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FACTORS TO BE TAKEN INTO ACCOUNT BY A DEVELOPING COUNTRY IN DECIDING ENTRY INTO THE THERMOPLASTICS INDUSTRY[1]

by

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SUMMARY

FACTORS TO BE TAKEN INTO ACCOUNT BY A DEVELOPING COUNTRY IN DECIDING ENTRY INTO THE THERMOPLASTICS INDUSTRY 1/

by

W.J. Hermier
Shell International Chemical Company
London, United Kingdom

General trends in production, consumption and prices are reviewed as a background to the various factors to be considered. The plastics likely to be of most interest to developing countries from the point of view of potential growth and range of application are the thermoplastics. The paper is mainly concerned with polyolefins, vinyl and styrene polymer. The principal sectors of the industry - polymer production and processing of polymers to finished articles - are examined in detail. Comparisons are made of the growth and distribution of plastics production and processing operations in developed and developing countries. The growth of plastics usage in different fields of application and the extent to which they have become the preferred raw materials for manufacture of certain end products is reviewed. Per capita consumption in developed and developing

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countries is compared. A number of marketing factors which will influence a decision to go into local plastics processing are considered, e.g. extent alternative raw materials are replaced: range of articles involved: saving in distribution costs: "in situ" applications: use with and possible promotion of exports. Some factors which will have a bearing on the choice of plastic production process are discussed: the first venture into this field is very often an extrusion or low pressure moulding process: the relation between scale of production and capital cost and, in certain cases, the dependence on integrated polymer production is examined. Some typical figures are given for the capital cost of plant to produce pipe, bottles, film, bags and sacks, and injection moulded articles from plastics. Reference is also made to certain low capital cost processes for conversion of plastics. The factors which will influence the case for going into local production of polymers are then considered, e.g. availability of raw materials: extent to which manufacture can be based on imported raw materials and prospects for extending this situation: intermediate manufacture of plastic compounds based on imported polymers: size and cost of plants to produce certain polymer: cost of locally produced polymer versus cost of imported polymer: labour element: degree of utilisation of production capacity: technical skills required: opportunities for export.

Examples are then given of some comparative costs which could be incurred in satisfying a demand for some typical plastic product by importation as such or by deciding to manufacture it locally through one or more stages.

The paper concludes with a summary of the different stages of entry to the plastics industry that are open to a developing country.

Introduction

A developing country may be defined in economic terms as one in which the per capita national income falls below a certain level. Where comparisons are made in this review the dividing line between developing and developed areas has been taken as 20% of the per capita national income of the U.S.A. This choice is arbitrary but within broad limits the level of income chosen has little effect on the general conclusions that are reached.

At the time of writing this paper there are some two dozen developing countries who have not yet become involved on any significant scale in the plastics industry:

The industry consists of four main sections: Those dealing with

a) production of plastics
b) processing of plastics
c) production of ancillary materials, e.g. stabilisers, plasticisers, pigments, etc.
d) machinery for processing of plastics.

The principal plastics and the raw materials from which they are made are listed in Table 1. This list is in descending order of current consumption in the U.S.A. Although each of the products will have some special manufacturing or marketing features an understanding of the factors involved in deciding to go into the plastics business can be gained by considering a comparatively small group of plastics. Those likely to be of most interest to developing countries from the point of view of growth and range of use are the polyolefins, styrene plastics and vinyl polymers which in aggregate [illegible] have more than 50% of world production today. The most widely used and cheapest of these is PVC. This paper is mainly concerned with these three groups of products in the context of the two main sectors of the business - production of polymer and processing of polymer to finished articles.

As the case in most industries, entry into plastics is a progressive affair which in a national sense is a process of integration back towards manufacture of the basic raw materials. The factors which have a bearing on the initial and subsequent stages of this development are reviewed.

Development of the Industry

Most of the primary raw materials that are required for manufacture of polymers are made by continuous processes where substantial savings in production costs can be obtained by scaling up the size of the equipment. This has favoured very large high capital cost plants and as a result production is in the hands of comparatively few producers mainly in developed countries; a good example is afforded by ethylene where 75 % of world production is in Western Europe and the U.S.A. Similar factors determine the production cost of some plastics - particularly the polyolefins - and as may be expected the pattern of distribution of these plants is very like that for monomers. For other plastics such as polystyrene and condensation type resins scale of manufacture is less important and there is a much wider distribution of plants. This is illustrated in Table 2.

The Plastics processing industry is not so capital intensive and the firms in this sector are generally small to medium size. A recent survey in the U.K. showed that there were some 1230 firms whose major activity was the processing of plastics; of these 632 employ less than 25 people and only 9 employ more than 1000 people. Some comparative figures for distribution of plastics processors are given in Table 3.

Table 3

Number of Plastics Processors per Million of Population

Area	Number		
U.K.	22	West Germany	37
Latin America (Brazil, Colombia and Peru)	4	Holland	26
Near East	2		

The growth rate of the industry in most developed countries over the past 10 years has been about [illegible] % per annum. A period of continuing expansion is foreseen and one of the more interesting forecasts that has been made predicts that by the mid-1[illegible]0's the output of plastics in volume terms will have overtaken that of steel. (Figure 1)

1) One of the main factors that has helped this growth has been the steady decline in price of plastics compared with the trend of increasing cost for many competitive materials. Recent trends in the U.K. which are typical of the price movements that have taken place in developed countries are shown in Figure 2. This price decline is slowing down as most of the saving achievable in production costs - certainly in the case of the major thermoplastics - has been passed on to the consumer.

Plastic articles may be classed under three types of outlets:

1) Products aimed at direct consumer spending e.g. domestic ware.
2) Products made for sale to other industries who convert them into the finished article; e.g. films for packaging; components for assembly.
3) Products for markets related to local authority and Government spending, e.g. plastic pipe for water distribution schemes.

The direct consumer market is usually the one where plastics make their first appearance. This market however only represents some 15 to 20 % of the total in most developed countries and there will be much greater room for expansion in the other two fields; in order to build up sales in these outlets it will be necessary to provide new standards and reliable data on long-term end use performance.

Some figures for the per capita consumption of plastics in a number of countries are given in Figure 3. Figure 4 shows the relationship between plastic consumption and rate of growth of national product.

Plastics Processing

The main factors to be examined before going into the processing of plastics are: size and nature of the demand in both home and export markets; relationship to other raw materials available; trends in consumption; selection of conversion process. Some aspects arising out of these are:

1. Selection of end product

Consumer articles are frequently amongst the first to be chosen. The demand for them is a continuing one and it is relatively simple to plan successive stages of production capacity to cater for this. Other applications may be for a more or less fixed quantity, e.g.

water distribution pipe; here it will obviously be essential to establish [illegible] the extent that the quantity is sufficient to support an economic [illegible] of conversion.

Articles that [illegible] volume to weight ratio, such as bottles, containers [illegible] substantial saving in distribution costs. Full advantage [illegible] taken when such articles are made in the [illegible] product with which they can be used. Two examples [illegible] production are: production of plastic bottles [illegible]; production of polyethylene sacks in a [illegible].

[illegible] of plastics has grown more rapidly than in other [illegible] can sometimes provide an indication of what the [illegible] is likely to be in a developing country. Growth trends [illegible] in the U.K. are shown in Figure [illegible].

2. <u>Replacement [illegible]</u>

As plastics [illegible] developing country, a situation soon arises [illegible] to compete as replacements for other raw materials. [illegible] this takes place will depend on a number of [illegible] contribution that the existing operation makes to the economy [illegible] of the other raw materials - are they indigenous [illegible] comparative costs, possible savings in foreign currency.

Some [illegible] of this replacement are:

i. [illegible] in developed countries largely [illegible] paper sacks for packaging fertilisers. In fact [illegible] stage of replacement is now emerging where the [illegible] toward changing over to sacks made from woven polypropylene tape.

ii. High density polyethylene and polypropylene crates are well established in the dairy industry as a replacement for wood or metal crates and have started to appear in the brewery industry.

iii. More than 3/4 million tons of PVC pipe have been produced used in Western Europe over the past 10 years. The main outlet is for water distribution and sewer schemes. Recently it has started to be used for transport of natural gas where it offers many advantages.

There is one [illegible] advantage that can arise from plastics material and that is its reuse value. For example, polyethylene fertiliser bags may be reused a number of times for storage or transport of products; or as a source of film for agricultural purposes.

3. Size and Cost

The principal processes for converting plastics into finished products are summarised in table 4. These may be divided into continuous processes such as extrusion of pipe or film, and discontinuous processes such as injection moulding or bottle blowing. The investment cost for a given capacity is lower for the continuous type of process. This is illustrated in figure 6 where a comparison is made between investment levels for different sizes of extrusion and injection moulding capacity. Average figures for the investment per capacity ton are £ 30 - 70 for extrusion equipment and £ [illegible] - 2[illegible] for injection moulding. This difference is one of the reasons why first ventures into plastics processing more often than not are in the field of extrusion.

Estimates of the capital costs required for a number of plastic conversion processes are given in table 5. These are for equipment only, are based on current f.o.b. West Europe prices, and exclude freight and installation charges. The substantial reduction in unit investment cost which can be gained by scaling up a pipe extrusion process should be noted. The thermo-forming process uses plastic sheet as its raw material and many of the [illegible] in [illegible] countries are an integrated part of a sheet extrusion line. Steam moulding of expandable polystyrene and low pressure moulding of PVC compounds are two examples of processes where a large investment in equipment is not required. Other low cost processes are [illegible] manufacture of flexible and rigid polyurethane foam articles: low pressure laminating of large [illegible] such as boats and tanks from glass fibre and polyester or [illegible] resin.

4. <u>Manufacturing [illegible]</u>

Table [illegible] figures for the production costs of articles made from [illegible] various conversion processes. The fixed cost element [illegible] allowance for installation charges, ancillary equipment and [illegible] charge for buildings: labour at current West European rates and depreciation at 2[illegible] per annum. Raw materials have been costed in [illegible] typical prevailing prices [illegible] developing countries and have [illegible] for scrap loss.

The effect of [illegible] on production costs is shown in Figure 7.

5. <u>Selection [illegible]</u>

Plastics [illegible] be made by more than one conversion process and the [illegible] of the most suitable is not always simple.

Economic and technical factors which can be involved are discussed below.

a) <u>Comp[illegible]</u>

A [illegible] main use for [illegible] impact polystyrene is in the manufacture of thin wall [illegible] and disposable cups. These can be made by injection or by thermoforming of extruded sheet. In the case of the tubs [illegible] degree of [illegible] required for [illegible] protection and the preferred [illegible] method [illegible] injection moulding. In the case of disposable [illegible] is less important [illegible] is possible to have a [illegible] be made by injection moulding. These [illegible] are therefore made by thermoforming, the higher operating [illegible] more than offset by the lower cost for raw materials.

b) <u>Size/[illegible]</u>

The injection moulding process cannot be used for producing articles having [illegible] re-entry curves. In thermoforming slight undercuts can sometimes be tolerated especially with thin sheet but in general the same rules apply as for injection moulding. Certain containers have a reverse tapered shape, e.g. yoghurt pots, and these are normally made by a combination of injection and blow moulding. Hollow articles such as bottles will normally be blow moulded although it is possible to injection mould or to thermoform two halves and subsequently join them together; this is a more expensive process and it is normally only done when an [illegible] control of wall thickness is required.

c) Numbers

The quantity of articles involved is important in view of the different mould costs for different processes. Expensive moulds are required in injection moulding because of the high pressures involved, whereas in thermoforming, the mould can be made from wood, aluminium or plaster [illegible]. An example of the effect that [illegible] can have in determining the choice of process is the production of refrigerator liners from high impact polystyrene. The first liners to be made were injection moulded but the relatively small quantity involved soon led to the use of thermoforming from sheet. Although there has since been a very large increase in the number of refrigerators this has been accompanied by an increase in the number of sizes and models and it is generally not economic to go back to injection moulding.

6. Exports

One cannot generalise on the opportunities for export as these will depend very much on trade and tariff relations between the countries involved. The prospects would be better for articles made by continuous processes since the disadvantage due to small scale of local production should be lower. [illegible] should [illegible] exports to adjacent countries particularly where large and bulky articles are concerned. There will be many cases where plastic goods can be used with the export of other articles and where they could even promote their sale, e.g. the use of polypropylene film to provide a more attractively packed article.

Plastics Production

Some additional factors which should be considered before deciding to engage in production of plastics, include:

1) Availability and cost of raw materials
2) Capital and operating costs
3) [illegible] skills
4) Opportunities for export.

1. Raw Materials

These [illegible] most important single element in the product [illegible].
Reference [illegible] made to the economies that can be obtained from [illegible] and how this has led to the need for very large plants [illegible] to be a competitive supplier in the international [illegible]. [illegible] support new production capacity today for raw materials [illegible] ethylene, [illegible] and chlorine, it is necessary to have [illegible] product and this is generally a large scale [illegible] operation. Some idea of the size of the outlet [illegible] which compares plant sizes that were considered [illegible] in 1958 with the levels that are being taken today [illegible] when planning new capacity.
One result of [illegible] production of polymers in developing countries [illegible] raw materials. This raises the question [illegible] raw materials mainly those in solid or liquid [illegible] available as international commodities whereas others [illegible] materials are not. There is no serious raw material [illegible] up polystyrene or phenol formaldehyde [illegible] developing countries but in the case of polyethylene and [illegible] production is almost entirely in plants that [illegible] processes [illegible] developed [illegible] signs that this may change as bulk sea [illegible] come into service; during the past two years some [illegible],000 tons of ethylene has been shipped from England to Holland.

2. Capital and Operating Costs

Estimates of capital and operating costs for some plastic plants are given in table 8. These are derived from figures published by the Institut Français du Pétrole in 1966. Published figures for capital cost of polymer plants vary widely and in studying projects it is important to understand clearly the basis on which they have been prepared. For example, what is included in the capital expenditure? This can range from the cost of equipment to be installed in a well established production site to the installed cost of a plant including bulk storage bunkers, warehousing, road/rail access, offices, etc. all to be erected on a green field site. Plant size has also an important bearing on the capital cost per annual ton of product; for most plastics the capital can be directly related to the 0.65 power of the capacity. For technical reasons there is a limit to the size of polymerisation lines. This depends on the particular processes - for example, where this is associated with glass lined equipment or with centrifuges these are likely to be the deciding factors in determining maximum size. Polyethylene provides a good example of where it has been possible to build larger and larger units as the technology of the process has been improved. In 1961 the largest polymerisation line for high pressure polyethylene was 5,000 t/a; by 1965 this had grown to 17,000 t/a and at the present time lines with a capacity of 50,000 t/a are being considered. Plant size is less important for other plastics such as polystyrene and there are many instances where this plastic is being produced economically on plants with a capacity of less than 10,000 t/a. Polystyrene is one of the first polymers to be selected when considering local production and table 9 shows how the number of plants producing this polymer throughout the world has increased since 195 .

Fixed costs of manufacture, excluding depreciation, are mainly based on labour charges and are more or less independent of the capacity of the particular process as long as the equipment is in principle the same. One final item which should not be overlooked is the cost of royalty and know-how fees which may well amount to 3 to 4 % of the selling price.

3. Manpower and Technical Skills

Neither polymer processing nor production are labour intensive industries. Typical figures for the output per man year from 20,000 t/a PVC and polystyrene plants are 700 to 1000 tons, whereas the figures from plastics processing operations of the type and scale considered in this paper, range between 40 to 50 tons. The smaller size of the processing plants however means that the total labour employed on them will not necessarily be very much different from that employed on polymer production plants.

An essential [illegible] in going into the plastics business will be the training of labour and staff. The skills required to operate most of the [illegible] processes are not very demanding or specialised and should be [illegible] after a short period. This is not the case in polymer production where technically qualified staff will be needed to direct and support the operation - in addition there could well be a considerable [illegible] expertise required if a modicum of development work is carried out to ensure that the process remains technically competitive for a reasonable time.

Maintenance [illegible] for both process and production and there will be a need for skilled engineering support bearing in mind that specialist [illegible] technical service may be a long way away.

4. Exports

It is not uncommon to find that export prices of plastics to developing countries are [illegible] lower than prices paid in developed countries. This happens most frequently for those polymers made on large plants where there is always some pressure on the producer to sell off marginal capacity at prices which may only just cover the variable cost of production. Whilst the first stage plants in developing countries can protect their home market by tariffs and import licensing restrictions the prospects for competing at prices outside these markets will be limited. These comments do not necessarily apply to polystyrene and other plastics made on small to medium sized plants.

Comparative Costs

In this section the cost of importing plastic articles is compared with the cost of making them locally. Several scales of conversion have been considered and in one or two cases the effect of basing the conversion on locally made compound is examined. The comparison has not been extended to include production based on locally made polymer as only in very exceptional cases would the latter be justified by one end use.

Three examples have been chosen:

1. Moulded one-piece coloured PVC shoes.
2. Rigid PVC pipe for water distribution.
3. Rigid transparent PVC bottles for foodstuff distribution.

Local production costs are expressed as a percentage of the cost of importing the finished product. In order to simplify the calculation, several assumptions have been made: freight and insurance for imported finished items has been taken as 15 % of the f.o.b. price. Working capital has been taken as nil: overheads of local processing have been ignored: no account has been taken of possible import restrictions or import duty.

1. Shoes

A simple case involving four sizes/styles in different colours has been chosen. In practice the range will be greater but outlay on the additional moulds required does not represent a significant element, e.g. trebling the number increases the manufactured cost of the shoes by less than 1.5 %. Three scales of local manufacture from bought in PVC compound and one case of manufacture from locally made compound are compared. It will be noted that the highest scale of production examined does not justify going into local compound production.

Table 10

Relative costs of obtaining PVC Shoes	
Import [illegible]	100
Manufact[illegible] [illegible] annum from [illegible]	73
Manuf[illegible] [illegible] pairs/annum from [illegible]	66
Manuf[illegible] [illegible] million pairs/ annum from [illegible] compound	61
Manuf[illegible] [illegible] million pairs from [illegible] compound	62

2. Pipe

Costs of [illegible] and [illegible] t/a from bought in compound and 500, 2,500 and [illegible] from locally made compound are compared. At an output of [illegible] worthwhile making compound locally. [illegible] calculat[illegible] fittings, it being assumed that these will be imported [illegible]

Table 11

Relative costs of obtaining PVC Pipe	
Import [illegible]	100
Manufact[illegible] t/a from [illegible] compound	107
Manufactur[illegible] t/a from imported [illegible]	78
Manufactur[illegible] t/a from own [illegible]	76
Manufactur[illegible] t/a from own [illegible]	60
Manufactur[illegible] ,000 t/a from own [illegible]	57

3. Bottles

Produc[illegible] .5 litre crystal clear bottles from bought in unmodified PVC compound [illegible] of 5 and 35 million bottles per year have been considered. In each case the local production is supported by a small injection moulding unit to produce polyethylene caps.

Table 12

Relative costs of obtaining PVC Bottles/Caps

Import as such	100
Manufacture 4 million bottles/annum from bought-in compound	66
Manufacture 35 million bottles/annum from bought-in compound	58

The possibility of saving in foreign currency which can be made by producing these articles locally rather than by importing them is shown in Table 13. It must be emphasised that these figures only provide a very approximate indication of what might be achieved. They have assumed that foreign currency will only be spent on capital equipment and finished goods or raw materials; they do not take into account the possible earning of foreign currency through exports.

Table 13

Possible Savings in Foreign Currency

Example	£'000 in first year
Production of 1 million pairs of shoes from imported PVC compound	90
Production of 500 tons of PVC pipe from locally made PVC compound	40
Production of 4 million bottles from imported PVC compound	45

Stages of Entry

The several stages in which a developing country will become involved in the course of establishing a broad base in the plastics industry can now be summarised. Before producing polymers locally it will be necessary to have a polymer processing industry, but apart from this, there are no hard and fast rules as to the sequence of development and the order given below is just one of a number of ways in which this could take place.

1. Manufacture of articles from imported semi-finished plastic materials. This is essentially a simple engineering operation - not involving any particular plastics skill - and has not been considered in this paper.
2. First stage of plastics processing. The choice will depend on the nature of the final article but in most cases can be expected to be an extrusion or low pressure moulding process.
3. Introduction of injection moulding, blow moulding and other more capital [illegible] processes.
4. Local production of [illegible] resins. The first choice is likely to be for those polymers that can be produced without a large capital outlay, that are comparatively straightforward to make and that are based on readily available commodity type raw materials.

The further stage of going back to production of monomer has not been considered as this is really an entry into the heavy chemical and petrochemical industries.

Table 1 - Principal Plastics and Resins

Type	Raw Material
Polyethylene (High Pressure)	Ethylene
Styrene Polymers	Ethylene, Benzene, Butadiene, Acrylonitrile
Vinyl Polymers	Ethylene, chlorine
Polyethylene (Low Pressure)	Ethylene
Phenolic Resin	Phenol formaldehyde
Polypropylene	Propylene
Amino Resins	Urea, Melamine, Formaldehyde
Polyester Resins	Polyols, Dibasic Acids
Polyurethan Resins	Polyols, Isocyanates
Acrylic Resins	Alkyl Acrylates
Cellulosics	Cellulose, Lower fatty acids
Epoxy Resins	Epichlorhydrin, Diphenylol propane
Polyamide Resins	Adipic Acid, Hexamethylene diamine
Polyacetal Resins	Formaldehyde

Table 2 - Distribution of Plastics Plants

	Western Europe	Latin America	Continental Africa
Polyethylene (high pressure)			
Number of plants	26	4	2
Number of plants / hundred million population	7	2	less than one
Total Capacity '000 t/a	1230	85	40
Average Capacity '000 t/a	47	21	20
PVC			
Number of plants	39	12	2
Number of plants / hundred million population	10	7	less than one
Total Capacity '000 t/a	2425	155	40
Average Capacity '000 t/a	62	13	19
Polystyrene			
Number of plants	27	10	2
Number of plants / hundred million population	7	5	less than one
Total Capacity '000 t/a	735	60	5
Average Capacity '000 t/a	27	5	3

Table 4 - Principal Primary Processes for Conversion of Plastics

Process	End Product
Blow Moulding	Bottles Containers
Calendering	Film Sheet
Casting	Large containers
Coating	Coated metal tube and components Supported sheet
Compression Moulding	Range of moulded articles
Extrusion	Coated Materials Film Pipe Profiles Sheet
Foaming	Rigid and Flexible Plastic Foams
Injection Moulding	Very wide range of domestic and industrial articles
Low Pressure Laminating	Glass Fibre laminates
Low Pressure Moulding	Expanded plastics for insulating and packaging Shoes

Table 5 - Capital Costs - Plastics Conversion Processors

Process	Plastic	Product	Capacity t/a		Capital Cost $/capacity Ton	
			[illegible]	[illegible]	[illegible]	5
Extrusion and Bag making	[illegible]	Heavy Duty Sacks	[illegible]	[illegible]	25	35
Low pressure [illegible]	[illegible]	Shoes	[illegible]	[illegible]	[illegible]	45
Extrusion	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	50
Steam [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	65
Inj[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.5	[illegible]
Sheet [illegible] and [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Flow moulding and Injection moulding	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	145
Tape Extrusion and Sack weaving	[illegible]	[illegible]	[illegible]	–	315	–

Table 6 - Production Costs of Plastics Articles

Product	Process	Plastic	Capacity MT/a	Production Cost $/MT
Heavy Duty Sacks	Extrusion and Bag Making	Polyethylene	1500 3000	175 150
Shoes	Low Pressure Moulding	PVC compound PVC	150 500	300 255
Pipe	Extrusion	PVC compound PVC	500 2500	245 185
Fish Boxes	Steam Moulding	Expandable Polystyrene	250 500	350 35[illegible]
Crates	Injection Moulding	Polyethylene	1000 2000	36[illegible] 350
Yoghurt Pots	Extrusion and Thermoforming	High impact polystyrene	250 500	35[illegible] 325
Bottles and Caps	Blow Moulding and Injection Moulding	PVC compound	[illegible] 2000	400 350

Table 7 - Size of Monomer Plants

1000 MT/a

	1963	1972
Ethylene	100	400
Styrene	75	200
Vinyl Chloride	50	200

Table 9 - Number of Countries Producing Polystyrene

	1950	1955	1960	1968
No. of Producing Countries	6	11	20	29
No. of Plants	12	30	61	121

Table 8 - Capital and Operating Costs for Some Plastics Producing Plants

Product	[illegible] tons	Capital cost £/capacity ton	Fixed cost £/ton	Variable costs/a £/ton
Polystyrene	[illegible]	[illegible]	20	1.[illegible] x + 5.5
PVC (suspension)	[illegible]	[illegible]	11	1.[illegible] x + [illegible].0
PVC (emulsion type)	[illegible]	6[illegible]	1[illegible]	1.[illegible] x + 14.0
Polyethylene (high pressure)	[illegible]	[illegible]	5[illegible]	1.0[illegible] x + 22.0
Polyethylene (low pressure)	[illegible]	[illegible]	67	1.[illegible] x + 36.0

a/ x = cost of monomer in £/ton

FIGURE 1

VOLUME OF PRODUCTS - STEEL vs PLASTICS - U.K.

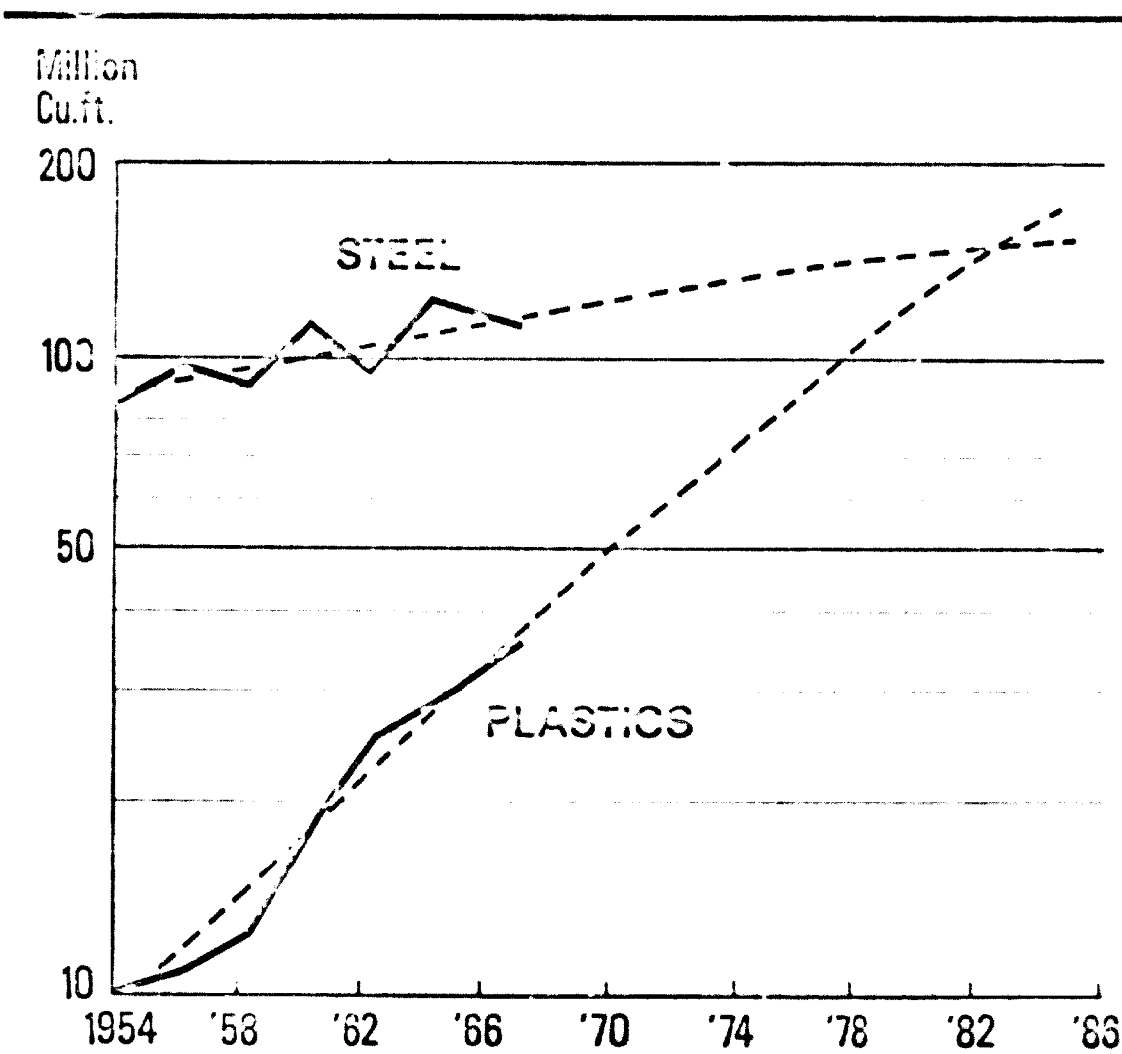
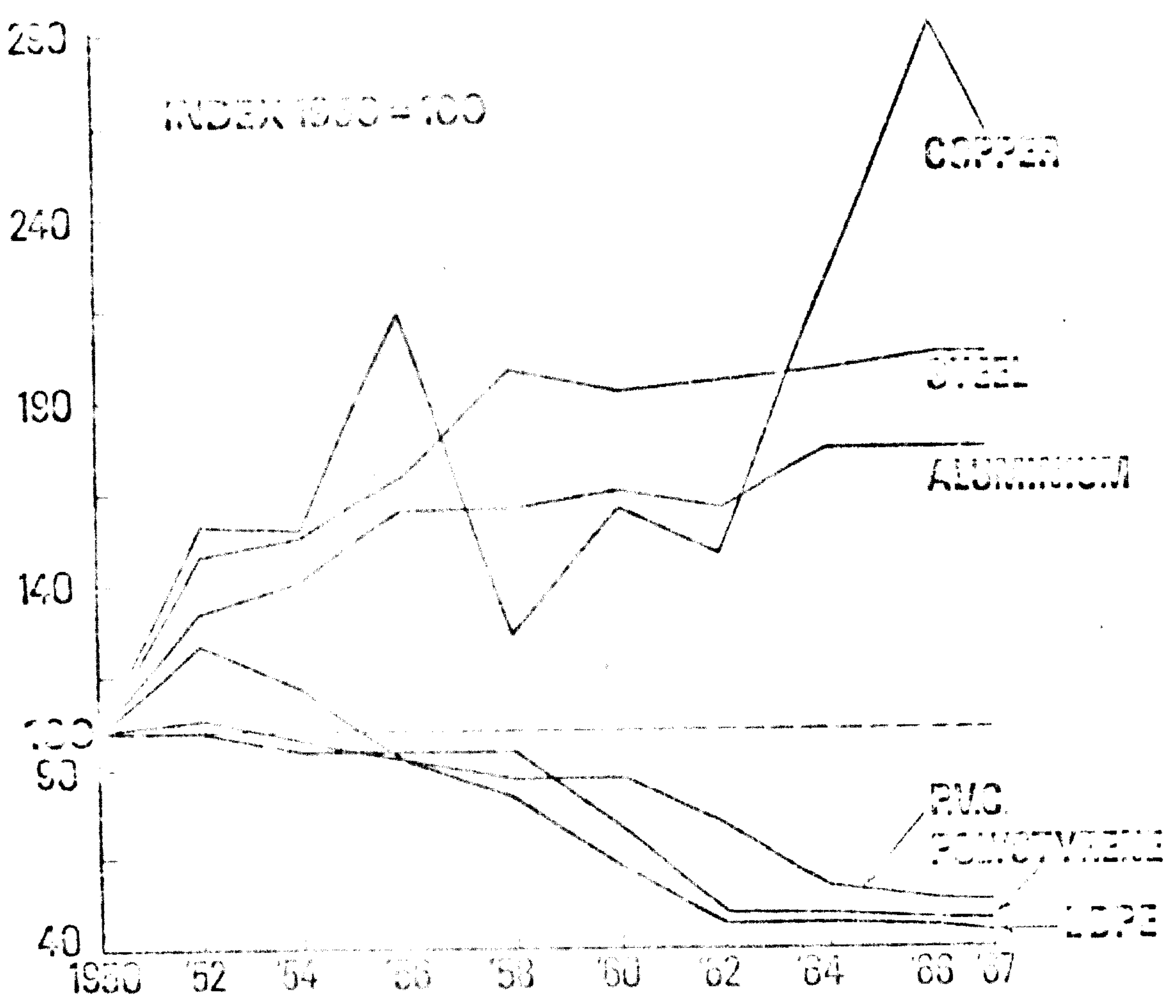


FIGURE 2

PRICE TRENDS - U.K.
PLASTICS & METALS 1950-1967



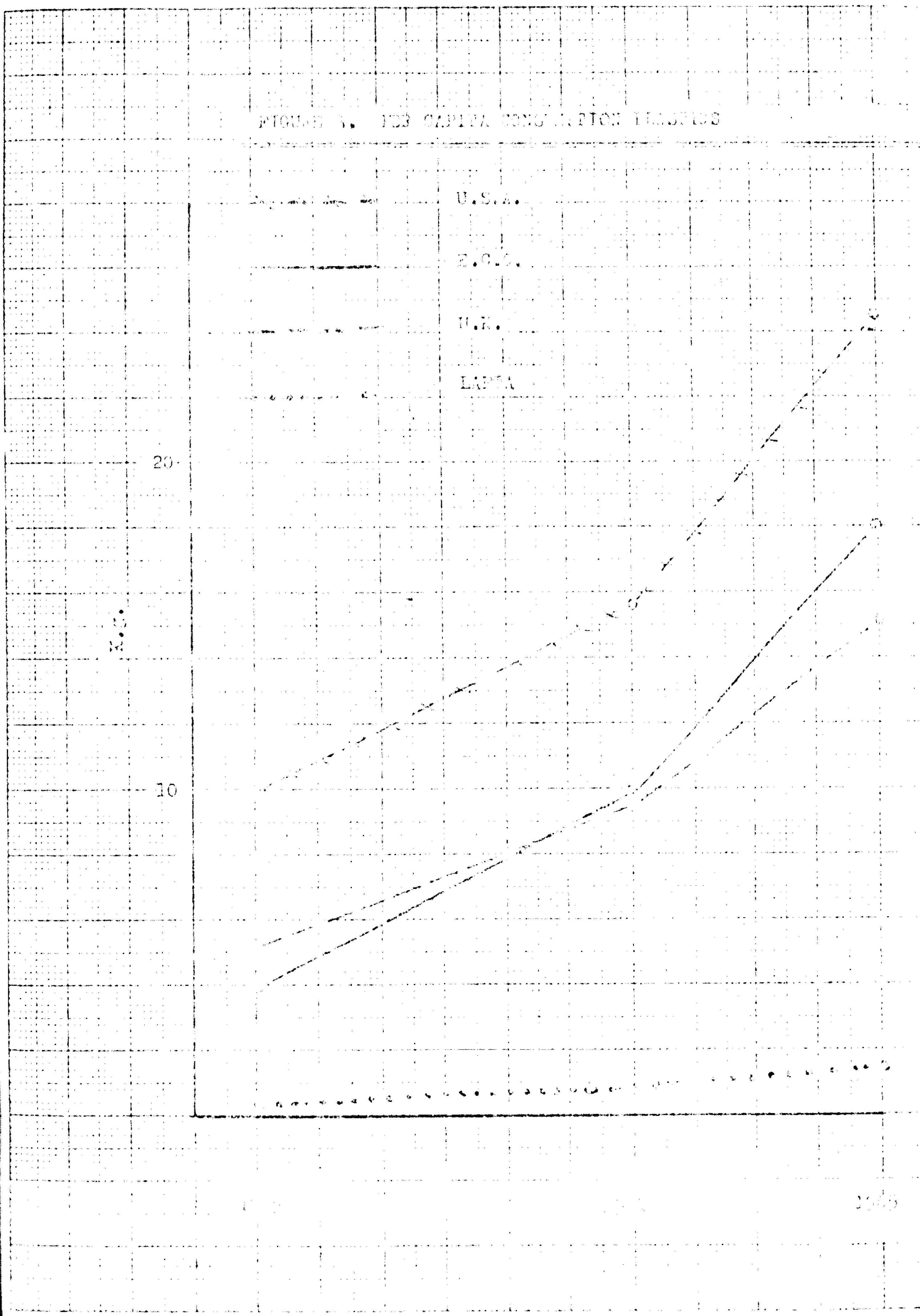
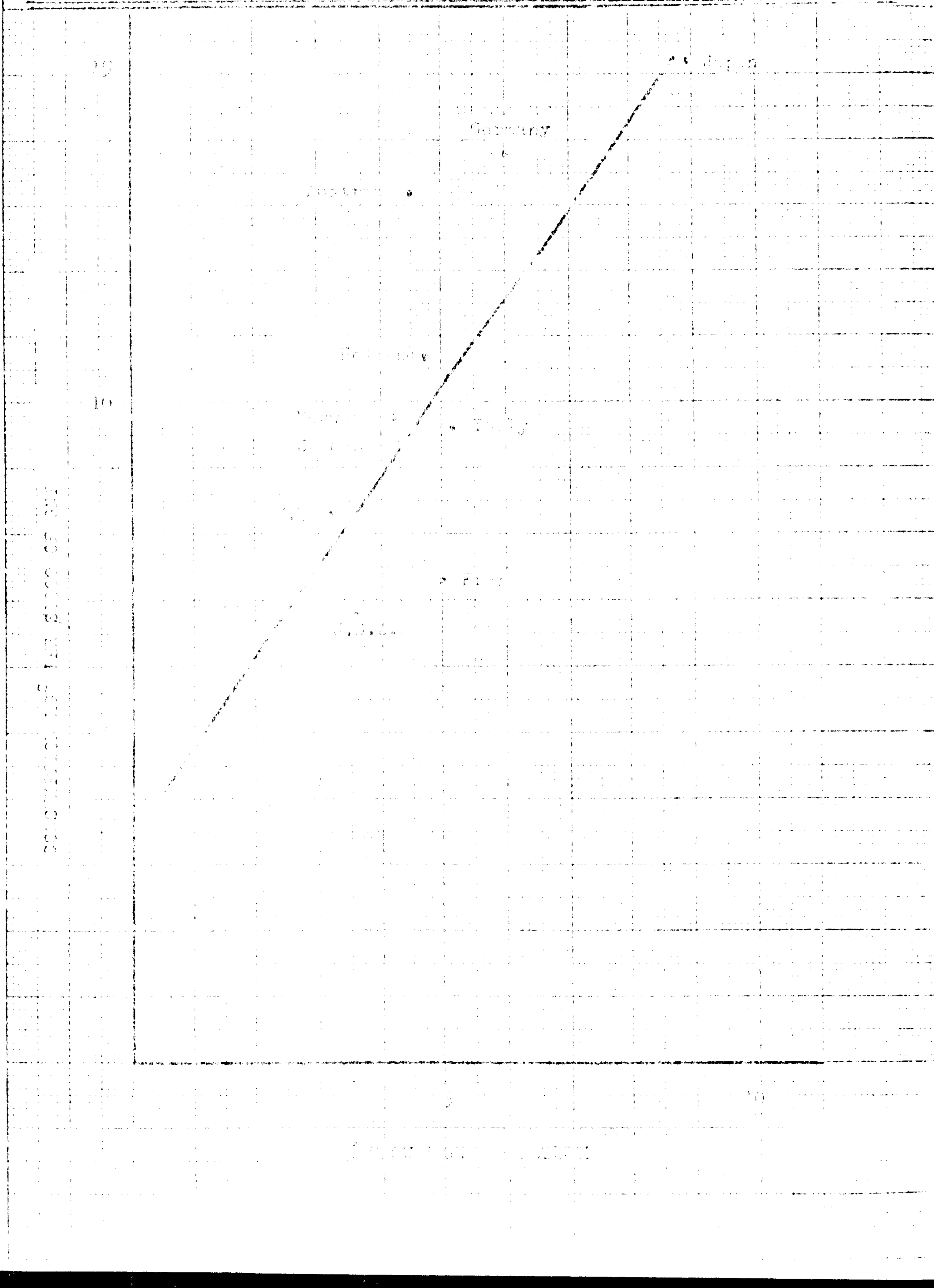


FIGURE . PER CAPITA CONSUMPTION TRENDS

FIGURE 4. RELATIONSHIP BETWEEN PLASTICS CONSUMPTION IN 1965 AND GROWTH OF G.N.P.



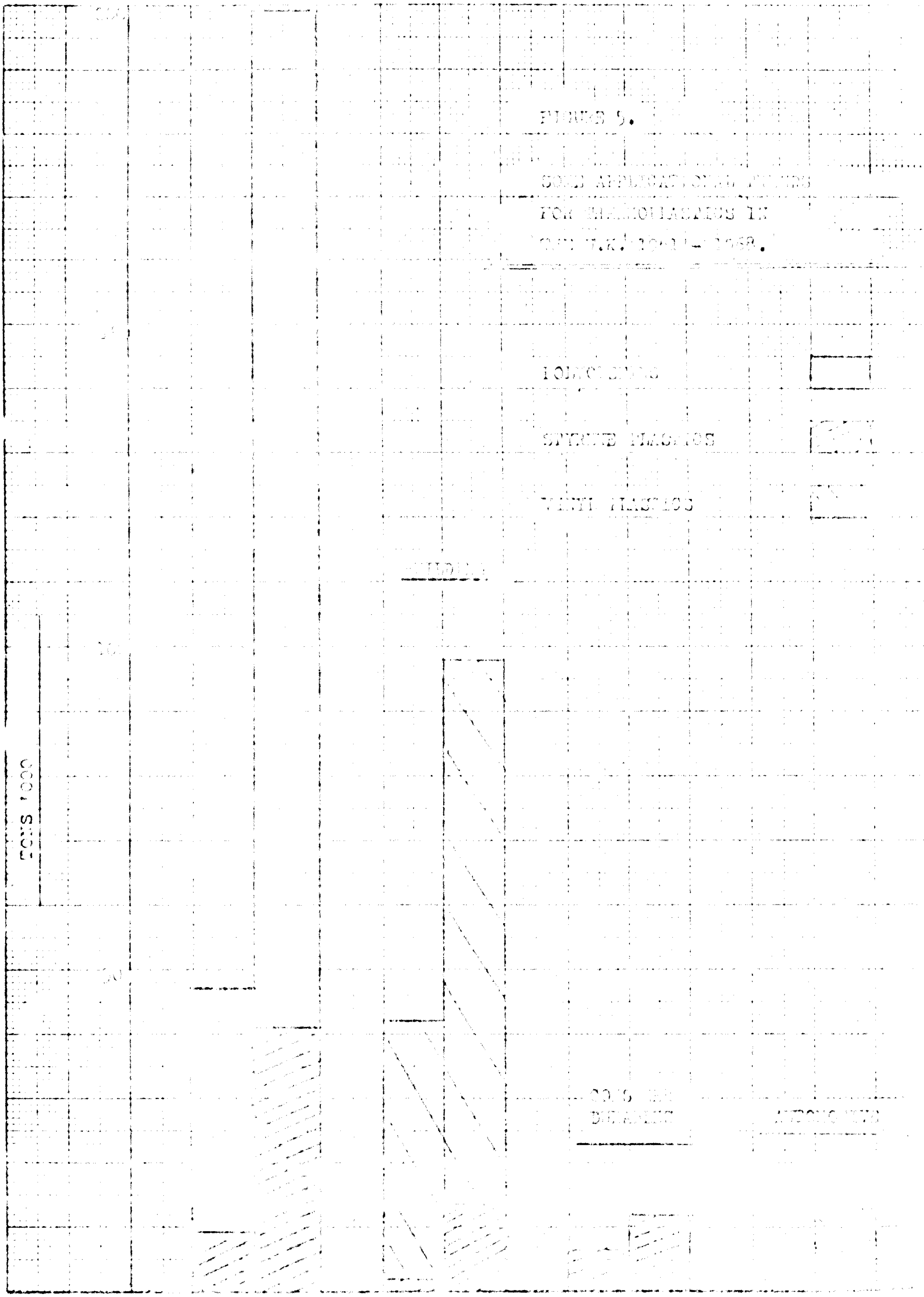


FIGURE 9.
POLYOLEFINS
STYRENE PLASTICS
VINYL PLASTICS
TONS '000

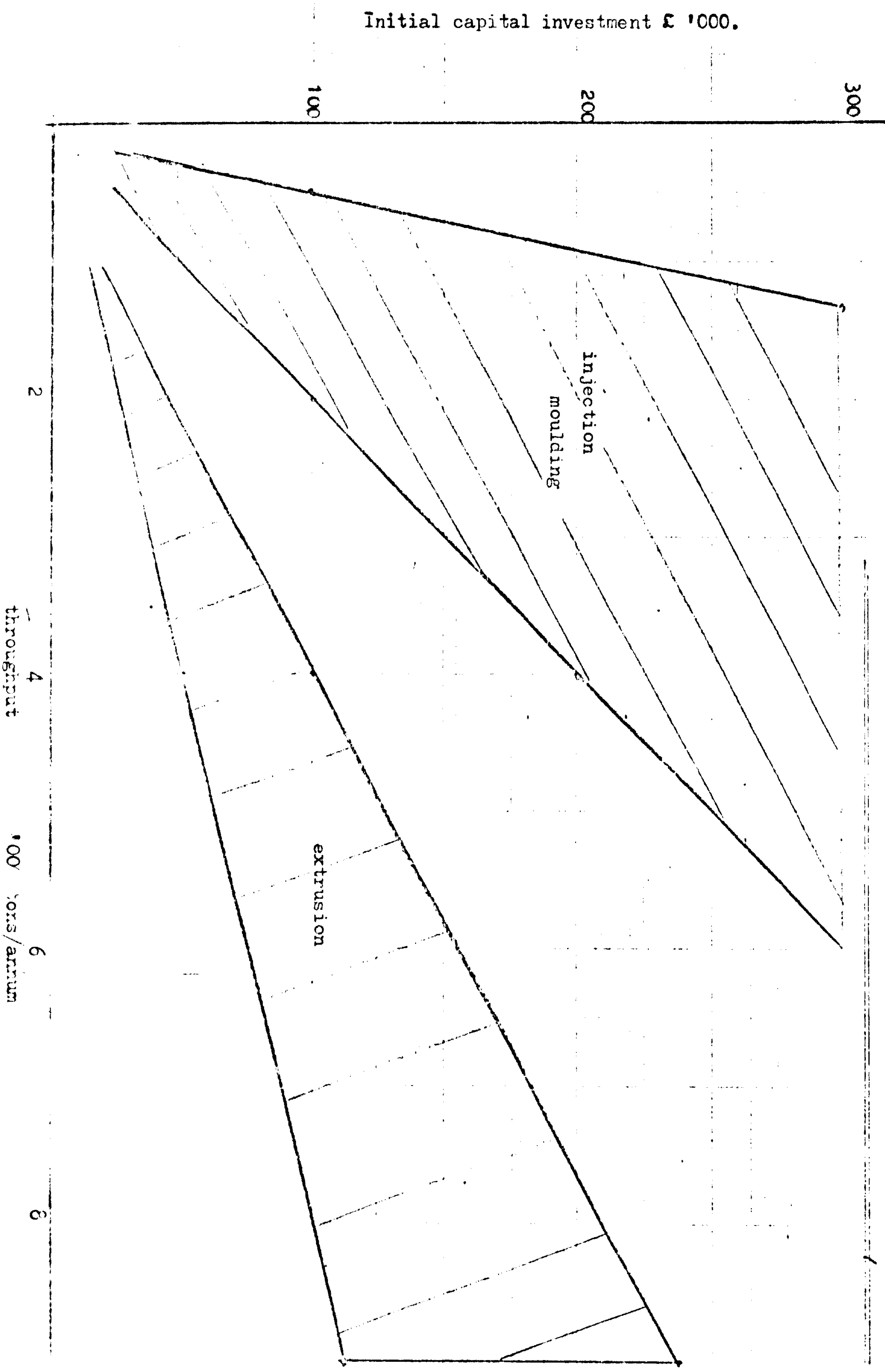
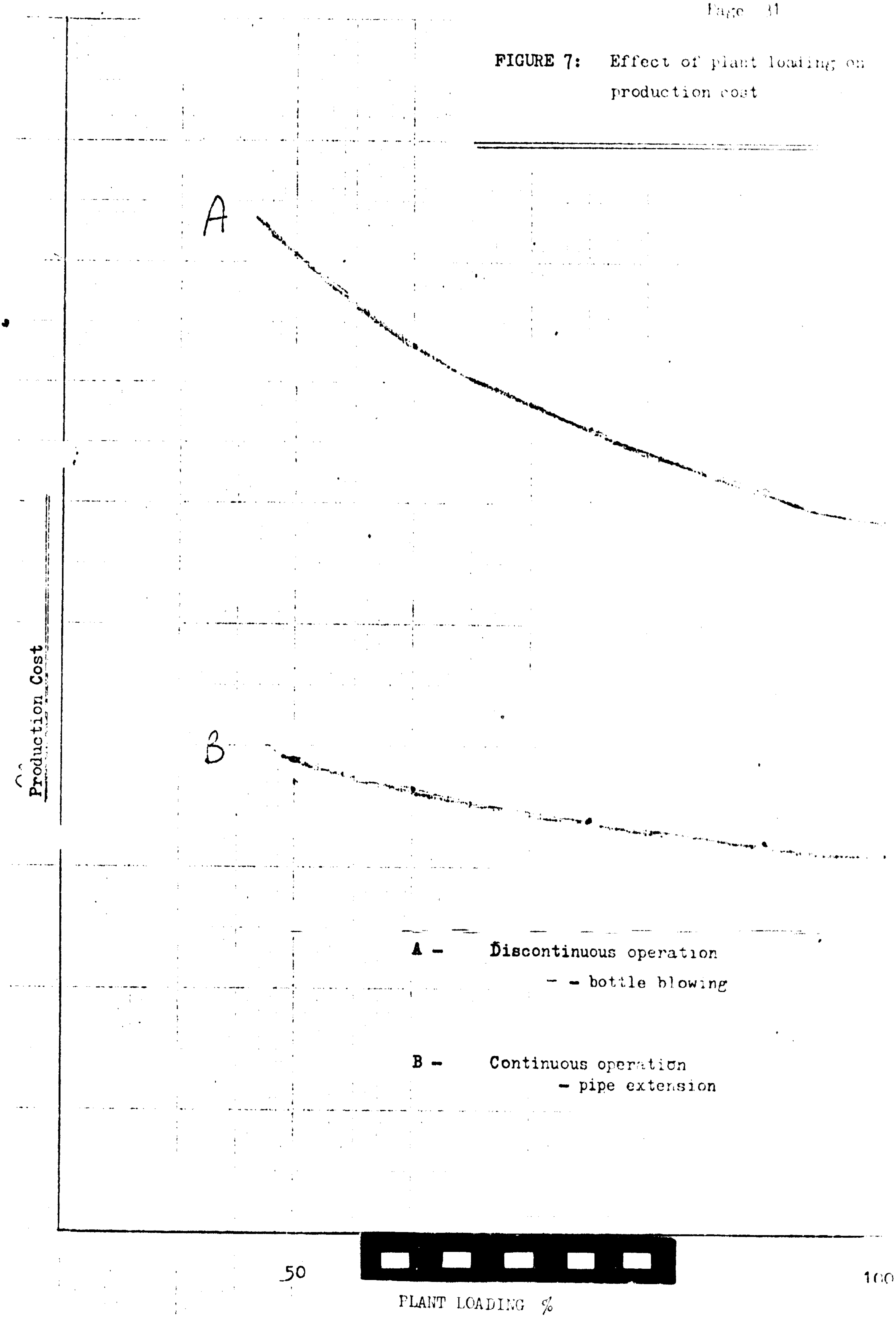


FIGURE 6: Relationship investment cost to process capacity

FIGURE 7: Effect of plant loading on production cost



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