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PRODUCTION OF GLASS FOR CONTAINERS AND FOR THE BUILDING INDUSTRY.

Background Paper.

PRODUCTION OF GLASS FOR CONTAINERS AND FOR THE BUILDING INDUSTRY

by

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1. Glass Containers for Food Processing Industry

1.1 Introductory notes

The continued growth in the standard of living has resulted in the development of agricultural production and prosessing. This concerns mainly milk and fruit processing, wine, beer, alcohol and mineral waters.

Since a long time glass is considered to be the adequate material for the production of food containers, and in spite of plastics competiting with it, it is still most willingly used in all kinds of applicstions. The fact that glass withstands competition with other materials is mainly due to its low production costs. They, in turn, depend on the kind of raw materials it is produced from, which are easily and in large amounts available in almost every country.

The main properties, which make glass an appropriate material for container manufacture, are the following:

- neutrality while in contact with almost all kinds of contents
- great possibility of achieving various shapes
- dimensional stability
- impermeability of gases
- transparency
- possibility of using various kinds of caps easy in application

- possibility of using one container several times
- reusing of glass from a previous melt /cullet/ which is an important factor in environment protection

Containers used for food products belong to so called narrow mouth assortments, to which all bottles from 200 cm^3 up to 2000 cm^3 can be classified, and to wide mouth assortments, that is jars.

Bottles are manufactured mainly in three colours: amber, used for substances sensitive to ultraviolet rays, green and colourless.

Glass used for containers should possess adequate chemical resistance which according to Polish standards corresponds to the fourth hydrolytic class. It should also be resistant to rapid changes of temperature from 20°C to 100°C.

As automatic lines for container stoppering are used on a large scale, it is essential to remain within dimensional tollerances which are specified for individual assortments.

In highly developed countries the weight of glass containers calculated per one inhabitant amounts to 33 - 60 kg. The differences arise also from the fact that certain bottles are used only once - they are so called non-returnable containers.

1.2 A suggestion concerning erection of a new plant

In order to enable choice of the correct size and technical level of a newly built plant, two variants, A and B, will be

considered. The optimum size of a plant would depend on the volume of investment outlays. Variant A gives a suggestion of a plant having a lower technical level. It would not require greater qualifications so there would be no need for special training of personnel. At the same time a large number of workers could be employed.

Variant A

A glassworks of a yearly production capacity of 14 million pieces, that is 5000 tons of containers, employing about 300 people. This glassworks would possess two furnaces: one for coloured containers, the other producing colourless glass. Each furnace would be equipped with 5 semi-automatic machines for container forming. Portioning of molten glass would be done manually. Furnaces of this type would require a yearly consumption of about 6 million Nm^3 of natural gas having a calorific value of 8000 Kcal/Nm^3, and about 2800 MWh/year of electric energy.

Inspection and sorting of ware would be also done manually. Then the finished products would be set on pallets and together with them covered with thermoshrinking sheeting. Units, formed in this way, are stored in a warehouse or in the open air from where they are transported to their place of destination by rail or by truck.

Variant B

Glassworks of an average technical level and automatic way of production in distinction to the previous one, where a

semi-automatic system has been proposed.

The production capacity of this plant would be about 40 million containers per year, that is about 14.000 tons/year. The number of people employed - 300. One furnace for coloured and one for colourless glass. Each furnace equipped with two Hartford type 4-section automatic forming machines, which can be adapted to produce in turn either jars or bottles. This versatility of production of jars and bottles is very important in the production of containers for food processing industry, as the demand for them depends on the crops in a given year.

Furnaces may be fi- d by oil or natural gas. For example the consumption of natural gas of a calorific value of 8000 Kcal/ /Nm^3 would be about 15 million Nm^3/year, and the approximate consumption of electric energy 14.000 MWh per year. Other technical solutions as in variant A.

In order to locate correctly individual production departments, an area of about 6,5 ha would be required.

The three principal ingredients employed in the container production are the following:

- quartz sand
- limestone flour
- soda ash.

A yearly consumption for plant A, is:

sand - 3.700 tons

limestone flour	-	820 tons
soda ash	-	1.200 tons

and for plant B, is:

sand	-	10.600 tons
limestone flour	-	2.800 tons
soda ash	-	3.4oo tons

Depending on the assignment of glass containers, inscriptions are made by means of screen printing.

Technical solutions, proposed in this paper, base on generally available machines and technological equipment, known in all countries producing glass containers. Poland, Czechoslovakia, Sweden, Italy, France, the Federal Republic of Germany and the United States of America are the suppliers of this machinery and equipment.

2. Manufacture of glass containers for pharmaceutical industry.

Development in the production of medicaments requires delivery of different packages in sufficient amount and of appropriate quality. Among glass containers, used for this purpose, bottles and jars are the most common, and their chemical resistance varies according to application. Within a large group of assortments the following are considered to be the most essential:

a/ bottles for blood and plasma

b/ glass containers for antibiotics

c/ other containers for pharmaceutical products

d/ neutral glass containers for medicaments like insulin, heparin, etc.

2.1 Bottles for blood and plasma

Containers of this type are obtained from laboratory molten glass, and are usually in three assortments: 100, 250 and 500 cm^3. A high chemical resistance is required, corresponding to the first hydrolytic class, as well as thermal resistance to the rapid changes of temperature from 100°C to 20°C.

2.2 Glass containers for antibiotics

Produced in four assortments: 8, 20, 30 and 50 cm^3, from molten glass characterised by chemical resistance corresponding to the third hydrolytic class, and thermal resistance to the rapid changes of temperature from 80°C to 20°C.

2.3 Glass containers for other pharmaceutical products

This group of containers comprises mainly bottles and jars for keeping drugs which do not require high chemical or thermal resistance of glass. The capacities most commonly used are from 25 cm^3 up to 500 cm^3. Glass colourless, or amber in case of necessity of absorbing infrared or ultraviolet rays.

2.4 Neutral glass containers

Because of high requirements as to chemical resistance, these containers are manufactured from borosilicate glass

corresponding to the first hydrolytic class. Capacities are 3, 5, 7 and 10 cm^3. The containers are produced by way of processing from glass tubes. Their resistance to the rapid changes of temperature should be such, so as not to show any traces of scratches or cracks when being exposed to temperatures of 100°C and 15°C.

2.5 Suggestion concerning building of a plant

In order to provide pharmaceutical industry with diversity of glass containers, a number of technological lines should be built. These lines would produce necessary assortments, described above.

While designing a plant, availability of labour in various parts of the country should be taken into consideration.

The technical design of a plant should meet the requirements of pharmaceutical industry, but still the lines should not be fully automatic, as otherwise they would require highly skilled personnel, complicated maintenance service, etc.

The new plant suggestion takes into account glass containers for penicillin, blood and plasma, as well as jars for other medicaments.

The best solution would be a plant consisting of three technological lines, that is housing three furnaces for melting: pharmaceutical colourless glass, pharmaceutical amber glass, borosilicate glass for blood and plasma.

2.6 A suggestion of a line producing pharmaceutical colourless glass containers.

Forming of ware is carried out on Hartford type six-section automatic machines, well known in the world. There are to be three of these machines installed at the furnace.
The furnace can be fired by natural gas, fuel oil or city gas. This type of line is capable of producing approximately 250 millions of containers per year. A similar arrangement of the furnace and forming machines can be used for the second production line, forming containers from amber glass. Altogether, the two furnaces, one for amber glass and the other for colourless glass, have a production capacity of 500 million pieces of containers per year, including bottles for penicillin.
The number of employees in such a plant is forseen to be about 600. The consumption of basic raw materials would be approximately 30.000 tons/year. Production quality inspection is to be carried out on so called cold end of technological line by means of gauges, or on automatic inspection lines. It is anticipated that part of the production, depending on the orders, would be decorated with screen printed inscriptions, and the rest, undecorated, packed on cardboard interlayers. Products, arranged in this way on interlayers and then placed on the pallets, would form unit loads, which would be next covered with foil and transported by trucks to the stores. These unit loads on pallets are transported to the purchaser by lorries or by railway baggage vans if there is a siding.

2.7 A suggestion of a line producing bottles for blood and plasma

As the requirements concerning this kind of containers are higher, special composition of borosilicate glass is used. The primary ingredients entering into the composition of batch are quartz sand, soda ash, borax and limestone. Raw material requirements as for typical colourless glass. One furnace of a melting capacity of 40 tons/24 hours is proposed, together with two Hartford type automatic forming machines. Such a line will produce about 30 millions of glass containers per year. Further technological process as per short description of glass containers for pharmacy.

3. Glass containers for chemical industry

The development of chemical agents necessitates building of package manufacturing plants. Among them, glass container plants are considered to be of great importance owing to the fact, that glass containers withstand competition with other packages due to their low production costs, especially when the plant is fully supplied with basic raw materials such as sand, soda ash, limestone. Knowledge of raw material market allows to make a correct choice while planning development of container production. As glass making raw materials are found in almost every country and delivery of machines and production technology presents no difficulty, hence glass is practically the easiest available material.

Chemical industry requires containers for detergents, petroleum, adhesives, cleansers, chemicals, etc. The containers

manufactured for these purposes range in capacity from 150 cm^3 to 1000 cm^3 and present no special requirements as to the type and composition of glass.

3.1 A suggestion on building a glass container plant

Assuming that raw materials such as quartz sand, soda ash and limestone of a quality and quantity as for traditional kinds of glasses are available, building of two production lines is proposed, with two glass furnaces, each of them equipped with 3 Hartford type six-section automatic forming machines.

Each furnace would supply approx. 100 tons of glass/24 h and would be fired by natural gas or fuel oil. In special cases town gas could be used.

Yearly production of such a plant amounts to approx. 230 millions of containers while the number of people employed is 300.

The products, having passed through inspection lines, are set on pallets by means of pallet loading machines and next they are covered with foil. Such unit loads are transported to the stores and from there by delivery truck or railway vans to the purchaser. The number of trucks depends on the volume of delivery and distance.

According to the needs as regards individual assortments, the number of production lines may be increased by installing additional automatic forming machines at the existing

furnaces. The possibility of acquiring additional melting capacity can be obtained with the help of boosting or assortment manoeuvre. In order to be able to make a correct choice of adequate technological variant, a detailed elaboration is required, basing on the conditions of a given country as regards raw materials, plant location, leading purchasers of containers, etc.

4. Delivery of technology, machines and equipment.

Solutions concerning the produotion of glass containers, proposed in this paper, are being widely used in all oountries producing glass. That is why, basing on agreements with other oountries and companies, there is a possibility of obtaining from them machines and equipment together with technology. Acquiring the possibility of training personnel in the production plants of the suppliers of technologies is of great advantage to the new investment, as it enables to reach full produotion capacity within a short period of time, and at the same time to reduce production costs. As there is an unceasing demand for glass containers on the world market, the oommercial negociations often allow for the possibility of partial repayment of technology and equipment with ready products, coming from the new installation.

5. Possibility of co-operation.

In the production of glass containers, the development of international specialization and cooperation is considered possible, both in the field of machines and finished glass

containers. Very often it may find expression in the arrangements to pay for technology and equipment with ready products, or it may concern product exchange. Economic effectiveness of glass container production is closely related to the development of appropriate assortment specialization, that is for instance designing one plant to produce wide mouth containers /jars/ only, and the other to produce bottles. The cooperation between factories may not only concern production technology but also joint production of spare parts for automatic forming machines, production of moulds, working out of new patterns, etc.

6. Training of personnel

Securing of appropriate instruction for the production people is one of the most important factors on the way to achieve best productionresults. Having this in mind, training centres are founded with the aim to train both workers, directly engaged in the production, and supervisory personnel. Practice has proved, that the best training results are obtained when organising courses for individual specializations and groups of occupations. Courses of this kind are organized at the factories or in training and research centres, properly prepared for this task.

7. Organization of research work and training.

Research work and training is carried out by a research institute department, specialized in training. This department may provide service for the whole glass container branch in

a given country, or a region or groups of glassworks. Training of specialists for glass industry is performed by such an institute, as the people, employed in it, are the best exponents of technical knowledge acquired in this field.

The main enterprises of such research and training institute arise from the needs of a given country. The most essential of these enterprises are listed below:

- research work on determining and specification of appropriate raw material resources
- elaboration of the most economical glass compositions
- work connected with utilization of waste materials including cullet
- work aiming at improving economics of the manufacturing process
- designing of new patterns of containers, caps, labels
- design work on moulds for automatic forming machines
- problems concerning organization of labour
- economics of costs of production

Beside the indispensable research apparatus, the centre is equipped with audio-visual aids for training purposes. Theoretical course for workers lasts approximately three months, assuming that fundamental general knowledge has been acquired by them during school years.

Apart from workers, training is organized for engineering and technical staff as regards new technologies, construc-

tion and other technical improvements introduced to production plants. The final test of acquired qualifications, indispensable for a given work station, is carried out directly at that work station in the factory. Accomplishing of desired operation results, that is good production quality and process control, proves that training has attained its object.

8. Location of glass container production plants.

The correct choice of the production plant location in a given country is of great importance as volumetric containers have to be transported to their place of destination. Hence glass production plants should be built in the vicinity of fruit and vegetable processing centres. Nevertheless, one should also consider the supplies of basic raw materials and fuel. Of no less importance is the possibility of providing work for people of various qualifications, and building of little plants in small towns and villages produces advantageous and desired effects.

9. Glass for building industry.

Glass is one of the primary materials used in the building industry. Its application arises from many functions it can perform in various kinds of buildings.
The continuous tendency of building industry to reduce cost of built objects together with the simultaneous application of light constructions, places glass in a position of a mate-

rial more and more widely used and frequently replacing traditional building materials. Glass also acquires importance in the manufacture of heat-insulating and acoustic baffles, used on a very large scale, especially in areas of high noise intensity, that is for instance in the vicinity of air-ports, etc. Furthermore, it plays a significant part in architecture, as it makes possible obtaining an infinite number of different interior designs as well as designs of facing exteriors of all kinds of buildings.
A growing demand for glass results not only from the development of building industry, but also from the necessity to preserve already existing buildings.

Certain trends in the development of building industry give preference to the development of certain glass assortments. If the development of industrial building /factories/, public building /schools, hospitals, department stores/ and housing is to be considered, the following glass assortments should be mentioned:

9.1 A. Sheet glass including its different types obtained by processing:

- tempered sheet glass
- enamel coated tempered sheet glass
- heat-insulating window-panes

In order to satisfy the demand for these types of glasses, installation of new technological lines, basing on well known Fourcault or Pittsburgh methods, is suggested. These are

traditional methods, well mastered in all countries producing sheet glass. Depending on the requirements, bigger or smaller furnaces may be used, producing glass in the amounts from 2 to 12 million square metres per year. Part of sheet glass production, again depending on the requirements, may be tempered in special furnaces, thus resulting in obtaining higher mechanical strength of a glass pane. Moreover, certain amount of sheet glass may be covered with special enamels. Coloured panes, obtained in this way, are used as fillers or wall linings. They are also willingly used for balcony shielding owing to the colour effects they produce.

Well known and widely used heat-insulating sheet glass, appearing under different trade names like Thermopane, Villaplex, requires special production technology which can be obtained from many countries.

9.2 B. Ornamental glass and wire glass

Because of the way of forming of glass panes, it is often called rolled glass. It is widely used in building industry owing to the patterned surface of colourless and coloured glass plates, which are especially suitable for making of partition walls, balcony shields, shower cabins, etc. The same equipment, which is used for the production of ornamental glass, is also used for manufacturing wire glass with a wire mesh set into it. Wire glass is mainly used for glazing of factory walls and roof skylights. Its application in factories arises from the basic function it performs: wire mesh prevents falling to pieces of cracked plate, what is vital for safety

reasons.

One production line would consist of a glass melting furnace, machine for plate forming and annealing furnace. With the glass ribbon width of 2,5 metres, the volume of production would reach approximately 1,5 million square metres per year. Tempering of glass plates, raising their mechanical strength, is performed just as in the case of normal window glass. Recently, the possibility of profile forming has been introduced on the same lines that manufacture ornamental and wire glass. These profiles are used for partition walls, wall fillings in factory buildings, etc.

9.3 C. Structural glass

This particular application is due to relatively strong structure of the material itself as well as to characteristic features of glass, making it an ideal material for architectural purposes. Structural glass is frequently used for large partition walls, wall fillings in factory buildings, and staircases. The elements vary greatly in surface ornamentation and colour.

The production line, equipped with one furnace and three automatic presses, is capable of producing approximately 12 thousand tons of elements per year, assuming the size of one element to be 250x250x80 mm.

9.4 D. Glass mosaic

It is a product in the shape of little blocks, the dimensions of which are 20x20x5 mm. Mosaic blocks are manufac-

tured in various colours and are stuck on paper to facilitate transferring them to wall surfaces.

Remarkable development in the production of this assortment results from the possibility of applying glass mosaic on large external wall sections directly during their production, that is while forming concrete slabs. These slabs with mosaic on the surface are then transported to their place of assembly.

Glass mosaic is widely used on facing exteriors of all kinds of buildings for its functional aspects: colour effects it produces, low production costs, and the possibility of cleaning it without any greater effort.

Owing to the above advantages, application of glass mosaic extended beyond large-panel construction, and it is now used for inner wall lining in public buildings, underpasses, corridors, sanitary compartments, etc.

9.5 An example of glass mosaic production line.

Usually two or three forming machines are installed at a glass melting furnace. Colouring of molten glass is effeotuated in forehearths, from where glass flows to the forming machines. The yearly production capacity of such a line is approximately 1 million square metres of glass, and the number of people employed amounts to about a hundred.

9.6 Raw materials and fuel

Raw materials, used in the production of all above men-

tioned types of glasses for building industry, are as traditionally used for glass melting. The basic ones are quartz sand, soda ash, limestone, dolomite, sodium sulphate, and some of the heavy metal oxides used as colouring agents: cupric oxide, chromium oxide, nickelic oxide and cobaltic oxide.

All glass melting furnaces, mentioned herein, can be fired by natural gas, town gas, fuel oil or mazout. The construction of the furnace and burners must of course be suitable to the kind of fuel being used.

10. Final remarks and conclusions

10.1 The basic suggestions on different applications and solutions, presented in this paper, include in a general way principal assortments of glass products, assigned for industries whose development is the subject of the organized conference.

Depending on the interest in a particular solution or conception, there is a possibility of submitting a detailed elaboration /a proposal/ after examining specific conditions which would influence the development in a given field. This concerns mainly raw material and fuel resources as well as energy supply, which are to be taken into consideration when choosing location for the new investment.

10.2 The conceptions of development, discussed herein, are based on the availability of deliveries from various companies and countries, producing finished glass-ware as well as

manufacturing machines and equipment for the glass production process.

10.3 Commercial agreements may allow for the repayment of technology and equipment with products obtained from the new investment.

10.4 In order to make production more efficient, the possibility of cooperation between countries, introducing development of glass industry, is considered, especially in:

a/ joint raw material investments, which are usually capable of supplying several production plants.

b/ commercial exchange leading to the development of specialization in particular groups of products.

c/ exchange of experience as regards engineering.

d/ establishing ofacommon technological progress department.

10.5 As regards enterprises listed in paragraph 10.4, a high degree of cooperation is also planned within the limits of one country, although it is anticipated that glass con - tainers will be produced by different branches of industry such as: pharmaceutical, chemical, food processing. Cooperation between those industries may result in organizing common workshops for spare parts and machines and equipment, and also a common centre for raising of qualifications of technical staff and skilled workers.

10.6 A Central Research and Development Institute.

A proposal is made for creating a Central Institute, which

would initiate the development of glass container production as well as production of glass for the building industry. Its sphere of activity would comprise one or more countries whioh plan greater development.

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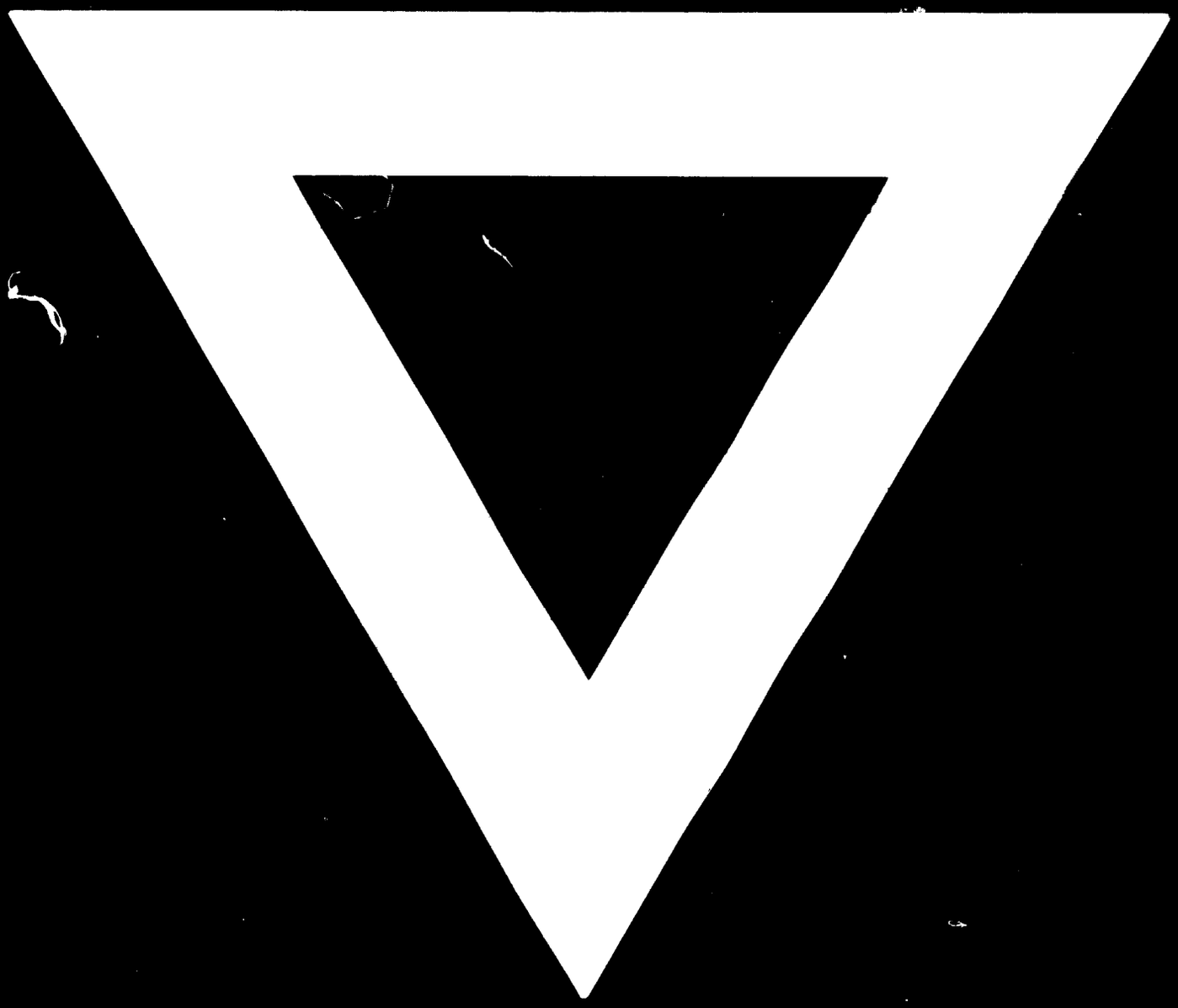

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