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RECENT DEVELOPMENTS IN PETROCHEMICALS AND PLASTICS IN JAPAN[1/]

by

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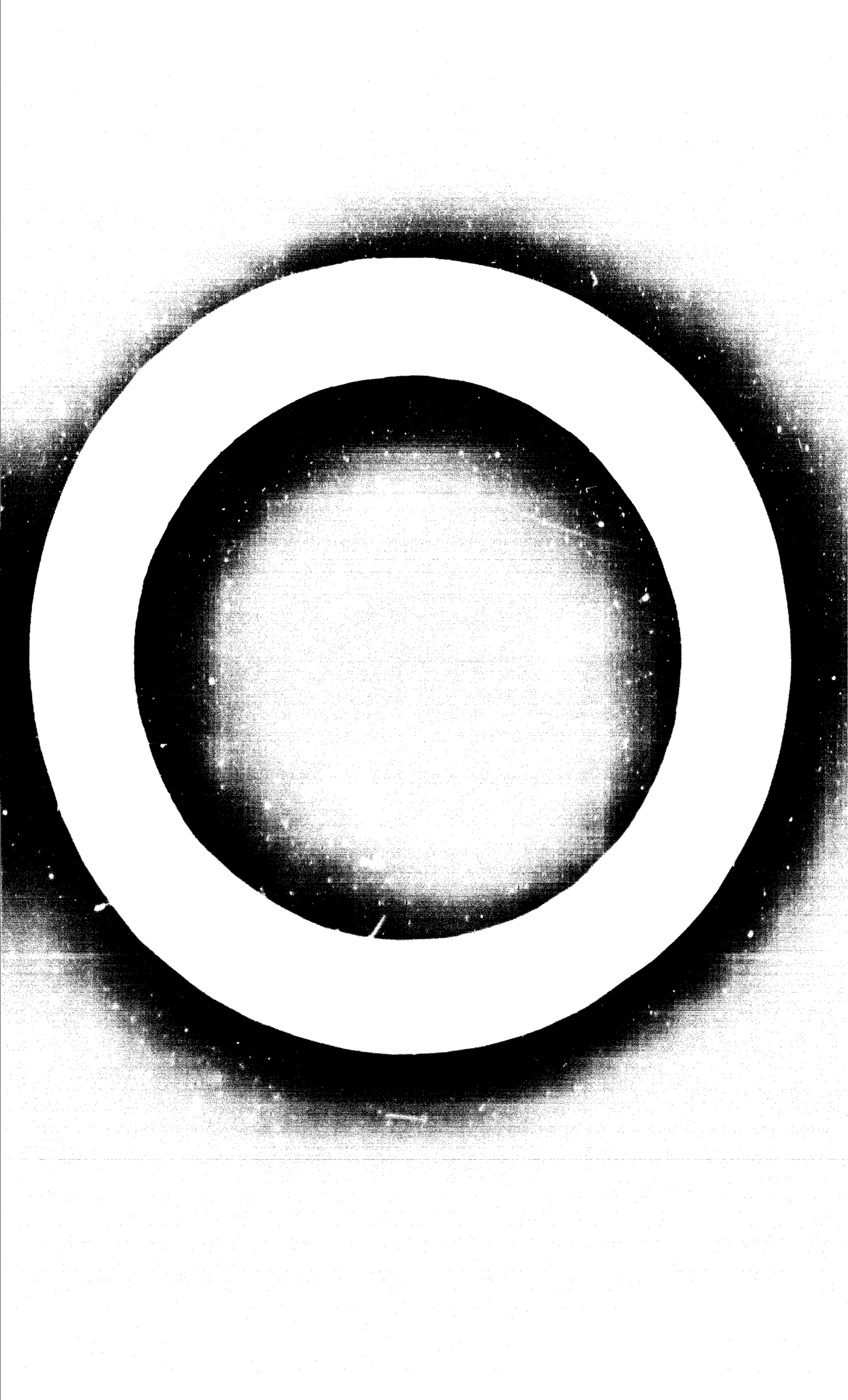
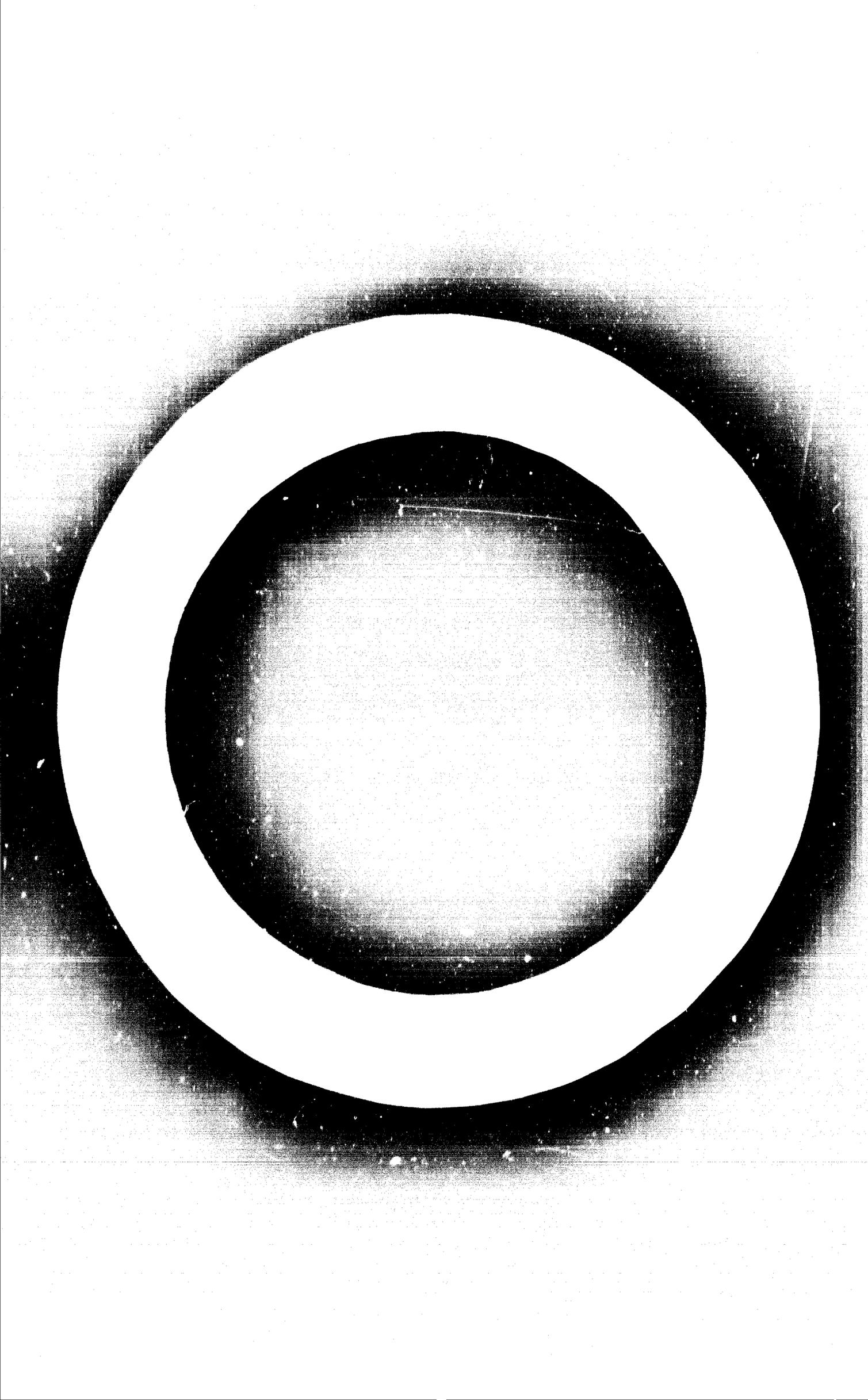




(1) The progress of petrochemical industry from its start to 1964

The Japanese petrochemical industry had started several years behind American and European industrial nations. That is to say, it was around 1954 - 1955 that the plan for building up petrochemical industry in Japan began to take shape. More strictly it was 1955 that the Ministry of International Trade & Industry (MITI) announced its policy so-called 'How to bring up petrochemical industry'.

The Japanese industry had been brought up under the control and protection of the government for more than 30 years until that time. Therefore all petrochemical plans had to subject to the MITI's approval and the number of plans thus approved was 15 in all. As a result 4 naphtha cracking centers were established and went on stream during a period from 1957 - 1959.

In the petrochemical plan was involved synthetic rubber manufacture. For the production of SBR, a new company, Japan Synthetic Rubber Co. was formed by the joint investment of petrochemical and rubber companies, and the government also participated in the venture with 40% interest. This formation was one of the important policies of the government.

The plan completed during the said period is called the 1st-stage plan. In this, Japan aimed at: a) successful shifting to economic petrochemical processes from conventional coal chemical, calcium carbide and fermentation processes; b) securing self-supply for the petrochemical products which had so far depended on the import from Europe and the USA. And I am happy to say that those purposes were almost fulfilled.

The following 2nd-stage plan (1959 - 1962) aimed at (a) the lowering of the production cost of petrochemicals to the international level and (b) also lowering the prices of the products from conventional processes without introducing any confusion by adjusting the competition between the old and the new products, and (c) finally to scrap the old plants based on the conventional processes. In order to carry out these purposes, their efforts were concentrated to enlarge the capacities of the four naphtha centers and to accomplish the full utilization of the primary products produced there so that a complete form of complex would be built up. And at the same time three more centers were added. In fact the result was that during that period the prices of the major products were cut by 40% approximately.

The next 2 - 3 years following the 2nd-stage is called the 3rd-stage plan. In this period the said additional centers were completed, and two more were again added, and at the same time ethylene production unit was totally expanded together with carrying out the general utilization of olefines. All production became economical and also expanded quantitatively. By 1963 the 9 centers entered into full operation. During the three periods our ethylene production capacity increased as follows:

1957 - '59	80,000 t/y	(4 centers)
1960 - '61	300,000 "	(4 ")
1962 -	340,000 "	(5 ")
1963 - '64	920,000 "	(9 ")

In those past 10 years the petrochemical industry made favourable stride being away from technical immaturity of no foundation. This could be done because the industry was favored by good surroundings to grow. One of them, as mentioned, was the direct control and protection of the government: all petrochemical projects had to subject to the government approval, but once approved they were given a long-term loan from Japan Development Bank, tax exemption (corporation tax, import tax, etc.) and special short amortization. Secondly until 1962, as you know, the industry had grown under the complete closed economy, so had been kept away from exposing itself to the severe competition from the European and American nations. Thirdly, although the industry had no petrochemical technology almost at all, the government was very positive to introduce foreign advanced techniques. because at that time it was before the trade liberalization, foreign capital participation was not compelled, so all necessary techniques were introduced for a short period on royalty base. And the Japanese industry rapidly mastered the imported top-advanced technology, which may well indicate that Japan was already at high industrial level.

(3) Developments since 1964

In 1962 trade was liberalized and in 1968 followed the liberalisation of capital transaction. Thus Japan entered into open economy considerably lagging behind American and European countries. Because of this reason, the industry found itself rather weak in terms of international competitive power.

Geographically Japan is located in Asian market isolated from the developments of the European and American block economy. On the other hand, she has to depend solely upon the export of products to survive. Therefore the lack of

international competitiveness has come to the most concerned problem for the industry.

Such being the case, their major efforts have been concentrated in, since 1964, the scaling up of unit production capacity for cost down, full utilization of co-products to improve the economy of production and improvement of imported technology. Particularly in view of the fact that a giant ethylene production unit began to appear in the overseas countries a few years ago, the ethylene production capacity as a unit is now set at 300,000 tons per year by the government, because otherwise they can hardly compete in cost. That is to say, MITI has decided not to give an approval to a production plan, if the capacity is less than this scale, and at the same time directed the existing plants to scale up their capacity to this size. Therefore smaller and less effective plants will be scrapped gradually.

The 300,000 t/y ethylene units now under construction are 7 (out of which one is under pending), all of which are scheduled for completion during 1969 - 1971. Together with other existing 11 centers, Japan will eventually have a total ethylene capacity of at least 4.1 million tons/y by 1970.

As you find, if the existing 11 centers build a new 300,000 t/y ethylene plant respectively, it is no doubt that Japan would face serious overcapacity. Therefore for a new ethylene project, investors are asked to form a group made up of 2 - 3 companies so that they can co-operate in joint investment or investment by turns. This type of co-operation may, I think, be typical to Japan. In addition the rate of plant expansion is now carefully controlled in parallel with the demand increase under the close co-operation between the government and the industry to prevent overcapacity. Anyway the final objective of this plan is to impart international competitive power to the industry, so it comes to the front as one of the very important objectives.

The present ethylene production capacity and the potential capacity by 1970 are as shown below. As you will see, Japan is situated second to the U.S.A. by these figures:

1967 (at year end)		1,662,000 t
1968	"	1,922,000 t
1970	"	4,172,000 t

The second important problem to the Japanese petrochemical industry which has come to the fore is the technological problem. Even if the production efficiency be successfully attained by the scaling up of plant capacity, it will, after all, face with the unbalance between demand and production capacity. So in order to prevent this, the development of manufacturing technique for the derivatives and their export are necessary. The former needs the invention of domestic technology and the latter needs competitiveness in the international arena.

Another potential importance seen in near future is how to secure the source of naphtha supply to meet the future demand. If during 1970 - 1971 years more than 4 million tons of ethylene capacity go on stream, about 20 million kl of naphtha will be required. This problem is more acute to Japan than other countries. In order to solve this problem, it is required to develop new technology to produce ethylene from crude oil or heavy oil, or technology that can allow a petrochemical plant to carry out crude oil processing and also full utilization of all distillates. These developments however need a certain length of time, so we have to start the developmental work right now. In Japan MITI sets a subsidy to foster such R & D works. And an ethylene production process based on crude oil is now being developed and a big pilot plant is under construction (Chem. Engineering News, Jan. 15, 1968, p 32).

In the next chapter I would like to explain about the developments of plastics (including synthetic rubbers and synthetic fibre materials).

(3) Developments of plastics (incl. synthetic rubbers and synthetic fibre materials) in these recent years.

As for plastic, the production of thermosetting plastics had been put on commercial operation many years ago, while that of thermoplastics made rapid stride as a result of the advancement of the petrochemical industry. During a period from 1960 when the petrochemical production went on stream for the first time to 1964, the annual growth rate of the total plastic production was 24 %, but during 1964 - 1968 the rate increased to 35 %/y. This can be seen by the following figures:

1960	697,000 t
1964	1,377,000 t
1968 (est.)	3,280,000 t

The plastics which show a growth rate of 50 - 60%/y are as follows:

LD polyethylene
Rigid polyurethane foam
Polystyrene
Polyamide

Polypropylene is a newcomer, which is growing at a remarkable growth rate of 140% annually. On the other hand PVC has maintained a steady growth rate of 21 - 22%/y for the past 8 years, and it is expected that the rate will also be kept in future without marking any decrease.

In the world production output, Japan stands second to the United States, but is ranked only 5th after the US, Germany, U.K. and France in terms of production per capita.

As for the synthetic rubber production, as I mentioned, first SBR production was started by a joint venture of rubber and petrochemical companies with 40% capital participation of the government. Later 9 companies entered the production of NBR, three entered chloroprene and recently four entered polybutadiene rubber and the total synthetic rubber production capacity of the 12 companies has reached 460,000 tons this year. The production from these plants is

SBR	250,000 t
NBR	140,000 t
Polybutadiene	64,000 t

Now plans are progressing for the production of polyisoprene rubber, epichlorohydrine rubber, EPR and butyl rubber. The total production of synthetic rubber will rise to about 363,000 tons this year from 122,000 tons in 1964 with annual growth rate of 50% during the period. Meanwhile the production capacity is expected to reach 765,000 tons/y by 1970, the breakdown of which is as follows:

SBR, NBR	362,000 t
Chloroprene	54,000 t
Polybutadiene	140,000 t
Polyisoprene	50,000 t
EPR	99,000 t
Butyl	60,000 t
Total	765,000 t

In 1966 the ratio between natural and synthetic in the total consumption in Japan was reversed with synthetic exceeding 50% over natural.

As for synthetic fibres, Vinylon from polyvinyl alcohol was early developed on the basis of carbide-acetylene as raw material, and the production of nylon 6 which starts from coal-based phenol has also been commenced early. The production of other man-made fibres made a start after the petrochemical industry went into operation. Now almost all major synthetic fibres are produced. Synthetic fibre as a part of petrochemical industry puts importance on the fibre materials, but here I hope you would understand that the word synthetic fibre includes all of its materials.

The production in 1968 will grow to 650,000 tons, with annual growth rate of 22% since 1964. The production capacity will reach 720,000 tons/y by 1970. However in this figure the capacity for cellulose fibres such as viscose and acetate are not included. Japan fastly could rank 2nd in the world synthetic fibre production capacity next to the U.S.A., and by 1967 her figure doubled that of Germany and U.K. and quadrupled that of Italy and France. The production in 1967 by fibres are:

Nylon	188,000 t
Vinylon	61,000 t
Vinylidene	5,000 t
PVC	9,000 t
Acrylonitrile	126,000 t
Polyester	152,000 t
Polyethylene	12,000 t
Polypropylene	26,000 t
Total	573,000 t

At the end of this chapter, I would touch on the matters relating to technology. Japan's calcium carbide production made remarkable progress from a long time ago and was maintaining a leading position in the world. On the basis of this product therefore acetylene chemical industry advanced remarkably, and the production methods for acetylene-based products, e.g. plastics and synthetic fibres were developed.

On the other hand, other synthetic fibre production went on stream in parallel with the development of the petrochemical industry and the production is solely dependent on foreign technology.

Nowadays synthetic fibre production has shifted to petrochemical process from acetylene-based due to economic reason. Why then Japan made so rapid development in synthetic fibre production? The reasons are a) her fibre industry which had relied largely on the import of natural fibres stimulated the early

establishment of self-supply of artificial fibre; b) there was a population large enough to require big production; I would say that the foundation had been enough prepared for the industry to grow.

(4) Japan's technological developments in recent years.

So far I have glanced at the developments of the Japanese industry from the production side. Next I would see it from a technological point of view.

Repeatedly the acetylene industry achieved early development based on the abundant availability of calcium carbide. That is to say, before petrochemical industry was established Japan had produced almost all petrochemicals that were available from acetylene. Among them were vinyl-based plastics, synthetic rubbers based on butadiene and chloroprene and Vinylon syntnetic fibre (created by the Japanese). On the other hand Japan had not any petrochemical technology around 1955 when the industry was first established. Therefore she had to rely completely on the import for her necessary technology from the overseas industrial countries, as I have mentioned. Today the products of which manufacturing is still completely dependent on foreign technology are chemicals such as ethylene, acetone, styrene monomer, acrylonitrile, higher alcohol, and also polymers such as polyethylene, polyacetal, polycarbonate, polyurethane, polybutadiene and isoprene, EPR, polyester, etc. The balance of trade in technological import and export of the whole Japanese industry in 1967 was only 11 for receipt against 100 for payment. These figures show the actual situation of Japan. However this situation has been changed gradually since 1964. That is to say, Japan who had lagged behind the world industrial countries because of long closed economy and 2nd world war was very active to introduce foreign petrochemical technology and expanded her production capacity rapidly to reach the world level. This means, I would say, that our country digested foreign technology completely for a very short period. And since 1964 when the petrochemical industry was entering expansion period, improvements and development of new techniques have reported one after another. Taking some examples, the Japanese licensees are in turn offering their improved technology to their original licensors, or they are developing more effective processes than the conventional processes of which patents or contracts have expired or are going to be expired, and license inquires rush on these new processes. The number of such developments will rise if included those which are under development. Therefore there is every tendency that the said technological balance of trade will largely be improved.

The technology recently exported from Japan in the fields such as petrochemicals, plastics and elastomers, synthetic fibres (incl. materials) is summarized in the following:

a) As for petrochemical processes, improvement of conventional processes and lesser extent new techniques are licensed to developed countries such as the U.S. and U.K. and also to other developing and Eastern block countries.

Now I would inform you as news that a very positive R & D work is being pushed forward in an attempt to discover new ethylene production technology from crude oil under the sponsorship of the government.

b) Amongst technological export, plastic production and fabrication techniques are numbered the most, especially new VCM process (oxichlorination etc.) and PVC fabrication techniques. Nations to which licenses were granted are the U.S., West Germany, Italy and others, and also developing countries which are scattered all over the world.

Recently new processes for the production of completely modified polyethylene, polypropylene, polyester and its material are under development, which seem to be licensable. Some of them are licensed to the U.S., U.K., Italy and West Germany, and also to South East Asian and Eastern block countries.

As one of plastic modifications, synthetic leather technology obtains patents overseas and attracts the world attention.

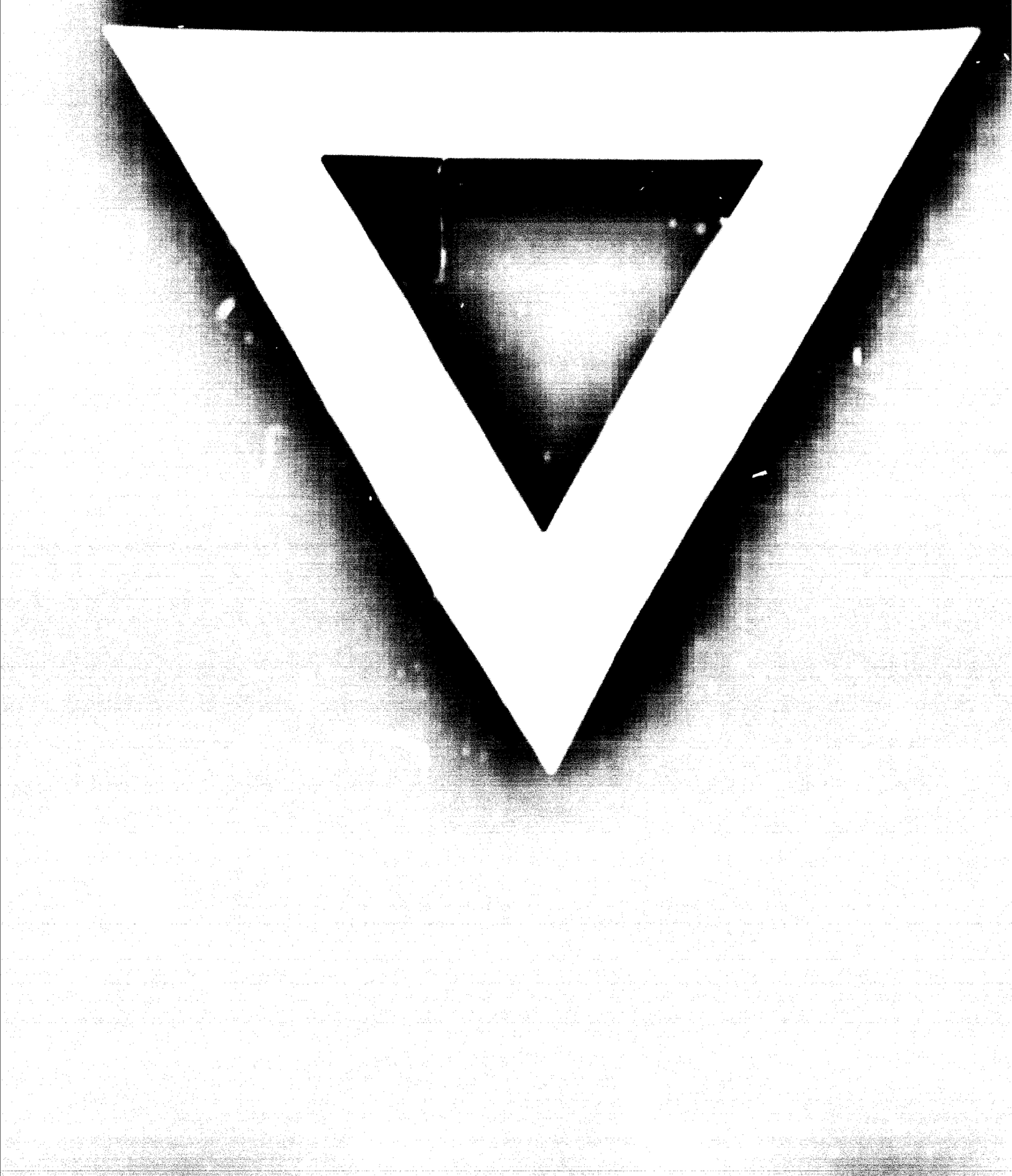
c) Domestic synthetic rubber technology is numbered a few, but it is noteworthy that a new technique for butyl rubber production which has so far been held under the Esso's exclusivity was developed. Besides, other Japanese own techniques for the production of EPR, epichlorohydrine rubber are under development.

d) Domestic technology for the production of synthetic fibres and their materials is also taking a growing interest of the world producers next to plastics. For example, processes for the production of nylon 6 and its material, caprolactam are licensed most and then follows the Vinylon. Apart from the special photosynthesis of nylon, new process for nylon is exported to developing countries and the Vinylon process to advanced countries, e.g. U.K., West Germany, France, etc.

Recently production methods such as high purity TPA, the polyester fibre material, new MEP process for polyester fibre production without via DMT, or direct continuous polymer chip production are watched with great interest especially by industrialized nations.

e) Other processes relating to plastics are radiation process, of which development is advanced fairly. The manufacture of synthetic protein from petroleum as feedstock for domestic animals is reaching next to commercialisation stage. R & D work for synthetic protein is carried out by 10 companies. I expect that the day will not be far distant when the commercial product will appear on the market.

I have mentioned simply about the Japanese technological development, which in a word I can again summarize that technologically our country has reached the level of other industrial nations and that Japan can now see substantial growth in the industrial construction of developing countries especially those [illegible].



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