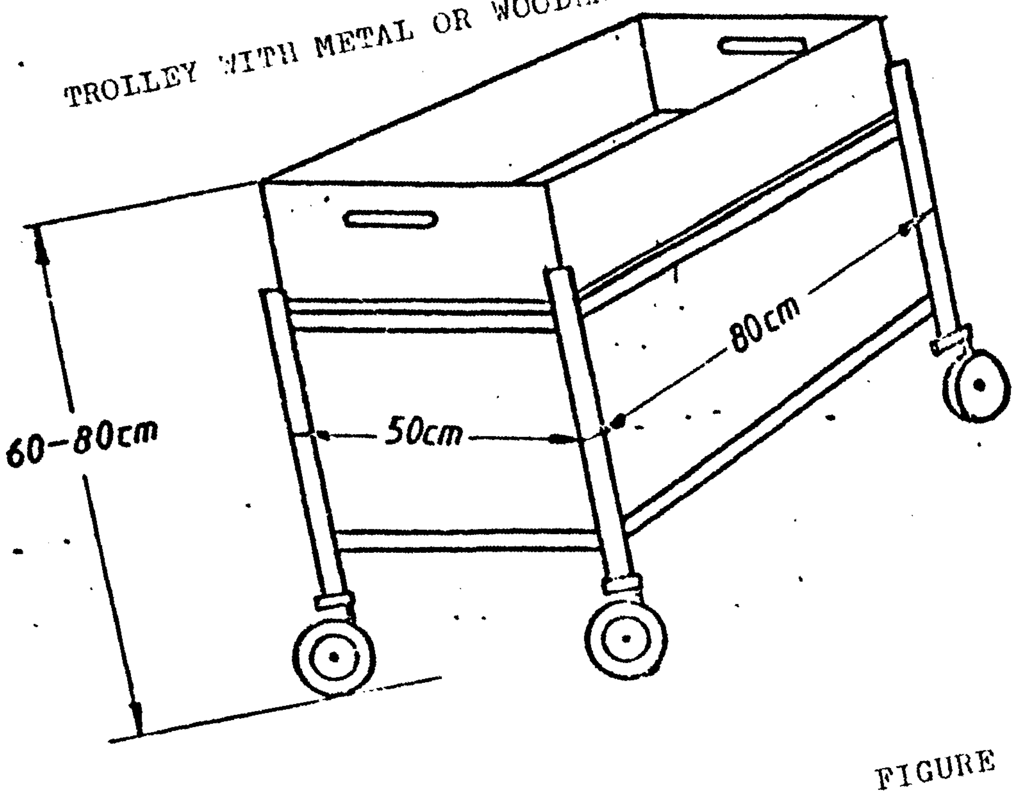
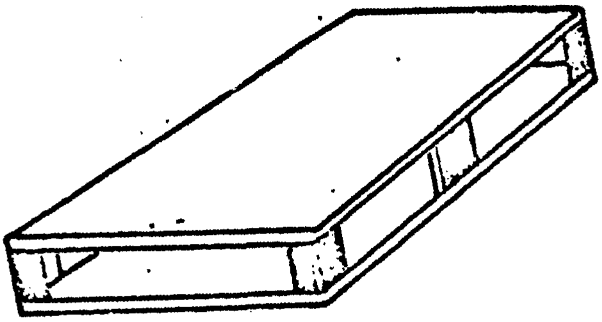
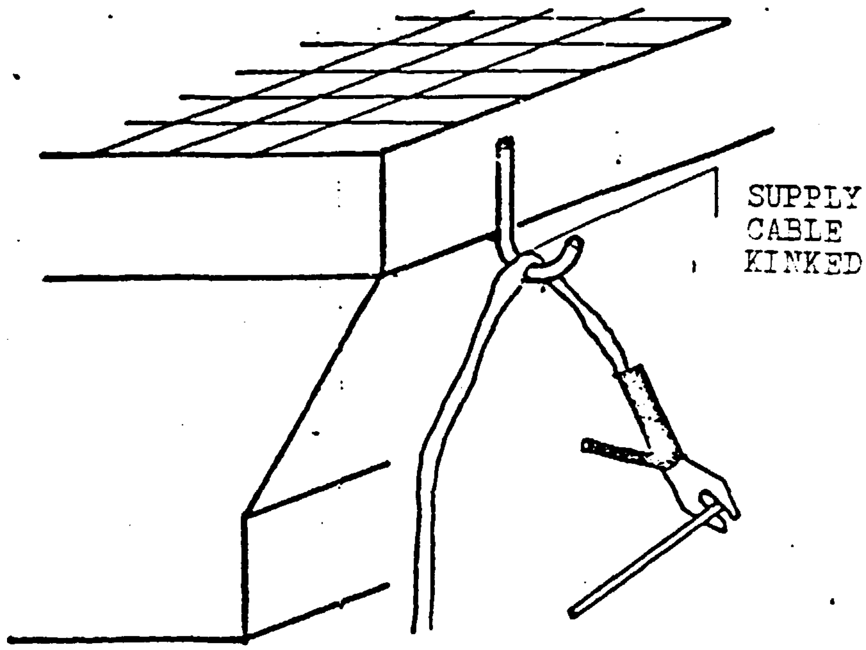


FIGURE 6



PALLET FOR LIFT TRUCK

WRONG



RIGHT

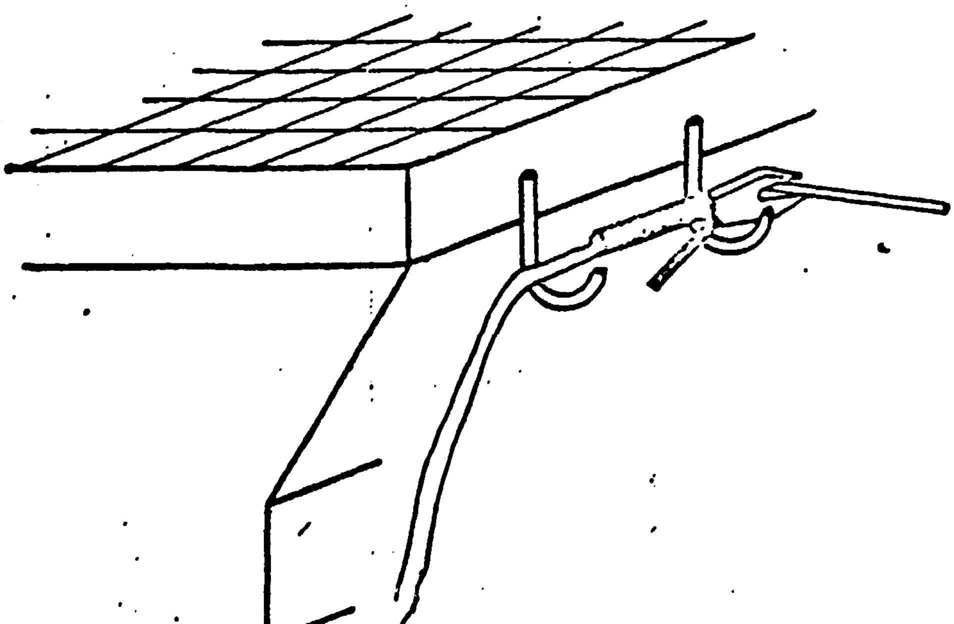


FIGURE 7

DETERMINATION OF DENSITY TO DIN 53420

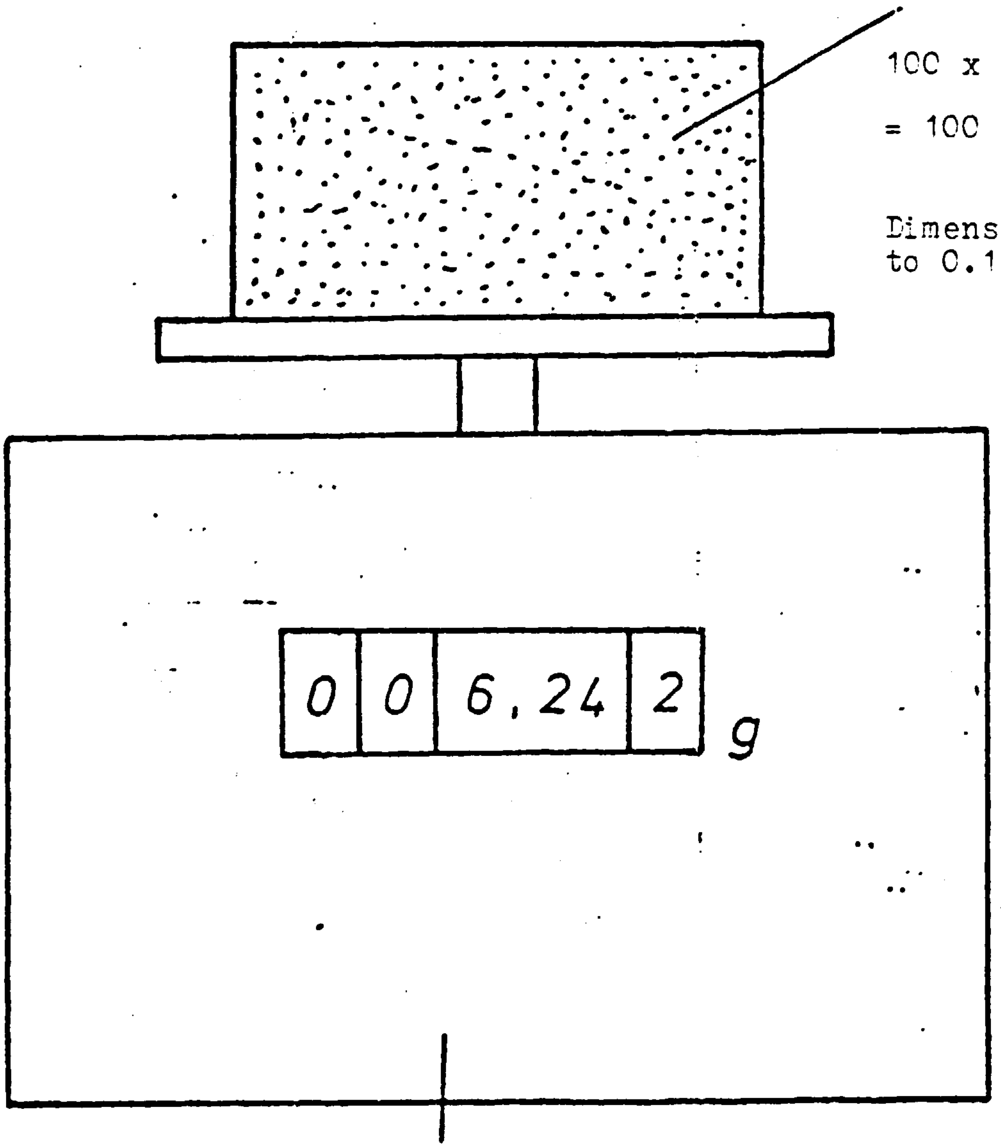
$$d_S = \frac{m}{V} = \frac{\text{Weight of sample}}{\text{Volume of sample}}$$

Minimum size of sample:

100 x 100 x 10 mm

$= 100\ cm^3$

Dimensions accurate to 0.1 mm



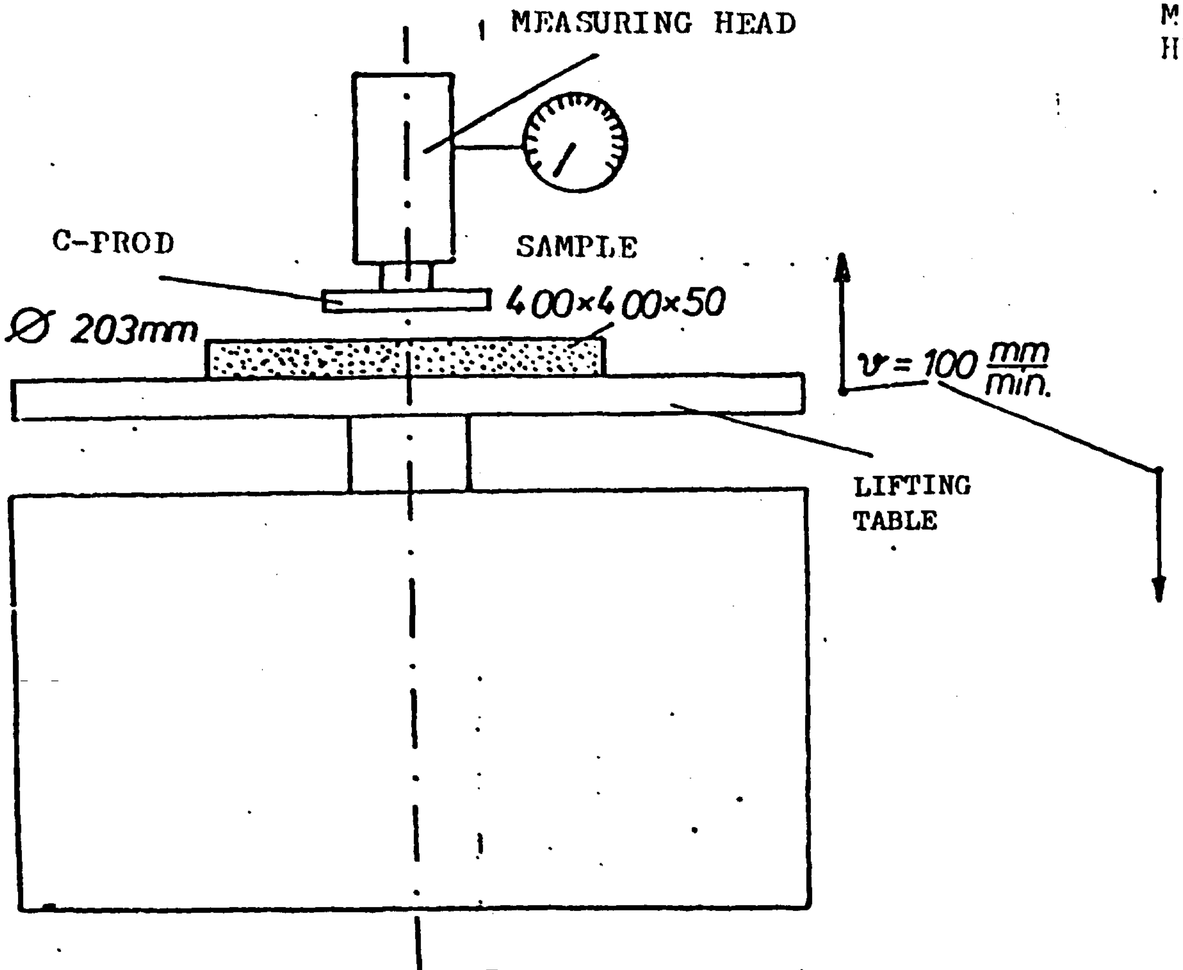
ANALYZER BALANCE

Accuracy of weighing: ± 5‰ of sample weight

FIGURE 8

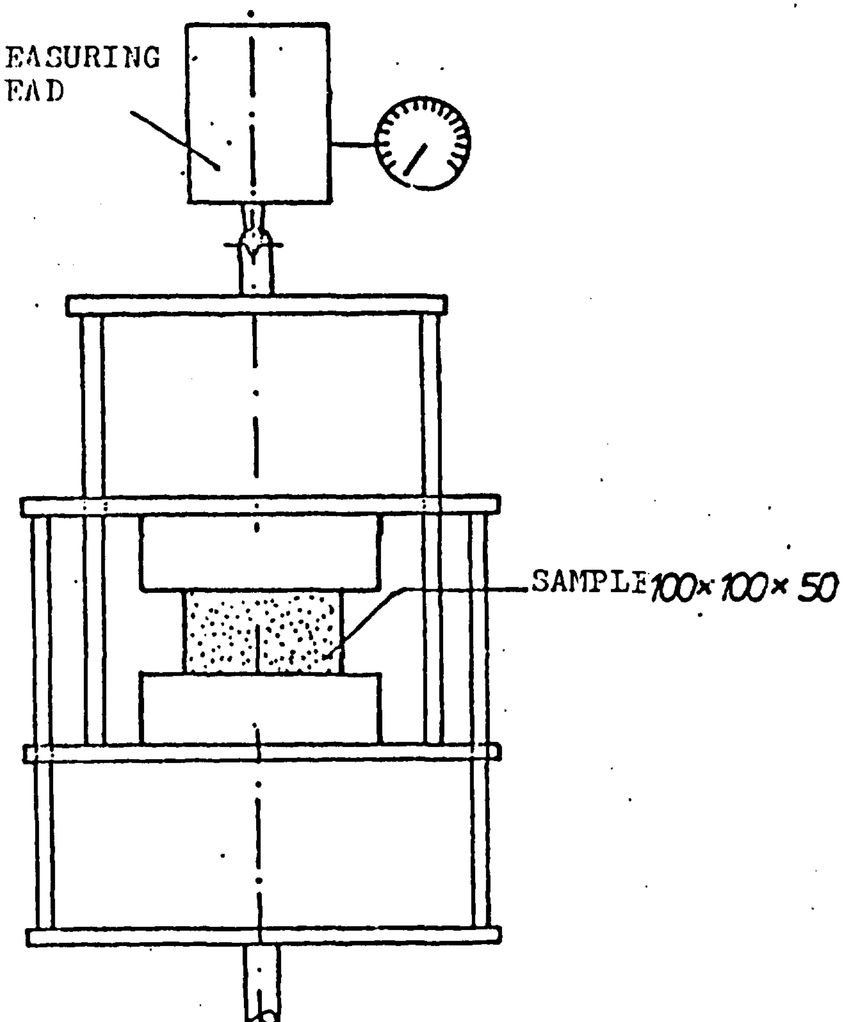
DETERMINATION OF HARDNESS INDEX AND COMPRESSION INDEX

HARDNESS INDEX, PROCESS C



Measurement procedure: 3 impacts to 70% penetration depth.
Hardness measured on 4th impact at 40% penetration depth. Hardness index in (N).

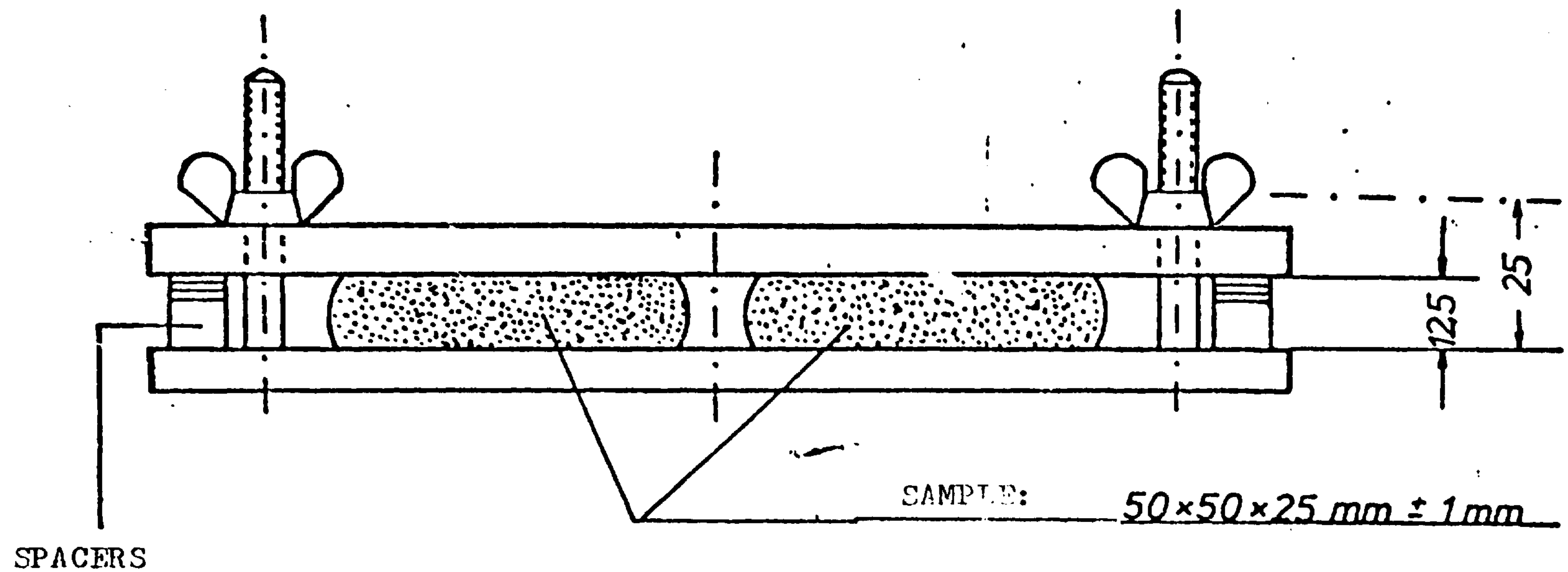
COMPRESSION INDEX



Measurement procedure: 3 impacts to 70% penetration depth. Compression measured on 4th impact at 40% penetration depth. Compression index in (kpa).

IGURE 9

DETERMINATION OF COMPRESSION SET TO DIN 53572



50% compression at 70°C for 22 hours.
Measurement after cessation of load + 30 minutes recovery time.
Set expressed as a percentage of initial height.

FIGURE 10

DETERMINATION OF REBOUND RESILIENCE

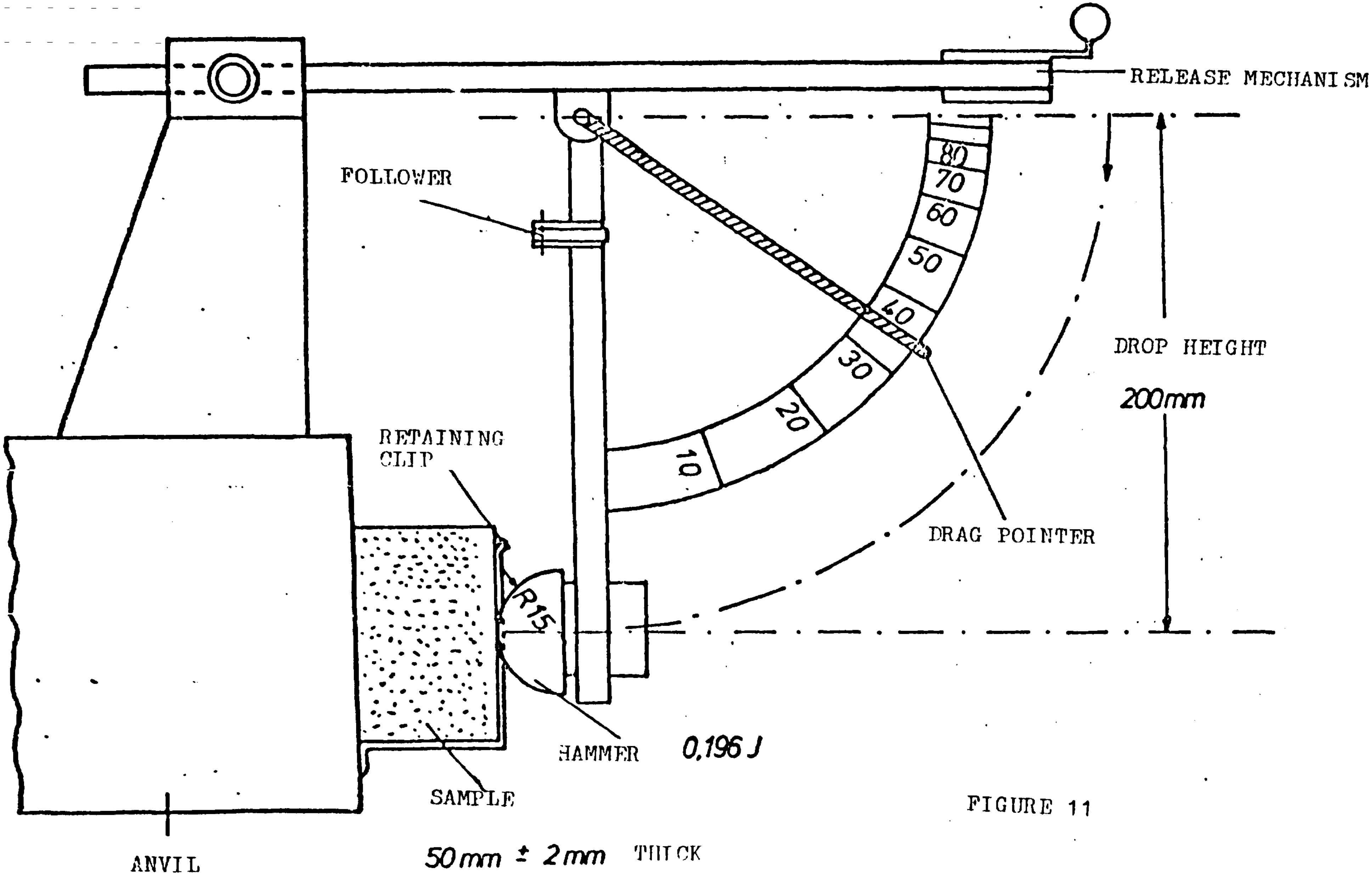
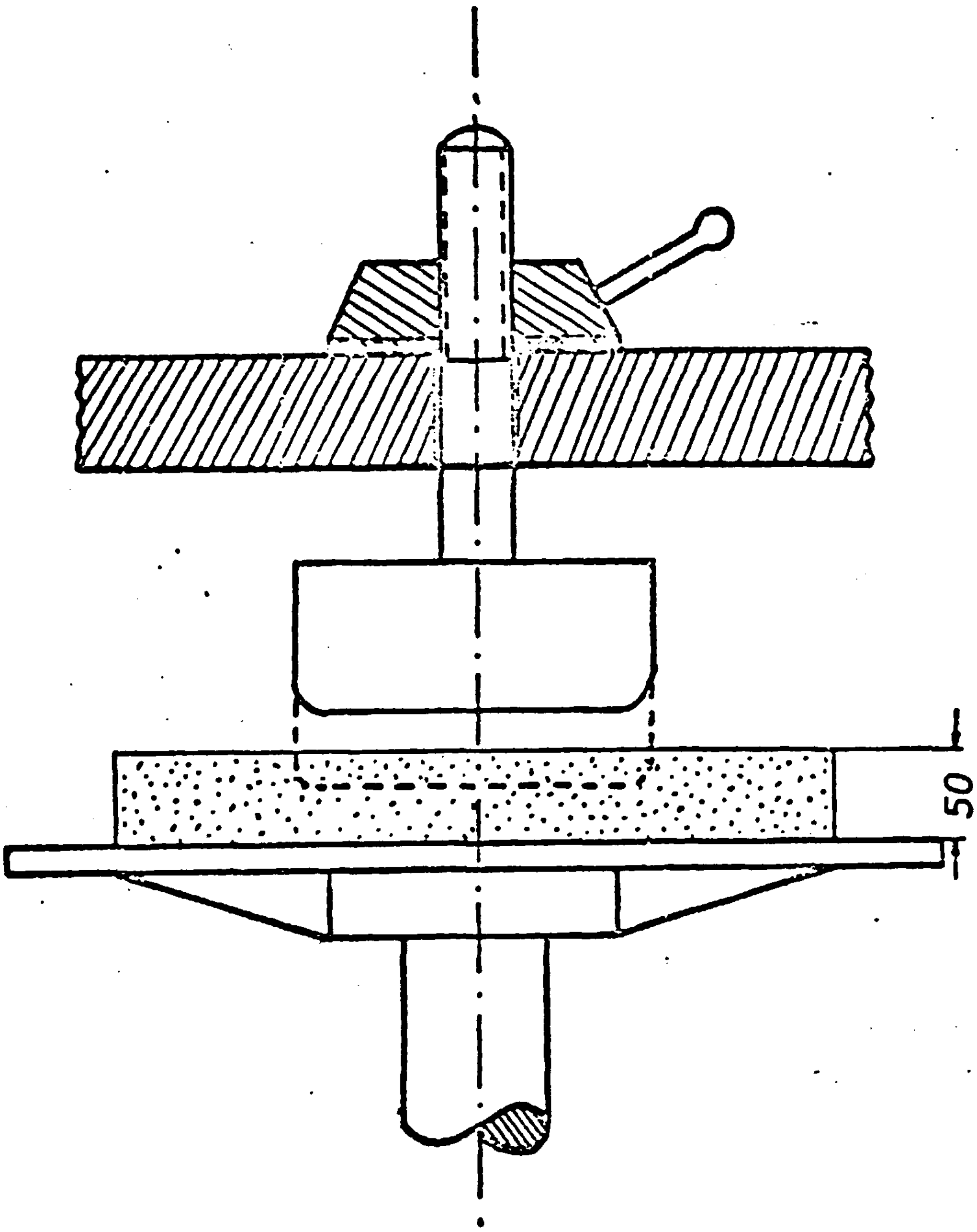


FIGURE 11

FATIGUE TEST TO DIN 53574



RAM DIAMETER	250 mm ± 1 mm
EDGE RADIUS	25 mm ± 1 mm
RAM FORCE	750 N ± 20 N AT REVERSAL POINT
LOAD ALTERNATIONS	80 000
FREQUENCY	70 ± 5 STROKES/MINUTE
SAMPLE DIMENSIONS	400 × 400 × 50

Evaluation: alteration of height and hardness

FIGURE 12

THE HUMAN PELVIS

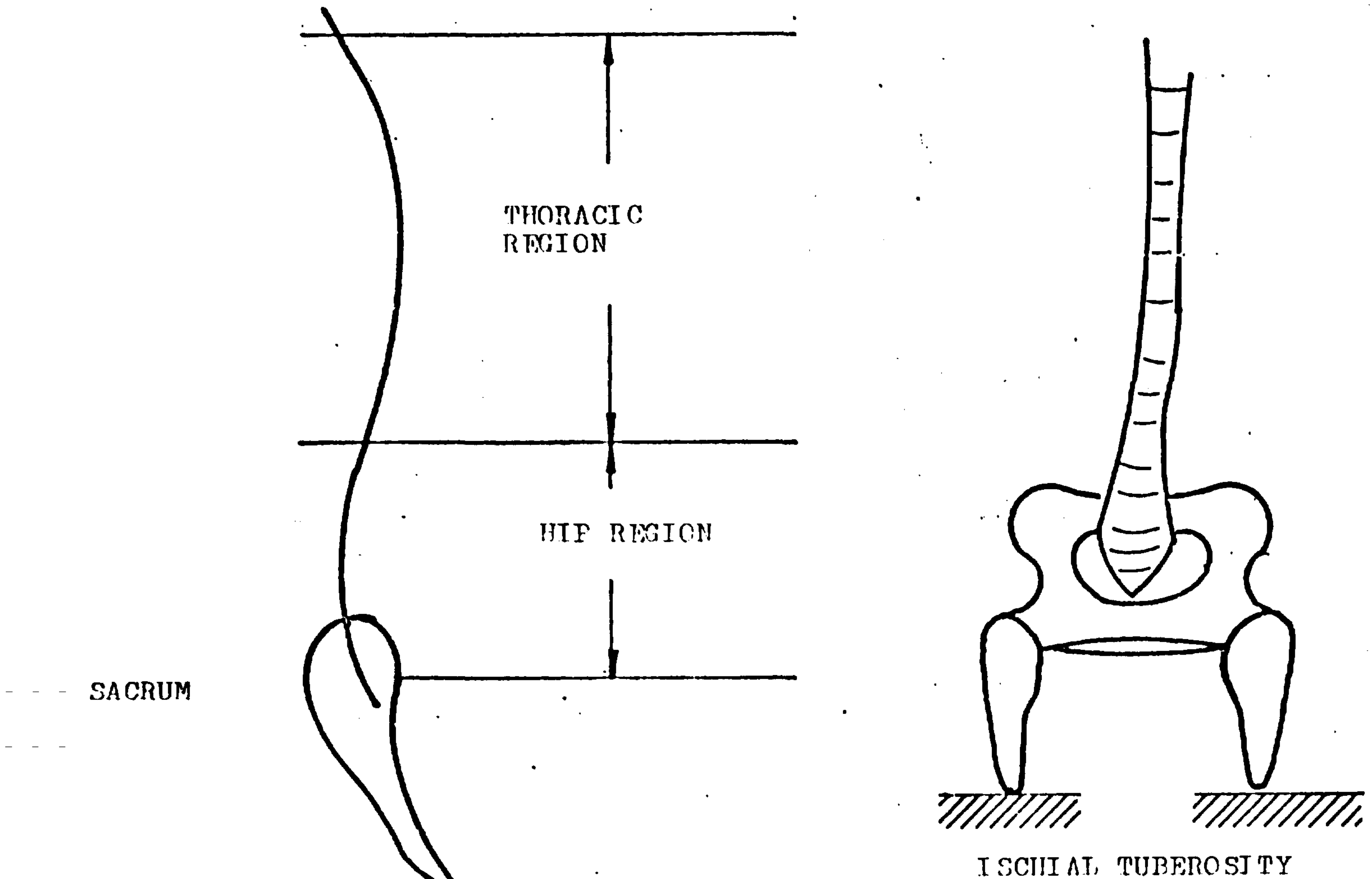
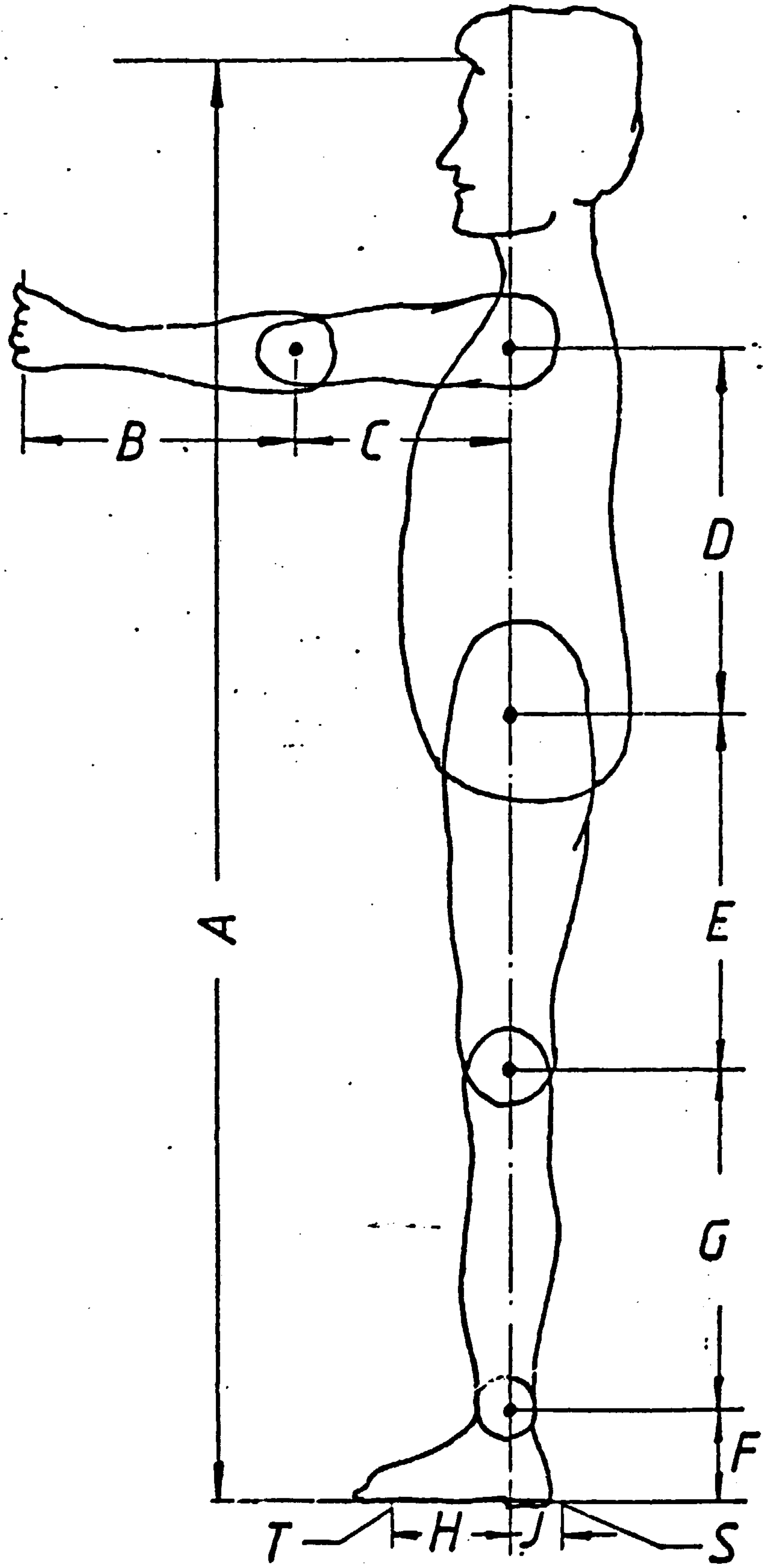


FIGURE 13

WORKING ENVIRONMENT
BIOCHEMICAL MODEL OF A HUMAN BODY



Measurements	5% female	95% male
A	1490	1860
B	258	382
C	241	300
D	355	452
E	345	445
F	92	113
G	417	490
H	130	160
J	60	70

FIGURE 14

STANDING HEIGHTS
(estimated)

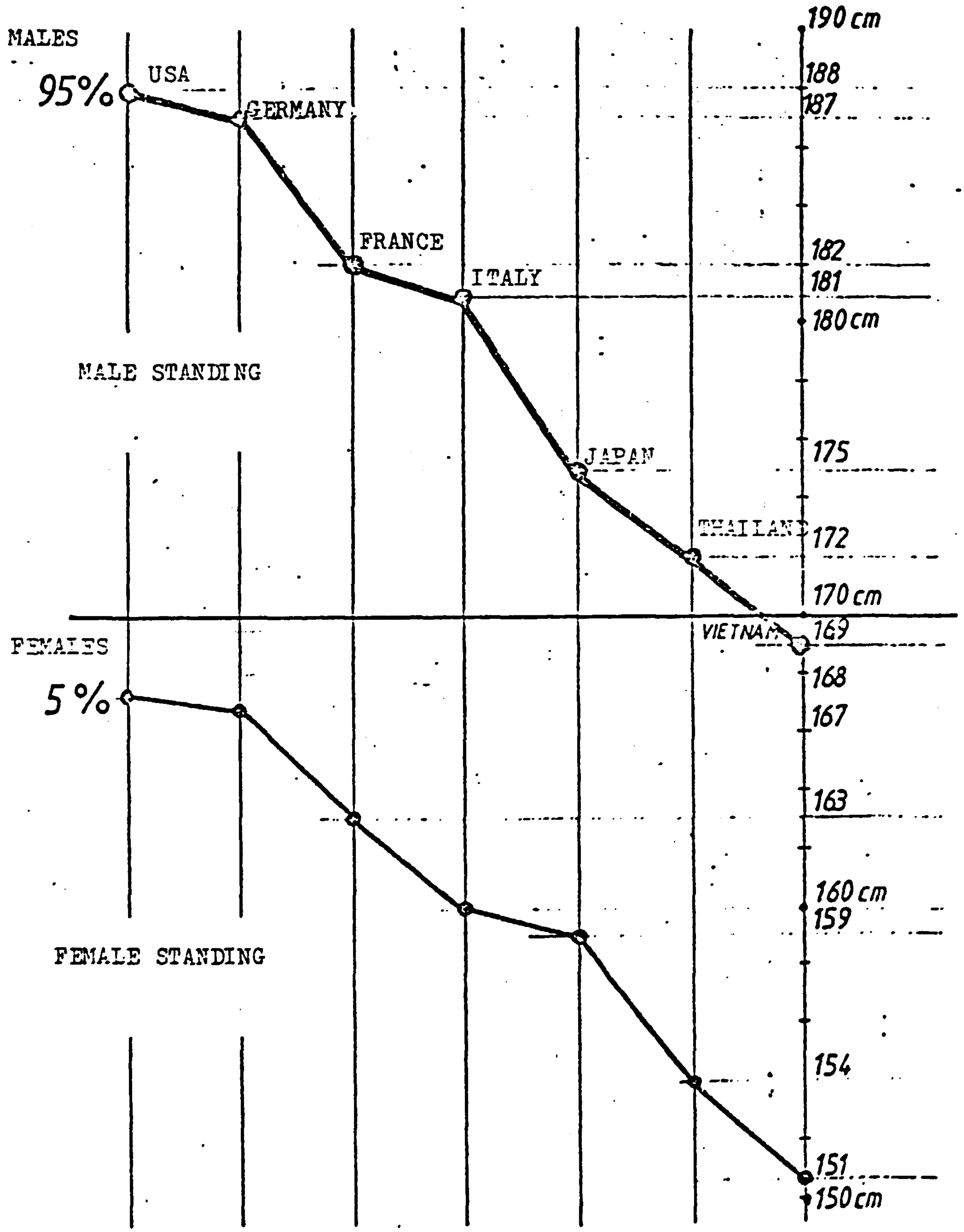


FIGURE 15

HEIGHTS OF MALES
(estimated)

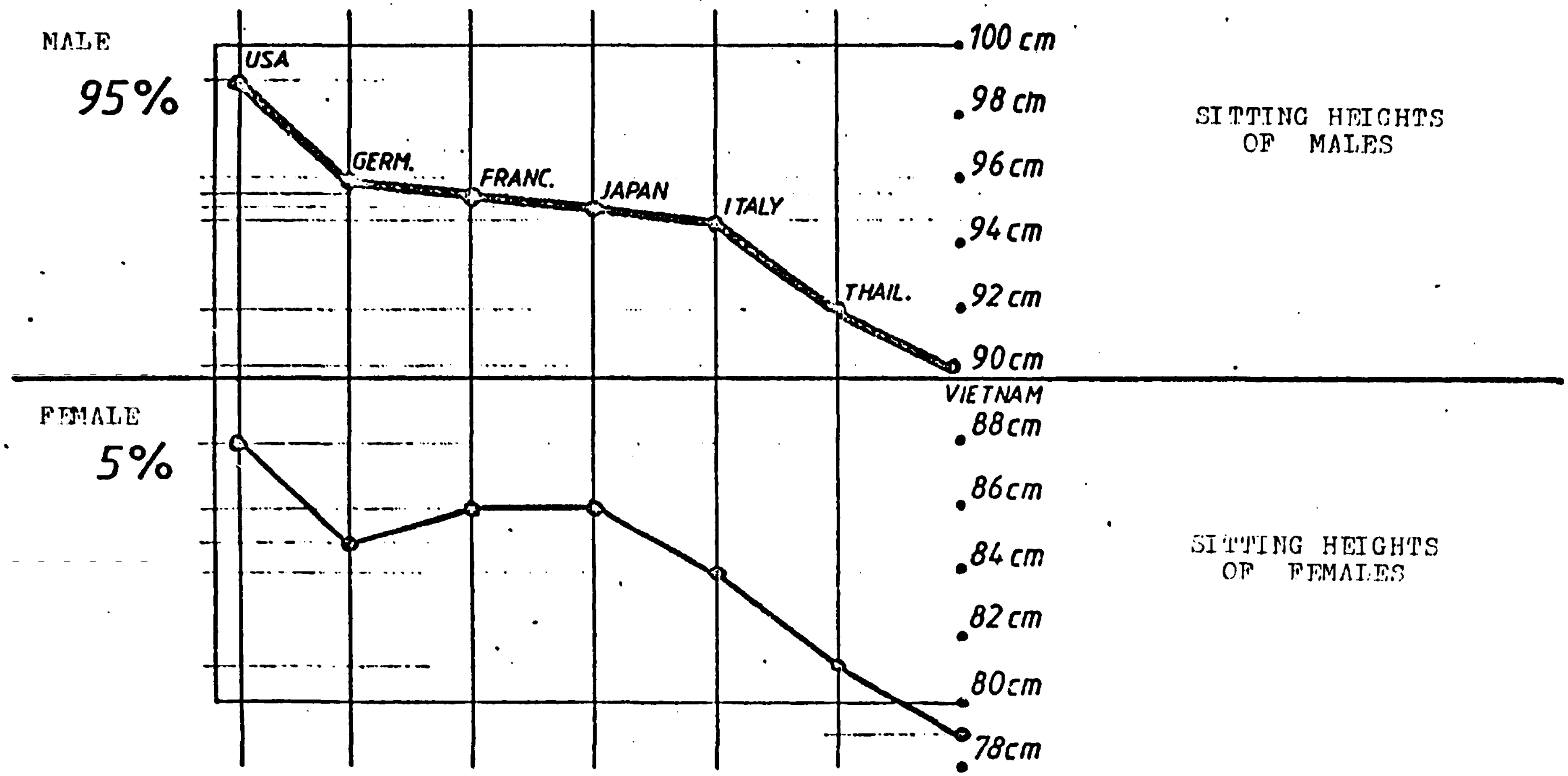
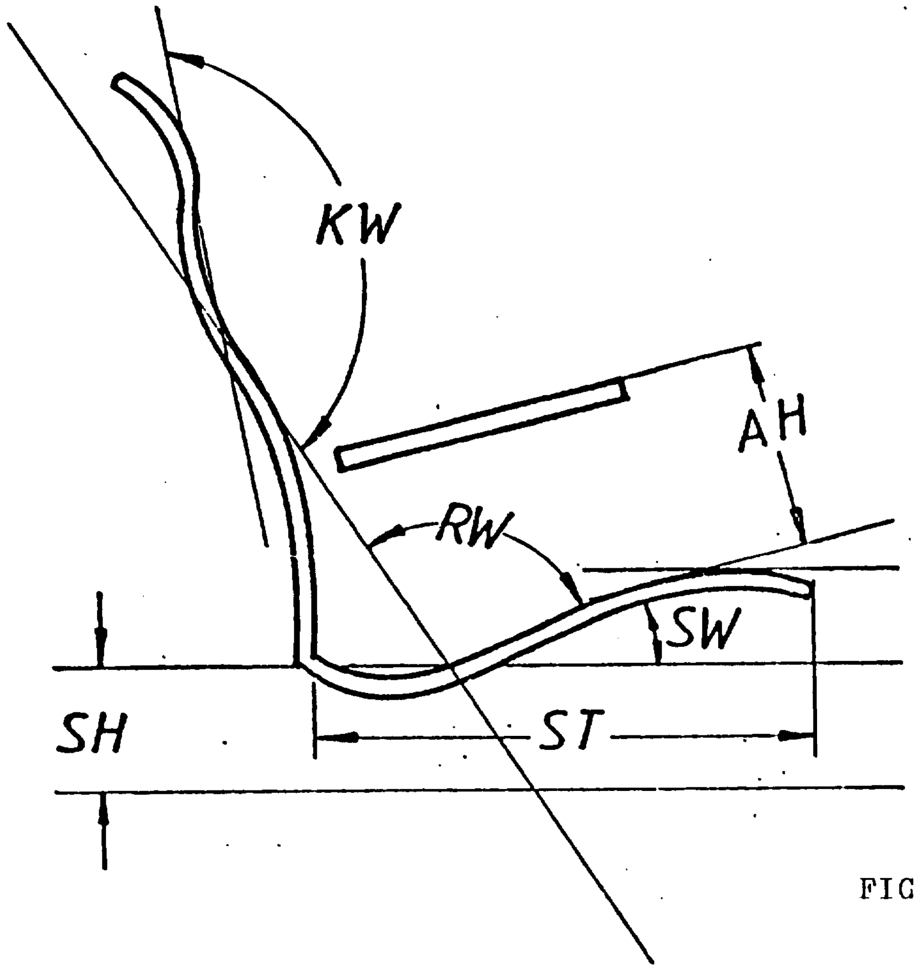


FIGURE 16

DESIRABLE SUPPORT AREAS IN EASY CHAIR DESIGN



DESIGN ELEMENT	DESIRABLE SUPPORT AREA
SEAT ANGLE	SW 16-30°
RAKE OF BACK	RW 102-115°
SEAT HEIGHT	SH 34-50cm
DEPTH OF SITTING AREA	ST 41-55cm
INSIDE BACK SUPPORT AREA	KW 6-18cm
ARMREST HEIGHT	AH 22-30cm

FIGURE 17

APPROXIMATE COMPRESSIVE LOAD ON A SEAT

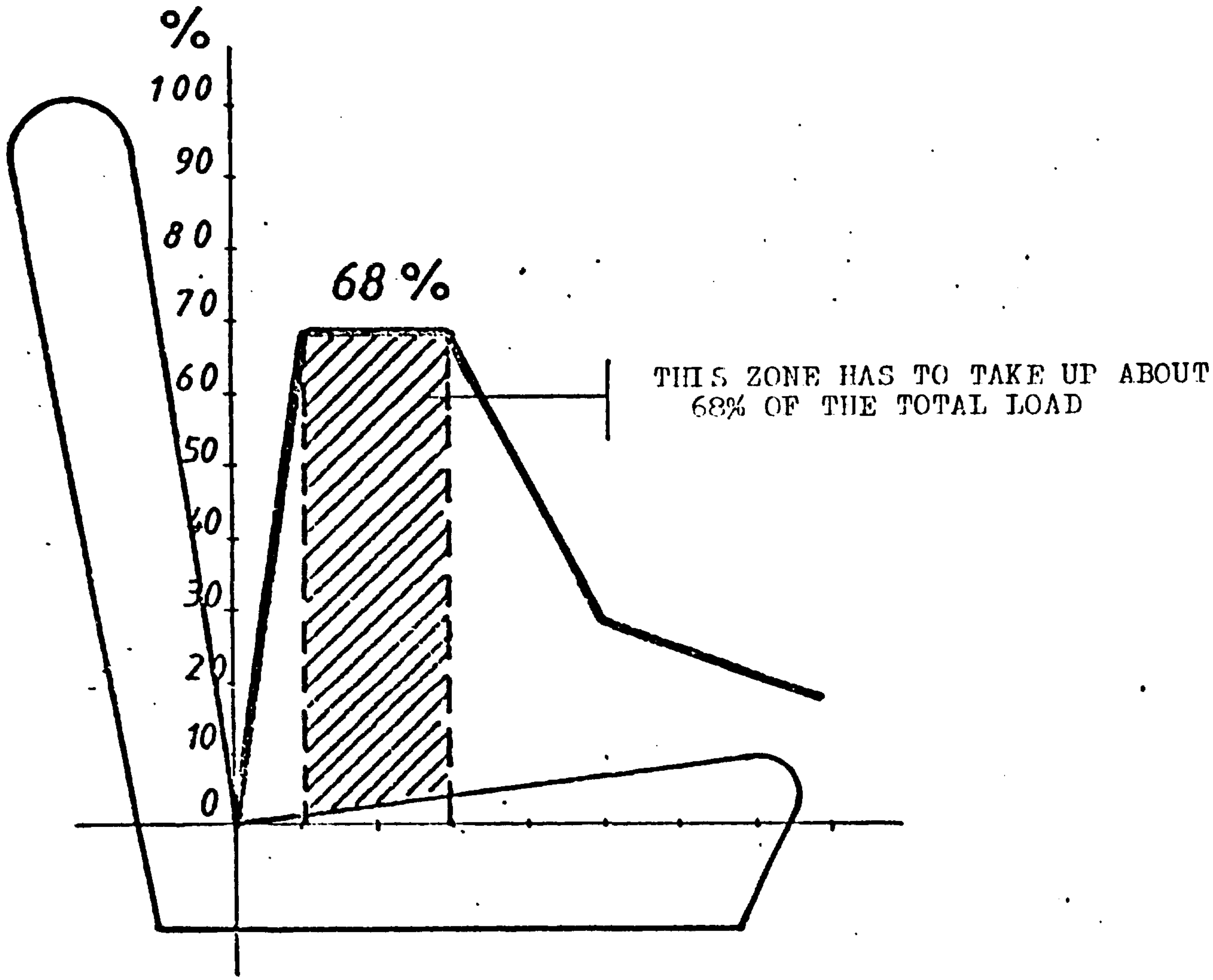


FIGURE 18

PREFERRED DISTRIBUTION OF STATIC SURFACE PRESSURE OVER SQUAB
(Daimler Benz, Statistics, 18 March 1980)

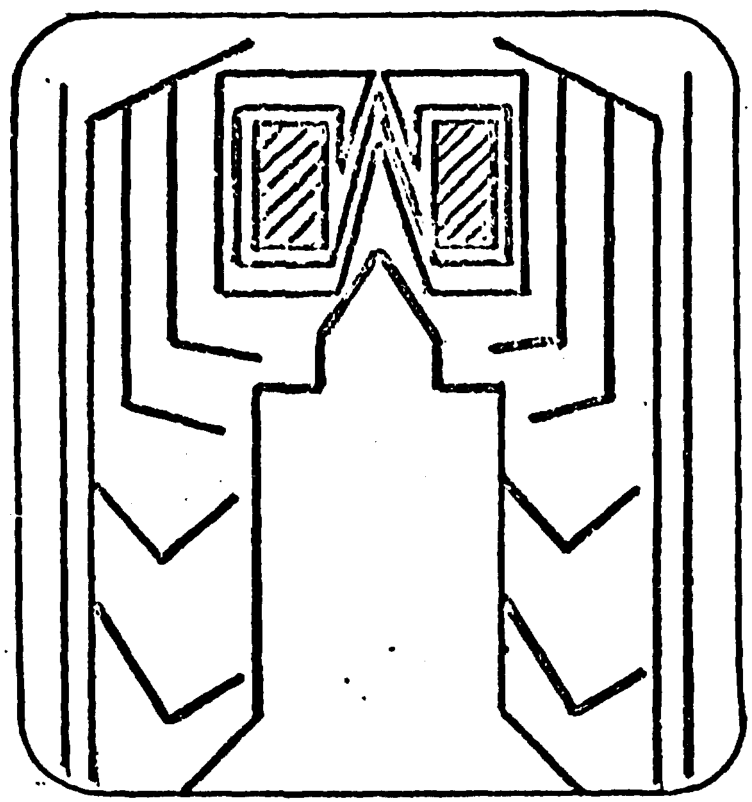


FIGURE 19

LIMITS OF DISCOMFORT FOR SEATED SUBJECTS
EXPERIENCING VERTICAL VIBRATIONS

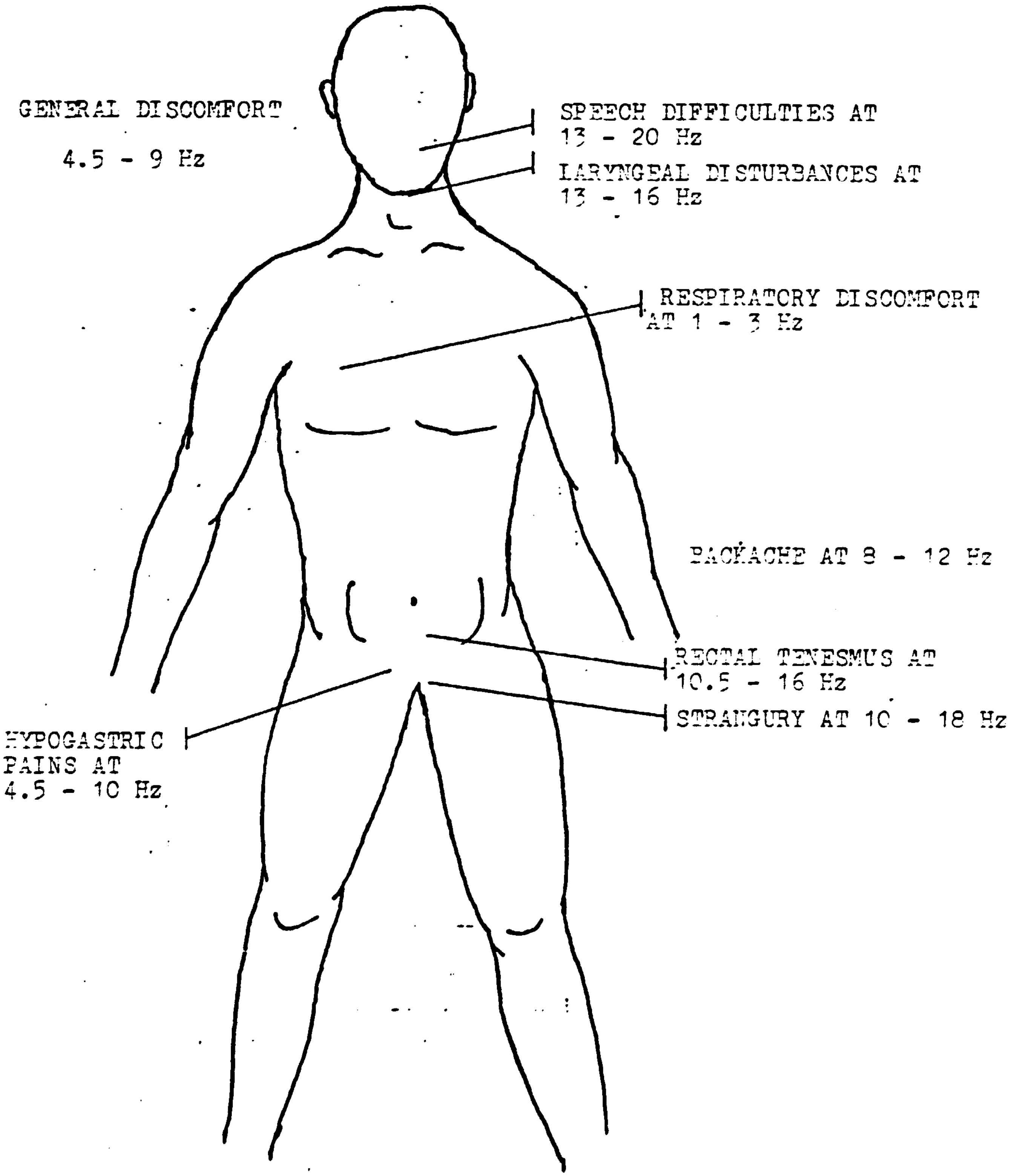


FIGURE 20

VIBRATORY BEHAVIOUR OF INTERNALLY SPRUNG AND ALL-FOAM SEATS - SEATING AREA FOR SUBJECT WEIGHING 75 kg

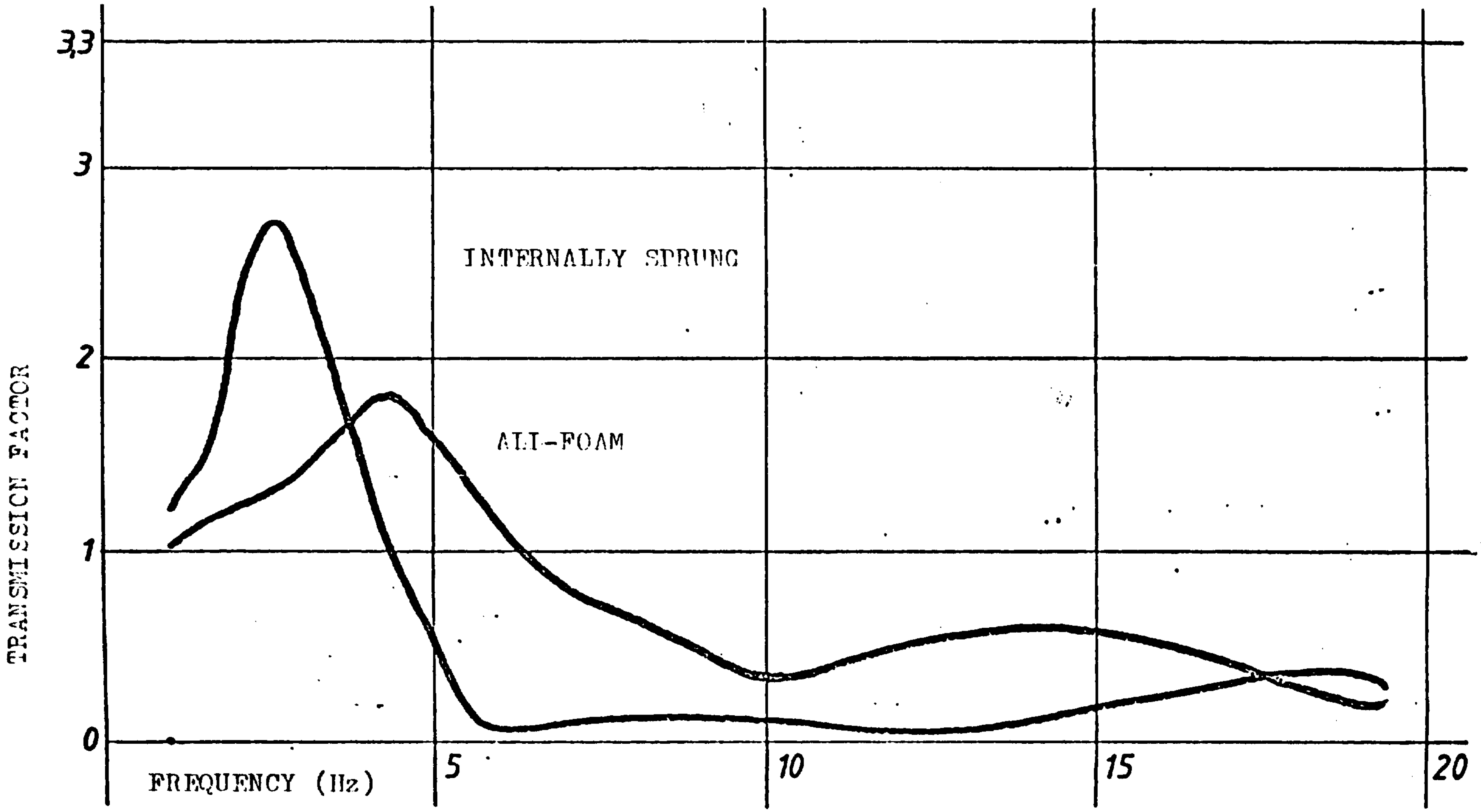


FIGURE 21

CUSHION OF FOAM MATERIAL
WITH STRUCTURED SURFACE

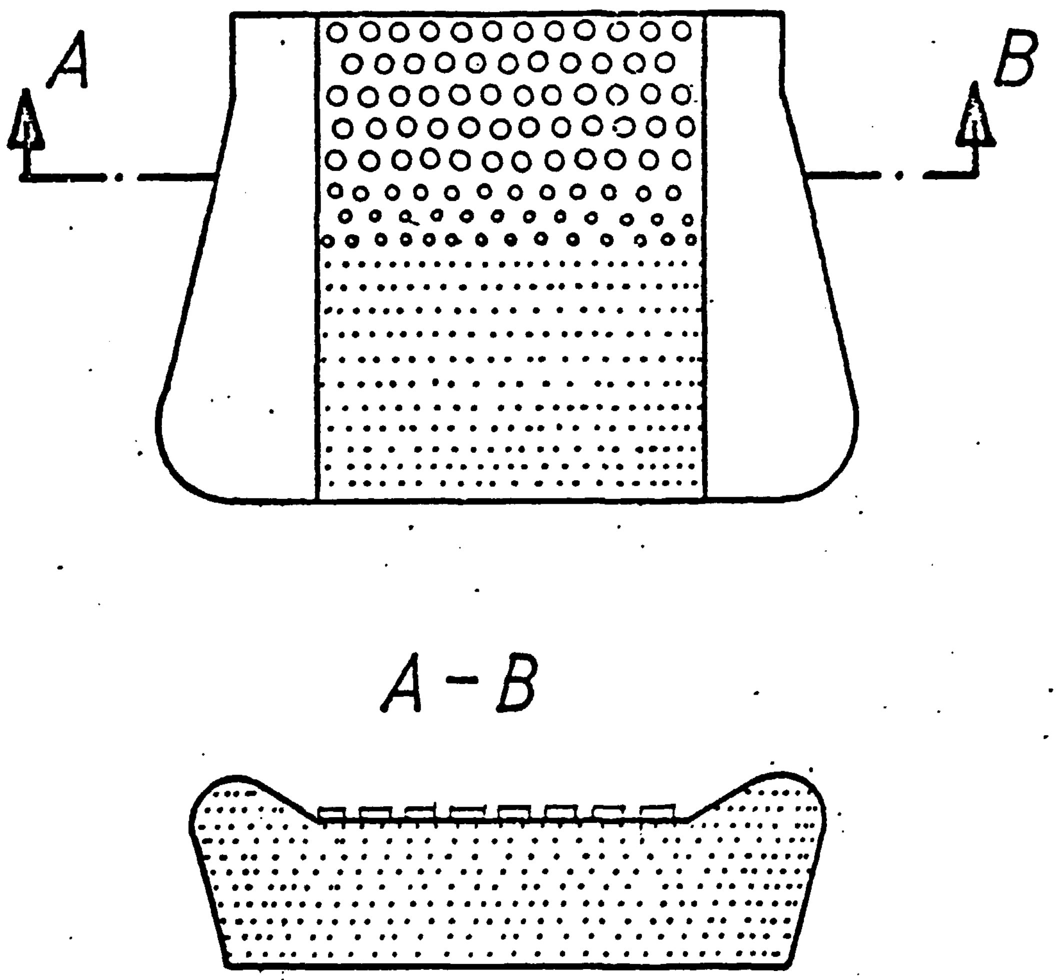
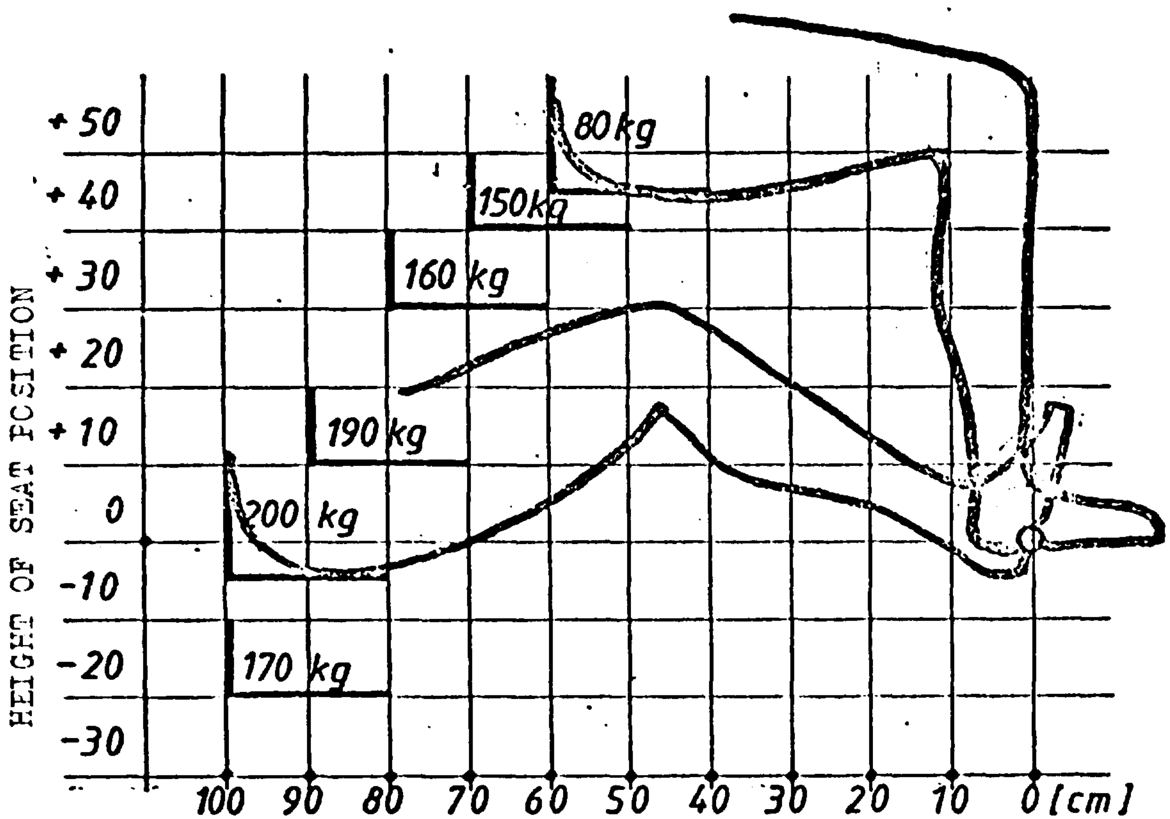


FIGURE 22

LEG STRENGTH RELATED TO SEAT POSITION

DRIVING POSITION



DISTANCE

= SEAT BACK TO TREAD

FIGURE 23

HEAT AND MOISTURE RESISTIVITY OF UPHOLSTERY MATERIAL

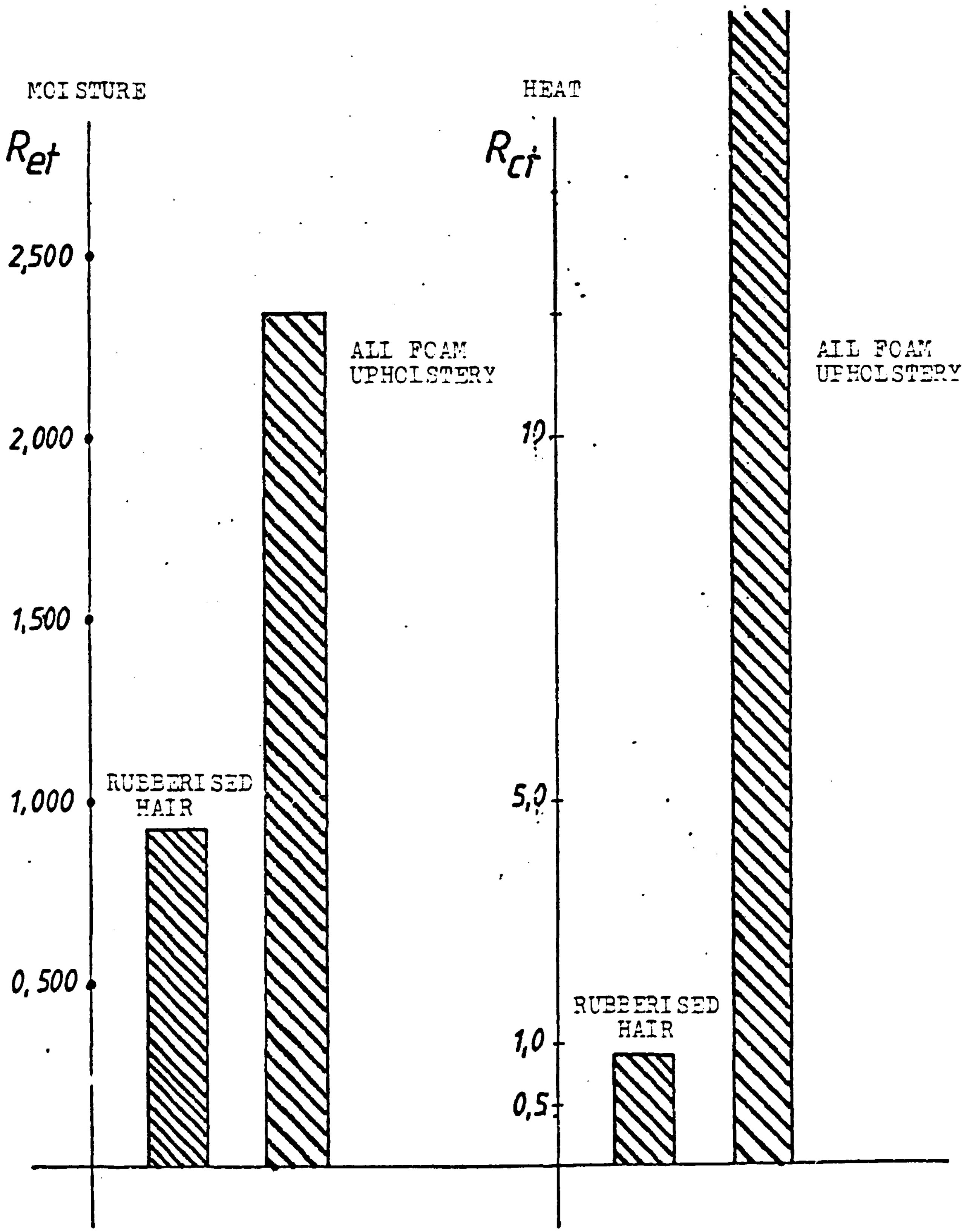


FIGURE 24

MATERIALS COMPARISON TU BERLIN

MATERIAL	RUBBERISED HAIR	"H"-FOAM	"K"-FOAM	
MOISTURE TRANSMITTANCE (g OF WATER)	32.0	8.7	10.4	HIGH
BLOCK COOLING (°C)	17.7	11.0	9.3	HIGH
RESIDUAL MOISTURE (g OF WATER)	4.3	5.6	6.3	LOW

FIGURE 25