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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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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CONTINUOUS PROCESS FOR PRODUCING NOVOLACK PHENOLIC RESINS[1]

by

V. Dyomkin
P. Ivanov
Plastics Scientific Research Institute
USSR

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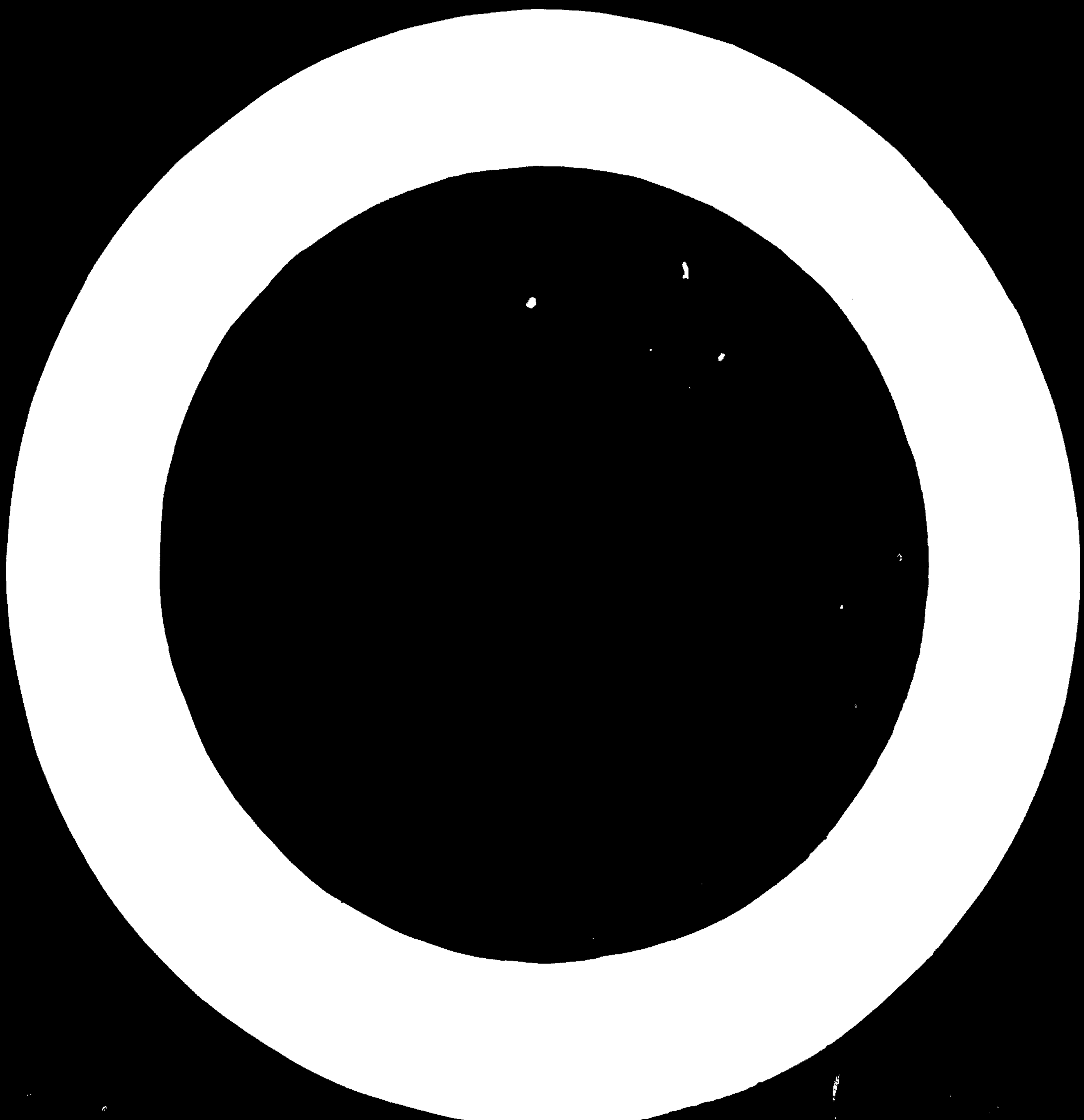


Novolack phenolic resins, being the oldest type of synthetic resins, have retained up till now their significance of being a most important polymeric material and are used in evergrowing quantities for the manufacture of moulding powders, abrasives, shell moulds and so on.

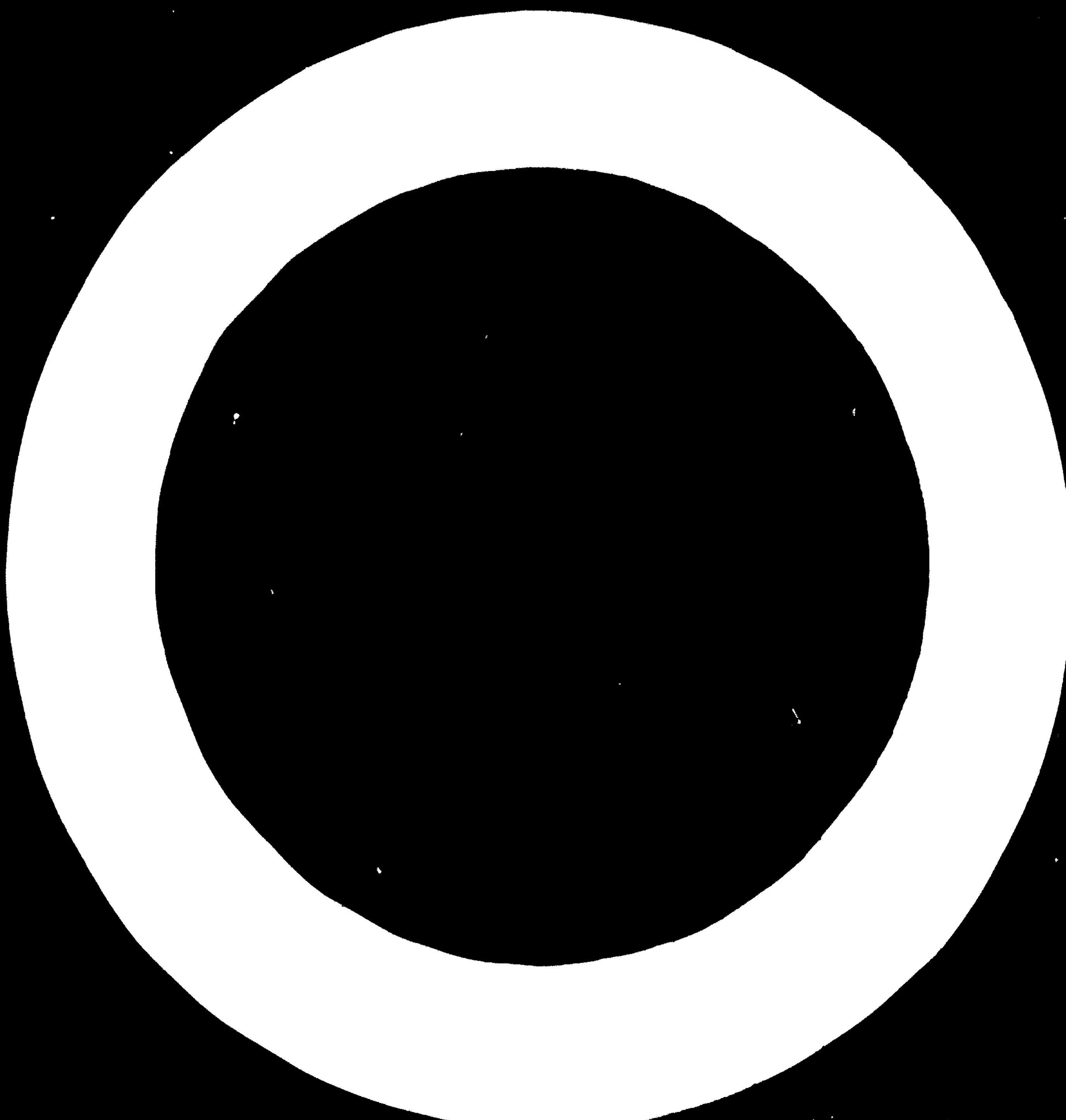
However, technology of the universally accepted batch manufacture of these resins from the very start, has had few changes, and from the point of the technical level does not meet the requirements of the up to date large tonnage production.

In the Soviet Union there has been developed and commercialized a Continuous process for the manufacture of novolack resins. Let us Various process engineering solutions of problems related to the process operations.

Polycondensation.

At present there are available two main types of continuous action reactors: apparatuses of displacement and apparatuses of mixing.

A number of patents are known which claim for displacement apparatuses (tubular reactors) for polycondensation of phenol with formaldehyde. However, these patents have not

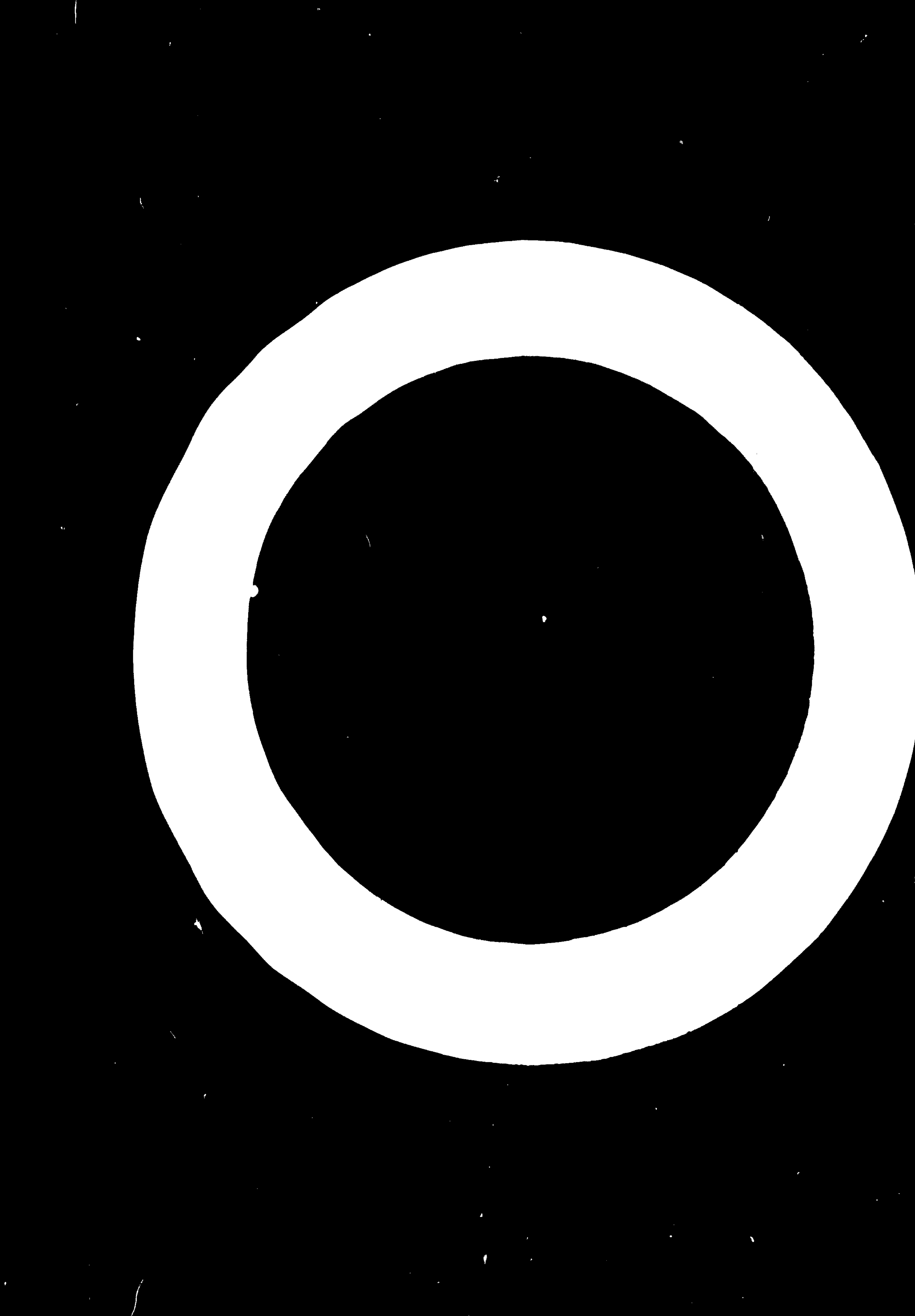


been industrialized [illegible] to the [illegible] [illegible] processes, [illegible]. [illegible] of these [illegible] which [illegible] with the [illegible] resin on the internal [illegible] resulting [illegible] impairment of exothermic [illegible] change [illegible] time of the thermal conditions of the reactor.

Therefore multi-section [illegible] chosen when developing continuous process for novolak resin manufacture. It was understood when calculating the number of sections that their increase in number alongside [illegible] reduction of the residence time of reaction components in the reaction zone and, therefore, with decrease in the reactor volume leads to the design complication.

Thus, the choice of the optimal number of sections is, essentially, an economic problem coming down to minimizing capital investments. The calculation [illegible] that the minimum weight of an apparatus is achieved with four sections. Design-wise four-section reactor has a column consisting of the four sections arranged directly one above the other. The advantage of the column compared to the conventional [illegible], connected in a consecutive order lies in the simplicity of design and compactness. It should be also noted that the column does not have moving parts.

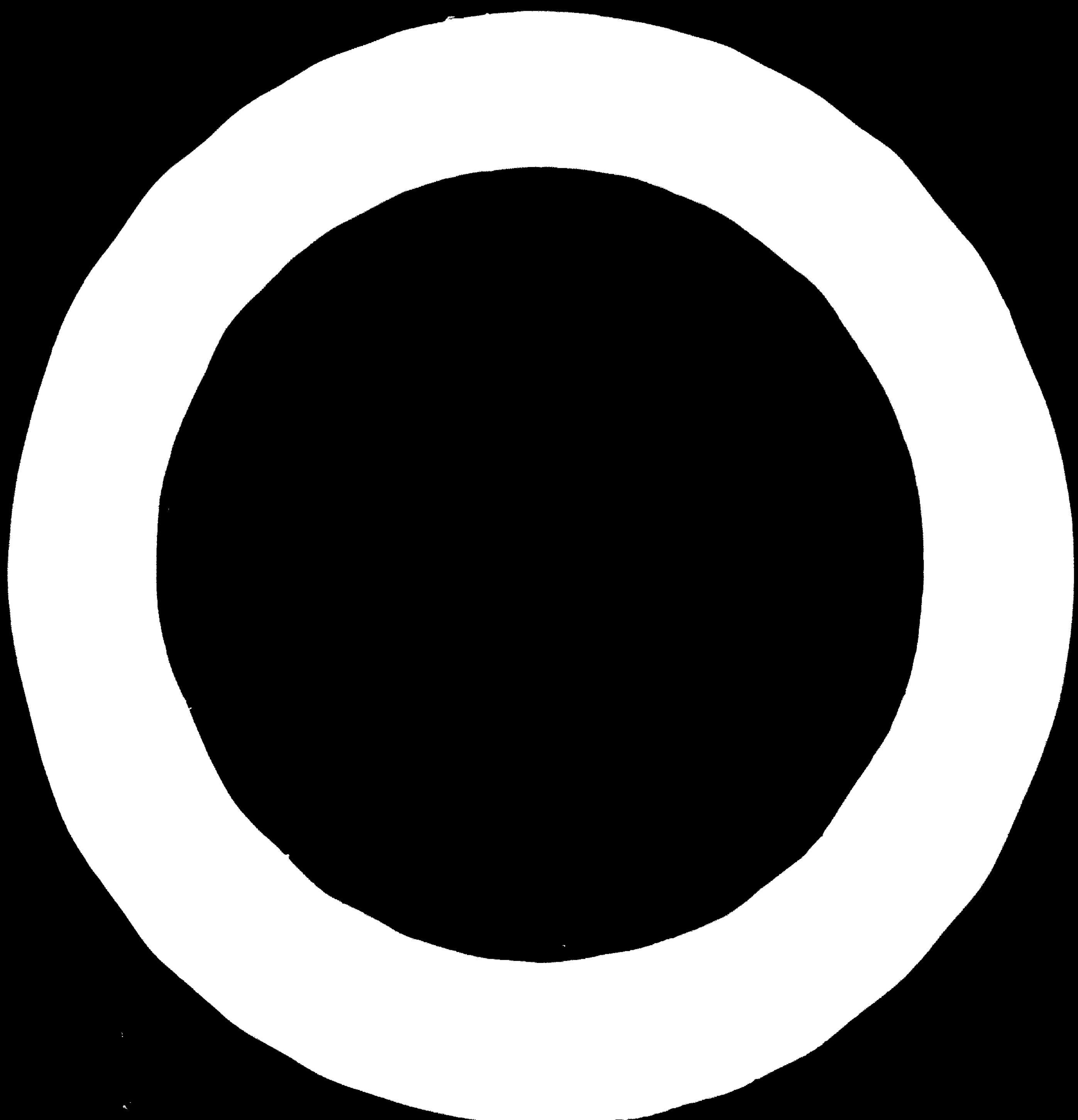
It has been decided for the continuous [illegible] condensation process to carry out the reaction at atmospheric pressure and at the boiling temperature of the reaction mass, additional advantage of this being simplicity of controlling temperature conditions in the sections. From the [illegible] condensation heat balance it follows that in each section heat deficiency occurs only in the first section of the column. There is surplus of heat in the other sections which is removed by evaporation. Utilization of surplus heat of the last sections for the heating of initial mixtures it is possible to maintain necessary temperature conditions in the reactor without an outside source of heat.



[illegible]

The phenomenon of liquid film [illegible] high speed stream of gases moving together with the liquid along [illegible] tal pipe was laid into the foundation of continuous [illegible] the evaporation of [illegible] volatile [illegible] from the resin obtained [illegible] conditions of the two-phase liquid- [illegible] pipe depends on the stream velocity. [illegible] liquid flows along lower [illegible] and the gas moves above the liquid. [illegible] speed results in the [illegible] liquid phase surface; the edges of the liquid [illegible] along the walls [illegible] pipe. When the gas stream [illegible] critical speed (approxima- tely 15-30 m/sec) the edges of the stream of liquid [illegible] the liquid moves along the internal walls of [illegible] shape of a layer with a ring-shaped cross-section. [illegible] stream moves along the central part of the pipe [illegible] film on the walls and moving the liquid along the [illegible] by means of friction forces.

The method developed [illegible] for the evaporation of vola- tile substances from the resin during its single [illegible] the externally heated, horizontal pipe of the evaporator; in the above pipe a circular flow of a thin layer of resin is maintained. The vapours of the volatile substances evolv[illegible] the heated resin and moving along [illegible] to the pressure drop maintained between the inlet [illegible] above gaseous phase [illegible] outlet of the [illegible]. The conditions of the circular flow secure good heat exchange and removal of volatiles, resulted in considerable reduction of the evapora- tion time, which usually does not exceed one minute. The appa- ratus used for the continuous evaporation is marked for compact- ness, good heat characteristics and absence of moving parts.



[illegible]

In [illegible] volatile [illegible] the [illegible] reactor [illegible] [illegible] entering [illegible] [illegible] intensified, [illegible] circular flow [illegible] unconverted [illegible] problem, [illegible] of [illegible] into the [illegible] mixture. [illegible] in the [illegible] Thus, in the [illegible] from [illegible] [illegible] the [illegible] sufficient [illegible] to the [illegible] of [illegible] in the [illegible] into the flow-sheet [illegible] and [illegible] the [illegible] as the [illegible] the [illegible].

The [illegible] flow [illegible] [illegible] quantities from [illegible] of [illegible] in the [illegible]-section column. [illegible] substances evolved during boiling of the reaction mass are cooled in the condenser, common for all the sections, the condensate from this condenser returning to the first section. The resin formed at the polycondensation stage is separated in the Florence flask from the water layer which is the only waste product. The resin separated from the water is fed by the pump to the tubular evaporation apparatus. Molten resin and vapours of volatile substances enter the homogenizer equipped with a steam jacket and an anchor agitator. The vapours of volatile substances are condensed in the condenser. The distillate formed returns to the polycondensation stage as phenolic raw stock. Molten resin from the homogenizer is continuously fed onto the surface of rotating drum cooled from inside, and is converted to the solid state and then is cut from the drum surface in the shape of flakes.

Industrial plants with the annual capacity of 3000, 5000 and 10000 tons per year have been developed on the basis of the above continuous method. Resins designed for manufacturing molding powders and adhesives are produced on these plants. The experience of operation of these plants during a long period of time has shown that the continuous method has a number of the following basic advantages as compared to the available batch process.

1. Consumption of phenol and formaldehyde per unit of the end product decreases.

2. Consumption of electric power and steam is considerably reduced.

3. Due to the reduction of the construction site 1,5-2 times, and volume of the shop and the weight of the process equipment as well the capital investments are reduced accordingly.

4. Complete mechanization and up-to-date level of automation of the technological process is achieved resulting in the reduction of labour.

[redacted]

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