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Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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Bogotà, Colombia, 20 November - 1 December 1972

CONTINUOUS MOULDING OF POLYSTYRENE BOARD [1/]

by

Jan Zembron
Gullfiber AB
Billesholm, Sweden

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SUMMARY

CONTINUOUS MOULDING OF POLYSTYRENE BOARD 1/

by

Jan Zembron
Gullfiber AB
Billesholm, Sweden

The Gullfiber process for the continuous manufacture of polystyrene board, which is the subject of a number of patent specifications, embodies the following essential features:

Partially pre-expanded beads are fed into an open-ended rectangular tunnel, the walls of which are formed by four suitably positioned endless stainless steel belt conveyors, two of which are perforated.

The tunnel is divided into a feed section, a heating section and a cooling section.

In the heating section, which is supplied with saturated steam injected through the perforations, expansion of the beads is completed in such a manner

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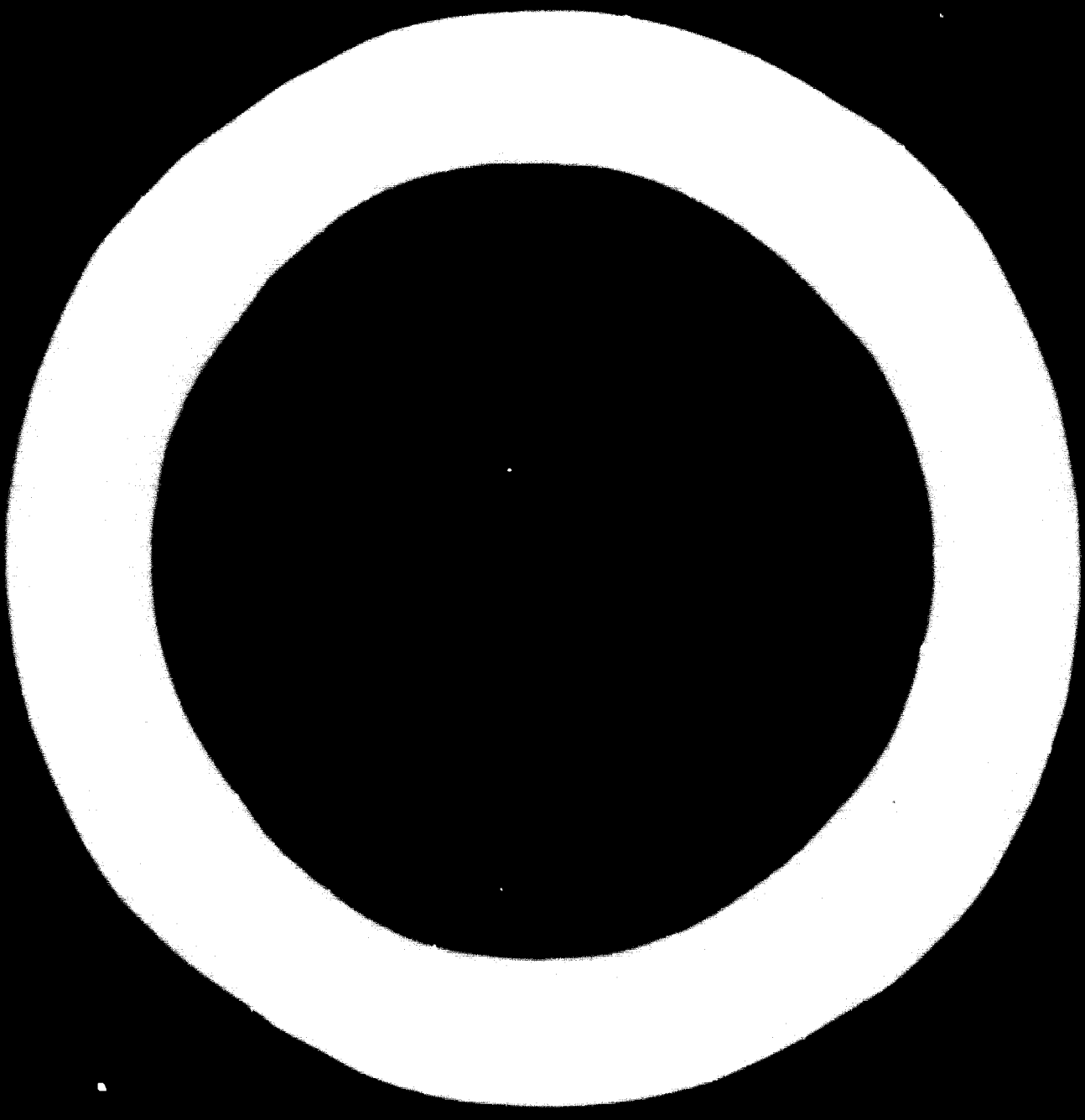
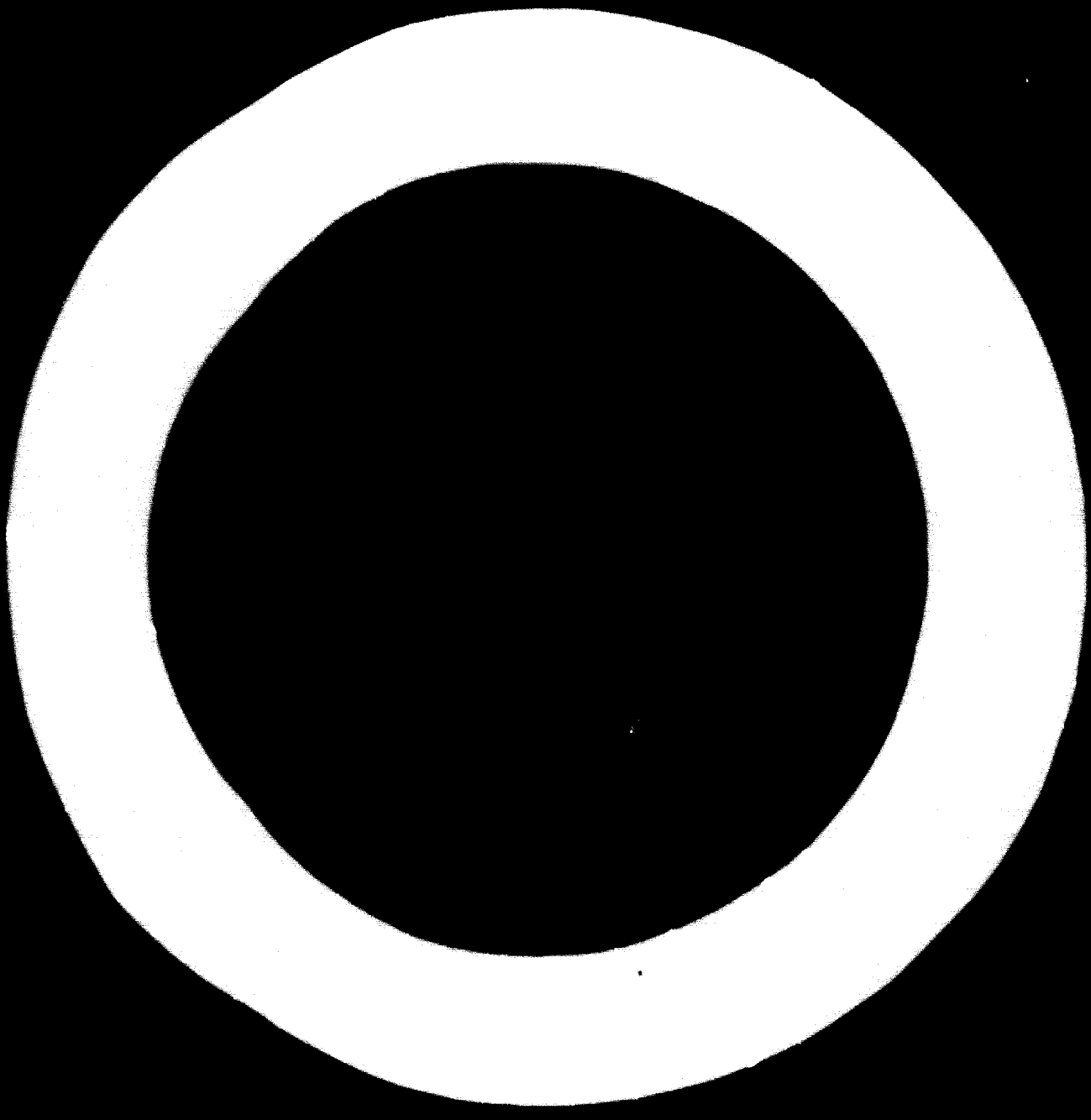




as to cause consolidation by pressure exerted by the moving walls and agglomeration.

This pressure is maintained throughout the first part of the cooling section, while at the same time vacuum is applied by means of chests above and below the perforated bands in order to evaporate residual moisture and effect a rapid cooling. A counter-current air stream, from chests on either side of the tunnel effects final cooling and conditioning.

Thickness adjustments are made by means of lateral spacer bars and board of a range of thicknesses from 20 to 120mm may be produced.

Facilities for side trimming, splitting and cutting off are included as ancilliaries trimming scrap being re-cycled after suitable comminution.

Details of the process, plant items, labour operating and services costs are discussed and capacities at various board thicknesses disclosed.

C O N T E N T S

1.0 INTRODUCTION - PROCESS DESCRIPTION

1.1 Due to the increasing demand for Expanded Polystyrene, particularly in the building industry and for cold storage insulation, great advances have been made in the methods of producing Expanded Polystyrene Board. The greatest advance in this field was the introduction of the WMB Continuous Board Machine which utilises the only proven continuous process and plant for the Manufacture of Expanded Polystyrene Board.

The continuous moulding process as well as the machine are patented in many countries and have aroused international attention. Exported machines are now running in several countries, i.e. USA, Japan, Roumania, Scandinavia, Belgium, West-Germany and the Sovjetunion.

Permanent improvements have made the machine the most up-to-date model in current operation, clearly illustrating a continuous production method which gives outstanding savings in raw material, manpower, space and utility requirements, as well as the almost complete elimination of waste.

The machine is not only characterized by its high rate of production but also by the resultant product which has a uniform quality throughout. Moreover the product is ready for delivery when leaving the machine. This moulding machine requires only two operators.

1.2 The continuous board machine we offer is designed to carry out the following sequence of operations:

1. moulding
2. side trimming
3. splitting
4. cut-off

The machine operates as follows:

1.2.1 Moulding

1.2.1.1 Feeding section

The production by the WMB-method is starting with the pre-expansion of the expandable polystyrene beads and with storage of the material for maturing in a traditional way. From the storage hoppers the material is transferred to the feeding section, usually by means of air. A cyclon separates the air from the material. Equipment built in secures a correct mixture of the cutting waste that is recycled from the trimming section of the machine and pre-expanded material.

A feeding roll mounted on the adjustable top part of the machine predetermined the outcoming material to the desired board thickness. The material bed is transferred through the machine between perforated stainless stell bands.

1.2.1.2 Steam section

In the steam section, saturated steam is injected through the perforated bands. The condensate from the steam is forced by the expansion pressure towards the feed end of the machine and is drained through the band perforations. The steam section has also some smaller compartments which serve as seals, preventing steam leakage and ensuring the best possible economy in this part of production. In the steam section the material has a temperature of 100 to 110°C.

1.2.1.3 Vacuum section

Leaving the steam section, the material - now expanded and fused - enters the vacuum section. Vacuum chests above and below the steel bands subject the material to vacuum which evaporates moisture at the same time as the temperature drops.

This cooling process is one of the reasons for the high production rate of the machine.

Moreover, vacuum cooling also stabilises the material prior to the further processing.

1.2.1.4 Cooling section

The cooling section results in a further temperature reduction by a stream of air, directed in opposition to band movement, from chests on both sides of the bands. The air is supplied by separate fans. Due to this effective cooling, the material is dimensionally stable right from the time it leaves the machine.

1.2.1.5 Changing of thicknesses

Settings for different product thicknesses are made by means of a lateral spacer bar system. Easily replaceable aluminium bars of various thicknesses - from 20 to 120 mm - in little more than quarter of an hour.

1.2.2 Trimming

In the section the board is trimmed to exact length and width, after which it is ready for packing and delivery - with no need for further stabilisation. Waste arising during trimming is automatically recycled to the feeding section.

The finishing section can be extended by adding further machinery for processes such as laminating, scoring, marking, tongue and grooving or other post-finishing operations.

1.4 Special Plant Features

In addition to being able to produce continuously the variety of sizes required, the machine has the following outstanding features.

1. It drastically reduces the wastage.

2. The machine requires only one operator and one material receiver.

3. The board produced on the continuous board machine does not need maturing and this means a significant floor space saving is achieved.

4. The steam consumption is considerably reduced because the stainless steel bands have a small heat capacity compared with the heavy moulds used in batch production. Further, the continuous board machine eliminates the sudden peak loads met within heating and cooling the batch moulds.

5. The board is more uniform in its physical characteristics than that obtained by other methods.

2.0 CAPACITY

The continuous board machine has a maximum capacity of 70 m3/h when producing 120 mm thick board of 1.3 m width and in density of 16 kg/m3, based on a raw material as outlined in section 5.

The actual capacity of the machine will vary with the board thickness and this is illustrated as follows:

Thickness	m3/h
120 mm	70
110 mm	65
100 mm	60
90 mm	55
80 mm	52
70 mm	50
60 mm	48
50 mm	45
40 mm	38
30 mm	30
20 mm	23

MACHINE FOR CONTINUOUS MANUFACTURING OF POLYSTYRENE

Model:	13-60 Variable
Max. band speed:	20 m/min
Width of product:	1000 mm - 1300 mm

Production capacity and technical description

Product dimensions:	Length unlimited Width: 1000 mm - 1300 mm Thickness: min 20 mm - max. 120 mm
Densities:	13 kg/m3 - 50 kg/m3
Capacity:	Theoretical capacity in relation to the band speed and thickness according to the diagrame enclosed.

Technical description

Generally

Machine dimensions:	Length: c. 21.7 m Width: c. 3.1 m Height: c. 2.5 m Height including feeder : c. 6.8 m
Machine weight:	Total c. 37 tons
Static qualities:	Deformation for vital units less than 0.2 mm

Steam, vacuum and cooling chest

Material:	Steam and vacuum chest: stainless steel Cooling chest: steel
Sliding lists:	The sliding lists can be adjusted gradually when they have been worn out. Furthermore they are reversible which means that they not until after a long time of service have to be replaced.

Mounting of supporting rolls in the chest:	A simple fastening construction is the reason to that short time it takes to mount and dismount the supporting rolls when the chest has been pulled out.
Pulling out of chests:	All the chests are provided with transport wheels, running on a rail, which facilitate the mounting and dismounting.
Cooling system	Four cooling fans (two pressure and two suction fans) with sufficient capacity cover the cooling need.
Supporting rolls	
Material:	Steam and vacuum section: stainless stell Cooling section: steel.
Bearing:	Steam and vacuum section: stainless bearings Cooling section: standard bearings
Steel bands	
Material:	Sandvik 12R11, stainless quality
Dimensions:	Width: 1400 mm Thickness: 1 mm
Perforating:	The small diameter of the holes and their frequency permit a large permeability area and contribute to an efficient steam treatment.
Band tension:	The machine is equipped with automatic, hydraulically guided band tension. The device keeps the band in a constant tension that has been adjusted in advance. Too high a band tension by cooling down at for instance machine stop is to be avoided and the risk for damages on the band can be eliminated in this case.
Band guiding device:	The machine is equipped with an automatic hydraulically guided band device. When the band has been adjusted the device controls and restores automatically the band movement.

Driving:

The driving is hydraulic and consists of 2 synchronized high-torque hydraulic motors, speed controlled from the manoeuvre panel via the hydraulic aggregate.

Operation of the top part of the machine

Raising and lowering of the top part (for instance adjustment of the product thickness desired) is carried out with a system of lift jacks. The system is remote-controlled and is manoeuvred from the panel. The lift jacks are dimensioned to carry the tensile load and serve then as tensile bars. The time for maximum raising and lowering respectively is 5 minutes.

Adjustment of product width (concerns only machines with variable product width)

The side guides are transferred sideways by means of lift jack system. The system is remote controlled and manoeuvred from the panel.

Manoeuvre panel

The main equipment of the panel consists of

- starters,
- motor protection,
- fuses,
- starting device and manoeovre device for driving (for instance band speed),
- automatic band tension,
- automatic band guiding,
- vacuum pump,
- cooling fans,
- lift jack system for raising and lowering,
- lift jack system for side guides (only for machines with variable width),
- indicating regulating and recording devices for pressure,
- indicating temperature meter.

3.0 Patent claims

1. A method of forming expanded granules of a synthetic thermoplastic material into coherent bodies which includes the steps of feeding partially pre-expanded granules continuously into one end of an elongated channel open at both ends and having at least two of its walls formed by driven endless belts, moving the granules a predetermined distance into a heating zone of the channel and then injecting into said zone a heated gaseous medium to cause the granules to expand further and to become pressed against the belts and against one another and thus to agglutinate and form a coherent body, the granules themselves counteracting motion in a direction opposite to the direction of feed of said granules, and gradually cooling the coherent body during its movement in the channel between the belts the latter continuing to exercise pressure against the granules.

2. A method as claimed in Claim 1, in which the granules are causued to remain for a longer time in the cooling zone than in the heating zone of the channel.

3. A method as claimed in Claims 1 and 2, in which the granules are fed into a channel having a rectangular transverse section of substantially larger breadth than height by means of a plurality of conveyor elements located side by side.

4. Apparatus for continuously forming expanded granules of a synthetic thermoplastic material into coherent bodies comprising an elongated channel of rectangular cross section open at both ends, said channel having each of its four bounding walls formed by adjacent runs of belts movable in an endless path, at least two of said belts being perforated and driven, at least one feeding conveyor located in front of a feed opening of the channel for continuously feeding pre-expanded granules into said channel, a heating zone provided in said channel in spaced relation from said opening means to supply a hot gaseous medium through the

perforations of the belts in said zone, a cooling zone provided beyond said heating zone and formed by a prolongation of the channel bounded by the belts and means to supply a cooling medium to said cooling zone to cool down the coherent body.

5. Apparatus according to Claim 4 in which the cooling zone has a substantially greater length than the heating zone.

TECHNICAL DATA

The process can be divided into sections, namely:

1. Pre-expansion of Polystyrene Beads
2. Board Manufacture

3.1 Pre-expansion of Polystyrene Beads

The pre-expansion of polystyrene beads will be carried out in the pre-expanders not included in the offer.

3.2 Board Manufacture

After the beads have matured in the existing storage bunkers, they are transferred by means of Client's conveyor to the feed hopper on the continuous board machine. This material is continuously fed into the machine bands and fixed sides, the upper and lower bands convey the material, and the narrow sides form the rectangular section of the moving mould.

The upper and lower bands are perforated and throught these steam is blown to finally expand and fuse the beads. At the end of the machine the board is cooled with air before it leaves the machine. There is also provision for vacuum cooling the board.

3.2.1 The machine specified for this plant continuously produces expanded polystyrene board having a width of 1.3 m which can be split into two or three narrower widths if required. The thickness of the board may be infinitely varied from 13 mm to 120 mm. A flying cut-off saw automatically cuts the board to the required length which may be varied from about 1.0 m to 4.5 m .

The waste from the side trimming unit is automatically fed back into the feed hopper of the board machine thereby avoiding wastage from this source.

The board leaves the machine as finished product, eliminating the need for maturing, or any further sawing operations.

4.0 OPERATING REQUIREMENTS - for Board Machine only

The following tables give data on operating requirements which will permit the assessment of operating costs under local conditions.

4.1 Utilities Consumption - all figures mentioned here are based on a density of 16 kg/m3.

Required power expressed in kWh/m^3 produced polystyrene

Machine capacity:

Thickness mm	Capacity m^3/h
120	70
50	45
20	23

Power installed: 41 kW

Required power = $\frac{\text{Power installed}}{\text{capacity}}$

Thickness mm	Required power kWh/
120	1.5
50	2.3
20	4.6

Steam required, expressed in kg steam/m^3 produced polystyrene

Thickness mm	kg steam/m^3 product
120	20
50	29
20	48

Per m^3 of product (16 kg/m^3)

	120 mm	50 mm	20 mm
Compressed air, Nm^3	0.2	0.3	0.4

These figures do not include any allowances for space heating, lighting, ventilation, sanitary purposes, etc.

4.2 Operating Labour

4.2.1 Shift Workers

1 - Operator

1 - Material receiver

1 - Pre-expander operator

These figures do not include for supervision, warehousing, transport and laboratory testing personnel which are assumed to be available.

4.3 Maintenance

It is assumed that specialist maintenance services for instrumentation and electrical equipment are available from the factory's centralized pool of fitters, and it is estimated that one day per week would be sufficient for the maintenance of this equipment.

4.4 Warehousing

It is assumed that facilities are available in the factory's existing warehouse should bulk storage of the finished product or of the expandable beads be required. The labour requirements for material handling in this area have not been included in the above figures.

5.0 SPECIFICATION OF RAW MATERIAL

The capacity figures we give for the board machine are based on the BASF's material currently in use on the existing machine. We should be prepared to arrange for tests to be carried out on your beads to assess their suitability for the process and the final capacity of the machine.

5.1 Typical properties of raw material

Property	Standard grade	Self-extinguishing grade
Sieve analysis 2.0 - 2.5 mm ø	max. 12.0 %	max. 10.0 %
0.8 - 2.0 mm ø	min. 79.0 %	min. 78.0 %
0.3 - 0.8 mm ø	max. 9.0 %	max. 12.0 %
0.3 - 0.4 mm ø	max. 0.5 %	max. 2.0 %
Humidity content	max. 0.7 %	max. 1.2 %
Minimum bulk density of the prefoamed particles	14 g/lit.	15 g/lit.

6.0 DESIGN STANDARDS

The board machine is designed, fabricated and tested in accordance with the standards currently used in Sweden. All ball bearings are made to ISA-standard.

The AC-motors are intended for 380/220 V, 3-phase, 50 Hz supply.

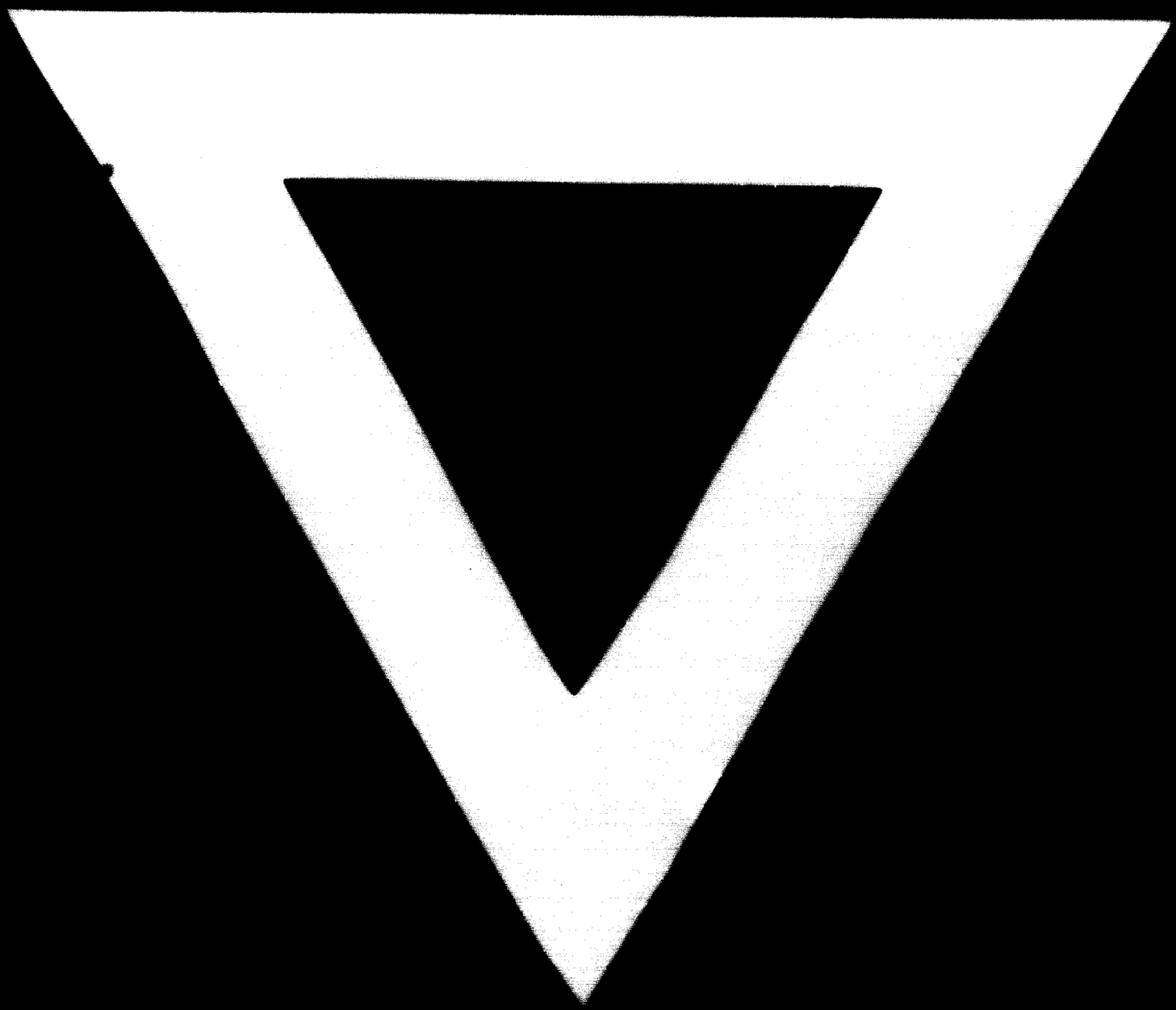
7.0 PLANT LAYOUT AND SPACE REQUIREMENTS

The area required for the board machine is indicated on the drawings attached.

As will be seen the great advantage of producing finished product from the board machine is that no intermediate storage is required for maturing the blocks, effecting a considerable space saving, and that the storage and despatch areas can be kept to a minimum of about 8-10 hours storage of board.

8.0 SPECIFICATION OF FINISHED PRODUCT

The physical properties of the expanded polystyrene board produced on the machine completely satisfies the requirements laid down in the German Standard Specification DIN 18164 and 4102 for self-extinguishing. The precise results will depend on the raw material being used.



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