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PROVINCIAL ECONOMIC CONFERENCE

APRIL 1934.

RESOLUTION AND APPENDICES.



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GOVERNMENT OF INDIA PRESS
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CHAPTER I.

INTRODUCTION.

This is the report of the Chemical Industries Committee appointed by Government in their resolution no. 2118-D., dated the 28th November 1938 for reporting on the possibilities of the development of chemical industries in the province (vide appendix I). The following members were appointed to constitute the committee :—

1. Mr. A. S. Khan, M.Sc., I.E.S., Principal, Science College, Patna—*Convener*.
2. Mr. Chakreshwar Kumar Jain, B.Sc., B.L., M.L.A., Zamindar and Mill Owner, Arrah—*Member*.
3. Dr. V. S. Dubey, M.Sc., Ph. D. (London), D.I.C., Professor of Economic Geology, Benaras Hindu University, Benares—*Member*.
4. One Industrial Chemist.

The Committee also co-opted as a member Dr. H. Mukherji the Agricultural Chemist to Government while dealing with chemical fertilisers and Mr. S. K. P. Sinha, Special Officer In charge Electrification, Bihar, while dealing with fertilizers and fuels.

The meetings were held at Ranchi in accordance with the orders of Government. Mr. Jain found it impossible to attend any of the meetings. The report has the approval of Dr. H. N. Mukherji, Agricultural Chemist to Government as regards the manufacture of fertilisers and of Mr. S. K. P. Sinha as regards this and the economic treatment of coal generally. Mr. Chakreshwar Kumar Jain, Dr. V. S. Dubey and Mr. A. S. Khan have signed the report subject to separate notes of dissent or explanation on a few points.

We have given very careful consideration to the possible development of the chemical industries of the province and the conclusions will be found in this report. We must however give a note of warning at the outset regarding the value to be attached to these conclusions. In the limited time at our

disposal and for lack of funds it has not been possible for us to record any evidence. We have received memoranda from certain official and non-official sources which have been of much help to us in the preparation of our report. Further our energetic Secretary has been able to collect a considerable amount of information by personal contact with industrialists in Calcutta. To these sources of information must be added the personal experience of some of the members of the Committee. While all these sources of information are very valuable and are sufficient to make our conclusions qualitatively definite we wish to make it clear that the figures of costs and productions are approximate. Our purpose in mentioning them has been merely illustrative, and hence in the case of industries involving large capital a closer scrutiny by experts actually engaged in the operation of such industries is recommended.

We have been asked to examine the possibility of the following 27 industries.

1. Oils.
2. Dyes.
3. Artificial silk.
4. Chemicals including pharmaceuticals.
5. Paper, pulp and celluloid.
6. Rubber (manufactured).
7. Glass and glass-ware.
8. Paints and painters materials.
9. Manures.
10. Toilet requisites.
11. Belting for machinery.
12. Earthenware and porcelain.
13. Soap.
14. Boots and shoes.
15. Tallow and stearine.
16. Gums and Resins.
17. Paper making materials.

18. Coal and coke.
19. Matches.
20. Leather, Raw hides and skins.
21. Oil cakes.
22. Lac.
23. Rubber (raw).
24. Mica.
25. Bones.
26. Candles.
27. Minerals.

For the purposes of our report we have re-grouped these headings as will be seen by a reference to the table of contents. Broadly speaking we may divide Bihar industries into two categories (1) those of all-India importance (2) those of provincial importance. By the former we mean those industries for which raw materials and other facilities are so abundant that they can be established on a sufficiently large scale to supply the whole of the Indian market. By the latter we mean those industries for which the facilities are not so good yet they are sufficient to supply local requirements at competitive prices. The importance of these industries is to be measured by the help which they can give to other local industries and to cottage industries which depend on them.

We have not considered it necessary to enquire into the possibilities of all the industries in detail. Some of them are dependent on others and it is useless to deal with the dependent industries until the possibility of the fundamental industry has been fully explored. We shall mention only one example to illustrate our meaning. To establish the synthetic dye industry it would be necessary to have a well established coal-tar industry and heavy and fine chemicals industry. It would, therefore, be futile to enter into an examination of the synthetic dye industry without exploring the possibility of the fundamental industries on which it is based.

Of the basic industries, the committee have naturally tried to develop only those for which the province possesses exclusive advantages in the shape of raw materials and other co-lateral facilities making the province the fittest economic supplier for the rest of the country. The chief characteristic

of the province is its unique fuel resources in the shape of coal which whether for a mere power industry or for the development of chemical industries is the essential raw material. Thus the proper utilization of coal with a view to develop a national fertiliser industry has been specially emphasized and recommended as the major industries to be established. The auxiliary industries for this purpose, for example, sulphuric and nitric acids, have been fully treated in the appropriate chapters.

In the opinion of the Committee the order of importance of the industries selected for the first instalment of the provincial programme is as follows:—

- (1) Low Temperature Coal Carbonisation and synthetic fertilisers.
- (2) Heavy chemicals.
- (3) Silicate industries : glass, ceramics, refractories, etc.
- (4) Pulp, paper and card-board.

After the above industries have been established it will be possible to start many other dependent industries such as aniline dyes from coal-tar and synthetic petrol which are of very great importance to the country and for which it is necessary that Government should begin to collect data from now.

Of the two all-India industries recommended neither of them is in existence in India, although they are so important to the nation. Hence it is imperative that these should be developed.

As regards silicate industry, though it is will developed in the United Provinces we have still to depend upon Japanese imports for more than 60 per cent of our requirements. The low price of Japanese products has dealt a severe blow to the glass industry in various provinces of India. If the glass industry is developed in Bihar, we may cut down the cost of production to such a figure that Japanese competition will be ineffective.

In the choice of the above industries we have been guided not merely by the existence of the necessary raw materials in the province but also to a certain extent by the necessity for co-relation of the industries to be established, the desirability of safe-guarding the key industries of the province, the possibility of future expansions and the requirements of a mainly agricultural population.

Our task has been rendered difficult by the fact that an industrial survey of the province has never been attempted and as the Director of Industries remarks guess work has often taken the place of statistical data. An accurate estimate of the mineral resources of the province also does not exist. In the absence of these we had to be content with such informations as our Secretary could collect from industrialists in Calcutta or from the published literature.

As regards finance, the Committee feel that this is perhaps outside their terms of reference. They wish to indicate, however, that there are three ways in which this problem may be approached—

(1) Government may finance the approved schemes by means of a loan.

(2) Government may guarantee a minimum dividend of 3 or 4 per cent in which case they should have some kind of control in the organization of the factory and a large share in the profits over a certain limit.

(3) The industry may be started by private individuals or companies, Government giving only technical advice and guidance.

In the case of industries of all-India importance such as coal carbonisation and nitrogen fixation the possibility of co-operation of all the provinces in raising funds and shouldering the financial responsibilities should be explored.

In conclusion the Committee wish to mention the difficulties under which they had to draw up the present report and the consequent shortcomings thereof. The time at their disposal was too short and the work was done by the members in the intervals of their normal duties in course of about three months. They hope, however, that they have brought together sufficient materials to help Government to decide whether or not it will be worth their while to proceed further with any of the schemes mentioned in the report.

The Committee wish to record their thanks to their Secretary Dr. S. C. Neogy, D.Sc., whose memoranda on the various industries have been of very great help to them. Dr. Neogy collected most of the informations given in this report by personal visits to industrial centres in Calcutta and without his help it would have been impossible to prepare the report in such a short time.

A summary of the Committee's recommendations will be found at the end of the report.

APPENDIX I.

No. 2118-D.

GOVERNMENT OF BIHAR.
DEVELOPMENT DEPARTMENT.

—————
RESOLUTION.
—————

Patna, the 28th November 1938.

At an informal conference held at Ranchi on the 24th and 25th October 1938 under the presidency of the Hon'ble Minister for Education and Development, to consider the industrial planning of Bihar, it was decided to form various committees for carrying out detailed investigation into the prospects of different industries in the province. The Government are, accordingly, pleased to appoint the following committees with the members mentioned under each :—

(a) CHEMICAL INDUSTRIES COMMITTEE.

1. Mr. A. S. Khan, L.E.S., Principal, Science College, Patna—*Convener.*
2. Mr. Chakreshwar Kumar Jain, M.L.A.
3. Dr. V. S. Dubey, M.Sc., Ph.D. (London), D.L.C., Professor of Economic Geology, Benares Hindu University.
4. One Industrial Chemist.

The Committee may co-opt as a member the Agricultural Chemist while dealing with chemical fertilisers and Mr. S. K. P. Sinha, Special Officer, while dealing with fuel and power generation.

(b) MECHANICAL INDUSTRIES COMMITTEE.

1. Mr. P. N. Mathur, the Tata Iron and Steel Company, Limited, Jamshedpur—*Convener.*
2. Mr. J. Tullis, Principal, Bihar College of Engineering, Patna.
3. Mr. N. N. Rakshit, General Manager, Tatanagar Iron Foundry, Jamshedpur.
4. Mr. B. K. Rohatgi, India Electric Works, Limited, Calcutta.
5. Mr. G. N. Maity, Managing Director, Vishwakarma, Limited, Dharamtola Street, Calcutta.
6. Mr. Gur Sharan Lall, Proprietor, Gaya Cotton Mills, Limited.

(c) COTTAGE INDUSTRIES COMMITTEE.

1. Mr. S. N. Dhar, I.C.S.—*Convener.*

APPENDIX I—*contd.*

3. Mr. Lakshmi Narayan Sahay, Secretary, Bihar Branch of the All-India Spinners' Association, Madhubani.
4. Mr. B N. Sarkar, Senior Marketing Officer, Bihar.
5. Dr. Gyan Chand, M.A., Ph.D. (London), Professor of Economics, Patna College.
6. Mr. K. S. Rao, Textile Expert, Member-Secretary.

2. All the three committees will have the power to co-opt additional members for dealing with particular problems, if they consider it necessary.

3. The Chemical Industries Committee and the Mechanical Industries Committee will also deal with all the cottage and small industries coming within their respective scope. The Cottage Industries Committee will therefore, meet after the reports of the other two committees are available.

ORDER.—Ordered that the resolution be forwarded to the Director of Industries and to all the members of the committees.

Ordered also that the resolution be published in *Bihar Gazette*.

By order of the Governor of Bihar,

S. M. DHAR,

Secretary to Government.

MEMO. NO. 2118-D.

Patna, the 28th November 1938.

Copy forwarded to all members of the committee and the Director of Industries for information.

2. The Chemical Industries Committee and the Mechanical Industries Committee will each have the services of a whole-time Secretary to be appointed by Government, orders about which are under issue separately.

3. The enclosed list shows the distribution of industries between the Chemical Industries Committee and the Mechanical Industries Committee but it is not exhaustive and is drawn up as a general guide.

4. The Chemical Industries Committee will meet at Ranchi, the Mechanical Industries Committee at Jamshedpur and the Cottage Industries Committee at Patna. Government hope that the Mechanical Industries Committee and the Chemical Industries Committee will be able to submit their reports by the end of December 1938 and the Cottage Industries Committee by the end of January 1939.

By order of the Governor of Bihar,

B. B. SINGH,

Assistant Secretary.

APPENDIX I—*concl'd.*

INVESTIGATION OF PROSPECTIVE INDUSTRIES IN BIHAR.

MECHANICAL INDUSTRIES COMMITTEE

- | | |
|---|-----------------------------------|
| 1. Machinery and Mill work. | 8. Toys and requisites for games. |
| 2. Metals. | 9. Bobbins. |
| 3. Vehicles. | 10. Umbrella and Fittings. |
| 4. Instruments, apparatus and appliances. | 11. Cutlery. |
| 5. Hardware. | 12. Furniture and cabinet ware. |
| 6. Building and Engineering materials. | 13. Clocks, watches and parts. |
| 7. Arms, ammunition and military stores. | 14. Coir and hemp. |

CHEMICAL INDUSTRIES COMMITTEE.

- | | |
|--|-----------------------------------|
| 1. Oils. | 14. Boots and shoes. |
| 2. Dyes. | 15. Tallow and stearine. |
| 3. Artificial silk. | 16. Gums and Resins. |
| 4. Chemicals, including pharmaceutical. | 17. Paper making materials. |
| 5. Paper and pulp including artificial silk and celluloid. | 18. Coal and coke. |
| 6. Rubber manufactured. | 19. Matches. |
| 7. Glass and glassware. | 20. Leather, raw hides and skins. |
| 8. Paint and painters materials. | 21. Oil cakes. |
| 9. Manures. | 22. Lac. |
| 10. Toilet requisites. | 23. Rubber raw. |
| 11. Belting for machinery. | 24. Mica. |
| 12. Earthenware and porcelain. | 25. Bones. |
| 13. Soap. | 26. Candles. |
| | 27. Minerals. |

CHAPTER II.

RAW MATERIALS OF BIHAR FOR CHEMICAL INDUSTRIES.

(A) Minerals. (B) Agricultural products. (C) Forest Products.

Before dealing with the Chemical Industries proper we wish to give a general survey of the raw materials available in the province as Chemical Industries must be ultimately based on these raw materials.

(A) MINERALS.

The following list represents the minerals of Bihar :—

- | | | |
|-----------------------|-----------------------|-----------------------------------|
| 1. Coal | 8. Glass making sand. | 15. Gemstone. |
| 2. Iron ore. | 9. Barytes. | 16. Graphite. |
| 3. Copper ore. | 10. Bauxite. | 17. Manganese. |
| 4. Mica. | 11. Kyanite. | 18. Apatite and other phosphates. |
| 5. Potassium nitrate. | 12. Chromite. | 19. Quartz and quartzite. |
| 6. Fire clays. | 13. Asbestos. | 20. Steatite. |
| 7. China clays. | 14. Limestone. | 21. Building materials. |

Most of these deposits are being worked in the province. Besides these there are several other deposits which are known to occur but which are not being worked :—

- | | | |
|------------------|---------------------|------------------------------|
| 1. Antimony ore. | 7. Fuller's earth. | 13. Platinum. |
| 2. Arsenic ore. | 8. Gold. | 14. Sodium sulphate. |
| 3. Bismuth ore. | 9. Lead and silver. | 15. Zinc ore. |
| 4. Cobalt ore. | 10. Tungsten ore. | 16. Radium and Uranium ores. |
| 5. Tin ore. | 11. Magnesite. | |
| 6. Corundum. | 12. Molybdenum ore. | |

In many cases detailed information is lacking and it is possible that further investigation may make their commercial working feasible.

Coal.—This is the most important of the Bihar minerals. This province is fortunate in having the largest deposits of coal in India. The chief deposits are at Jharia, Raniganj, Bukaro, Ramgarh, Giridih and Raj Mahal. Some of these are still undeveloped being far off from railways. Most of these coals are quite suitable for metallurgical purposes. The occurrence of iron in the neighbourhood makes these deposits of exceptional

value. Unfortunately the mines are not being worked either efficiently or economically, and the coal itself is being consumed most unscientifically. It is true that there are coke oven plants at Barhahi, Lodhna and Giridih and the iron and steel companies are manufacturing and using about 19 lakhs of tons of *hard* coke and recovering some of the bye-products, but the present condition of the *soft* coke industry is very backward. The coal is heated in open air and all the volatile matter is allowed to escape. Nearly $\frac{1}{3}$ rd of the total quantity of coal extracted is lost in the coalfields because it is in too finely powdered a state to be used in the ordinary way. Power plants utilizing pulverized fuel might be one of the solutions of this problem.

Iron ore.—As regards the occurrence of iron ores Bihar is the most important province in India. As we have already stated the occurrence of suitable coal deposits in the province and also of such materials as limestone, chromium and manganese makes this deposit of special significance. At present iron and steel are being manufactured for the production of ordinary goods only such as sheets, girders, rails and other common articles. If India has to be industrialized it is necessary that more highly specialized products must also be manufactured. Several kinds of alloy steels which require chromium, manganese, nickel, tungsten, etc., for their manufacture should be produced as they are indispensable in most heavy machinery and chemical industries.

Copper.—India has been a great copper producing country in the past but during the last century competition with better and cheaper goods from abroad killed this village indigenous industry. In these days small plants have no chance of surviving before modern methods of manufacture. At present manufacture of copper on more modern lines has been started at Ghatshila in this province. The total production of this Copper Corporation is valued at about Rs. 80 lakhs. In some chemical operations special alloys containing copper are required. The production of such alloy will become increasingly important as the Chemical Industry advances. Another problem in connection with the manufacture of copper in India is the utilization of sulphur in the ore. The concentrated ore contains about $\frac{1}{3}$ rd of its weight of sulphur. No attempt is made to utilize this sulphur. This means that we are wasting about 7,000 tons of sulphur every year. As there are few sources of sulphur in India the problem of utilizing this source of sulphur in the interest of key industries like the sulphuric acid industry is deserving of most serious consideration.

Mica.—India is one of the largest producer of mica and of the total quantity exported, Bihar furnishes some 80 per cent. The export figures are given below :—

	1935-36.	1936-37.	1935-36.	1936-37.
			Rs.	Rs.
Mica..In blocks	24,528 cwt.	27,295 cwt.	41,64,650	47,08,397
Mica..In splittings	142,121 „	152,299 „	41,53,997	46,97,580

The electrical machinery industry is dependent upon mica and in the absence of any such industry in India, the only possible way of disposal of mica is to export it to the European countries. Micanite, a valuable insulating material, is manufactured from thin sheets of mica and shellac. It would not be impossible to undertake the manufacture of micanite goods in Bihar but the protective tariff in the European countries, will make the disposal of the articles difficult. Waste mica may, however, be utilized mixed with asbestos powder and a binding material for a composition of boiler covering, which is now imported.

Saltpetre.—It is found in large amount in Bihar. It is extracted by dissolving the soil containing the salt and filtration. Most of the saltpetre is used in the manufacture of gun powder and small quantities also serve as manure. In Bihar it is produced to the extent of about 2,000 tons a year. India exports about 8,500 tons of saltpetre annually costing about 13 lakhs of rupees or about Rs. 7 per cwt. It is a very important compound as it contains potash, a valuable constituent of manures. In India apart from wood and plant ashes there are no other sources of potassium and so this is the ultimate raw material from which all the requirements of potash salts in India can be met.

Glass, Ceramic and Refractory raw materials.—These include glass making sands, China clays, fire clays, silliminite, kyanite, silica and graphite all of which are known to occur in the province. Besides these plenty of quartz and felspar are available which on crushing can be utilized for glass industry.

The glass sands are found near Rajmahal Hills, and in the south they are found near Barakar while quartz occurs in many places of a quantity suitable after crushing for glass manufacture. Quartz and felspar are associated with mica and occur in the mica belt of Hazaribagh.

Barytes.—It is found in the Singhbhum district but the mineral has not been much exploited till now. It is being mined in small amounts, its chief use being in the paint industry.

Chromite—Occurs in Bihar in several localities near Chaibassa. It has not been mined extensively till now, but there are good reserves of this mineral. One important use for it would be in the manufacture of alloy steels, as such steels are very important in machinery manufacture. Chromite can also be used in the manufacture of potassium dichromate necessary in the tanning industry as potash salts also are available in the province. Neutral refractories can be manufactured out of chromite which are used for steel and other metallurgical industries.

Asbestos—Is found in Singhbhum district. It has been mined in small amounts but has not found much use in the country till now. The production in India of asbestos most of which comes from Bihar amounts to nearly 90 tons annually. Though Indian asbestos is not of very good quality still it can replace much of what is imported at present from foreign countries. It can be used for the manufacture of eternite sheets and roofing materials. The import of raw asbestos annually is worth about 2 lakhs of rupees while that of finished goods is over 12 lakhs giving a total of nearly 15 lakhs of rupees. Most of this can be substituted by the asbestos found in Bihar.

Limestone.—Limestone has great many uses these days. It is used in various industries such as lime, cement, iron and steel, glass, chemicals, etc. Of these the most important use is in the cement and iron and steel industries. Bihar is very fortunate in having large deposits of limestone in close proximity to other suitable materials. In Bihar there are at present three cement factories manufacturing about 1,500 tons of cement per day worth nearly Rs. 50,000 or more than a crore of rupees per year. Bihar limestone is also used exclusively at the Tata Iron and Steel Works, as well as the Indian Iron and Steel Works. It has not been much used in the chemicals and glass

industries till now. The reserves of this mineral in the province are said to be enormous and can adequately supply the growing need of all the industries.

Bauxite—Is the ore of aluminium. Large deposits of bauxite are found near Ranchi and Palamau districts situated quite near the coalfields from which cheap current can be generated for aluminium manufacture. The amount of bauxite is large and the quality fairly rich. This industry has great future in Bihar as aluminium is used in many industries. The present import of aluminium in India amounts to about 3,000 tons including wrought and unwrought materials worth about 43 lakhs of rupees.

Graphite—Does not occur in large amounts in the province, and the quality of the mineral requires investigation. It is used for the manufacture of crucibles and other refractory materials.

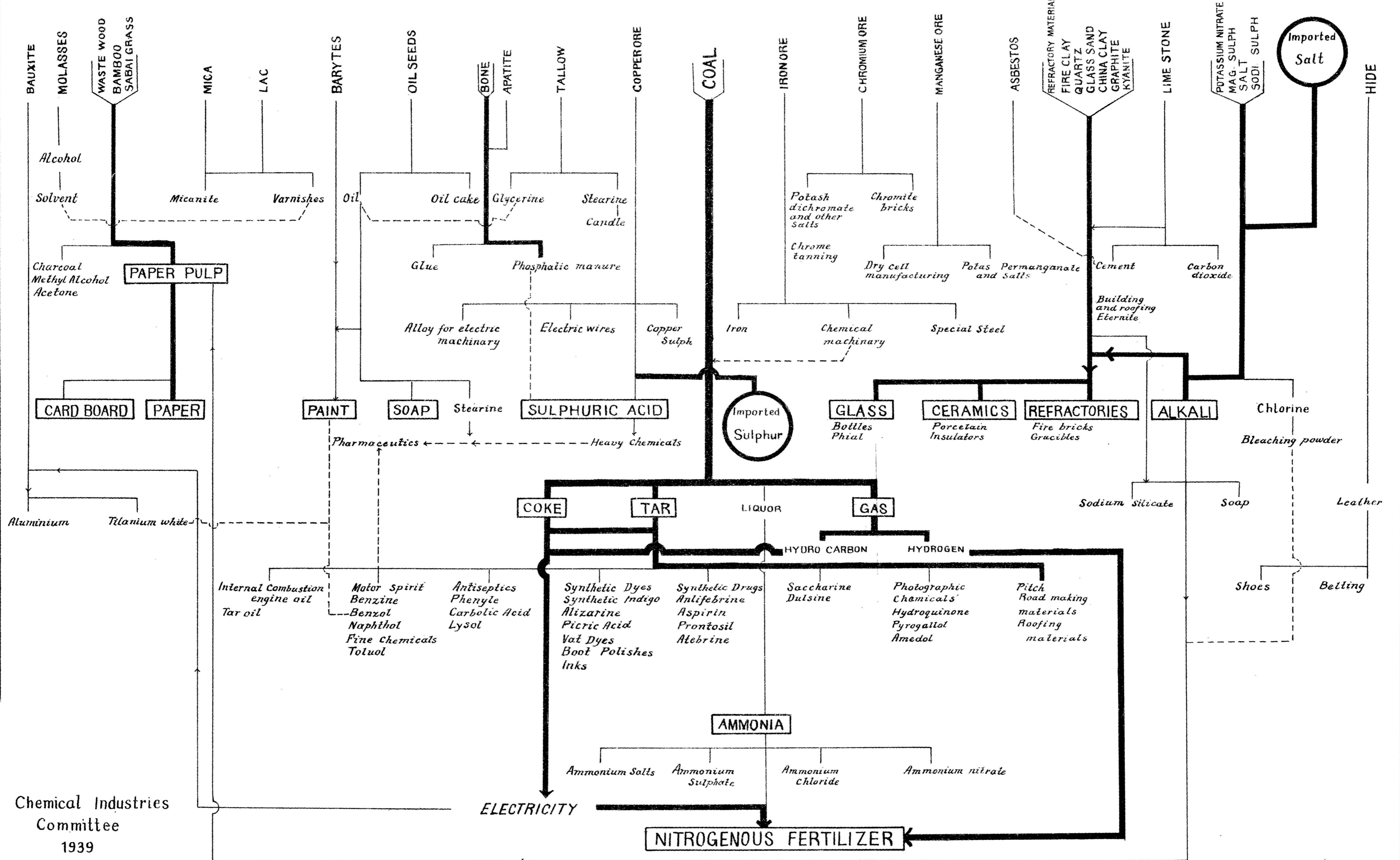
Manganese.—Ores of manganese are found in several localities in the province. The deposits of importance are those in the Gangpur State and in Sirghbhum. The production of the metal in the province in 1936 amounted to nearly 12,000 tons. Manganese is used in the manufacture of ferromanganese and where it is obtained in a pure condition it can be used for glass industry.

Besides the above many other minerals are found in the province, but these have not been fully investigated. As the country advances industrially the value of these minerals is bound to increase. At present it is not possible to suggest any method of exploiting them.

(B) AGRICULTURAL PRODUCTS.

Bihar is very rich in agricultural resources. Rice, wheat, maize, linseed, rape and mustard, groundnuts, pulses, etc., are grown abundantly in the province. Fruits like mangoes and lichees are also plentiful. The relationship of agricultural products to chemical industries arises from two causes. Firstly chemical manures are necessary for intensive cultivation and secondly some of the agricultural products are required as raw materials in certain chemical industries. Oil is required for soap and paint industries, glycerine and toilet preparations. Similarly fruits can be converted into jams and preserves while food-grains can be used for biscuit making and other such industries. It is not necessary for us to go into greater details as the memorandum submitted by Mr. B. N. Sarkar gives all the relevant facts and is exceedingly interesting.

CHART
SHOWING THE RAW MATERIALS OF BIHAR AND THE CORRELATION OF THE CHEMICAL INDUSTRIES WHICH CAN BE BASED ON THEM



Chemical Industries
Committee
1939

A.S.K.

CHAPTER III.

ECONOMIC TREATMENT OF COAL.

Low Temperature Carbonisation.

The coal deposit of any country is an asset of the greatest national importance and its conservation should engage the attention of all well wishers of the country quite apart from the question of immediate industrial developments. It is a duty which we owe not only to the present generations of India but to posterity. Bihar is the principal coal-producing province in India. This will be evident from appendices 3 (a) and 3 (b). It will also be evident that in Bihar the chief coal-producing locality is Jharia. The total reserve of coal in India is stated to be 54,467 million tons of which 30,573 million tons is in Bihar. The total reserve of coking coal in India is said to be 3,948 million tons of which 2,940 is in Bihar. When we examine the actual production figures we find that Bihar contributes as much as 53 per cent of India's production of coal and Jharia alone produces about 41 per cent. Any scheme of coal conservation in India should, therefore, be initiated at Jharia where it has the best chance of success and indeed is likely to produce the maximum effect.

Coal conservation.

That the need for coal conservation is urgent will appear from the following extracts :—

“The working of great seams in this country has resulted in a confessedly immense wastage, almost unparalleled elsewhere..... This wastage whatever be the cause, is a scandal for which the present generation will ultimately be called to account”. (John, Henry, Trans. Min. and Geol. Inst., Vol. XXIV, 1929, pages 117-118.)

“With regard to conservation of coal and the Grading Board, it so happens that in the Jharia coalfields there are certain thick seams of which only a part of the section has been graded as ‘selected’ or ‘first class’. Now many companies cannot dispose of anything inferior to at least ‘first class’ graded coal at the present day, so they have no alternative but to work only the better graded section of these seams, and leave the rest which, in some cases, amounts to 60 per cent of the total coal in the seam;

this portion, in one particular instance being in the upper part of the section is entirely lost to posterity, when the lower and better part of the seam is goaved. The top portion, although not graded as 'selected' or 'first class' is a very valuable coal which may some day be wanted". (Starksfield—Trans. Min. and Geol. Inst., Vol. XXIV, 1929, pages 117-118.)

"In the absence of good market second class coal is being neglected and sometimes unmined. Better class coals normally, suitable for metallurgical purposes sometimes occurring below the second class coal are being extracted and used up in large quantities for boiler firing..... After this extraction the whole of the upper layer of rocks, together with millions of tons of second class coal are allowed to go down into goaf consisting of a hopelessness of rock and coal debris from which there is absolutely no chance of the economic extraction of coal. Thus not only is a large quantity of coal occurring at the deeper regions of the mine, faced with the danger of abandonment on account of fire, flood and the present day methods of faulty working but many coal seams occurring near the surface are also being ruined". (S. K. Roy—Bulletin no. 1, 1937. The Geol. Min. and Metal. Soc. of India, page 1.)

From the above it is clear that there is urgent need for a scheme of coal conservation in the province. This is all the more necessary as the reserve of coal in India is extremely poor compared with the population of the country. Now if we analyse the various causes of wasting of coal we find that the two main causes are:—

- (1) Bad methods of working.
- (2) Want of market for second and lower grade coals.

In this report our purpose is to suggest remedies for the second cause of waste, i.e., to find market for second and lower grade coals. Various suggestions have been made to bring about this result. Among these are the following:—

- (1) To encourage the use of second class coal in boilers.
- (2) To manufacture oil from low grade coals.
- (3) To manufacture smokeless fuel or soft coke from low grade coals and to make use of the bye-products for

industrial purposes such as the manufacture of oil and fertilisers and the generation of electricity. To us it seems that item (3) should be taken in hand first.

It has been shown that generally speaking Jharia coals are quite suitable for the manufacture of soft coke by Low Temperature Carbonisation and many valuable bye-products can be recovered. (R. C. Bhattacharjee—*Qurt. Jour. the Geol. Min. and Metl. Soc. of India*, Vol. I, page 101, K. L. Roy, S. S. De and B. C. Guha, *Ind. and News Edn. of J. Ind. Chem. Soc.*, 1938, page 48.)

From the available data of consumption of coal in India it will be seen that barely 3 million tons of coal are used for household purposes. Without question it can be asserted that there are possibilities of great expansion in the household coal trade. In order to help this branch of the coal industry an act (Act VIII of 1929) known as "Indian Soft Coke Cess Act" was enacted. The main features of this are (1) "to levy and collect on all soft coke despatched by rail from collieries in the provinces of Bengal, Bihar and Orissa a cess at the rate of two annas per ton" and (2) "the proceed of the cess and any other monies received by the committees shall be applied to meeting the expenses of the committee and the cost of such measures as it may consider advisable to take for promoting the sale and improving the methods of manufacture of soft coke".

Although due to the efforts of the soft coke cess committee consumption of soft coke is increasing year by year yet from the fact that only 860,000 tons of soft coke are consumed annually (note on the production and consumption of coal in India, 1934, p. 1870), it is evident that only a few million people use it. For large circulation of this material it is necessary that this fuel should be available at a cheaper rate.

According to the present day method of manufacture of soft-coke in the coalfields about 100 tons of coal is burnt to produce only 50 tons of soft coke. (Rec. G. S. I., Vol. LXIV, 1930, p. 67.) By this method all the bye-products are lost. But when a ton of coal is subjected to a low temperature carbonisation process about 15 gallons of tar yielding 1.5 gallons of motor spirit can be recovered. (Bulletin 1, 1937—*The Geol. Ming. and Metl. Soc. of India*—p. 47.) Also by the same process one ton of coal yields about 14 cwts. of soft coke that is recovery is about 70 per cent against 50 per cent in the ordinary method.

Even taking the present day consumption of soft coke it will be seen that about 2 crore gallons of tar yielding 20 lakhs gallons of motor spirit are wasted every year. If a scheme of low temperature carbonisation can be shown to be feasible the abovementioned valuable bye-products will not be allowed to be wasted.

COAL CARBONISATION.

When coal is subjected to a suitable process of destructive distillation (carbonisation) the following primary products are obtained :—

- (1) A smokeless fuel (coke).
- (2) Coal-tar.
- (3) Ammonia.
- (4) Coal gas.

The quantity of the products varies with the kind of coal and the process of coking. On the average one may assume that 1 ton of coal will produce 14 cwt. of soft coke, 15 gallons of tar, 5,000 cubic feet of gas and 25 lbs. of ammonium sulphate.

Soft coke can be used as domestic fuel; but it can also be utilized for all purposes for which coal can be utilized including the firing of boilers and the manufacture of gaseous fuel (producer gas and water gas). Coal-tar can be utilised for the manufacture of various liquid fuels for motor and diesel engines or as nucleus of synthetic dye and organic chemical industry. Coal gas can be burnt either in an internal combustion engine or under a suitable boiler for the generation of power which can be obtained in the form of electricity and transported to long distances. The hydrogen in the coal gas can if so desired be separated and utilized for the manufacture of ammoniacal fertilisers and for other purposes. The gas remaining after the removal of hydrogen can be burnt for the production of heat or electricity in the usual manner.

THE ECONOMICS OF THE PROCESS.

It has not been possible for us in the short time at our disposal to obtain recent quotations from abroad for low temperature carbonisation plants. Consequently figures based on such quotations cannot be included in the report. However the illustration given below may serve to explain the nature of the problem with which we have to deal

In a well known publication (Lander and McKay, Low Temperature Carbonisation, page 269) the following balance sheet is given to illustrate the economics of low temperature coal carbonisation for conditions prevailing in England soon after the war :—

Sheet A.

Income.			Expenditure.				
£. s. d.			£. s. d.				
Coke 14 cwt. at 20 sh. per ton.	0	14	0	Coal 1 ton at 20 sh. per ton.	1	0	0
Tar 15 gallons at 5 d. ..	0	6	3	Cost of carbonising including fuel.	0	4	0
Gas 30 therms. at 4 d. . .	0	10	0	Interest and depreciation.	0	4	0
Total ..	1	10	3	Total ..	1	8	0

Favourable balance 2 sh. 3 d. or 11 per cent on cost of plant.

If we were to apply the above figures to conditions in India the following balance sheet will result :—

Sheet B.

Income.			Expenditure.					
Rs. a. p.			Rs. a. p.					
14 cwt. of coke at Rs. 4 per ton.	4	2	13	0	1 ton coal at Rs. 2 ..	2	0	0
15 gallons of tar at annas 3.	2	13	0	Cost of carbonisation including fuel.	1	7	3	
Gas 5,000 cu. ft. ..	0	6	6	Interest and depreciation.	2	8	0	
Total ..	6	0	6	Total ..	5	15	3	

Favourable balance annas 0-1-3.

In this balance sheet Indian price of raw materials and products has been substituted for the English price. The cost

of coal is put down at Rs. 2 per ton because it is only the inferior kinds of coal which will, in practice, be subjected to low temperature carbonisation. The cost of interest and depreciation will not alter very much while the cost of carbonisation will be reduced as it includes fuel also. In sheet A the cost of carbonisation is four shillings which includes the cost of $\frac{1}{10}$ ton of coal which at 20 shillings per ton will amount to 2 shillings. If we exclude the cost of fuel, the cost of carbonisation alone will be 2 shillings or Rs. 1-4-0. To this must be added the cost of fuel at the Indian rate of Rs. 2 per ton i.e., annas 0-3-3. Thus the total cost of carbonisation will amount to Rs. 1-7-3 per ton.

On the income side the price of coke and tar is in accordance with the present day market rates. The price of gas is according to its value as a fuel reduced to its equivalent in Indian coal.

The conclusion to be drawn from this balance sheet is that if expensive imported machinery of such a type is used that the depreciation and interest charges would amount to Rs. 2-8-0 per ton of coal treated, then the margin of profit will be small although even in this case there will be no actual loss. It is clear from this that every effort will have to be made to keep the cost of carbonisation and depreciation as low as possible.

Dr. H. K. Sen of the Lac Research Institute, Namkum, has been conducting researches on coal carbonisation for a number of years. We have examined the result of his experiments and have privately discussed the matter with him. It is clear to us that if the cost of machinery is reduced by making use of the simplified type of plant devised by him low temperature carbonisation will become not only a practicable but a most profitable industry for Bihar. For comparison with sheets A and B above we give sheet C below which is based on Dr. Sen's experiments.

Sheet C.

Income.	Rs. a. p.	Expenditure.	Rs. a. p.
Price of 14 cwt. of coke at Rs. 2-12-0.	1 15 3	1 ton coal at Rs. 2 per ton.	2 0 0

	Rs. a. p.		Rs. a. p.
Gas 5,000 cu. ft. ..	0 6 6	Cost of 7—100 tons of fuel.	0 2 4
		Labour ..	0 6 0
		Over-heads ..	0 2 4
			<hr/>
		Total ..	0 10 8
			<hr/>
		Interest and depreciation at 15 per cent on 1,000.	0 7 0
			<hr/>
Total ..	5 2 9	Total ..	3 1 8
			<hr/>

Favourable balance Rs. 2-1-1 per ton of coal carbonised.

Our colleague Mr. S. K. P. Sinha has suggested certain amendments in prices of tar, coke and coal in this sheet which will have the effect of reducing the margin of profit to a certain extent as shown in sheet D below.

Sheet D.

Income.	Rs. a. p.	Expenditure.	Rs. a. p.
14 cwt. coke at Rs. 5	3 8 0	Coal at Rs. 3 per ton ..	3 0 0
15 gallons tar at annas 2	1 14 0	Cost of carbonisation ..	0 10 8
Gas ..	0 6 6	Depreciation and interest.	0 8 0
			<hr/>
Total ..	5 6 6	Total ..	4 2 8
			<hr/>

Favourable balance Rs. 1-3-10.

Dr. Dubey has worked out a balance sheet based on imported machinery in accordance with American practice and finds that even in case of this type of machinery there will be ample profit. We give his figures as balance sheet E.

Sheet E.

Income.	Rs. a. p.	Expenditure.	Rs. a. p.
14 cwt. coke at Rs. 2-12-0.	1 15 3	Coal at Rs. 2 per ton ..	2 0 0
17 gallons tar at annas 3.	3 3 0	Cost of carbonisation...	0 11 6
Gas utilized for heating.	0 0 0	Interest and deprecia-	0 14 6
Therefore no income from it.		tion.	
Total	... 5 2 3	Total	.. 3 10 0

Favourable balance Rs. 1-8-0.

In all the above computations the price of tar has been assumed to be not more than annas three per gallon but we hope that once the coal distillation process comes into general use the further working up of the tar into useful products will also be started. The extended use of internal combustion engines for the production of power is bound to create a good market for distilled tar to be used as liquid fuel. The effect of all this will be that the price of tar will not only be maintained at its present value but will very probably increase.

In none of the balance sheets have we taken the value of ammonium sulphate into consideration. We are certain that the isolation of this substance will become a valuable source of additional income to the coke manufacturers. According to the nature of the coal and of the process of carbonisation 14—40 lbs. of ammonium sulphate per ton of coal can be obtained. Assuming 25 lbs. to be the average, the cost of manufacturing ammonium sulphate will be about six annas which according to the present market price of Rs. 100 per ton will fetch annas eleven and thus leave a clear margin of five annas to be added to the income side of the balance sheets given above.

The price of gas has been assumed to be annas 0-6-6 only on the basis of its value as second class fuel in terms of coal at Rs. 2 per ton. In our opinion this is a very conservative estimate. Gas as fuel is too valuable to be ranked as a second class fuel. If we treat it as a first class fuel its price can be easily doubled and if it is found possible to utilize even a portion of it either as illuminant or for the manufacture of chemicals its value will be still more increased.

We thus see that the balance sheets as they stand are far from discouraging. But the important thing to remember (and which does not appear in the balance sheet, is that on the asset side we should also place the advantages of coal conservation and the prevention of the disastrous consequences of the waste of low grade coals which we have fully explained in the beginning of the chapter. To these advantages may be added those arising from the starting of certain key industries in the country which are based on coal carbonisation, of finding employment for the educated young men of the province and of preventing the smoke nuisance which though not so great as in European countries is bound to increase in future and is already a menace to health in the larger towns.

SUGGESTIONS.

A comparison of the balance sheets shows that there is distinct agreement between sheets (C) and (D) but sheet (B) characterises itself by increased allowance on the cost of plant imported from abroad. If the cost of this plant is reduced to Rs. 2,500 per ton of coal treated per day or even to Rs. 3,000 as appears to be indicated from reference to the cost of plants already in operation abroad and if corresponding charges for depreciation and interest are effected in balance sheet (B), the margin of profit becomes Re. 1-1-6 per ton. It would appear, therefore, that low temperature carbonisation under Indian conditions is a profitable venture, apart from its far reaching influence on the general economy of coal in the country.

We are definitely of opinion that the present wasteful method of making soft coke by burning coal in heaps in the open should not be allowed to continue. The committee definitely recommend to Government that immediate and imperative steps should be taken to stop this irrational method of handling coal.

Having thus established a definite objective the next question that arises is what method should be adopted of bringing it about. As we have already stated Dr. H. K. Sen has been working on a special method of low temperature carbonisation about the potentialities of which we are very hopeful. In fact he has already got a plant working on a miniature scale at Namkum. A somewhat enlarged experiment on the same line is about to be conducted at the Science College, Patna and it is our hope and belief that that experiment will yield valuable results which will go to show conclusively that this scheme of low temperature carbonisation can be made a commercial success.

even on a comparatively small scale. We are conscious of the fact that the experiment at the Science College is yet in an embryonic stage, but the committee after considering the potentialities of the scheme feel justified in entertaining the hope as outlined above.

For the reason given above the committee recommend to Government to prohibit by legislation the present open air method of the manufacture of soft coke. Firms and individuals who are engaged in this trade can make it by the new process. The capital cost involved is by no means prohibitive and Government, by way of assistance to them should make plans available and should give all facilities and help. With this method of manufacture of soft coke two bye-products will become available. One is gas which the manufacturer will be able to utilise himself in heating the retort and the second bye-product will be crude tar.

In the opinion of the Committee Government should guarantee the purchase of all the the tar at a fixed price of annas two per gallon to such producers as are prepared to enter into agreement with Government as to its sale for a long term. The tar should be dealt with at a central factory under state auspices.

While we are convinced of the soundness of our above recommendations we are of opinion that before undertaking legislation it will be advantageous for Government to invite the present producers of soft coke to a conference and discuss with them the specific steps suggested above.

The committee are not prepared to recommend to Government to start a big central carbonisation plant by itself, but they feel justified in suggesting that the question of putting up a plant in connection with the Electrification Scheme where the products may be utilised in that scheme for heating the boilers, may be properly examined and investigated.

SUMMARY OF RECOMMENDATIONS.

(1) Open air method of soft coke manufacture should be prohibited by legislation and the manufacturers required to instal low temperature carbonisation plant.

(2) Government should guarantee the purchase of all the tar produced.

No central factory for coal carbonisation should be erected by Government but possibility of erecting a plant in connection with the Electrification Scheme should be investigated.

APPENDIX III(a).

Reserve of coal of all kinds in India (in million tons).

Coal fields.			Total all kinds of coal.	Total coals of coking quality.	All coals other than coking coals.
			Ton.	Ton.	Ton.
Bihar.	Giridih	60	40	20	
	Jharia	20,500	2,300	18,200	
	Bokaro Ramgarh ..	1,000	600	400	
	Karampura South ..	75	} Not fully tested.	8,975	
	Karampura North ..	8,900			
	Auranga	20	..	20	
	Hutar	9	Said to be some.	9	
	Daltonganj	9	...	9	
	Rajmahal area ..	200	Not properly tested.	200	
Total		30,773	2,940	27,833	
Raniganj	22,000	408	21,592		
Sirguja, Korba, Sambalpur ..	200	Some in Korba small quantity.	..		
Talchar	44	..	44		
Wardha and Godavari valleys ..	400	..	400		
Satpura Region	150	Some very small amount.	..		
Assam	600	600	There are some.		
Other fields	100	..	100		
Total		54,467	3,948	50,519	

APPENDIX III(b).

Annual production of coal from various coal-fields in India.

Countries.				Year 1934.	Per cent of total.
				Ton.	Ton.
Bihar—					
Bokaro	..	...	..	1,399,261	6.34
Giridih	..	...	...	761,010	3.45
Jainty	..	..	..	42,717	0.19
Jharia	..	...	..	9,057,546	41.06
Karanpura	..	..	..	397,147	1.80
Rajmahal Hills	..	..	..	1,599	0.01
	Total	..	..	11,659,280	52.85
Bengal and Orissa—					
Rampur	..	...	...	28,128	0.13
Raniganj	..	..	..	6,795,838	30.81
Talchar State	..	..	..	306,649	1.39
Central India—					
Sohagpur (Rewah)	..	..	..	194,638	0.88
Umaria (Rewah)	..	..	..	94,743	0.42
Central Provinces—					
Ballarpur (Chanda)	..	..	..	321,038	1.46
Korea State	..	..	..	400,350	1.82
Pench Valley	..	..	..	1,117,942	5.07
Raigarh State	..	...	...	3,162	0.01
Hyderabad—					
Sasti	...	..	...	41,880	0.19
Singareni	..	..	..	527,989	2.39
Tandur	..	..	..	199,767	0.91
	Total	..	..	21,691,404	98.34

ADPENDIX III(b)—concl'd.

Countries.	Year 1934.		Per cent of total.
		Ton.	Ton.
Assam—			
Makum, etc.		186,313	} 0.86
Khasi and Jaintia hills		3,214	
Baluchisthan—			
Kalat State		4,221	} 0.07
Khost (Sibi district)		4,161	
Quetta (Fishin district) ...		6,358	
Punjab (Salt Range)—			
Jhelum district		54,909	} 0.57
Mianwali district		64,986	
Shahpur district		5,371	
Rajputana—			
Bikaner		36,510	0.16
Total		336,043	1.66
Grand total		22,057,447	100

(Note on the production and consumption of coal in India 1934, pages 2-3).

CHAPTER IV.

SYNTHETIC FERTILIZERS.

Nitrogen Fixation.

As we have already stated previously the economic treatment of coal is an all-India problem. We have also seen that its chance of success will be greatly increased if it is combined with other useful schemes for the utilisation of tar and gas which will help the industrial development of the province. One such scheme is the production of nitrogenous artificial fertilizers by the process of nitrogen fixation. We have chosen this item to be in the fore-front of our programme for the following reasons:—(1) All the raw materials required for the industry are available in Bihar. Coal the most important material is obtainable more cheaply in this province than anywhere else in the world. (2) This industry can be made to fit in with a scheme of coal conservation, and soft coke manufacture. (3) There will be no difficulty in marketing the products. (4) India is principally an agricultural country and nitrogen fixation for the production of a cheap fertilizer is of the greatest national importance and is pre-eminently a key industry.

Two of the essential things required for intensive cultivation are water and fertilizers. In the past a great deal has been done to extend the benefit of irrigation but as regards fertilizers, almost nothing has been done with the result that India has to import a large amount of synthetic fertilizers from abroad. At present the amount of ammonium sulphate imported into the country can satisfy the need for nitrogen for a very small acreage only and the cost is too high to bring it into general use. For the agricultural prosperity of India it is necessary that fertilizers like ammonium sulphate should be available at as cheap a cost as possible. For this it is necessary to have a cheap and abundant source of ammonia.

For the production of ammonia most of the civilised countries of the world have got well established nitrogen fixation industry. In countries like Germany, Japan, United States of America and U. S. S. R. the amount of fixed nitrogen produced per year amounts to two to four lakhs of tons while in India even a beginning has not yet been made. India is importing about 60,000 tons of ammonium sulphate per annum which means about 12,000 tons of fixed nitrogen. This amount is nothing compared with the production of three lakh tons of fixed

nitrogen or about 15 lakhs tons ammonium sulphate in Japan and similar production in other countries. There has been a great increase in the number of plants for nitrogen fixation during the last few years and now it has become comparatively an easy task to obtain suitable plants.

The chief raw materials for the manufacture of synthetic ammonia are nitrogen and hydrogen which are combined under certain conditions to give rise to ammonia. As far as nitrogen is concerned, the only thing required for its manufacture is power which is utilised to liquify the air from which pure nitrogen is obtained. The other raw material, hydrogen is more difficult to obtain and its cost is much higher than that of nitrogen.

Manufacture of hydrogen.

On examination of the synthetic ammonia plants of the world, we find that there are three main sources of hydrogen. (1) Coke oven gas. This gas coming out as a by-product from coke oven, contains about 50 per cent of hydrogen the rest being other combustible gases. In the case of Low Temperature Carbonisation in the externally heated retorts, the gas given out amounts to 3—6 thousand cubic feet, 25 per cent of which is hydrogen, while in the case of Low Temperature Carbonisation in the internally heated retorts, the amount of gas given out amounts to 30—35 thousand cubic feet, about 16 per cent of which or say 5,000 cubic feet is hydrogen. This method of obtaining hydrogen can be adopted near the coal fields with well developed coke oven plants.

(2) The second source of hydrogen is water gas produced from coal. When steam is blown over a bed of glowing coke water gas is produced which contains 50 per cent of hydrogen. Besides this it also contains carbon monoxide. This carbon monoxide gas can be made to react with steam to give rise to hydrogen and carbon dioxide. So this water gas is another source of hydrogen. For producer gas manufacture, inferior coal will serve the purpose; in Germany brown coal is utilised for this purpose. In India this method of production of hydrogen can only be useful near the coalfields and is rather unsuitable for any other part of India. If in Bihar, coal distillation plant is not established the hydrogen can be easily obtained by this method. But the price of hydrogen would work out to be slightly higher in this case than in the case of by-product coke oven gas. For this reason it is desirable that synthetic ammonia

manufacture should if possible be combined with coal carbonisation and if this cannot be done then and then alone water gas method of making synthetic ammonia should be used.

(3) The third source of hydrogen for manufacture of synthetic ammonia is electrolysis of water. In those localities where electric current is very cheap this method of production of hydrogen has been utilised for the production of synthetic ammonia. In Bihar this method is not likely to be as economical as either the coke oven gas or water gas method. The power produced at the coalfields with coal at Rs. 4 a ton will cost not less than $1\frac{1}{2}$ pice per unit. The cheapest rate at which electric power is available in any part of India is Rs. 60 per K. W. Y.* at Mettur in Madras which also works out to $1\frac{1}{2}$ pice per unit.

Cost of machinery.

From the above consideration it is clear that there are no inherent difficulties in obtaining the raw materials for ammonia manufacture in Bihar. We have next to examine the cost of machinery and the cost of production of the finished goods to see whether or not nitrogen fixation is likely to be a commercial success. Unfortunately none of the members of this committee have first hand knowledge of nitrogen fixation. It is, therefore, not possible to go into full details but our colleague Dr. V. S. Dubey has been long in correspondence with Mr. Fauser an Italian expert who is a patentee of one of the well known processes of nitrogen fixation. Mr. Fauser has supplied certain figures for the cost of manufacture based on the prices of power and raw materials available in India. The report is confidential but Dr. Dubey has been good enough to make it available to the committee. It is appended to this report for the information of Government. It will appear from a perusal of these papers that the capital required will be of the order of 60 thousand to one crore of rupees. The cost of synthetic ammonia will be approximately £ 6/4 per ton and may be as low as £ 4 per ton if certain economies are effected by combining the process of nitrogen fixation with that of low temperature carbonisation. It appears to the committee that these figures are most encouraging and if they are found to be confirmed by expert examination nitrogen fixation is a very practicable proposition for this province.

*Dr. H. K. Sen in his Presidential address on some aspects of National Planning delivered before the Institution of Chemists (India at Jamshedpur 1939 vide pages 14—19), has calculated the cost of 1 K. W. Y. as low as £ 1.53 or Rs. 22 by a combination of low temperature distillation of coal and subsequent gasification of the soft coke by the Mond process. If his figures stand rigorous scrutiny, the production of electrolytic hydrogen is expected to be as cheap, if not cheaper, than by the other two processes.

Ammonium Sulphate.

Ammonia after manufacture must be converted into some form of ammonium salt before being placed on the market as fertiliser. The usual salt in agriculture is ammonium sulphate. According to Dr. H. K. Sen who has considerable experience in this line the cost of ammonium sulphate from ammonia at £ 6/4 per ton will not be more than £ 4 per ton which can be sold to the cultivators at Rs. 65 per ton. The present selling price of imported ammonium sulphate is Rs. 100 per ton F. O. B. Calcutta. We thus see that the synthetic ammonium sulphate could be placed on the market at lower prices than at present.

We have seen above that nitrogen fixation is quite practicable if the ammonia is converted into ammonium sulphate. If however the ammonia can be sold in the alternative form of nitro-chalk then the proposition would become not only more feasible but one of the most successful and profitable enterprises we can think of. Subject to the accuracy of the figures supplied by Mr. Fauser and to certain reservations regarding the suitability of nitro-chalk for Indian soil which we shall explain later we feel that the manufacture of nitro-chalk has certain inherent advantages which require closer examination and which we explain in the next paragraph.

Nitro-Chalk.

As we have already stated the usual salt used in agriculture is ammonium sulphate but for this purpose sulphuric acid is required. Now a suitable source of sulphur has not yet been discovered in this country and this makes the sulphuric acid industry dependent on imported sulphur. For this reason the cost of sulphuric acid works out to be high and so also that of ammonium sulphate. Moreover the supply of sulphur may be cut off during war time, in which case a key industry of the nature of nitrogen fixation on which so much capital is to be sunk will find itself in great difficulty.* From all these considerations it appears desirable that if possible the ammonia should be

*In the Presidential address referred to in the previous foot note Dr. H. K. Sen has laid special stress on the feasibility of using gypsum instead of sulphuric acid, for fixing ammonia. As a matter of fact this process was used in the Haber Process of manufacturing ammonium sulphate during the last world war. Considerable deposits of gypsum are available in several places in India and on the assumption that a ton of gypsum could be had for Rs. 15 at any suitable site in Bihar, the cost of production of ammonium sulphate from synthetic ammonia would be of the order of Rs. 43 per ton. This process deserves therefore to be carefully considered. The bye-product ammonium sulphate manufactured with gypsum would cost about Rs. 22 per ton.

converted into ammonium nitrate for marketing as nitro-chalk. In this process a portion of the ammonia will be oxidized by a catalytic process into nitric acid and combined with the rest of the ammonia to form ammonium nitrate which will then be mixed with lime-stone and sold as nitro-chalk.

Mr. Fauser thinks that this is the best solution of the problem of the dearness of sulphuric acid and has supplied figures of production cost of nitro-chalk which we have included in the appendix. From these figures it seems that the cost of production of nitro-chalk containing 15 to 16 per cent of nitrogen will be about Rs. 26 per ton or if an alternative method of hydrogen manufacture is chosen to about Rs. 20 per ton. Nitrogen for nitrogen this price is one quarter of the present selling price of ammonium sulphate. It could be supplied to cultivators at prices which will make it popular and bring it into general use in the country.

As we have said before nitro-chalk contains 16 per cent of available nitrogen as against 20 per cent of ammonium sulphate; but if it can be manufactured so cheaply as Mr. Fauser's figures indicate it is really much more economical than ammonium sulphate and has the advantage of not being dependent on imported sulphur. Its suitability for Bihar soil however has yet to be proved. This is the reservation to which we alluded in a previous paragraph. It is true that this material has been widely used in Europe and America but Dr. H. N. Mukherji, Agricultural Chemist to Bihar Government, is of opinion that without experiment it would be risky to assume that it will be suitable for Bihar soil and thinks that on theoretical grounds there is some danger of the nitrogen as nitrate being lost by being washed away from the soil during heavy rains as the absorption of this portion of the nitrogen by the soil is not as rapid as that in the ammonia part. Moreover the deliquescent nature of nitro-chalk may make its storage and transport more difficult than that of ammonium sulphate.

SUGGESTION AND RECOMMENDATION.

After fully taking into consideration the potentiality of the market for the sale of ammonium sulphate, the desirability of this industry from the national point of view the practicability of the process and the availability of the raw material we are of opinion that it is most desirable that a nitrogen fixation industry should be established in Bihar. In the opinion of the Committee the proposition is quite feasible but as none of the members of the Committee have any direct experience of the nitrogen

fixation industry they recommend that for the settlement of technical details as well as for the selection of suitable plants the Government will be well advised to refer the matter to a Committee of Experts, who may also be required to critically examine the financial aspects of the question.

APPENDIX IV(a).

Capacity of plants for ammonia per day.

Belgium	..	..	400 tons per day ammonia.
Canada	..	..	100 " " " "
Czechoslovakia	..	..	20,000 tons of nitrogen per year.
China	..	.	15,000 " " " " "
England	..	..	25,000 " " " " "
France	..	..	234,000 " " " " "
Germany	..	..	250,000 " " " " "
Holland	..	..	360 tons per day ammonia.
Italy	..	..	400 " " " "
Japan	..	..	400,000 tons of nitrogen per year.
Korea	..	..	150,000 " " " " "
Manchukuo	..	..	150 tons per day ammonia.
Norway	..	..	100,000 tons per year nitrogen.
Poland	..	..	50,000 " " " "
Spain	..	..	10,000 " " " "
South Africa	..	..	8,000 " " " "
United States	..	..	350,000 " " " "
U. S. S. R.	..	..	200,000 " " " "

Sources of hydrogen in different plants of the world.

Coke oven gas	...	..	29 plants.
Water gas	..	..	20 "
Electrolysis of water	..	..	23 "
Electrolysis of sodiumchloride		..	4 "
Total			76 plants.

APPENDIX IV(b).

Estimate of cost of a complete plant for an output of 60 tons per day of ammonia starting from water gas and of 360 tons per day of nitrochalk of 15—16 per cent nitrogen content according to Mr. Fauser received through Dr. V. S. Dubey.

The production of 60 tons a day of anhydrous ammonia requires about 168,000 of N—H mixture of which 126,000 c. m. is hydrogen and 42,000 c. m. nitrogen (at 0 and 760 mm Hg.).

Consequently the converted gas will contain including a reserve of 10 per cent, $126,000 \div 0.9 = 140,000$ c. m. hydrogen.

It is assumed to gasify coal to obtain water gas with a hydrogen yield after conversion of CO, of 75 per cent by volume. The requirements of water gas are therefore $140,000 \div 0.75 = 186,000$ c.m. per day.

£ s d.

(a) *Cost price of 1,000 kg. anhydrous ammonia—*

Depreciation, interests, machinery	$\frac{406,288 \times 0.16}{350 \times 60}$ ...	...	...	3	1	10
" " buildings	$\frac{30,951 \times 0.11}{350 \times 60}$ ...	...	...	0	3	3
Coal	1,900 kg. at 5 11 d.	...	...	0	11	2
Workmen	6.5 h at 6 d	...	...	0	3	4
Water	150 c. m. at nominal	...	...	0	1	1
Copper	0.14 kg. at 11 d.	...	...	0	0	2
Formic acid	0.85 kg. at 1-4	...	...	0	1	2
Electric energy	1,600 kwh at nominal	...	...	1	0	0
Maintenance and sundries	...	...	...	1	2	6
Total	...	...	...	6	4	6

APPENDIX IV(b)—concl'd.

(b) Cost price of 1,000 kg. nitric acid referred to 100 per cent—

			£ s. d.	
Depreciation, interests machinery	$\frac{119,229 \times 0.16}{350 \times 130}$	...	...	0 10 7
" " buildings	$\frac{5,055 \times 0.11}{350 \times 130}$	...	...	0 2 2
Ammonia ...	290 kg. at $1\frac{1}{2}$ d.	...	...	0 15 7
Electric energy ...	25 kwh at nominal	...	...	0 0 4
Workmen ...	0.6 h at 6 d.	...	...	0 0 4
Water ...	100 c.m. at nominal	...	...	0 0 4
Maintenance, and sundries	...	...	...	0 1 6
Platinum ...	0.05 kg. at 1-6 d.	...	...	0 0 3
Total				2 11 2

(c) Cost price of 1,000 Qkg: nitro-chalk of 15—16 per cent N₂ in store—

Depreciation, interest, machinery	$\frac{50,585 \times 0.16}{350 \times 130}$	...	...	0 2 0
" " buildings	$\frac{8,441 \times 0.11}{350 \times 350}$	...	...	0 0 2
Ammonia ...	110 kg. at $1\frac{1}{2}$ d.	...	...	0 13 2
Nitric acid (100 per cent)...	300 kg. at $\frac{1}{2}$ d.	...	...	0 18 7
Lime-stone ...	520 kg. at nominal	...	...	0 1 9
Coal ...	25 kg. at 5 11 d.	...	...	0 0 2
Current ...	35 kwh. at nominal	...	...	0 0 5
Workmen ...	0.9 h at 6 d.	...	...	0 0 3
Water ...	10 c. m. at nominal	...	...	0 2 3
Total				1 19 1

Rate of depreciation for buildings	...	...	5 per cent.
" " " " machinery	...	...	10 " "
" " interest	...	...	6 " "
Working days in one year	...	...	350

CHAPTER V.

PHOSPHATIC MANURES.

Three of the most important elements which are essential for the growth of plants and therefore for crop production are fixed nitrogen, phosphorus and potash. We have already made our recommendations regarding the former. As regards phosphorus there are four important sources of this type of manure:— (1) phosphatic rocks, (2) bones, (3) oil-cakes (4) basic slag. The first does not occur extensively in India and therefore one of the most important ingredients for the manufacture of superphosphate is lacking. Another ingredient for this purpose is sulphuric acid which also is not sufficiently cheap in India. The second source of phosphorus is bone. It can be used either as bone meal or converted into superphosphate in which form it is more rapidly absorbed by the soil. Unfortunately bone is being exported either abroad or to other provinces and Bihar soil is being gradually depleted of this most necessary constituent. If this bone had been allowed to remain in the soil instead of being collected and exported even then it would have served a useful purpose in conserving the amount of phosphorus within the province as sooner or later by a process of natural decay the phosphorus would have returned to the soil to be taken up by plants and subsequently by animals to be again returned to the soil in the form of bone or seeds. The export of the bone seriously interferes with this natural circulation of phosphorus in the soil with the result that the country is sure to become increasingly less fertile if steps are not taken to prevent this or to make cheap phosphatic manure available to the cultivator.

With regard to the third source of phosphorus, viz., oil-cakes the position is equally unsatisfactory. The seed takes up phosphorus from the soil which appears in the oil-cake. If the phosphorus in the oil cake were ultimately returned to the soil by using it as cattle food, for instance, then the natural cycle will not be interfered with, but as is the case at present the seeds are largely exported and the phosphorus goes to the soil of another country. We think that every effort should be made to encourage the crushing of oil-seeds locally and to popularize the use of oil-cake as cattle food.

As regards basic slag, we are informed that about 4,500 tons per month are available as a waste product from the Duplex Plant of Tata Iron and Steel Company. This slag contains

7 per cent phosphoric acid of which 60—70 per cent is soluble in citric acid. On account of the low percentage of phosphoric acid it cannot be directly used as manure. The Agricultural Chemist to the Government of Bihar is of opinion that if this slag is used for mixing with ammonium nitrate the cost of manufacture will be lowered and the manure will be better because of the presence of phosphoric acid. He has already started experiment with ammonium nitrate and a sample of slag obtained from Tatas and will be in a position to report the affectiveness of the mixture as compared to nitro-chalk within a short time. We are of the opinion that this is a very promising line and his experiments should be watched with interest. If the results are satisfactory steps should be taken to utilize the basic slag with synthetic nitrogenous fertilizers.

SUPERPHOSPHATE INDUSTRY.

In 1931 as the result of an exhaustive enquiry by the Director of Industries, Bihar, it was revealed that the total quantity of bones exported from the districts of Bihar, came up to 300,000 maunds at a price of Rs. 47 to Rs. 50 per ton at Calcutta. In a memorandum which has been submitted by the Senior Marketing Officer, Government of Bihar, the quantity of bones available in the province is stated to be as follows:—

			Mds.
(1) From dead animals ..	...	...	1,331,374
(2) From slaughtered animals ..	...	..	67,859
			<hr/>
Total ..			1,399,233
			<hr/>
Export .. ..	..	..	303,068
Net available supply ..	..	..	1,096,165

It thus appears that there is a large quantity of bones available in the province which has no value at present and which could be utilised either as bone meal or as bone superphosphate.

The import of superphosphate into India is considerable.

1935-36.	1936-37.
6,483 tons	6,009 tons.
Rs. 4,67,064	Rs. 3,99,713

Regarding the use of bone meal as fertilizer, it is known that the disintegration of bone meal and the absorption of phosphoric

acid by the soil, is a very slow process and some three to five years must elapse before the action of the fertilizer is manifested. Bone meal may therefore be only used for waste lands which are to be brought under cultivation for the first time. Superphosphates on the other hand are very rapid in their action on plants. Although no superphosphate is being manufactured in India at present the world consumption of superphosphate has been estimated to be 15 million tons in 1938. (Chem. Met. Eng. Feb. 1939.)

The process of manufacture of superphosphate from bone meal is well known and requires no explanatory remarks. The cost of installing a plant for handling five tons of raw bone per day is given in the appendix.

In conclusion we think that the export of bones from the province should be discouraged and every encouragement given to the local crushing of bone and the preparation of superphosphate for the province.

APPENDIX V.

The following are the principal items of cost involved in the process :—

1. Weighing and receiving the raw bones.
2. Cleaning or washing.
3. Drying.
4. Storage.
5. Crushing.
6. Storage for crushed bones.
7. Weighing and mixing.
8. Acid storage.
9. Damping in " dens ".
10. Excavation and storage of manure.
11. Lands and sheds.
12. Supervision.

(1) *Weighing and Receiving.*—A small platform weighing machine capable of weighing upto five cwts. would suffice. The bones are to be loaded into wooden carts which can be pushed on to the machine and then dumped into the cleaning tanks.

	Rs.
Price of machine	500
Installation and accessories at 20 per cent	100
Total	600
Daily charges :—	
	Rs.
Interest at 6 per cent	0·12
Depreciation at 10 per cent	0·20
Maintenance and repairs at 5 per cent	0·10
Labour—16 man hours at anna 1 as per man hour.	1·00
Total	1·42

APPENDIX V—contd.

(2) *Washing and Clearing.*—The washing is to be done in masonry tanks, two tanks are necessary, one being emptied while the other is being charged. Shallow tanks of 150 c.ft. capacity would suffice.

		Rs.	Rs.
Cost of tanks	.. ..	2×40	80
Daily charges :—			
Labour 48 man hours, at anna 1 per hour.		..	3

(3) *Drying.*—In summer months the process of drying would only involve the spreading of the bones on the drying yard. During the rainy season a drying stove of the simple hot room type would be necessary.

			Rs.
Cost of erecting the room	.. ..		500
Accessories at 10 per cent	.. ..		100
			—
	Total	..	600
			—

Daily charges :—

			Rs.
Interest at 6 per cent	... ..		0-11
Depreciation and maintenance at 5 per cent...			0-09
Fuel for heating	.. ..		1-00
			—
	Total	..	1-20
			—

(4) *Storage.*—The dried bones should be carefully conserved and guarded against moisture and putrifaction. A good stock should be held.

Daily charges :—

		Rs.
Labour 48 hours (man), at anna 1 per man hour.		3

APPENDIX V.—*contd.*

(5) *Crushing.*—Two toothed roll mills are to be used in series followed by a simple roll mill delivering a product of about 40 mesh size, the mills should be capable of handling about $\frac{1}{2}$ th ton per hour normally.

		Rs.	Rs.
Price of the toothed roll mills	..	2×2,000	4,000
Price of the ordinary rolls	..	...	1,500
			<hr/>
Total	..		5,500
			<hr/>
Accessories and installation at 30 per cent	..		1,650
			<hr/>
Total	..		7,150
			<hr/>
Daily charges—			
Interest at 6 per cent	..	...	1.43
Depreciation at 10 per cent	..	..	2.38
Maintenance and repairs at 10 per cent	..		2.38
Power 7 H. P. per hour at anna 1 as per K. W. H.			2.61
Labour 32 man hours at anna 1 as per hour			2.00
			<hr/>
Total	..		10.80.
			<hr/>

(6) *Storage for crushed bones.*—A storage bin capable of holding about 10 tons of crushed material is necessary (500 c. ft.).

			Rs.
Cost of erection	...	...	100
Accessories	..	...	100
			<hr/>
Total	..		200
			<hr/>
Daily charges—			
Interest at 6 per cent	..	..	0.04
Labour 16 man hours at anna 1 as per hour	...		1.00
			<hr/>
Total	...		1.04
			<hr/>

APPENDIX V—*contd.*

(7) *Weighing and mixing.*—Three mixers each having a capacity of about 12 c. ft. would be necessary.

			Rs.
Price of weighing machine	..	..	300
Accessories at 20 per cent	..	..	60
			<hr/>
	Total	..	360
			<hr/>
Mixers—3 × 800	..	..	2,400
Installation and accessories at 25 per cent	..	..	600
			<hr/>
	Total	..	3,360
			<hr/>

Daily charges—

			Rs.
Interest at 6 per cent	..	..	0.67
Depreciation at 10 per cent	..	..	1.12
Maintenance and repairs at 10 per cent	..	..	1.12
Power 3 H. P. per hour at anna 1 as per <i>kwh.</i>			1.10
Labour 32 man hours at 1 anna per man	..	..	2.00
			<hr/>
	Total	..	6.01
			<hr/>

(8) *Acid storage.*—For five tons of bone meal, about 2.6 tons of chamber acid are required. Provision should be made to store acid sufficient for a week's consumption. This would require a 15 ton acid tank connected with a three ton "calibrated" feed tank.

			Rs.
Price of tanks	..	..	2,000
Installation and accessories at 30 per cent	..	..	600
			<hr/>
	Total	..	2,600
			<hr/>

APPENDIX V—contd.

Daily charges—

			Rs.
Interest at 6 per cent	..	..	0.52
Depreciation at 15 per cent	..	..	1.22
Maintenance and repairs at 10 per cent	..	..	0.86
Labour 8 man hours at anna 1 as per man hour			0.50
			<hr/>
	Total	..	3.17
			<hr/>

(9) *Dumping*.—Two dens should be constructed on two sides of the mixing machines, which should be provided with arrangements for titling on both sides. Each den should be big enough to hold a day's charge, so that they may be filled and emptied alternately.

Cost of two dens	Rs. 400.
------------------	----	----	----------

Daily charges—

Interest at 6 per cent	Rs. 0.08
------------------------	----	----	----------

(10) *Excavation and storage*.—Hand excavation is to be resorted to and the material after excavation is to be stored in a closed bin or silo.

			Rs.
Cost of erecting a silo	..	..	250
Accessories at 20 per cent	..	..	50
			<hr/>
	Total	..	300
			<hr/>

Daily charges—

			Rs.
Interest at 6 per cent	..	..	0.06
Depreciation and maintenance		..	0.05
Labour 48 man hours at anna 1 as per man hour.			3.00
			<hr/>
	Total	..	3.11
			<hr/>

APPENDIX V—contd.

(11) Land and sheds—

			Rs.
Buildings and sheds	..	..	5,000
Land	..	..	2,000
			<hr/>
		Total	7,000

Daily charges—

			Rs.
Interest at 6 per cent	..	..	1.40
Depreciation and maintenance on buildings and sheds at 10 per cent.			1.66
			<hr/>
		Total	3.06

(12) Supervision—

			Rs.
(1) One Chief Chemist	..	..	200 per month.
(2) One Assistant Chemist	..	..	100 „
(3) Two mechanics	..	..	80 „
(4) Accounts clerk	—	..	80 „
(5) Two ordinary clerks	..	..	80 „
			<hr/>
		Total	540 „

Daily charges—

18.00

Total costs—

Items.		Investment.	Daily charges.
		Rs.	Rs.
1. Weighing and Receiving	..	600	1.42
2. Washing and cleaning	..	80	3.00
3. Drying	..	600	1.20

APPENDIX V—concl'd.

	Rs.	Rs.
4. Storage	...	3-00
5. Crushing	7,150	10-80
6. Storage for crushed bones	200	1-04
7. Weighing and mixing	3,360	6-01
8. Acid storage	2,600	3-17
9. Dumping	400	0-08
10. Excavation and storage	300	3-11
11. Lands and buildings	7,000	3-06
12. Supervision	...	18-00
13. Sulphuric acid 2.6 tons at Rs. 50 a ton.	...	130-00
14. Bone at Rs. 40 per ton	5 tons	200-00
Total	22,290	382-89

The product from 5 tons of bones would be about 6.6 tons on a theoretical basis. The present market price of superphosphate is about Rs. 76 per ton so that the total sale proceeds will amount to Rs. 426.

CHAPTER VI.

HEAVY CHEMICALS AND SULPHURIC ACID.

In introducing this section, we have taken note of the heavy chemicals at present being imported into the country, both with regard to their quantities and their distribution. We find that amongst these, four items deserve our closest attention and scrutiny, viz.—(1) Acids (including the salts), (2) Alkalies, (3) Fertilisers and (4) Bleaching powder. In the latter two, acids have taken part in some stage of manufacture and as such the manufacture of acids may replace, for the matter of classifications, these two items. Thus in developing a heavy chemical industry, one has to consider the development of the alkali and the acid industries.

We propose, therefore, to examine first the possibilities of developing these two industries in Bihar. Acids are dealt with in this chapter and alkalies in the next.

Acid industry.—As sulphuric acid is the most important of generally required acids, and as on it depends the manufacture of other acids and salts, we give below the position of large-scale manufacture of this acid. It is well known that India, as yet, has no sulphur deposit of her own and the recently discovered pyrites deposit near Simla has not been sufficiently explored to give us the fundamental raw material for the sulphuric acid industry. We mention, however, in this connection that while for the present we are forced to depend upon imported sulphur, the possibility of utilising Indian gypsum and the zinc blende of Burma requires to be explored by a special committee appointed for the purpose. It has come to the notice of the committee, that a good deposit of pyrites also exists in Burma but how far transport facilities would admit of its use should be gone into by the proposed special committee. Whilst recognising this inherent difficulty in building up an independent sulphuric acid industry for the present, pending these inquiries, the committee would like to point out the advantage which the province enjoys in regard to the freight which imported sulphuric acid has to pay. The cost of producing sulphuric acid in Bihar at any reasonable distance from Calcutta, with imported sulphur, will not exceed Rs. 40 per ton of pure sulphuric acid in form of chamber acid (see Appendix VI). This is about Rs. 10 to 12 more than the cost of production of sulphuric acid in European countries. As mentioned before, the freight tends to equalise this difference. India imports today 27,582 tons of sulphur and among 20 sulphuric acid works most of it is consumed. Seeing

that the actual import of sulphuric acid as such is negligible it is clear that the country is manufacturing its sulphuric acid at a competitive rate. The question, therefore, is to trace how much sulphuric acid is indirectly coming into the country in the shape of heavy chemicals like salts and fertilisers. From a reference to the sea-borne trades figures, it would appear that about 60,000 tons of ammonium sulphate, 6,000 tons superphosphate, 232 tons sodium sulphate, 546 tons magnesium sulphate, 1,655 tons of copper sulphate, 205 tons alum and 1,719 tons aluminium sulphate are at present imported. This would correspond to 46,772 tons sulphuric acid per year, besides the quantities that must have been used in the manufacture of these commodities in which sulphuric acid is used but is not present in the finished product. It would be fair, therefore, to assume at least 100,000 tons per year as the requirement of this country, if a self-contained manufacture of a group of heavy chemicals were contemplated. As we have already recommended that amongst the fertilisers ammonium sulphate should be manufactured in Bihar to the extent of 60,000 tons now being imported, for Bihar alone 45,000 tons of sulphuric acid would be required. The location of sulphuric acid plants would depend upon where the coal carbonisation or the synthetic ammonia plants are established and this would involve roughly the expenditure of Rs. 20,00,000 as capital charges (vide Appendix VI).

The committee are of the opinion that to initiate a heavy chemical industry, the establishment of sulphuric acid plant in Bihar, linked up with the manufacture of fertilisers in special and other chemicals in general, is essential. It may also be pointed out that this acid will be required in larger quantities with the development of co-lateral industries, whether in heavy chemicals or in fine chemicals.

A recent development about the problem of sulphur is worthy of serious consideration. In a recent number of the Journal of the Society of Chemical Industry of Great Britain (J. Chem. Soc. Ind. 1939, 58, 163, 707) an article has been published about the recovery of sulphur from coke oven gases. The process is known as the Thylox process and is being successfully worked in the United States of America, Germany and Japan. It has been stated that the cost of recovery of sulphur from gases containing 250—600 grains of sulphurated hydrogen per 100 cu. ft. is 0·09 d. and a ton of sulphur can be produced at 60—80 yens. Bihar coals are somewhat poor in sulphur (about 0·5 per cent). In the case of high temperature carbonisation, almost the whole of the organic sulphur passes out into the

gas and may be recovered. It is not known whether the low temperature carbonisation process will yield a gas equally rich in sulphurated hydrogen or not. When countries like United States of America and Japan with huge sulphur deposits have taken up this process investigation is necessary in this direction for exploring the possibility of recovering the sulphur of Indian coals as India has to depend mainly upon imported sulphur for meeting the demands of heavy chemical industry. Another possible line of development in this direction is to utilise the sulphur dioxide gas produced in the smelting of copper ores at Ghatsila. Quite a large amount of sulphur dioxide, of a dilution suitable for conversion into sulphuric acid by Chamber process is being wasted in this operation. As we have already pointed out in Chapter II about 7,000 tons of sulphur are wasted every year. The utilisation of this sulphur will partly solve the problem of imported sulphur.

The use of sulphuric acid in the manufacture of hydrochloric, nitric, acetic acids, etc., is well known but as the consumption of these acids is as yet low no specific recommendation is made here. As the manufacture of bleaching powder is effected generally now-a-days by chlorine, directly obtained from the electrolytic alkali industry, the use of hydrochloric acid in this direction is not emphasised. The consideration of the manufacture of bleaching powder is, therefore, linked up with the manufacture of caustic soda by the electrolytic method.

The other important heavy chemicals that are at present imported into India are potassium chlorate and potassium dichromate. Potassium chlorate is imported to the extent of 2,000 tons valued at Rs. 9,00,000. We are also importing potassium chloride, 3,000 tons valued at Rs. 2,00,000. Potassium chlorate is manufactured from the chloride by an electrolytic process. With cheap electricity, the manufacture of this commodity would present no great difficulty in the near future.

The import of potassium dichromate is also considerable, 2,400 tons. It is largely used for leather manufacture and match industry. With chromites available in the province, serious attempts must be made to take up this industry by private parties. It must be borne in mind when the manufacture of potassium dichromate is contemplated, that a factory worked for a number of years at Calcutta for the manufacture of this commodity. The quality of the product was excellent but the factory had to be closed down. The causes of failure of Dutt Chemical Works should be thoroughly investigated before a new attempt is made in this direction.

APPENDIX VI

*Estimate for a 10-ton sulphuric acid plant.**(Chamber Process.)*

	Rs.
1. Lead sheets for chambers and towers ..	65,000
2. Building	10,000
3. Wooden frame (for chamber) ...	3,000
4. Coils	1,000
5. Platform	1,000
6. Pumps	2,000
7. Atomiser and compressor..	5,000
8. Cooling tanks	2,000
9. 4 acid tanks on top of towers ...	} 3,200
4 acid tanks at the bottom of towers ..	}
10. Coolers	2,000
11. Burners	3,000
12. Erection charges	10,000
Total	1,07,000

Monthly expenses.

	Rs.
1. Manager	300 per month.
2. 3 chemists at Rs. 100 each ..	300 " "
3. 3 assistant chemists at Rs. 50 ..	150 " "
4. 9 labourers for sulphur burners at Rs. 30 each	270 " "
5. Coolies (9) at Rs. 20	180 " "
6. Mechanics (3) at Rs. 40.. ..	120 " "
Total	1,320 " "

APPENDIX VI—concl'd.

Raw materials.

	Rs.
30 tons sulphur at Rs. 90 per ton	2,700
0.5 ton sodium nitrate at Rs. 120 per ton ..	60
	<hr/>
Total ..	2,760
	<hr/>

Cost of production of 1 ton of chamber acid, assuming an efficiency of 97 per cent :—

	Rs. a. p.
1. Sulphur—0.33 ton	30 0 0
2. Nitre	0 12 0
3. Labour and overhead charges	4 10 0
4. Depreciation at $7\frac{1}{2}$ per cent on Rs. 1,25,000...	3 2 0
	<hr/>
Total ..	38 8 0
	<hr/>

CHAPTER VII.

ALKALI INDUSTRY.

The alkali industry is one of the legs on which modern civilization stands or runs. No chemical industry can exist on a satisfactory basis in India or in any other country, without the establishment of alkali and sulphuric acid industries. There is no doubt that the manufacture of this chemical is a key industry whose ramifications are very wide and its establishment in India is essential to the expansion of the future home industries.

The oldest process for the manufacture of sodium carbonate is Leblanc process which requires cheap sulphuric acid and common salt for its success. This process is still in use in some parts of the world but has been greatly supplanted by other processes. It cannot be worked successfully in India as we have no source of cheap sulphuric acid. The ammonia soda process in which sulphuric acid is not required has a better chance of success and is said to be operating successfully in Japan.

Caustic soda can be manufactured easily from sodium carbonate by treatment with lime but the bulk of the caustic soda now manufactured in America and Europe is produced electrolytically from aqueous solution of common salt. Chlorine and hydrogen are obtained as bye-products. The former can be utilised for the manufacture of bleaching powder and the latter for the hydrogenation of oil or for other technical purposes. For the establishment of this industry in India the following conditions are necessary :—(1) cheap electricity, (2) common salt, (3) existence of market for the product not too far from the place of manufacture to minimise the cost not only of transport but sometimes also of evaporation as in those industries in which a solution of caustic soda is used it will save the cost of evaporation if the solution produced in the process of manufacture could be used directly, (4) market for the bye-products, viz., bleaching powder or chlorine and hydrogen.

Probably the most dangerous competition which Indian alkali may have to meet is the sodium carbonate from Lake Magadi in East Africa but as the alkali industry is a key industry this competition must be faced.

We understand that a great step forward in the manufacture of alkali in India has already been taken and that in the near

future India may become independent of foreign sources of supply of this important commodity. The Alkali and Chemical Corporation of India, Limited, has recently been constituted as subsidiary to the Imperial Chemical Industries (India), Limited, and is going to manufacture both caustic soda and sodium carbonate. The sodium carbonate plant will be erected at Khewra in Jhelum district in the Punjab and the caustic soda plant in the vicinity of Calcutta. Tata and Sons, Limited, are also said to be contemplating the erection of a plant at Port Okha in Baroda for the manufacture of caustic soda and sodium carbonate. Details are not available but it is said that the company will have an authorised capital of Rs. 5,00,00,000 but only Rs. 1,25,00,000 will be issued at present. The salt required for the manufacture of these chemicals will be obtained from the Okha salt works which the company intends to take over and limestone can be obtained from large and rich deposits in the immediate neighbourhood. It is estimated that this scheme will only meet about $\frac{1}{3}$ rd of the total demand for alkalis in this country leaving $\frac{2}{3}$ rd of the amount consumed to be manufactured elsewhere or imported.

In Madras Presidency the Mettur Chemical and Industrial Corporation has been formed with the object of manufacturing caustic soda, bleaching powder, hydrogen and other chemicals. The company proposes to produce initially $4\frac{1}{2}$ tons of chlorine and 5 tons of caustic soda daily. If all these enterprises succeed, and there is no reason why they should not do so, this crying need of the country will be entirely met and India will soon become self-supporting in this respect.

In Bihar many of the conditions for the success of a large alkali industry are wanting. It is true that on account of cheap coal, electricity can be produced fairly cheap but common salt, the chief raw material, will have to be brought from a distance. Also there is no near market for the finished products. No heavy chemical industry exists in the neighbourhood nor is there a home market for the bleaching powder which will have to be exported to Bengal or the United Provinces. In spite of all these drawbacks the existence of industrial centres like Jamshedpur gives some hope of starting a small alkali industry in the province. This will become more desirable if soap factories, glass factories, tar distilleries and other such industries spring up round the coal-fields as they are bound to do.

One of the arguments against the establishment of alkali industry in Bihar is that the province has to depend upon salt

which must be obtained from Bengal. Even if it is assumed that the railway freight from Calcutta to a suitable site in Bihar will come up to four annas per maund or Rs. 7 per ton, yet the province has an advantage in having deposits of limestone within its boundary. The Calcutta figures for the electrolytic manufacture of caustic soda and bleaching powder are as follows :—

For a plant of 3 tons of caustic soda and $7\frac{1}{2}$ tons of bleaching powder per day —

	Rs.
Salt—5·7 tons at Rs. 15 per ton	86
Lime—5·25 tons at Rs. 20 per ton	105
	<hr/>
	191
	<hr/>

In Bihar, near limestone deposits the figures would be as follows :—

	Rs.
Salt—5·7 tons at Rs. 15 per ton	86
Freight at Rs. 7 per ton	39·5
Lime at Rs. 10	52·5
	<hr/>
	178
	<hr/>

So that even with imported salt the industry will not be at a great disadvantage when considering the price of raw materials alone. If the possibility of generating electric power at a very much cheaper rate in Bihar is taken into consideration, then the prospects of the industry will become still more hopeful. It must also be taken into consideration that a saving in railway freight will be effected for supplying the finished products to dealers within the province and in the neighbouring provinces like United Provinces and Central Provinces.

An estimate for a 3-ton caustic soda and 7·5-ton bleaching powder plant with daily approximate cost of production is given in appendix VII(a).

SOLVAY SODA OR AMMONIA SODA PROCESS FOR THE MANUFACTURE OF SODIUM CARBONATE.

The manufacture of sodium carbonate by this process occupies to-day a predominant position in chemical industries. From an insignificant beginning in 1865, 100 tons per annum, the annual output at the present time, exceeds 300,000 tons. This industry has practically driven Leblanc soda out of the market but it is itself challenged by two serious rivals, the electrolytic method of manufacture of caustic soda and the vast deposits of soda near Lake Magadi in British East Africa. Soda is largely causticised by lime and if the electrolytic process can produce caustic soda at a sufficiently cheap price the industry will certainly suffer to a great extent. The large deposits of soda in British East Africa will certainly play a very important part in this industry, when the factories for working it are fully equipped but seeing that the crude soda has to be carried to the sea-ports at a distance it may be expected that the price will not be very much lower than the Solvay soda.

The only serious attempt that was made in India for the manufacture of soda by this process was at Kathiawar. It is said that the failure of the undertaking was probably due to the plant being far from up-to-date. We understand that there is a proposal to start a solvay soda factory in South Bengal. An American firm is prepared to supply the necessary plants for the production of 10 tons of sodium carbonate per day at a cost of Rs. 6,00,000. The firm in question will supply the technical men necessary for starting the plant, with the guarantee of production of 10 tons a day on the condition that they will receive a royalty of Rs. 5 for every ton of soda manufactured during the first seven years. Fuller details are not available.

A scheme for a 60-ton plant for carbonate of soda by the Solvay process is given in appendix VII(b). As we have remarked in the introduction to this report these figures are given merely for the purpose of illustration. Considering the progress which is reported to have been made recently in the schemes for the manufacture of soda in India any special efforts on the part of the Government of Bihar to establish soda industry in the province is perhaps not necessary. The matter may be left to private enterprise assisted by such aid which Government may be able to give under the Aids to Industries Act.

APPENDIX VII(a).

Estimate for 3-ton caustic soda and 7½-ton bleaching powder plant.

			Ra.
I. Cost of machinery .. .. .	..	..	3,33,000
(a) D. C. power plant .. .. .	..	..	80,000
(b) Cells with accessories .. .. .	..	..	1,08,000
(c) Evaporating plant .. .. .	..	..	40,000
(d) Lime slaking plant .. .. .	..	..	15,000
(e) Bleaching power plant .. .. .	..	..	65,000
(f) Melting plant .. .. .	..	..	5,000
(g) Filter press, pumps .. .. .	..	..	5,000
(h) Boiler plant .. .. .	..	..	5,000
(i) Transport, elevators, etc. .. .. .	..	..	10,000
(j) Building and erection cost .. .. .	..	..	1,00,000
(k) Working capital .. .. .	..	..	1,00,000,

Production cost of a 3-ton capacity caustic soda plant and 7½-ton capacity bleaching powder plant for 24 hours :—

			Ra.	a	p.
(1) Power— .. .. .	..	..	196	0	0
4,170 K.W.H. per ton of caustic soda per day— $3 \times 4,170$ or 12,500 K.W.H. at 0.25 anna per K.W.H.					
(2) Salt— .. .. .	..	..	86	0	0
1.9 tons of salt per ton of caustic soda— 3×1.9 or 5.7 tons at Ra. 15 per ton.					
(3) Lime— .. .. .	..	..	105	0	0
0.70 tons per ton of bleaching powder— 0.7×7.5 or 5.25 tons at Ra. 20 per ton.					
(4) Coal— .. .. .	..	..	42	0	0
2 tons per ton of caustic soda— 2×3 or 6 tons at Ra. 7 per ton.					
(5) Labour— .. .. .	..	..	33	0	0
14 unskilled labour per shift at Ra. 15 per month. 6 skilled labour per shift at Ra. 20 per month.					

APPENDIX VII(a)—*contd.*

	Rs.	a.	p.
(6) Overhead charges—	50	0	0
1 foreman per shift at Rs. 40 per month.			
1 Electrician per shift at Rs. 40 per month.			
1 Mechanic per shift at Rs. 40 per month.			
1 Chemist per shift at Rs. 150 per month.			
1 Laboratory boy per shift at Rs. 10 per month.			
1 Engineer at Rs. 150 per month.			
1 Manager at Rs. 300 per month.			
1 clerk at Rs. 40 per month.			
1 stenographer at Rs. 30 per month.			
1 office boy at Rs. 10 per month.			
2 watchmen at Rs. 15 per month each.			
(7) Renewals and maintenance— ..	55	0	0
	Rs.		
Electrolyser	20		
Evaporating plant	10		
Melting	5		
Bleach plant	15		
Pipe line	5		
(8) Packing—			
210 drums of 1 cwt. at Rs. 1 per drum.	210		
(9) Depreciation—			
Machinery Rs. 3,33,000 at 10 per cent.			
Building Rs. 1,00,000 at 3 per cent.			
(10) Interest—	17	0	0
Running capital Rs. 1,00,000 at 5 per cent.			
(11) Insurance, etc.	6	0	0
Machinery Rs. 3,33,000 at 0.5 per cent.			

APPENDIX VII(a) *concl.*

	Rs.
Yield per year—	
900 tons of caustic soda at Rs. 240 per ton ..	2,16,000
2,250 tons of bleaching powder at Rs. 120 per ton.	2,70,000
	<hr/> 4,86,000 <hr/>
Total cost per year	3,11,560
Cost of production per year	2,76,000
Selling cost	35,260
	<hr/> 3,11,560 <hr/>
Net income	1,74,440 <hr/>

APPENDIX VII (b).

Scheme for a 60-ton plant for carbonate of soda by the Solvay process.

	Rs.
Machinery	12,00,000.
Duty, freight, insurance, etc., on machinery at 20 per cent.	2,40,000.
Cost of land	2,40,000
Building and quarters	3,25,000
Working capital	3,30,000
Factor of safety at 5 per cent	1,21,750
	24,56,750

Cost of production per ton of soda ash.

	Rs.	a.	p.
Salt at Rs. 15 per ton 1.6 ton	25	0	0
Limestone at Rs. 7 per ton 1.3 ton	9	2	0
Coal at Rs. 7 per ton 0.5 tons	3	8	0
Coke at Rs. 12 per ton 0.13 ton	1	9	0
Ammonium sulphate at Rs. 7 per cwt.	1	14	0
Bags 20, 1 cwt. capacity	4	4	0
Power 225 K. W. H. at 0.5 anna per K. W. H.	7	1	0
Labour	5	0	0
Technical management	1	8	0
Depreciation	8	8	0
	Rs.	a.	p.
10 per cent on machinery	8	0	0
3 per cent on buildings	0	8	0
	8	8	0
Repairs	1	0	0
Insurance	0	4	0
Sales and office	1	0	0
Factor of safety at 5 per cent	3	5	4
	72	15	4
Total			

APPENDIX VII(b)—concl'd.

RECEIPTS.		EXPENDITURE.	
			Rs.
Proceeds from sale	$360 \times 60 \times 20$	Cost of production	$360 \times$
$\times 5.9 =$	Rs. 25,60,000.	60×73	.. 15,76,800
		Management and sales	
		expenses	.. 28,000
			17,04,800
			Rs.
Profit	..	25,60,000	
		17,04,800	
		7,55,200	

CHAPTER VIII.

GLASS INDUSTRY FOR BIHAR.

As we have already stated in the Introduction, Bihar is a suitable place for the establishment of glass industry on a provincial basis. By this we mean that although some of the raw materials, specially alkalis, are not available in Bihar yet on account of the cheapness of certain raw materials, specially coal, it would be possible to start this industry on a scale which will readily supply most of the local needs at competitive prices.

In India there has been a great development in the glass industry during the last 30 years, and at present this country is said to be producing glass goods worth about 75 lakhs of rupees annually. The two chief centres of production are United Provinces and Bengal, but in spite of the development of this industry, large amounts of glass goods worth about 125 lakhs of rupees is imported annually. The details of the import are given below :—

Name of the article.	1934-35.	1935-36.	1936-37.
	Rs.	Rs.	Rs.
1. Bangles ..	31,00,000	27,00,000	28,00,000
2. Beads and false pearls	13,00,000	15,30,000	12,15,000
3. (a) Bottles (soda-water)	5,67,000	8,12,000	5,44,000
(b) Bottles (other-types)	19,14,000	22,10,000	18,11,000
Total ..	1,25,00,000	1,31,00,000	1,19,00,000

In the year 1936-37 goods worth Rs. 62,38,325 were imported from Japan, Rs. 19,71,960 from Czechoslovakia Rs. 15,72,457 from Germany, Rs. 12,54,279 from Belgium and

Rs. 10,00,952 from United Kingdom. In 1937-38 Bihar imported 84,000 maunds of glass whereas only 8,000 maunds were exported. These figures clearly show that there is a great scope for further development of this industry in India. A study of the import list of these articles reveals that they can be divided into two groups :—

- (a) Goods such as bottles and phials which can very easily be manufactured in the existing glass factories of the country. But Japanese competition stands in the way the price of the Japan-made bottles being lower than those manufactured in the country. As regards sheet glass it also is being manufactured at Bahjoi in the United Provinces but due to hard Japanese competition, the market for the products are limited.
- (b) Goods of special type which require high technique and skill such as the optical and chemical glass-wares, which have not been manufactured in India up till now.

The only way to produce in India articles belonging to group (a) is to try to cut down the cost of their manufacture so that it may be possible for them to find a market against Japanese competition. As regards the manufacture of articles of group (b) it will require a certain amount of local investigation and the introduction of new technique.

As pointed out in the beginning, the present glass industry of India is concentrated in the United Provinces and Calcutta. The chief raw materials required for the manufacture of glass are sand, lime and soda which form the main constituents of the mixture which is melted to produce glass. In order to melt this mixture coal is required. The third item of cost after batch and fuel is refractories (heat-resisting materials) which are used for constructing pots and furnaces for melting glass.

At present, the chief locality of glass sand production is Bargarh at a distance of 30 miles south of Allahabad. Sand from this locality is being sent to western United Provinces, a distance of about 350 miles and to Calcutta, a distance of about 500 miles. Thus sand which costs at Bargarh Rs. 0-2-0 per maund, costs in western United Provinces about Rs. 0-6-0 and at Calcutta Rs. 0-8-0 per maund. Most of the lime used in glass

manufacture is imported from Katni which is about 400 and 600 miles respectively from western United Provinces and Calcutta. Soda is imported from England and distributed to all the northern Indian towns from Calcutta. As regards coal it is being supplied from Bihar coal-fields to glass factories, both in the United Provinces and Calcutta. The refractories, firebricks, blocks, etc., are also supplied to these centres of glass production from the coal-fields of Bihar where there is a well developed industry in refractory materials.

In order to prepare one maund of melted glass we require about 28 seers of sand, 13 seers of soda and 4 seers of lime; fuel consumption is about two maunds of coal. Unfortunately the present glass-manufacturing centres are situated at fairly long distances from the localities where raw materials are available, as indicated before. Moreover, the manufactured goods instead of being consumed in the local markets are sent to far off centres up to a distance of 1,000 miles. Under these conditions the price of the glass goods is bound to be high and it is no wonder that the present glass industry is unable to compete with Japan. For Calcutta, although coal is comparatively near, all the other raw materials have to be obtained from a distance of 500 miles or more.

From the different proportions of the raw materials required to prepare one maund of glass it is clear that the requirement of coal is highest in amount being double the weight of melted glass. Thus it is obvious that the cost of coal will be a very important factor in determining the cost of manufactured glass. The cost of these two maunds of coal in western United Provinces factories amounts to Re. 1, at Calcutta Rs. 0-10-0, while in the coal-fields of Bihar it would be Rs. 0-5-0 only.

A detailed survey of the raw materials for the manufacture of glass in Bihar, carried out by one of us (Dr. V. S. Dubey) showed that within 50 miles of different coal-fields, quartz, quartzite and sand-stone are found which are suitable for being turned into glass sand while good quality limestone also occurs within 100 miles. As regards soda, it is obtained from England and has almost the same cost at different localities in India.

Thus we see that the total cost of raw materials and fuel is the least at the coal-fields as compared with any other part of India. The following table represents the comparative cost

of different raw materials and of one maund of melted glass at different centres of the country.

Locality,	Sand 30 seers.	Lime 4 seers or limestone 7 seers.	Soda 13 seers.	Other chemicals required in small amount.	Coal 2 maunds or crude oil 5 maunds.	Total.
1	2	3	4	5	6	7
	Rs. s. p.	Rs. s. p.	Rs. s. p.	Rs. s. p.	Rs. s. p.	Rs. s. p.
1. Western United Provinces ...	0 4 6	0 1 6 lime.	1 5 0	0 2 0	1 0 0 coal.	2 13 6
2. Calcutta ...	0 6 0 at present.	0 1 6 lime.	1 3 0	0 2 0	0 10 0 coal.	2 6 6
3. Coals-fields of Bihar ...	0 2 0	0 0 6 limestone.	1 4 0	0 2 0	0 4 0 coal.	1 12 6
4. Bombay ...	0 6 0	0 1 0 lime.	1 3 0	0 2 6	1 6 0 coal. 0 13 0 crude oil.	3 4 0 coal. 3 3 0 crude oil.
5. Madras ...	0 2 0	0 0 6 limestone.	1 3 0	0 2 0	1 4 0 coal. 0 12 0 crude oil.	2 11 6 coal. 3 3 6 crude oil.

Besides the raw materials and fuels the other items of cost in the glass manufacture are the refractories and the labour for making finished articles from molten glass. The cost of refractory per maund of glass depends on the location and the size of the plant. The chief centres of production of refractories in India are the coal-fields where naturally they are cheapest. The cost of refractories, pots, etc. to the western United Provinces glass manufacturer using pot furnaces amounts to Rs. 0-4-0 per maund of glass melted and for a tank furnace, about Rs. 0-2-6 per maund, but if the glass industry is started on a large scale with tank furnaces in Bihar coal-fields, the cost of refractories will amount to about Rs. 0-2-0 per maund as they are the cheapest there.

As regards other items of cost of production, that is the charges for turning the molten glass into finished goods, a good deal depends on the method of working, namely, (1) mouth blowing, (2) automatic machine blowing and (3) semi-automatic machine blowing. It is not possible to enter into the details of their respective costs, but it may suffice here to say that the average cost of mouth blowing will be about Rs. 0-12-0 per maund, while in the case of automatic machinery, producing large amount of goods, the cost of making finished articles from molten

glass may amount to Rs. 0-6-0 per maund, while from semi-automatic machinery, it will amount to Rs. 0-8-0 per maund. This cost of turning out finished articles from molten glass by different devices will not vary with the locality but on the whole will be slightly cheaper in the coal-fields due to the low cost of power.

As regards the manufacture of sheet glass there are well standardised automatic machines and there is no question of alternative methods of working. But naturally the production cost will be the least in the coal-fields as the power is cheapest there. From all these considerations it is clear that the cost of production will be the least in the coal-fields and if there is any chance of competing with Japan with regard to bottles and sheet glass it is possible only if the industry is established near the Bihar coal-fields. The details of the cost of production and the question of competition with Japan have been further discussed later on.

The cost of manufacture of bottle and sheet glass at the coal-fields of Bihar.

Before working out the cost of manufacture it is essential to decide about the size of the plant because to a great extent the cost of manufacture will depend upon it. In deciding about the size of the plant one may assume that in the beginning the aim of the Bihar factory will be to replace the import of the Japanese bottles from Calcutta port and the factory should cater for the market which is being supplied from Calcutta port at present. The import list shows that Calcutta imports bottles and phials up to the extent of about seven lakhs of rupees and assuming an average price of Rs. 150 a ton, the import at Calcutta port amounts to about 5,000 tons a year. So the size of Bihar bottle plant should be about 10 tons a day. The plant should be so designed that it should manufacture 10 tons of bottles a day economically. Besides this bottle plant there ought to be a sheet glass plant as it is impossible for the present factory at Bahjoi to compete with Japan in this line. As regards the size of sheet glass plant in the beginning it should also cater for the needs of Bengal and Bihar. In the case of sheet glass the import figures are not clear as in the list of imports, sheet and plate glass are given together. The import of sheet and plate glass at the Calcutta port amounts to about Rs. 6½ lakhs a year weighing about 5,000 tons and if out of this 90 per cent be assumed to be sheet glass and 10 per cent plate glass, the import of sheet glass will be about 4,500 tons a year. So for the sheet

glass also we ought to have a plant manufacturing 10 tons a day. Therefore, the size of both sheet glass and bottle plant should be on an average 10 tons a day each. It is not possible here to go into details about the cost of the plant but the capital required including building will be of the order of about 8 lakhs while three lakhs may be required as working expenses. Thus a total sum of approximately 10 lakhs will be adequate for starting this industry.

Cost of manufacture of bottle, glass, etc., capacity of the plant being assumed as 10 tons per day.

	Rs.
The cost of 12.2 tons of batch at Rs. 1-6-0 per maund	460
Cost of 20 tons of coal at Rs. 4 per ton ..	80
Electric power 50 H. P. at 6 pies per unit ..	30
Bottle-making charges at Rs. 14 a ton including labour	140
Repairs and maintenance of furnace, etc., at Rs. 12,000 a year or per day	35
Mould repairs and maintenance at Rs. 7,000 a year or per day	20
Fixed costs—	
Salaries of technical staff Rs. 100 per day (Rs. 50 to be debited to bottle plant)	50
General administrative expenses Rs. 50 a day (Rs. 25 to be debited to bottle plant) ...	25
Depreciation and interest at 15 per cent on Rs. 3,45,000 per day	150
Packing charges at Rs. 0-8-0 a maund ..	140
	1,125

Therefore the total cost of 10 tons of glass bottles manufactured per day amounts to Rs. 1,125. So that the cost of bottles packed for delivery works out on an average Rs. 4 per maund. The cost of Japanese bottles at Calcutta port never amounted to less than Rs. 5. So if we sell our bottles at Rs. 4-12-0 for northern Indian markets and Rs. 4-8-0 for the Calcutta we can successfully compete with Japan. Assuming the selling price on average of Rs. 4-10-0 at the factory we get a margin of Rs. 0-10-0 per maund or Rs. 18 a ton or about Rs. 180 per day or

about Rs. 63,000 per year over and above the 6 per cent interest charged, in the calculation of the cost. Thus the total profit works out to be about Rs. 90,000 or so a year. With this rate of selling at Rs. 4-14-0 a maund it is possible to compete with Japan successfully and if the whole thing works in an efficient manner it should be possible to displace the import of Japanese glass bottles firstly from northern India and then from Madras and Bombay.

Cost of manufacture of sheet glass, capacity of the plant being assumed as 10 tons per day.

	Rs.
Cost of 12.2 tons of batch at Rs. 1-6-0 per maund	460
Cost of coal 15 tons at Rs. 4 per ton	60
Electric power 80 H. P. at 6 pies per unit ..	50
Plate machine expenses including labour per day ..	100
Repairs and maintenance of plant per day ..	50
Repairs and maintenance of the furnace ..	100
Salaries of technical staff per day	100
General administrative staff per day	75
Interest (6 per cent) and depreciation (9 per cent) at 15 per cent on Rs. 4,00,000.	170
Packing charges	130
	1,245

Say about Rs. 1,250 per day which is for producing 10 tons of goods.

The above figures correspond to a cost of Rs. 4-8-0 per maund of glass produced. The lowest price of the Japanese plate glass is about Rs. 5 per maund. So, if our plate glass obtains a price of about Rs. 5 a maund we can make a profit of about Rs. 140 per day or annually about Rs. 59,000 over 6 per cent interest. Therefore including the interest the profits amount to about Rs. 83,800 which works out to be about 17 per cent on an investment of 5 lakhs (including one lakh running capital).

SUMMARY.

From the details of cost of manufacture it is clear that if this industry is started at the coal-fields in Bihar there is a good chance of competing successfully with Japan. The first thing to be decided is about the exact location of the industry. There are several coal-fields in the province where most of the raw materials are available in the neighbourhood. It will require a very detailed study to select the best place. The locality should be such that besides coal it should have as many raw materials as possible occurring in the vicinity. It should also be near the places where packing materials are available as also the market. In order to decide all these questions it will be essential to set up a committee of experts to visit the different centres to make a detailed study of the advantages offered by the respective localities. After this the size of the plant should be definitely decided upon. This can be done only after critically investigating the market condition including the question of competition.

As regards finance it would require about Rs. 10,00,000 of capital. For suggestions for raising this amount see Chapter I.

Porcelain industry.

The chief raw materials for ceramics are china clay, quartz and felspar. China clay is found in large quantities in Rajmahal hills and also in Singhbhum. In both these places it is associated with quartz and felspar deposits, the other essential raw material, coal, of fairly good quality is also available at a comparatively cheap price. The close association of the raw material and fuel ought to have given a great impetus to the porcelain industry in the province but unfortunately no porcelain factory has yet been established in Bihar although India imported earthenware and porcelain goods to the value of Rs. 47,81,011 in 1937-38. It is regretted that it has not been possible to frame any estimates of cost and machinery required for this industry but a fairly good-sized factory will require a capital of the order of 5 lakhs of rupees.

Refractories.

The common refractory materials are fire-clay, kyanite, silica, graphite, magnesite, etc. With the exception of the last one, magnesite, all the others are found in abundance in Bihar. Fire-clay found in coal seams, is being utilised for the manufacture of fire-bricks for which Bihar along with Bengal holds the

monopoly. But unfortunately kyanite, which is found near Ghatshila and in the Kharsawan State is being exported at a cheap rate. Attempts should be made to prepare kyanite-sillimanite refractories in the province, which are undoubtedly better than fire-clay refractories. Graphite, which is used in large quantities for the manufacture of crucibles, is not being utilised within the province. The question of the manufacture of bauxite refractories requires careful consideration. Bauxite, as mined, contains a large quantity of combined water and shrinks considerably on heating to ordinary ranges of firing temperatures for refractories. If it is possible to heat bauxite up to 1500°—1600°C, an alteration in the physical structure takes place, so that bricks manufactured from this ignited material, do not exhibit any shrinkage and are ideal for basic furnace linings. But at present, the cost of heating bauxite to 1600°C is prohibitive and hence the industry has not been taken in hand by any manufacturer.

CHAPTER IX.

PULP, PAPER AND CARD-BOARD MANUFACTURE.

We attach great importance to the establishment of pulp, paper and card-board industry within the province. Its establishment will benefit practically every industry specially a number of cottage industries. Almost anything sold these days requires paper either for packing, wrapping, labels, advertisement or at least for account keeping. On the successful manufacture of paper pulp will depend the establishment, at a later date, of such an important industry as the artificial silk industry. Paper pulp industry is truly a key industry and every effort should be made to make the province self-sufficient in this respect. We understand that Messrs. Dalmia have started the manufacture of paper and paper pulp at Dehri-on-Sone. In the opinion of the Committee this is a very desirable undertaking and deserves to be encouraged. But the manufacture must be conducted on modern lines and under proper technical control.

Although there are a number of paper mills working in the different provinces of India, the consumption of paper in India is beyond the capacity of the existing factories and a very large quantity of paper has to be imported every year.

	Import of paper in cwt.		Price in rupees.	
	1935-36.	1936-37.	1935-36.	1936-37.
1	2	3	4	5
			Rs.	Rs.
Packing and wrapping paper.	405,495	364,146	53,01,635	48,05,959
Printing paper (machine glazed poster paper).	33,646	28,062	4,36,479	3,66,641
News printing ..	686,555	734,961	52,44,990	52,99,242
Writing paper ..	147,233	156,486	34,71,153	33,59,888

The cheaper varieties of paper for news print, etc., are made from raw materials which are found in abundance in Bihar. The available quantity of sabai grass and bamboo in Bihar is considerable.

Sabai grass—100,000 maunds per year.

Bamboo—Considerable but quantity not known.

16,000 maunds of sabai grass are used locally for rope-making the remainder being sold outside the province. Similarly in the case of bamboo, after meeting the local demand for building houses for the poorer classes, the excess is exported. The cultivation of sabai grass and bamboo should be encouraged and further suitable areas should be planted under the directions of the Forest Department. A number of paper mills near Calcutta, are manufacturing pulp from bamboo by digestion with caustic soda and there is no reason why the same process should not be successfully worked in Bihar.

A difficulty that is being experienced in this process is the recovery of caustic soda. Bamboo, as is well known, contains a fair quantity of silica and during alkaline digestion this is converted into sodium silicate which brings about considerable difficulty in the recovery of soda from the waste liquors.

The other essentials for a paper factory are filling and sizing materials and the cheap supply of electric power for the manufacture of chlorine. The former are found in abundance in Bihar and when the Electrification Scheme comes into operation, a cheap supply of electricity will also be available. As all the raw materials are available in the province, the question of starting paper factories ought to be taken up seriously by the industrial men of the province.

The cost of machinery for a bamboo pulp and paper mill of 5 tons capacity for 24 hours is given in the appendix.

APPENDIX IX.

Estimate for a paper mill of 5 tons capacity per day.

	Rs.
1. Bamboo crusher, conveyer, autoclaves for digestion, etc.	1,02,500
2. Mixing chest, strainer, pumps, fittings, etc. ..	14,400
3. Paper making machine	1,06,400
4. Re-winder, slitter, cutters, etc.	5,600
5. Accessories to paper machine	4,200
6. Erection charges	52,500
7. Bleaching liquor plant	1,00,000
8. Caustic recovery plant	75,000
9. Boiler	20,000
10. Power plant	50,000
11. Buildings and sheds	25,000
	<hr/>
	5,55,600
12. Working capital	2,00,000
	<hr/>
Total	7,55,600

Cost of production of a ton of bleached bamboo pulp paper. 1 ton of paper (90 per cent pulp 10 per cent filler.)

	Rs.
Pulp	127-65
Bleaching powder 200 lbs. at Rs. 120 per ton ..	12-5
Sizing materials and chemicals	12-0
Coal 2-5 tons at Rs. 8 a ton	20-0
Labour	20-0
Repairs	10-0
Packing	20-0
Overhead charges	10-0
Depreciation on machinery	15-0
Depreciation on buildings	1-7
Interest on working capital	20-0
Insurance	5-0
	<hr/>
Total	272-35 per ton.

The average price of this type of paper is about Rs. 400 per ton, so that there is ample margin of profit for the undertaking.

CHAPTER X.

THE MANUFACTURE OF ARTIFICIAL SILK IN INDIA.

In our opinion the establishment of the artificial silk industry must follow and not precede the establishment of heavy chemical and ordinary paper pulp industry. We, therefore, do not recommend that Government should examine the possibility of this industry any further at present. The following note, however, is added in case Government desire to have further information on the subject :—

At present for the manufacture of artificial silk, two principal processes, viz., the viscose process and the acetate process, are in use. The main materials required for these processes are many and only a few of these are manufactured in India. These processes are of high technical complexity and require for their successful exploitation, a range of raw materials of high quality as well as skilled and experienced technical staff and costly plants.

For the viscose process sulphites for the preparation of wood pulp, carbon bisulphide and sulphuric acid for the actual artificial silk process and other auxiliary materials are required. It appears that India and specially Bihar, may in future become a supplier of artificial silk if it is found practicable to utilise the deposits of pyrites in Bihar or in the neighbouring state of Nepal for the extraction of sulphur for use in the manufacture of carbon disulphide. In the absence of cotton linters of standard quality it may be found possible to employ soft woods like spruce and silver fir found in the Himalayas for the manufacture of wood pulp. But all this will require extensive research and investigation.

As regards raw materials for the acetate process, the position is no more attractive since no acetic acid, acetone or acetic anhydride are at present being manufactured in this country. Molasses from sugar factories may become the source of these important chemicals. Here again Bihar occupies a very favourable position as she has a large surplus of molasses from sugar factories.

The above two processes for the manufacture of artificial silk are well known and standardised and there is no necessity for a pilot plant to be installed in India simply for the purpose of demonstrating that artificial silk can be made. Pilot plants are desirable however for investigating the suitability and economics of the manufacture of high grade cellulose from various grades of cotton linters and from wood. The question

then arises as to what should be regarded as a suitable size of pilot plant for this purpose. The pulping plant of the Titaghar Paper Mills, Calcutta, for the production of bamboo pulp is of interest in this connection as the average size of the pulping digestors installed by this firm is of 5 tons capacity, i.e., five tons per charge which is quite normal for this type of plant. A plant of 1-10th this capacity would provide a suitable pilot plant for our purpose. Similarly a pilot plant to investigate the possibilities of producing chemical cotton should have a capacity of say 800 lbs. (2 bales).

As regards the availability of other raw materials the present position is as follows :—

Materials in use in the principal manufacturing countries for production of artificial silk by the Viscose process :—

Raw materials.

Cellulose (chemical wood pulp and chemical cotton).

Caustic soda.

Carbon bisulphide.

Sulphuric acid.

Auxiliary materials.

Glucose and sizing materials.

Sodium sulphate.

Zinc sulphate.

Sodium hypochlorite.

Hydrochloric acid.

Sodium carbonate (soda ash).

Softening oils.

Dyes.

We have already indicated that chemical wood pulp and chemical cotton are not produced in India at present. Caustic soda also is not produced in sufficient quantity but as we have already mentioned there is good prospect of this difficulty being solved in the near future. Carbon bisulphide is not manufactured in India, but as indicated before it may be manufactured where pyrites or other sources of sulphur are available. Sulphuric acid is manufactured in India from imported sulphur.

As regards the auxiliary materials suitable glucose or other sizing material is not at present produced in India, but there

should be no difficulty in their preparation once the heavy chemical industries are safely established. Zinc sulphate, sodium hypochlorite, softening oils, and suitable dyes are not produced in India, but their manufacture also is governed by the same consideration of establishment of heavy chemical industry. Sodium sulphate (Glauber salt) and hydrochloric acid are produced in India but with the aid of imported sulphur. Sodium carbonate (soda ash) is not at present produced in India but will shortly be manufactured here by Messrs. Imperial Chemical Industries. Dyes of the types in general use are not manufactured in India. Indigenous dyes might be suitable but this would require lengthy and intensive investigation.

Materials used in the principal manufacturing countries for production of artificial silk by the acetate process.

Main materials.

Cellulose (chemical cotton).

Acetic acid.

Acetic anhydride.

Acetone.

Auxiliary materials.

Sulphuric acid.

Sodium carbonate (soda ash).

Sodium acetate.

Softening oils and sizing materials.

Dyes (Special dyes).

Acetic acid, acetic anhydride and acetone are not produced in India. Their production from molasses will require the setting up of new factories. Sulphuric acid is available though as mentioned above, this is manufactured from imported sulphur. Sodium carbonate, i.e. soda ash, will shortly be manufactured in India by Messrs. Imperial Chemical Industries and possibly also by Messrs. Tata and Sons, Limited. Sodium acetate is not at present manufactured in the country but this will be readily possible when soda ash and acetic acid are available. Suitable softening oils and sizing materials are not at present produced here but there is no inherent difficulty in their production. The dyes required in the case of this process are of a highly specialised type such as the Solacet range of Azo dyes developed by Messrs. Imperial Chemical Industries, and are not manufactured in India.

From the above it is evident that an artificial silk industry set up in India at present would be dependent upon a large number of imported raw materials. It is consequently desirable that every thing should be done to develop the production of the necessary raw materials which are not manufactured in India and which have been specified above. The most important of these are alkalies, sulphuric acid, acetic acid and coal tar dyes. For the present, therefore, the artificial silk industry cannot be regarded as a feasible industry in this province but one which is potentially a possible industry and which it is desirable to establish in not too distant future.

Import of camphor.

Celluloid is a solid prepared by subjecting pyroxylin, a nitrated cellulose with 11—12% Nitrogen camphor and other substances which act as stabilizers, to hydraulic pressure. The import figures of celluloid are not available but that of camphor is given below :—

Import of camphor.

In lbs.		Rs.	
1935-36.	1936-37.	1935-36.	1936-37.
2,207,386	1,868,011	22,41,510	21,24,856

As stated before, pyroxylin is a nitro-cellulose and consequently an explosive. Although there are no technical difficulties in its preparation yet proper safeguard must be introduced to prevent its manufacture, distribution and use by authorised firms or individuals. Camphor, the other essential constituent, can be made from Indian turpentine but there is no factory where this has yet been attempted.

The method of preparation consists of mixing moist pyroxylin with powdered camphor, sprinkling alcohol on the mixture and kneading at a temperature below 35° C for several hours. The resulting mass is soft and by the application of hydraulic pressure it is formed into sheets, rods or blocks. Pigments are incorporated during the kneading, zinc oxide giving a white body resembling ivory. For transparent celluloid urea is used as a stabilizer. Camphor not only plasticises pyroxylin but removes its explosive nature. This industry also is not feasible in the province under the present conditions and must wait until the artificial silk industry has been established so that large quantities of suitable cellulose becomes readily available.

CHAPTER XI.

BELTING FOR MACHINERY.

The manufacture of beltings for machines is one of great importance for every country where machines are used in large numbers for manufacturing processes. The import prices of beltings during the last two years are given below :—

1935-36.

1936-37.

Rs. 53,51,072

Rs. 45,95,033

The imported materials are usually made from the following sources :—

1. Cotton.
2. Hair.
3. Leather.
4. Other materials.

There are two belting manufacturing factories near Calcutta—(1) Messrs. Bengal Belting Works, Ltd., (2) Messrs. Birkmyre Bros. A third is in course of construction. During the visit of our Secretary the factory of Messrs. Birkmyre Bros. was not working but from the discussion he had with the various firms the following points were brought to light :—

(1) Messrs. Bengal Belting Works, Ltd., with a capital of Rs. 3,00,000 is now turning out belting to the value of Rs. 3,50,000 per year, working one shift per day. With double shifts the output may be raised to Rs. 7,00,000 per year. This firm is manufacturing beltings of the following varieties :—

(a) Cotton—mainly brought from Cawnpur, (b) hair from imported Australian wool, (c) flax—the yarns being imported from England, (d) silk—from Assam silk. Canvas and hose pipes of various sizes are also being manufactured in the factory.

(2) Messrs. Birkmyre Bros. The output of their factory is Rs. 10,00,000 per year. It is said that they have to close down because of the unfair competition of imported materials.

It was pointed out to our Secretary that although the jute mills of Calcutta and the cotton mills of Bombay are virtually enjoying a protection from the Government of India very few of them are using beltings manufactured in the country. As the

total production of these two factories near Calcutta working two shifts per day may come up to Rs. 34,00,000 the country might be independent of foreign supply if proper protection is given to this infant industry with the understanding that unless the price of raw materials exceeds the present figures the price of beltings manufactured by them will not be allowed to be enhanced. The establishment of any new belting factory for Bihar need not be considered at present unless the demand increases beyond the production capacity of the existing firms. This is extremely unlikely as the modern tendency of machine manufacture is to dispense with belting drive and to provide individual motors as the regulation of speed and the facility of working are greater with this form of driving.

It is very probable that the quality of the Indian produced beltings requires to be further improved so as to appeal to those users who are at present using imported materials.

THE BENGAL BELTING WORKS, LIMITED, SERAMPORE.

Weaving shed :—

- 5 looms to make 7" to 10" belts.
- 1 loom to make 12" to 24" belts.
- 12 looms to make 4" to 6" belts.
- 1 loom to make Listing.
- 14 looms to make $\frac{3}{4}$ " to 4" belts.
- 2 looms to make Hose Pipe.

Monthly production at present is Rs. 25,000 per single shift. On double shift the production may reach Rs. 1,00,000 worth of Belting and Hose Pipe.

Preparatory shed :—

- 3 Re-winding machines.
- 3 Beaming machines.
- 1 Big Beamer.
- 2 Twisting machines. 1 more Twisting machine under construction.
- 1 Cheese Winder.

CHAPTER XII.

OIL INDUSTRY.

As we have already stated elsewhere the local crushing of oil seeds deserves to be encouraged because when seed is exported the oil cake which is an excellent manure and contains both nitrogen and phosphorus is lost to the province. There are very few sources of phosphorus in India and the conservation of this element is most desirable. A reference may be made in this connection to Chapter V dealing with phosphatic manures.

There are 31 oil mills in this province all of which are equipped primarily for crushing mustard but all of them crush a certain amount of linseed and *serguja*. Almost all these mills work on the system of power-driven rotary *ghanis*, only some of the mills having expellers. As far as can be ascertained the number of rotary *ghanis* is about 3,000 and the number of expellers 30. The industry is concentrated in the towns situated along the south bank of the Ganges, mainly because of the facilities afforded by cheap river transport. There are still thousands of old fashioned village *ghanis* in use, although their number is fast decreasing under the pressure of competition from power-mills.

Oil seed crushing industry is recognised to be one of the important industries of the country. The import of different classes of oils is not insignificant.

Import in gallons.

—	1935-36.	1936-37.	1935-36.	1936-37.
	Gallons.	Gallons.	Rs.	Rs.
Cocoanut oil ..	8,543,902	7,826,528	90,19,207	91,36,803
Ground nut oil ..	1,664	1,355	2,709	1,997
Linseed oil ..	136,311	143,518	3,27,118	3,54,854

The export of oil during these periods is insignificant. The export of oil seeds however is very considerable.

Export of oil seeds, in tons.

	1935-36.	1936-37.	1935-36.	1936-37.
	Tons.	Tons.	Rs.	Rs.
Castor	59,968	43,089	83,14,775	62,97,761
Copra or cocoanut kernel	48	38	17,652	15,158
Cotton seed ..	730	9,003	45,215	5,01,764
Ground nut ..	412,567	739,483	6,65,10,263	12,28,57,494
Linseed ..	164,743	296,034	2,20,62,178	4,36,44,191
Mustard ..	2,117	2,615	4,06,955	4,78,929
Rape	19,021	37,637	25,78,782	53,67,792
Sesame ..	1,300	14,216	2,69,803	27,15,117

Among the important class of oil seeds, Bihar exports a fairly large quantity of linseed whereas she has to depend upon the import of mustard and ground nut for supplying her local demands.

A scheme for the setting up of a plant capable of crushing 10 tons of oil seeds per day of 24 hours is given at the end of this chapter [see appendix XII(a)]. In the case of mustard seeds ordinary types of *ghani* are said to be necessary for the first crushing of the seeds in order to impart the pungent odour to the product. It is possible that the problem of pungency may be solved by the use of synthetic pungent principles which are on the market. The output of the factory will depend upon the nature of seeds crushed. Most of the progressive oil mills near Calcutta have installed machineries of this type and are running at a profit. It seems that in Bihar, the conditions will not be very different. The prices at which the factories in Bihar would be able to obtain seeds like ground nut, castor, etc., would be lower than those obtaining in the Calcutta markets and consequently the price of oils would naturally be slightly lower. In this connection attempts should be made for the manufacture of cold drawn castor oil, which after refining may be sold as medicinal product.

OIL CAKES.

From the manurial point of view, compared with the synthetics, oil cakes fetch a fairly good price (vide the export figures). The question then arises whether we should preserve the oil cake for cattle feeding and manurial purposes, or continue to export them. Taking a long view, these cakes should be utilised in the country for the sake of improving the cattle as also to check the phosphorus impoverishment of the soil. We say long view, because the effect on the cattle cannot be so definitely measured as to be able so say whether export prices are not compensated thereby, but experts are of the opinion that the retention of the oil cakes in the country is a move in the right direction. In any case, a restriction on the export of oil cakes, after thorough calculation of our cattle requirements is imperative.

The export trade of India in oil cakes is very large as the following figures will clearly indicate :—

—	1935-36.	1936-37.	1935-36.	1936-37.
	Tons.	Tons.	Rs.	Rs.
Castor cake ..	1,657	1,698	69,671	82,777
Cocoanut cake ..	3,825	4,187	2,54,331	2,94,106
Cotton cake ..	6,213	4,187	2,92,147	5,43,833
Ground nut ..	1,94,238	2,37,760	1,16,36,320	1,64,33,687
Linseed cake ...	71,774	50,194	43,93,826	34,51,280
Rape and sesame cake.	7,697	13,736	2,72,029	4,97,759

The problem of the utilisation of this vast quantity of oil cake is very pressing. Besides containing a certain percentage of oil (7-10 per cent), the oil cakes are employed as manures in foreign countries. The usual export practice is to guarantee 2.75 per cent P, O₂ and 4.5 per cent N.

SOAP.

The supply of vegetable oils for the manufacture of soap is fairly abundant in Bihar. Of the other raw materials, caustic soda, sodium silicate, etc., have to be imported. A cost sheet for a plant manufacturing 0.75 tons washing soap and 0.25 tons of milled toilet soaps is given in appendix XII(b). The prices given are those obtaining in the Calcutta markets at the present time.

Soap is a feasible industry for Bihar and may be left to private capitalists. It is one of those chemical industries which are suitable for cottage scale production in Bihar. We have discussed this point in the chapter on Cottage industries.

TOILET GOODS.

The use of toilet goods, like snows, creams, toilet powders is on the increase among the educated classes all over the country. The preparation of these can easily be undertaken by an experienced chemist, without any costly machinery and the profits are very alluring. Details as to the cost of manufacture for a fairly large concern are given below. The undertaking may easily form part of a soap factory.

SNOW.

Raw materials.—

			Ra.	a.	p.
Stearic acid—10 lbs.	..	..	3	12	0
Borax and caustic potash	..	..	0	10	0
Perfume—1 oz.	..	..	10	0	0
Labour ..	..	..	10	0	0
Containers and packing for 500 bottles	..	..	47	0	0
			<hr/>		
Total	..	..	71	6	0
			<hr/>		
			Ra.	a.	p.
Sales commission at 10 per cent of the sale price	..	..	25	0	0
Dealers' commission at 12½ per cent.	..	..	42	0	0
Delivery charges at 2½ per cent.	..	..	6	4	0
Advertisement at 5 per cent.	..	..	12	8	0
			<hr/>		
Total	..	..	157	2	0
			<hr/>		

	Rs.
Sale price for 500 bottles at annas 8 per bottle	250
Profit	92

Cold Cream.—The preparation of cold cream is very similar to that of snows, the only difference being that a part of stearic acid is replaced by lanolin. The production cost and the profits are about the same.

Toilet powder.—

	Rs.	a.	p.
Talc. 56 lbs.	3	8	0
Starch 56 lbs.	3	8	0
Boric acid ..			
Magnesium carbo- nate ..	3	8	0
Zinc oxide ..			
Scent 2 per cent. at Rs. 16 ..	33	0	0
	<hr/>		
	39	8	0
Sale charges at 30 per cent ..	49	0	0
Labour	7	0	0
	<hr/>		
Total	93	8	0
	<hr/>		

	Rs.
Sale price at annas 3 per packet of 2 oz.—896 packets	168
Profit	74

TALLOW, STEARINE AND GLYCERINE.

Import of Glycerine.

1933-34.		1934-35.		1935-36.
11,464 cwt.	..	10,334 cwt.	..	9,420 cwt.
Rs.		Rs.		Rs.
3,63,291	..	3,66,709	..	4,08,768

The import figures for tallow and stearine are not available, the current prices of these in Calcutta markets are given below :—

	Rs.	a.	p.	
Australian Best White Mutton Tallow ..	21	8	0	per cwt.
„ Mixed Tallow no. 1 ..	20	0	0	„

The industry of the hydrolysis of tallow for the production of stearic acid and glycerine is now well-established in European countries, the stearic acid being utilised for the manufacture of candles. But unfortunately this industry is non-existent in India, because stearine candles are looked upon with disfavour by the majority of our countrymen. The main uses of stearic acid in India are the manufacture of shaving soaps, cosmetics, leather dressings, etc. The high price of this commodity stands against its use in the soap industry although the process of manufacture may be considerably simplified with stearic acid as the starting material.

The second product of the process is glycerine which is used in large quantities for the manufacture of explosives and certain medicinal preparations. The usual source of glycerine is the waste-lye of the soap factories. But unfortunately that soap factories of our country are built in such small units that the quantity of waste-lye in each factory would not be enough to justify the cost of a glycerine recovery plant. If, however, a central factory is erected, near a group of soap factories where the waste-lye from each of them may be easily transported, the proposition may turn out to be a promising one. There is no such place in Bihar at present. Moreover, the manufacture of pure glycerine from soap lye is a highly technical process. The prospect of the manufacture of glycerine by the hydrolysis of tallow is most promising because the crude glycerol is obtained in a comparatively pure state.

The methods that are used for the splitting of fats are the following :—

- (1) Saponification under pressure, with bases like lime, magnesia, etc.
- (2) Acid saponification process, in which concentrated sulphuric acid is used as a hydrolysing agent, the fat being intimately mixed with the acid by mechanical agitation and kept fluid by the addition of dry steam.

- (3) Lipase fermentation process in which the fat is hydrolysed by an enzyme present in castor seeds.
- (4) Twitchell process, which consists in emulsifying the fat with water by small quantity of certain compounds (sulpho aromatic fatty acids) and passing open steam through the emulsion.

A comparison of these processes shows that none of these is without some disadvantage. In the first process, the saponification is carried out under pressure which involves rather costly plants and a part of the stearic acid is converted into insoluble soaps. On the other hand, the stearic acid is very pure and white and the yield of glycerol is very good. In the sulphuric acid process, the yield of solid fatty acids is greater than that in any other process (55—65 per cent from tallow) but the quality of the acid and also of glycerol is poor. The fermentation process gives a fairly pure fatty acid but the yield of glycerol is low and owing to the presence of foreign organic matter, the process of recovery becomes cumbersome. The Twitchell process has been found to give the best yield and quality of fatty acid and glycerol.

The Twitchell reagent is prepared by adding a large excess of sulphuric acid to a mixture of benzene and oleic acid in molecular proportions and washing the resulting product. Tallow after preliminary purification is treated with the reagent 1 per cent sulphuric acid (60° Be, 1 c.c. per lb. of tallow). Steam is then passed through the mixture for 12—15 hours, when the hydrolysis is complete. A better and more active reagent can be prepared from naphthalene instead of benzene. About 96 per cent of the fat is hydrolysed by heating for 12—24 hours, and the fatty acid is easily pressed out and is found to be of a white colour. The yield of glycerol in this process is 7-8 per cent.

There is, however, little prospect of success of this industry in Bihar at present. A small plant will be uneconomical. For a large unit, the necessary raw materials will not be easy to collect and there is sure to be difficulty in marketing the products as there is no local demand at present for large quantities of these materials.

APPENDIX XII(a).

Estimate for a plant capable of crushing 10 tons of oil seeds per day of 24 hours.

	Rs.
One Hexagonal screening reels capacity 1,500 lbs. per hour	2,830
One Oil-seed mill with superimposed rollers, for the preliminary crushing ..	10,545
Two Oil expellers "Schler system" at Rs. 9,100 each less 7½ per cent ..	17,900
One Filter press with pump 24½" × 24½" ..	3,010
Buildings and land	5,000
Erection charges	1,000
Motor—50 H. P. 1,200 revol.—	
One D. C.	1,500
One A. C.	1,200
Shafts, countershafts, pulleys, plumber, blocks, beltings	3,000
Boiler, 4N H. P.	1,000
6 Oil tanks—10 tons capacity ..	600
Contingency	2,000
	49,585
Total	49,585

APPENDIX XII(b).

A cost sheet for a plant manufacturing 0.75 tons washing soap and 0.25 tons of milled toilet soaps.

Block capital—

	Rs.	a.	p.
1. One boiler for steam generation ..	4,000	0	0
2. One soap pan 7'×7'×8' for washing soap base or a cylindrical one 8' diam. ×8' depth	1,000	0	0
3. One soap pan 7'×7'×8' for toilet soap	1,000	0	0
4. Fittings for the soap pans ..	200	0	0
5. Iron soap boiling pan 50—60 mds. capacity for making semi-boiled soap 15 mds. per day	90	0	0
6. Soap framers, capacity 12—13 mds. of soap 10 frames for (2) and (3) at Rs. 80 each	800	0	0
7. Soap slabbing apparatus ...	20	0	0
8. Soap cutting machine for washing soap 2 at Rs. 50 each	100	0	0
9. Stamping machine (country made) —2 at Rs. 60 each	120	0	0
10. Soap chipping machine	250	0	0
11. Steam drying chamber for drying toilet soap chips with exhaust fan and motor as designed by the Director of Industries, Bengal	2,000	0	0
12. Complete toilet soap machinery including one plodding machine, one milling machine, one cutting machine and one stamping machine with one motor 12 H. P.	6,000	0	0
13. Erection expenses, etc.	1,000	0	0
14. Building, sheds, etc.	10,000	0	0
15. Land 2 bighas	4,000	0	0
Total	30,580	0	0
Working capital	1,00,000	0	0
Grand total	1,30,580	0	0

APPENDIX XII(b)—*contd.*

Raw materials—		Rs.	a.	p.
1. Caustic soda—1 ton per week	...	207	8	0
2. Soda silicate (country) 5 cwt. per week		20	0	0
3. Salt—20 mds.	„ „	40	0	0
4. Tallow—for toilet soap—35 mds.				
	for semi-boiled—20 „			
	—	55	„	per week
		605	0	0
5. Cocoanut oil—Toilet—10 mds.				
	Washing—20 „			
	semi-boiled—30 „			
	—	60	„	per week
		600	0	0
6. Mowha oil—washing—25 mds. per week		275	0	0
7. Ground nut oil—Toilet—3 mds.				
	Washing—5 „			
	semi-boiled—9 „			
	—	17	„	per week
		180	0	0
8. Castor oil—toilet—2 mds.				
	Washing—3 „			
	—	5	„	per week
		55	0	0
9. Rosin—toilet— $\frac{1}{2}$ mds.				
	Washing— $2\frac{1}{2}$ „			
	semi-boiled— $1\frac{1}{2}$ „			
	—	$4\frac{1}{2}$	„	per week
		40	0	0
10. Perfume for toilet soap 9 lbs. at Ra. 8 per week	... ..	72	0	0
		<hr/>		
	Total	2,094	8	0 per week.
11. Power	.. ..	50	0	0 „ „
		<hr/>		
	Grand total	2,144	8	0 „ „

APPENDIX XII(b)—contd.

Wages—				Rs.	a.	p.		
Chemist	..	...	...	50	0	0	per week.
Assistant chemist	..	...	...	20	0	0	„ „
Boiler man	...	..	...	10	0	0	„ „
Soap boiling mistry	...	...	...	15	0	0	„ „
Assistants to soap boiling mistry,—2 at Rs 7 each per week	...	...	...	14	0	0	„ „
Labour for soap boiling—5 at annas 4 per day	...	..	...	7	8	0	„ „
For washing soap unit—								
3 expert stampers at annas 8 per day	}			15	0	0	„ „	
2 expert cutters at annas 8 per day								
7 coolies at annas 4 per day	..	...	...	10	8	0	„ „
For toilet soap unit—								
2 coolies for chipping and drying at annas 4 per day	...	...	...	3	0	0	„ „
2 expert stampers at annas 12 per day	...	...	...	9	0	0	„ „
2 expert hands for plodding milling at annas 12 per day	...	...	...	9	0	0	„ „
6 coolies and packers at annas 4 per day	...	...	...	9	0	0	„ „
1 Electrician and mechanic...	...	...	...	9	0	0	„ „
Total				...	181	0	0	„ „
Office expenditure—								
1 accountant	..	...	...	15	0	0	per week.
2 clerks	..	..	...	20	0	0	„ „
1 cashier	..	..	...	10	0	0	„ „
1 store keeper	..	..	..	10	0	0	„ „
1 bearer	..	..	...	4	0	0	„ „
Total				...	59	0	0	„ „

APPENDIX XII(b)—concl'd.

Sale charges—		Rs.	a.	p.		
Canvassers at 10 per cent of the sales.	...	365	0	0	per week.	
Advertisements at 5 per cent	.. ..	182	0	0	.. ..
Delivery charges at 5 per cent	.. ..	182	0	0	.. ..
Cost of production—						
Materials	... ..	2,144	8	0	.. ..
Labour	... ..	200	0	0	.. ..
Depreciation	... ..	25	0	0	.. ..
Office expenditure	... ..	59	0	0	.. ..
Canvasser	.. ..	365	0	0	.. ..
Advertisement	.. ..	182	0	0	.. ..
Delivery	.. ..	182	0	0	.. ..
Total		3,163	8	0	.. ..
Sales—						
90 mds. semi-boiled soap at Rs. 11 per md.		999	0	0	per week.	
60 mds. washing soap (sunlight type) at Rs. 13 per md.	.. ..	780	0	0	.. ..
32 mds. toilet soap (Turkish bath type) at annas 10 per seer	.. ..	800	0	0	.. ..
18 mds. toilet soap at Rs. 1-8-0 per seer	...	1,080	0	0	.. ..
Total		3,650	0	0	.. ..
Working expenses		3,163	0	0	.. ..
Profit		487	0	0	.. ..

APPENDIX XII(c).

Estimate of a plant for producing one ton of stearin per day.

	Rs.
A.—Machinery—	
Boiler 5,000—6,000 lbs. of steam per hour ..	20,000
Two hydraulic presses $\frac{1}{2}$ ton capacity, hot and cold at Rs. 5,000	10,000
Two glycerine concentration pans (200 gals. capacity)	1,000
One vacuum distillation plant for glycerine (capacity 2 cwt.)	10,000
One fatty acid distillation plant	10,000
Twitchell plant (pumps, lead-lined vats, etc.) ..	10,000
Crystallisation apparatus and refrigerating plant	5,000
	<hr/>
Total ..	66,000
	<hr/>
B.—Buildings, etc.—	
Factory shed 6,000 sq. ft.	6,000
Office and godown	2,000
Furniture, equipments, etc.	1,000
Miscellaneous	5,000
	<hr/>
Total ..	14,000
Working capital	1,00,000
	<hr/>
Total ..	1,80,000
	<hr/>

(Working expenses.

Wages and salaries—

- (a) Manager at Rs. 150 per month.
- (b) Chemist at Rs. 100 per month.
- (c) Assistant chemists 3 at Rs. 60 per month.
- (d) Clerk at Rs. 50 per month.
- (e) 30 coolies in 3 shifts at Rs. 20 per shift.

APPENDIX XII(c)—concl'd.

	Rs. s. p.
Raw materials—	
Tallow 1·1 ton at Rs. 17 per cwt. ...	374 0 0
Twitchell reagent (25 lbs.) ..	7 8 0
Sulphuric acid and lime ..	1 0 0
Fuel (5 tons)	50 0 0
Interest on capital—	
Rs. 1,80,000 at 6 per cent per annum ...	29 8 0
Depreciation on machinery—	
At 10 per cent	16 8 0
Miscellaneous	15 0 0
	<hr/>
Total	... 529 8 0
	<hr/>
Sales—	
Stearic acid 9·4 cwt. at Rs. 45 per cwt. ..	413 8 0
Oleic acid 9·4 cwt. at Rs. 15 per cwt. ..	141 0 0
Glycerol 1·3 cwt. at Rs. 60 per cwt. ..	78 0 0
	<hr/>
Total	.. 632 8 0
	<hr/>
Profit—Rs. 103 per day of 24 hours.	

CHAPTER XIII.

PAINTS, VARNISHES, LACQUERS.

Bihar produces one-sixth of the total linseed of India and practically exports 80—90 per cent of its production. After meeting the local demands, a portion of the large quantity now exported, could be converted into raw and boiled linseed oils, for use in the manufacture of paints. The pigments required, their sources, and processes of treatment are all described in brief in the appendix, which would show that the establishment of a paint factory on suitable lines, depending on the economic availability of pigments could be recommended. As the consumption of paints in Bihar is not definitely known, we are of the opinion that for the present, only a small factory, capable of further extension can be recommended to be safely undertaken by capitalists.

Spirit varnishes.—French polish is one of the most important of spirit varnishes, and already the required quantities are manufactured in the country, simply by dissolving shellac in spirit and adding the desired colour. No factory exists for this as this varnish is made in small lots by the user, whenever required. A small amount of ready-made French polish is imported but its quantity is not such that an independent factory can be recommended. It is suggested, however, that the existing paint works should look into this problem as an adjunct to their ordinary manufactures. Colourless French polish would require bleached lac for its manufacture. The beaching of lac, though simple, requires experience, but as details are available as a result of experiments at the Indian Lac Research Institute, the paint manufacturers might well look into this part of the trade as a subsidiary enterprise to their own.

In the case of lacquers, which are nothing but solutions of nitro-cellulose, aceto-cellulose and shellac, in various solvents, the chief difficulty lies in the necessity of importing special solvents. In spite of this, it has been found possible to manufacture lacquers at a profitable price. We have, however, dealt with the problem of solvent manufacture under a different section which may be read along with this.

Oil varnishes.—The manufacture of oil varnishes, whether from imported resins or from indigenous varieties, is being done by some of the paint manufacturers but as there is still considerable import of this commodity, there is room for further

development. The manufacture of lac-oil varnishes can now be safely recommended as the pioneering work in this direction has been done by the Indian Lac Cess Committee's Laboratory (vide Bhattacharya and Gidvani Paint Techn. 1938, 3, 189-90).

Pigments.—The common pigments like ochres, siennas, barytes, etc., are already being prepared in the country for use in the paint industry. Neither lead pigments nor zinc pigments have sure prospects as long as these metals are not manufactured in the country. But attention may be drawn to the titanium oxide which, it is hoped, will shortly be made available from the aluminium factories. Private enterprise in this direction is recommended.

For further informations see Appendix XIII.

APPENDIX XIII.

A REVIEW OF THE PAINT AND VARNISH INDUSTRY.

The raw materials used in the manufacture of paints and allied products are very numerous and every country manufacturing these commodities has to import a considerable proportion of its raw materials. In this respect, India is very favourably situated and in a better position than Great Britain. India grows her own linseed, contains large pine forests which are potential sources of turpentine and rosin and has virtually a monopoly of lac. Of the materials used as pigments, barytes is found in various places as also ochres and oxides. The Persian Gulf Red oxide which was used extensively a few years ago, for the manufacture of red oxide paint, is being gradually replaced by red oxide manufactured at Katni in Central Provinces. Synthetic red oxide, from the waste acid of Tatas, is being manufactured on a large scale at Tatanagar and has been found to be quite satisfactory. The Bangalore White Lead Syndicate is producing white lead at Bangalore and Messrs. D. Waldie and Company, are manufacturing red lead at Konnagore near Calcutta. The raw material for the manufacture of the important pigment—Titanium white—will be available in large quantity, when the factory of Messrs. Aluminium Corporation of India is put into working.

The paint manufacturing industry in India has however not reached the state of development that these advantages appear to warrant. The imports of paints and paint materials are still high and far in excess of Indian manufactures.

IMPORT OF PAINTS AND COLOUR INTO INDIA.

1930-31.	1931-32.	1932-33.	1933-34.	1935-36.	1936-37.
Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
492,701	453,131	3,33,726	3,69,915	371,498	372,425
Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
85,80,724	66,49,173	70,26,976	70,28,844	80,55,025	76,54,770

IMPORT OF ENAMELS.

1930-31.	1931-32.	1932-33.	1933-34.
U. K. cwt.	U. K. cwt.	U. K. cwt.	U. K. cwt.
4,490	2,621	2,342	1,873
Rs.	Rs.	Rs.	Rs.
2,51,626	1,44,804	1,71,096	1,35,570
Foreign cwt.	Foreign cwt.	Foreign cwt.	Foreign cwt.
1,895	836	993	1,097
Rs.	Rs.	Rs.	Rs.
1,42,642	53,650	53,747	59,470

APPENDIX XIII—*contd.*

IMPORT OF VARNISH.

1930-31.	1931-32.	1932-33.	1933-34.
U. K. cwt.	U. K. cwt.	U. K. cwt.	U. K. cwt.
27,740	22,258	23,463	21,949
Rs.	Rs.	Rs.	Rs.
14,44,996	11,38,651	11,64,933	11,08,440
Foreign cwt.	Foreign cwt.	Foreign cwt.	Foreign cwt.
6,194	5,883	5,699	5,538
Rs.	Rs.	Rs.	Rs.
3,36,369	2,70,894	2,46,964	2,23,389

No figures are available for the output of the Indian factories but it might be assumed that the production of these has reached a total value of Rs. 80,00,000 to Rs. 90,00,000 at the present time. It may therefore be reasonably said that at present, the Indian industry is, compared with its possibilities, poorly developed. The branch of manufacture that is best represented is the manufacture of ordinary oil paints, i.e., grinding pigments in oil and subsequently thinning with further oils and solvents in order to make a mixed paint. The manufacture of pigments is less advanced; although some advance has been made in recent years, as described in the first paragraph. Many of the other pigments required in paint making are made by Indian paint manufacturers for their own use but majority of the factories import most of the pigment that they use.

With regard to varnish industry, the picture is rather depressing. Indian made varnish is generally said to be inferior to imported varnish. There is no apparent reason why this continues to be the case. Gums and resins, of good quality, may be imported into India, as in all other countries while turpentine, linseed and white spirit are already available in India. The Indian manufacturer is in a position to study the effect of the Indian climate or rather the various climates of India, on varnish. But in spite of these natural advantages, the varnish industry is not making any great progress in India.

RAW MATERIALS.

Ordinary paint (oil paint) consists of an intimate mixture of very finely divided solids, known as pigments and a liquid, known as the vehicle. The vehicle is a mixture of a drying oil, generally linseed and a "thinner". Raw linseed oil dries very slowly in air and for enhancing the rate of drying, it is heated to 150°, with the addition of "driers" to accelerate the subsequent drying of the oil in paints. The function of the pigment is to support and strengthen the paint film and to give it colour and opacity.

A mixture of boiled linseed oil and pigment in the best proportion, is too thick for proper application and consequently most paints contain a "thinner"—a volatile oil such as turpentine or a petroleum product, known as white spirit. When the paint is applied, the thinner evaporates

APPENDIX XIII—*contd.*

slowly and its function is merely to make the paint of the correct consistency for the purpose of application. In the case of oil varnishes, the strengthening of the film given by a drying oil, generally linseed oil or tung oil, is obtained by the incorporation of hard resins, usually copal.

DRYING OILS.

Linseed oil.—Of all the drying oils used in paint and varnish industry linseed oil is the most important. It is obtained from the seeds of flax plant which grows in North and South America, Russia and India. Of the Indian production, about 50 per cent comes from the Central Provinces. The production in India fluctuates greatly. In 1908 it was 163,000 tons, in 1912, 641,000 tons, in 1924, 463,000 tons and in 1935, 90,144 and in 1936, 217,666 tons. The Bihar production is about 1/6th of the total production of India.

Most commercial linseed oil is obtained by pressing the hot and moistened seed in a hydraulic press. The cake, amounting to about 66 per cent of the seeds, presents a problem for its disposal. It is generally used as cattle food. If it could be used in India at a reasonable price, we would be able to export linseed oil instead of the whole seed as is being done at present.

Boiled linseed oil.—In preparing boiled oil, the raw oil after storage is heated to a temperature of 150°C, while air is blown through the oil. Driers, consisting of rosinate or linolate of lead, manganese, cobalt, etc., are added in small quantity to accelerate the drying. During this heating, the chemical nature of the oil is changed in that it is partly polymerised. The oil becomes thicker and drier.

Stand oil.—Stand oil is linseed oil thickened by heat alone. It has undergone considerable polymerisation and differs materially in its qualities from ordinary linseed oil, raw or boiled. Stand oil finds considerable use in the manufacture of varnishes and enamels and in printing inks.

Tung oil.—There are two varieties of tung oil, Chinese and Japanese, but only the Chinese variety is used in paints. The oil is prepared from the nuts of *alcaresites cordata*, by a process of roasting, crushing and pressing. This oil is the most important of the drying oils other than linseed oil. The raw oil dries rapidly but gives a film quite unsuitable for paint making. On moderate heating, it polymerises and the polymerised oil is used in the varnish industry.

Soya Bean oil.—The soya bean is cultivated widely in the Far East and it has also been grown in India. The oil has moderate drying properties and is sometimes used when the price of linseed oil is very high.

Poppy seed oil.—The varieties of poppy seed used for oil pressing are grown in France, India and the Near East. The principal crushing industry is in France to which the bulk of the Indian crop is exported. The oil is used in artists' paints and is said to remain whiter than linseed oil. The drying power is, however, inferior to that of linseed oil.

APPENDIX XIII—contd.

THINNERS.

Turpentine.—The most widely employed “thinner” in the paint industry is turpentine, the essential oil of the oleo-resins obtained from different species of pine. The production of turpentine in various countries is given below :—

				Barrels of 50 gallons.
U. S. A.	..	..	..	650,000
France	..	..	..	130,000
Spain	..	..	..	50,000
Greece	..	..	..	15,000
India	..	..	..	2,500

Two centres of the important and growing turpentine industry are at Jallo in the Punjab and Clutterbuckganj in the United Provinces. The Indian production of turpentine is given below :—

1900-01	...	..	..	1,600 gallons.
1916-17	..	..	..	1,000 "
1926-27	..	..	..	280,743 "
1936-37	..	..	..	245,871 "

The value of turpentine as a thinner in paint and varnish industry is due principally to its solvent action on paint vehicles and on its convenient and regular rate of evaporation. Unlike petroleum “white spirit” turpentine is a solvent of the hard varnish making resins and hence it is universally used in the manufacture of varnishes made from such resins (i.e., copal varnish). A disadvantage in the use of turpentine is that the substance is subject to oxidation on standing in presence of air, forming non-volatile bodies. Even in absence of air, on long storage, it partly polymerises to non-volatile products.

White spirit.—The increasing demand for paint thinners and the relatively stationary amount of the supply of turpentine, has made the use of other solvents imperative in paint manufacture. White spirit is the substitute most commonly employed. It is a petrol fraction boiling between 150°—200°C. Although, originally a substitute for turpentine, the improvement in the quality of commercial product with the use of white spirit, has led to the extensive use of this product by paint manufacturers. Again compared with turpentine, white spirit has the advantage of its permanence on keeping and of leaving no residue on evaporation. On the other hand, its solvent properties are much inferior to turpentine. The use of white spirit as a thinner is therefore restricted to the paint industry. Mixed with turpentine it is employed in varnish making.

RESINS.

The resins do not form part of the vehicle of paints. They are used for the manufacture of varnishes. The principal varnish making resins or “gums” as they are named technically, are the different copals, resin in its various forms, dammar, lac, etc. Copal and resin are used for the manufacture of oil varnishes while dammar and lac are used in the

APPENDIX XIII—*contd.*

Copal.—“Copal” is a word used to cover a large variety of varnish making resins. The best copals for the varnish maker come from East and West Africa. Manila is the trade name of Asiatic copals from Phillipine Islands and Straits Settlement and Kauzi is found in New Zealand. The last two are inferior to the first two in varnish making properties. The value of copal is determined by its hardness and colour, the hard copals making the better varnish. No suitable copal is found in India.

Resin.—When pine oleo-resin is distilled, the volatile distillate consists of turpentine while the residue in the still is resin. The molten resin is sieved, strained and run off into casks for the market. The yield is about 70 per cent of the oleo-resin. For use in varnish manufacture, resin is hardened by making salts with lead oxide or zinc oxide, in some cases. The prevailing practice is however to make the calcium resinate and cheap varnishes contain no other resinate.

An ester of resin with glycerol is known under the name ester gum. In conjunction with tung oil, ester gum is extensively used in water resisting varnishes.

Dammar.—The most important source of dammar is the Straits Settlement. It is a soft resin and dissolves in turpentine to form an almost colourless varnish, suitable for some particular purposes, e.g., as a paper varnish.

PIGMENTS.

The pigments used in the manufacture of paints are very numerous and include both natural and synthetic materials. Of these inert pigments or fillers form an important group.

Barytes.—The most important of the inert pigments is barytes or barium sulphate. Extensive deposits of this mineral are found at Cuddapah and at Kurnool in Madras Presidency and also in Alwar State, Rajputana. Deposits of coloured barytes occur near Ranchi in Bihar, which are being used by Messrs. Napier Paint Works of Calcutta.

Barytes is the principal constituent of cheap coloured paints which must possess good opacity. Thus cheap oxide paint may be made of 5 per cent red oxide and 95 per cent barytes. In cheap black paints, the percentage is still higher. Barytes is also used in white paint but on a smaller scale.

Raw barytes is first washed in a “tromel”, consisting of a rotating tube in which the crude material is washed with water. The outlet of the tube is provided with screens to allow the fine particles of sand and dirt to pass through while the larger pieces pass on to a picking table. The barytes travels along the table on an endless band and is hand picked to remove impurities. The barytes is next pulverised in two ball mills and sieved.

Other fillers which are rarely used in paint manufacture are the following:—(1) “Blanc Fixe” or permanent white—is the artificial form of barium sulphate, prepared in the usual manner. The high price of sulphuric acid offers a great difficulty in its extended use. (2) Gypsum has little to commend its use in paint and its partial solubility in water renders

APPENDIX XIII—*contd.*

the use of this material rather undesirable. The anhydrous form is said to be used in fairly large quantities in the United States of America. (3) Whiting of commerce is imported from England. It is generally used in distemper, in whitewash and in a stiff paste with linseed oil as putty.

Iron oxide pigments.—The range of pigments obtained from iron oxide^o is extensive. Hydrated forms of iron oxide give yellow, passing through various shades of brown to red. The state of hydration thus plays an important role in its value as pigment while the presence of a small quantity of manganese oxide also influences the colour.

A well-known natural oxide is found in the Persian Gulf area and is widely used as a bright red pigment. The best Indian oxide comes from Katni and is inferior to the Persian Gulf variety in its brightness of colour. The Bihar iron oxides are generally light red or purple in colour. As these oxide paints are used for under-coats, the depth of colour is of no great consequence.

Analysis of red oxide paints.

					Persian Gulf.	Katni.	Bihar.
Moisture	...	...	...	...	1.4%	0.5%	1.4%
Loss on ignition	...	...	...	...	1.0%	1.3%	5.7%
Silica	...	...	...	...	18.7%	5.3%	9.9%
Ferric oxide	...	...	...	...	72.5%	91.0%	77.2%
Manganese Dioxide	...	...	...	...	...	...	0.2%
Alumina	...	...	...	...	2.8%	1.7%	5.7%
Lime...	...	...	...	...	0.7%	...	...
Magnesia	...	...	...	...	2.5%	Trace	Trace.
Soluble Chloride	...	...	...	...	0.3%	...	...
				Total	99.95	99.8	100.1

An impure variety of artificial oxide is made from the waste acid liquors of galvanising industries at Tatanagar. The liquors are exhausted acid baths and are charged with iron. The iron is precipitated by the addition of lime and the precipitated hydroxide of iron with calcium sulphate, is roasted till the desired depth of colour is obtained.

Yellow Ochre.—Yellow ochre consists of hydrated ferric oxide, with considerable amounts to silica and clay. Deposits of varying colour and importance are found in many places of India—near Chaibassa, at Katni in Central Provinces and at Patna in Central India.

APPENDIX XIII—*contd.*

Sienna.—The true siennas are only found in Italy. It is used in paint manufacture, either in the natural state "raw" or "burnt" after calcination which modifies the colour very considerably.

Umber.—This is also a hydrated iron oxide pigment containing an appreciable amount of manganese. The best varieties come from Cyprus and are known as Turkey umber.

White Lead.—The import of white lead into India is considerable. In 1935-36 the total import was 12,665 cwt. and in 1936-37, 13,589 cwt. In addition to this, a considerable quantity of "reduced" white lead is also imported. Some 10 or 12 years before, a plant was working at Bangalore for the manufacture of white lead. The production figures from 1922—25 are as follows :—52 tons, 55 tons, 175 tons and 216 tons. No further information about this enterprise is available. The absence of any lead smelting factory in India is a great handicap to the development of this industry. A Calcutta firm has very recently taken up the lease of a property near Jasidih in Santal Parganas. The quality of galena is fairly good and if the deposit proves to be of commercial value, the possibility of starting a lead smelting plant and a white lead factory may be considered to be hopeful. With imported lead, the prospects of starting this industry is not very promising.

Zinc white.—Zinc white is also imported in large quantities into India.

IMPORT OF ZINC WHITE.

					1935-36.	1936-37.
Pure	...	...	...	...	1,375 cwt.	1,788 cwt.
Reduced	...	...	...	..	35,140 "	32,695 "

Paint made from zinc white has a high spreading power and gives a smooth, hard film which however has a tendency to peel off on exposure to sun light. Mixed with white lead it is an excellent paint for outside work, while for interior work, zinc white alone or lithophone is very satisfactory. The prospect of the manufacture of zinc white in India depends upon the supply of zinc concentrate from the Baldwin mine in Burma. In 1926-27 nearly 19,000 tons of zinc concentrates were exported.

Lithophone.—Another important white pigment is lithophone a mixture of zinc sulphide and barium sulphate, containing about 30 per cent zinc sulphide and a little zinc oxide. The import of this is also fairly large:

					1935-36.	1936-37.
Lithophone	...	...	...	...	28,160 cwt.	30,419 cwt.

The material is frequently used for painting interiors and as a constituent of washable water paint. When used outside it is liable to crack and darken. Better results are obtained by mixing lithophone with a portion of zinc oxide.

The manufacture of lithophone is complicated and unless proper supervision and expert advice are available, it would be difficult to take up its manufacture.

APPENDIX XIII—*contd.*

Titanium white.—This pigment is rapidly coming to the front of all white pigments, on account of its excellent body and non-poisonous properties. It does not peel off or crack like zinc white or lithophone and has been tested under the most trying conditions in marking roads with excellent results. At present, Travancore exports about 30,000 tons of illeminite per year for the manufacture of titanium white. Stray, deposits of illeminite occur in Santal Parganas near Simultala but unless a thorough survey of this district is made, it is difficult to ascertain the quantity of available material. Another source of this pigment will be available when aluminium extraction is started in India from Indian bauxite which is very rich in titania. No inherent difficulty is known to exist in extracting pure titania from bauxite residues.

Red Lead.—The import figures of red lead are given below:—

	1935-36.	1936-37.
Pure red lead ..	36,761 cwt.	15,573 cwt.
Reduced read lead ..	3,443 „	1,846 „

It is manufactured by Messrs. D. Waldie and Company, Konnagar, Bengal, but the production figure is not known. Chemically red lead is triplumbic tetroxide but the commercial variety contains upto 25 per cent lead monoxide. The presence of lead monoxide alters the character of red lead. It is a pigment of great importance, forming a hard coat of remarkable durability in a short time. As regards the prospect of its manufacture, a great deal will depend upon the availability of metallic lead or scrap lead in fairly large quantities (see white lead).

Prussian Blue or Chinese Blue is an extremely fine pigment of a deep, rich, transparent colour. It is generally used with other pigments such as barytes and in conjunction with yellow pigments to form different greens. It is made locally by mixing ferrous sulphate with sodium or potassium ferrocyanide and oxidising the precipitate. The colour of product varies with its mode of manufacture, the best ones having a cop pery lustre.

Ultramarine is another important blue pigment and is used to a limited extent in paint manufacture. As the raw materials for its manufacture are easily available there is no reason why its manufacture should not be attempted in India.

Lead chromes.—The lead chromes are a series of pigments ranging in colour from yellow to red. They are generally prepared by the precipitation of lead nitrate or acetate with alkali chromates. For pale shades, sodium sulphate is added simultaneously to precipitate lead sulphate and for the deeper shades, caustic soda. The large paint factories manufacture lead chromes according to their requirements.

Zinc chrome.—Zinc chromate is prepared by precipitating zinc sulphate with sodium chromate. It is used for making greens and is said to inhibit the formation of rust on iron and steel. This is also made in the local factories.

APPENDIX XIII—*contd.*

Brunswick Green.—The majority of green pigments sold under this name are mixtures of Prussian blue and lead chrome in varying proportions, with an addition of lead sulphate. All these varieties are made locally as required.

Chromium Oxide is a green pigment which is prepared by fusing alkali dichromates with boric acid. The pigment so obtained is permanent but costly. It is also made in India.

Black pigments.—Lamp-black; carbon-black, bone-black and graphite are some of the blacks that are on the market. When properly made, these with the exception of graphite, are fair paint materials, although they require a long time for drying or a large percentage of "driers". Graphite is said to be not suitable for direct coating of steel work since it appears to enhance the rusting of iron.

Manufacture of paints.

The pigments used in paint manufacture are required to be ground to an exceptional degree of fineness, most of the machines required in a paint factory are for these grinding operations. In recent practice, a system of air flotation of the finer particles is frequently employed.

Paints may be made either from a single pigment or a mixture of pigments. The modern practice seems to favour a mixture of pigments. High grade white paints for outside work frequently contain 60—80 per cent white lead and 40—20 per cent zinc white with about 5—10 per cent of inert material. Grey paints are made from a mixture of white lead and barytes tinted with lamp-black. Red oxide paints also contain barytes to a considerable extent. Expensive green paints contain 75 per cent of pigment and 25 per cent of barytes; the cheaper ones containing only 10 per cent of pigment.

The oil used in paint grinding is invariably linseed oil, raw or boiled. White lead requires about 8 per cent of oil for grinding and barytes about the same. Carbon black requires more than its own weight of oil.

Stiff paints.—The usual practice of paint manufacture is first to produce stiff paint, i.e., the mixture of pigments ground to a paste with linseed oil. The stiff paint can be stored satisfactorily without settling of the pigment. For making "stiffs", the mixture of pigments and oil receives a preliminary mixing in a pug mill or edge runner and the grinding proper is carried out in triple roller mills. The rollers are usually of granite or chilled steel, and revolve at different speeds. The paint is ground by passing between the middle and back roller and is then carried round to the middle roller and is again ground between the middle roller and the front roller. It is removed from the latter by a scraper. In order to achieve a thorough mixing of oil and pigments, it is necessary for the paint to be passed several times through the rolls.

Mixed paint.—The mixing of the "stiffs" with additional oil and "thinners" is carried out on a large scale in a mixer consisting of a rotating pan inside which vertical paddles revolve. The oil used is boiled linseed oil and "thinner" is white spirit and turpentine. Additional driers are added as necessary at this stage.

APPENDIX XIII—*contd.*

VARNISH.

Import of varnish.

1935-36—26,069 cwt.

1936-37—24,144 cwt.

The most important varnishes in the market at present are the Copal varnishes. They are made in numerous varieties, and sold under different names. Copal varnishes are made from copal and linseed oil with the necessary driers and thinners. Calcium resinate is sometimes used in partial replacement of copal in cheap varnish. The differences among the various copal varnishes are largely due to a variation in the proportion of copal to oil. The proportion of driers also varies considerably according to the nature of the varnish and the practice of the manufacturer.

The first operation in varnish making is the "running" or melting of the copal. The resin, about 100 lbs. is placed in a metal pot mounted on wheels, so that it can be drawn on and off the fire easily. When the resin has melted, well-settled, raw linseed oil, previously heated, is added in small quantities at a time. The varnish maker withdraws a small quantity on his rod and allows a few drops to cool on a glass plate. If the cooled varnish is turbid, it is indicated that the mixture requires further heating before the addition of another portion of oil. Driers are added at this stage and finally the pot is withdrawn from the fire and allowed to cool. When the temperature is low enough, "thinners" are added cautiously. The freshly made varnish is clarified by a prolonged process of storage whereby the suspended impurities settle out and the varnish matures.

Varnish is made by most of the paint factories in India and has a ready market. Since linseed oil is available, there is no reason why varnish manufacture should not be successful in Bihar.

LIST OF MACHINES.

1. Raymond mill with air separator.
2. Flat stone machine with sieving and air separator.
3. Levigator with filter press and tank.
4. Pug machine.
5. Lead-lined vats for chromate.
6. Wooden precipitation vats with steam pipes.
7. Filter press.
8. Hot air drying chamber.
9. Edge runner—double roll.

APPENDIX XIII—*conctd.*

10. Triple roll machine.
11. Torren's combination mill—rolls of chilled iron.
12. Buhler machine—with water cooled rollers.
13. Torren's master mill.
14. Ball Mill.
15. Tanks with stirrer.
16. Storage tanks.
17. Aluminium pots—for gum melting.
18. Centrifuge.
19. Storage tank.

As most of these machineries have to be imported from Great Britain, the prices cannot be stated with any certainty. A complete factory for the manufacture of paints, varnishes, etc., with a capacity of 5 tons per day may be started with a capital of Rs. 2,00,000 and a working capital of Rs. 1,00,000. This does not include the cost of erection, power plant and other accessories.

CHAPTER XIV.

INDUSTRIAL SOLVENTS.

With the development of arts and industries, the use of solvents is continually increasing. As yet there is no consolidated solvent industry in India, whilst there is considerable use of directly or indirectly imported solvents in the country. The varnish and lacquer industries consume considerable quantities of varieties of solvents whilst the chemical industry itself depends upon a few major solvents for the production of which no attempt has been made so far. Solvents may be divided under the following heads :—

- (a) Hydrocarbons.
- (b) Alcohols.
- (c) Ketones.
- (d) Esters.
- (e) Glycols.
- (f) Cyclo-hexane derivatives.
- (g) Chloro compounds.
- (h) Furfurals.
- (i) Plasticising solvents.

It is not the intention of the Committee to describe the manufacture of these solvents in this report but it would be useful to indicate in short the sources of these solvents from which the practicability of certain solvent industries in Bihar will be apparent.

Benzene, toluene and xylene are obtained in the fractional distillation of coal tar and is collected in the fraction, known as light oils. After preliminary purification, they are separated by fractional distillation. With the development of bye-product coke-ovens, the quantity of tar and consequently, the quantity of these hydrocarbons, will be on the increase. The three hydrocarbons are largely used as diluents for lacquers. Cymene or p-methyl-isopropyl-benzene is not found in coal tar but is present in resin oil and spruce turpentine; it is also obtained as a bye-product in the manufacture of sulphite pulp. Cyclo-hexane or hexemethylene is now available technically and is manufactured by the catalytic hydrogenation of benzene. It may replace benzene in lacquers. Tetrahydronaphthalene

(tetralin) and Decahydronaphthalene (decalin) are two hydrogenated derivatives of naphthalene. These are excellent solvents for oils, resins, waxes, etc., but do not dissolve cellulose esters, hard copals or bakelite.

The alcohols constitute another important group of solvents for varnishes. The first number of this series, methyl alcohol, was formerly obtained by the destructive distillation of wood but the greatly increased demand for this solvent has led to the development of various synthetic processes for its manufacture. Pure methyl alcohol dissolves neither cellulose acetate nor nitrate but the presence of a small quantity of acetone renders it a potent solvent for these cellulose derivatives.

Ethyl alcohol is manufactured from starchy materials or molasses and the anhydrous alcohol is a good solvent for ethyl cellulose, colophony, dammar, shellac and also for synthetic resins. It is miscible with castor oil and hydrocarbons. Of the two propyl alcohols, n-propyl alcohol is one of the chief constituents of fusel oil while iso-propyl alcohol is manufactured either from acetone or from gases arising from the cracking of petroleum. N-butyl alcohol is of great industrial importance since butyl acetate is the most widely used of cellulose nitrate solvents. This alcohol is manufactured by the fermentation process developed by Strang, Graham, Fernbach, Weizmann and others. It is also manufactured in large quantities from acetaldehyde. Butyl alcohol has the unique property of being a solvent for hard copals. Of the eight amyl alcohols two only occur in fusel oil, viz., primary amyl alcohol and active amyl alcohol. Synthetic amyl alcohol is also available being produced from the pentanes obtained in petroleum distillation. Synthetic amyl alcohol is not a solvent for cellulose esters but it dissolves ester gum, shellac, etc., and is miscible with castor and linseed oils and with hydrocarbons.

The esters of the alcohols, described in the previous paragraph, and acetic acid are good solvents for cellulose nitrate and acetate. Of these n-butyl acetate and amyl acetate are the ones that are widely used in spite of many new additions during the last decade. They are very well adapted for cold lacquers and cellulose paints since their volatilities are sufficiently high to leave the film readily and quite dry. They are also non-toxic and easily miscible with oils and hydrocarbons.

The esters of ethyl and butyl alcohol with lactic acid are the most important of high boiling solvents for cellulose nitrate and acetate. Compared with the corresponding acetates their

solvent action for cellulose nitrate is distinctly slower and their solutions are decidedly of higher viscosity but they will tolerate two to three times as much non-solvent dilution : quantities of water up to 20 per cent can be added without causing precipitation or blushing on subsequent evaporation.

Of the dihydric alcohols or glycols, ethylene glycol mono-methyl ether and ethylene glycol mono-ethyl ether, are the most important solvents for cellulose derivatives. The methyl ether is a good solvent, not only for cellulose acetate and nitrate but also for the gums and resins incorporated in cellulose lacquers. The ethyl ether on the other hand is not a good solvent for the resins in the lacquer. The addition of other solvents like benzyl alcohol, amyl acetate, ethyl lactate, removes this defect. In the absence of resins, solutions of cellulose nitrate in the ethyl ether have a high tolerance for dilution with solvents. In spite of these defects, this ether offers the advantage over most other solvents of similar boiling points in having but a slight odour. This ether is made commercially from ethylene chlorohydrin by first converting it into ethylene oxide and adding this with stirring to cold ethyl alcohol containing one per cent sulphuric acid, the product being neutralised and fractionally distilled. Other ethers may be made by the use of appropriate alcohols or phenols.

Cyclo-hexanol and methyl cyclo-hexanol are prepared by the hydrogenation of phenol and cresols, under a pressure of four atmosphere in the presence of nickel as catalyst and temperatures between 160°—200°C. They are excellent solvent for cellulose acetate but not for the nitrate. But their addition to solution of cellulose nitrate in amyl alcohol, increases the tolerance of the solution to dilution with hydrocarbons. They dissolve ester gum, resin, shellac, bakelite, etc., and are miscible with linseed oil, petroleum and aromatic hydrocarbons.

The acetates of cyclo-hexanol and methyl cyclo-hexanol, which are prepared by direct esterification, are non-poisonous and powerful solvents for cellulose nitrate and acetate. They are also solvents for gums and resins present in lacquers.

Ethylene chlorohydrin is a good solvent for cellulose acetate and the solutions have a high tolerance for water. Cellulose acetate containing over 50 per cent of combined acetic acid, will dissolve in a mixture of equal parts of ethylene chlorohydrin and water. It is usually prepared starting from ethylene which is converted into chlorohydrin by treatment with chlorine water. Mono-chlorohydrin and dichlorohydrin are not very suitable

for lacquers as they tend to liberate hydrochloric acid in presence of moisture. Chloroform, carbon tetrachloride and sym-dichlorethane are not very suitable for dissolving cellulose derivatives. Tetrachlorethane is dangerously toxic and attacks iron, copper, nickel and lead slightly and aluminium vigorously. It is non-inflammable and is useful for reducing the inflammability of lacquers. It is usually prepared by passing alternately acetylene at 60°—80°C and chlorine at 80°—100°C into antimony pentachloride.

Furfural is prepared at present from oat hulls, a waste product of the manufacture of rolled oats. These hulls contain 32—36 per cent of pentosans, 35 per cent of cellulose and 10—15 per cent of lignin. These are digested in copper-lined steel autoclaves with one-third of their weight of 5 per cent sulphuric acid with the passage of steam at 60 lb. pressure at the bottom of the mass. The exit steam contains about 10 per cent furfural and is passed into a copper fractionating column where crude furfural with 16 per cent water is collected. By careful distillation in specially designed vessels, the water is removed and crude furfural is obtained which may be further purified by fractional distillation under vacuo.

Furfural dissolves cellulose nitrate, acetate and nearly all known cellulose esters and ethers but is rather slow in its action. Its solvent properties are increased by mixture with alcohol and benzene. It is not a good solvent for some resins and for linseed oil.

Tetrahydro-furfuryl alcohol is a product obtained by the partial hydrogenation of furfural. It dissolves cellulose nitrate and these solutions have high tolerance for aromatic paraffin. It is also a good solvent for gums and resins used in lacquer manufacture.

The substances described below are known in the trade as plasticising solvents. The first substance of this class is acetophenone which possesses softening as well as solvent properties for cellulose nitrate, acetate, shellac and other gums and resins. The high price of this article is against its extended use. Diacetin and triacetin, the acetyl derivatives of glycerol, are fairly good solvents for cellulose acetate and resins but they are not miscible with linseed oil or with hydrocarbons. Glyceryl tribenzoate is a solid plasticiser and is soluble in all anhydrous solvents with the exception of petroleum. It is rapidly gaining favour in the lacquer industry.

Tricresyl phosphate is one of the most widely used plasticisers. It is an extremely stable ester, practically non-volatile and odourless. It has a moderate solvent action on cellulose nitrate but none on acetate. It is, however, a good solvent for gums and resins and is miscible with castor and linseed oil in all proportions as also with hydrocarbons. It also diminishes the inflammability of cellulose nitrate films.

From the above it would appear that the manufacture of many of the solvents is feasible in Bihar, specially those dependent upon coal distillation and fermentation of starch and sugar. The employment of synthetic transformations of carbon monoxide and hydrogen into methyl alcohol is another practical feature in solvent production. The large quantities of molasses available for fermentation and subsequent treatment of industrial alcohol to produce acetic acid and acetone is an important feature. Although all these processes have been well worked out abroad, the Committee is of opinion that in order to develop a solvent industry in the province some preliminary experiments should be undertaken by the Government of Bihar in their own laboratories or by sending out properly trained young men to different Indian laboratories to perform pilot experiments with the aid of Government funds. At the same time efforts should be directed to secure quotations of plants from abroad, with a view to utilise the experience of chemists trained by the Government of Bihar. Unless the coal tar industry and other allied industries for the manufacture of benzol, alcohol, acetone, acetic acid, higher alcohols, etc., are developed, there is little chance of this industry making any great progress in this province.

CHAPTER XV.

LAC INDUSTRY.

The annual production of scraped lac in India varies between 1,200,000—1,600,000 maunds and the export of shellac of all kinds varies from 400,000—800,000 cwts. valued at from 1·6 to 1·8 crores of rupees at the present time. Of this annual production, Chota Nagpur contributes about 55 per cent.

The industries into which shellac enters are many and varied. The most important is the gramophone record industry which absorbs 30—35 per cent, the electrical, paint and varnish industries utilise about 35 per cent and the hatting trade about 10 per cent. As most of the countries of Europe and America had to depend, formerly, for the supply of this important resin, on India, synthetic substitutes have been produced which are extremely satisfactory for some of the trades in which shellac was formerly employed. These rivals of lac owe their position not so much to any intrinsic superiority over the natural product, as to the frantic efforts of the consuming countries to be self-sufficient at the time of emergency. Among these substitutes of shellac, the most important is bakelite, a condensation product of phenol and formaldehyde, which are available in all industrial countries of Europe and America at a very cheap price. The competition from this synthetic product has given the lac industry a severe blow in its use in the electrical trade. In the varnish industry also, bakelite, other aldehydic condensation products and cellulose preparations are now firmly established, partly owing to the ease with which they can be applied and partly due to their standard qualities. In the gramophone record industry, however, shellac is still supreme and all attempts of synthetics to capture this market have been unsuccessful up till now.

In the face of this intensive competition from synthetic resins, it is high time to find out further industrial uses of shellac, on which the well-being of a large part of the population of Bihar depends. We cannot think of anything better than to indicate the lines along which the Indian Lac Research Institute at Ranchi and at London, are working at present. Lac contains two distinct products—a dye similar to cochineal and a resin. Unfortunately the competition of synthetic dye-stuffs has driven the lac dye out of market and it is extremely doubtful if the industry can be revived, even for local consumption. Investigations are now being made at Namkum for improving the quality of shellac varnish by removing its low water resistance,

which would undoubtedly extend the usefulness of the natural resin. It has been demonstrated that the addition of a small quantity of certain chemicals to shellac varnish results in a profound change in the varnish film on drying, in that it loses its solubility in organic solvents and becomes extremely resistant to water. The successful completion of this work on shellac varnish may put the shellac varnish industry beyond the competition of the varnishes made from synthetic resins and cellulose preparations. The hardening of shellac resin by the addition of urea, has been observed for the first time at Namkum and efforts are now being made to use this hardened resin in the moulding industry, which, up till now, has been a monopoly of synthetic resins of bakelite type. An extension of this work by combining shellac with formaldehyde and urea, and in special cases, starting with vulcanised shellac, has led to very important practical results. Moulding powders can now be prepared which could be pressed on the bakelite technique, with very little difference in the quality of the finished product the cost of articles being appreciably lower than those made from bakelite and other synthetic resins (see appendix XV).

These are some of the problems on shellac resins which are now being investigated and on which the future expansion of the industry depends greatly.

In the manufacture of shellac of good quality a large quantity of an inferior grade of resin, known in the trade as 'kiri', is obtained. Attempts are also being made to utilise this by-product. 'Kiri' is extracted with solvents to get the shellac in solution. This solution is mixed to a paste with wood flour and dried. The dry powder when heated under pressure cements the wood flour into a moulding which is quite strong and takes an attractive polish. As the price of this material is very low, it will be of great value as a substitute for the cheaper grades of moulded articles and may even replace the cheaper grades of articles now being made from bakelite resins.

In the processing of shellac new developments have taken place both in London and at Namkum which are in a position to place practically a standardised product called Hard Lac Resin, in the market. Its use in the paint and varnish industry is expected to be considerable and already several firms in England have been manufacturing this product.

Shellac oil varnishes are also finding limited use in the trade, and a bleached lac industry for lacquering can also be

visualised at no distant date. The development of a solvent industry in the country (vide solvents) is very urgent in this connection, as with imported solvents the margin of profit is small.

Various other uses of shellac and shellac derivatives are possible with the growth of micanite industry, safety glass industry, water-proofing of fabrics, shellac bonded fabrics, etc. The chief mass use of shellac, however, in the absence of other heavy industries, is, for the present, only in the moulding and the varnish industries for which large fields exist. The replacement of imported bakelite goods, both fancy and electrical, would open an avenue for the manufacture of goods to the tune of 3,00,000—4,00,000 of rupees with prospects of doubling or trebling this figure.

In the indigenous processing of shellac, seed lac is an important stage. This seed lac is now being sold to the extent of 300,000—400,000 mds. annually, principally to the United States of America and in small quantities to other countries. There have been frequent complaints about the quality of this commodity, but a recent investigation at Namkum has so far improved the technique that this product can now be manufactured at slightly increased cost as practically a standard product. When the process is adopted by the indigenous manufacturer a profitable export trade can be visualised in this commodity alone. We are of the opinion that the Government should direct its attention to the general improvement of shellac manufacturing process by disseminating knowledge and where necessary, by rendering small aids to the smaller manufacturers.

The Committee recommend that the industry should be aided by encouraging the establishment of a moulding industry based on shellac with the assurance that Government requirements would be purchased exclusively from such factories if the quality of their products comes up to a standard. It further recommends that as there are a dozen moulding factories in India encouragement should be given towards the establishment of a moulding powder factory to supply shellac moulding powders to the factories in India.

Synthetic resins.

Synthetic resins belong chemically to a group of non-crystallizing organic compounds, resembling natural resins in

appearance and properties. The products marketed by the manufacturers are in an unfinished state. Under the action of heat and pressure, the unfinished products are transformed into insoluble, infusible, lustrous articles.

Synthetic resins may be divided broadly into two classes. In the first class are included those which after moulding and curing, give products of various shapes and in the second class, are placed film-forming substances, for use in varnishes and protective coatings and, in general, soluble in oils. An older plastic, still very valuable, is celluloid, a nitrated cellulose, plasticized by camphor. Casein plastics are also used for some special purposes. It is unfortunate that in the absence of raw materials like phenol, formaldehyde, etc., at a cheap price the industry of synthetic plastics is non-existent in India and dealers in the market import the unfinished product at a cost of Rs. 60—80 per md. and subject them to the finishing process, with machineries imported at a cost of Rs. 80,000 to 1,00,000. In the event of a war in Europe, the supply of unfinished material will be stopped and the factories will have to be closed down.

The process of manufacture of phenol-formaldehyde resin does not involve any great difficulty. Equal weights of phenol and 40 per cent solution of formaldehyde are placed in a kettle with a reflux condenser, with 0.5—5 per cent of a catalyst, the nature of which varies with different manufacturers. With the application of gentle heat, the liquid in the kettle is kept boiling for 2 hours. The upper aqueous layer is run off and the thin-flowing liquid is the resin, which on cooling hardens to a brittle solid, soluble in organic solvents. The fusible dehydrated resin thus obtained is mixed with sufficient hexamethylene tetramine and wood flour and ground in a ball mill. Such a powder charged into a steel mould and subjected to heat and pressure, is changed to an infusible, rigid moulded article.

As the success of the whole process depends upon careful chemical investigation an impetus should be given by the Government to specific research in this direction in suitable laboratories under them by all possible means.

In the absence of phenol and formaldehyde produced locally, it would not be economical to start the industry in Bihar. Phenol is obtained from coal tar and formaldehyde from methyl alcohol. If the coal tar industry in the province develops in accordance with our suggestions in Chapter III and wood distillation makes methyl alcohol cheap or some

other independent source of formaldehyde is utilised, e.g., from coal (the methanol process), then the manufacture of bakelite itself is not likely to give much trouble and can be safely established in Bihar. Its reaction on the shellac industry has already been discussed, but in a provincial or national planning, an adjustment between synthetic and natural resin can be brought about, according to their importance, nature of use and costs of production.

APPENDIX XV.

Estimate for a plastic industry utilising Bihar lac.

CAPITAL INVESTMENT.

		Rs.
Sixty-ton automatic press	..	4,000
Eight impression mould (4 switches)	..	2,000
Mixing machine	...	3,000
Grinding machine	.. ..	750
Vacuum drying machine with recovery still		3,500
Building	.. ..	5,000
Incidentals	.. ..	1,750
		<hr/>
Total	...	20,000
		<hr/>
Working capital	.. ..	12,000

With the above equipment 60 lbs. of powder could be prepared and handled every day. By taking 30 pressings, i.e., 30×4 or 120 switches per hour, daily output will be 80 dozen switches.

Cost of materials, process and overhead charges. (For 960 switches.)

		Rs.	a.	p.
Powder 960 oz. at 4 annas a lb.	..	15	0	0
Electrical energy	... ..	1	0	0
Two working men for the press	..	1	0	0
Two working men for making powder	..	1	0	0
Supervisor	.. ...	3	0	0
Mechanic	.. ..	3	0	0
Inserts and screws (at Re. 0-1-1 each switch)	.. ..	65	0	0
Finishing (buffing, etc.) at $\frac{1}{4}$ anna each		7	8	0
Depreciation on Ra. 20,000 at 10 per cent about	.. ..	6	0	0
Interest on above at 5 per cent	..	3	0	0
Interest on working capital of Ra. 12,000 at 5 per cent	..	2	0	0
Office management, etc.	about	11	8	0
		<hr/>	<hr/>	<hr/>
Total	..	120	0	0
Cost per switch	... ..	0	2	0
Sale price	... ..	0	2	9-75
Profit per article	.. ..	0	0	9-75
Profit on 360×960 articles	.. ..	17,550		

CHAPTER XVI.

LEATHER INDUSTRY.

The quantity of raw hides and skins exported from Bihar is very considerable. In the absence of factories for the manufacture of finished goods, the export of raw hides and skins is a source of loss to the province, as we have to import the tanned goods at a greatly enhanced price. The province is also supplied with materials from which tannin may be extracted easily. Thus there is no inherent difficulty in the manufacture of leather and leather goods in Bihar.

Vegetable tanning materials.

Some of the more important vegetable tanning materials are mentioned below :—

- (1) *Babool*.—(*Acacia arabica*).—The bark contains 12-20 per cent tannin and is used largely in India. The pods also contain tannin and are used for bating in India.
- (2) *Chestnut*.—The bark contains tannin up to 17 per cent and is used as a tannin material. The wood containing 3-6 per cent is used in very large quantities.
- (3) *Gambier*.—A climbing shrub of East Indies. The material on the market occurs as a hard earth-like substance with about 45 per cent tannin.
- (4) *Hemlock*.—The tree grows in the Himalayas from 6,000 ft. upwards. The bark contains 8-10 per cent tannin and is used in large quantities in America.
- (5) *Oak*.—The bark containing upto 10 per cent tannin, is one of the earliest tannin materials known and is still used to a great extent for sole leather.
- (6) *Myrobalans*.—are the fruits of a species of trees growing in India. They usually contain 30-40 per cent tannin and are valuable tanning material.
- (7) *Quebracho*.—The tree is grown in the Argentine and the wood contains about 20 per cent tannin. It is now used to an enormous extent in the form of extract, made in the forests.

Of the mineral tanning processes, the most important is that involving the use of chromium salts. About 2,400 tons of potassium dichromate is imported into India for the purpose of chrome tanning and also for the manufacture of matches.

As hides and skins as well as tanning materials are available the manufacture of leather and leather products is a feasible industry in Bihar ; but competition from neighbouring provinces will be very keen. The manufacture of leather goods as a cottage industry is already established in the province and deserves to be encouraged.

A scheme for the manufacture of boots and shoes on a small scale as also of a small leather factory is given in appendix XIV(a).

Rubber industry.

The use of manufactured rubber goods is on the increase all over the world and the import of rubber goods into India is considerable, as the following tables will indicate :—

	1935-36.	1936-37.	1935-36.	1936-37.
			Rs.	Rs.
Raw ... lbs.	1,010,817	684,615	3,37,749	2,04,918
Motor tyres ..	280,866 pcs	290,367 pcs	1,26,22,468	1,32,08,548
„ tubes ..	253,865 „	263,922 „	15,62,559	14,05,969
Total import of rubber, raw and manufactured is Rs. 2,10,22,396.				

There is only one factory that of Messrs. Dunlop Rubber Company, near Naihati, Bengal, which has started working within the last few years and is turning out different varieties of manufactured products in considerable quantities. The smaller concerns near about Calcutta are engaged in the manufacture of rubber cloth and other articles from raw rubber imported from foreign countries.

The establishment of a rubber factory for Bihar is not feasible. Neither raw materials nor skilled labour is available. The matter, therefore, need not be considered any further. For those who are interested in the subject additional information will be found in appendix XVI(b).

APPENDIX XVI(a).

A SCHEME FOR A SHOE-MAKING BUSINESS ON A SMALL SCALE WITH A CAPITAL OF RS. 2,000.

Estimate of capital required.

A. Block.—(i) *Building.*—It is assumed that such a business should better be started in a hired building. Monthly rent for necessary accommodation has been provided for in the scheme.

(ii) *Tools and accessories.*—

	Rs.	a.	p.
One Singer sewing machine ..	375	0	0
Lasts, small tools, furniture ..	175	0	0
Total—Tools and accessories ..	550	0	0

B. Working.—It is estimated that 260 pairs of shoes of different types and designs as per details given below will be produced in a month of 26 working days.

Cost of materials for 260 pairs of shoes to be manufactured monthly.

	Rs.	a.	p.
Gent's oxford (good quality) 7 pairs at Rs. 3-6-0 per pair	23	10	0
Do. (medium) 20 pairs at Rs. 2-8-0 per pair ..	50	0	0
Do. (cheap) 25 pairs at Rs. 1-8-0 per pair ..	37	8	0
New cut selim, etc. (chrome quality) 60 pairs at Rs. 1-2-0	67	8	0
Do. (glace kid) 38 pairs at Rs. 1-4-0 per pair.	65	10	0
Do. (fancy) 9 pairs at Rs. 2-8-0 per pair average.	22	8	0
Sandals 104 pairs at annas 12 per pair average ..	78	0	0
	344	12	0

Labour.

Pattern cutter and upper closer on Rs. 50 per month.	50	0	0
1 do. assistant on Rs. 25 per month ..	25	0	0
Bottoming 260 pairs at annas 7 per pair average	113	12	0
1 boy assistant at annas 4 per diem ..	7	8	0
House rent, etc.	20	0	0
Advertising and canvassing	20	0	0
Total—Working ..	581	0	0
Say ..	580	0	0

APPENDIX XVI (a)—*contd.**Summary of capital required.*

			Rs.	a.	p.
Block	..	..	550	0	0
Recurring	..	...	580	0	0
Reserve	..	..	870	0	0*
Total	..	..	2,000	0	0

*As the capital invested in this business may take about a month to revolve the reserved capital has been kept at Rs. 570.

Expected realisations from the sale of 260 pairs of shoes monthly.

			Rs.	a.	p.
Gent's oxford (good quality)	7 pairs at Rs. 6 per pair	..	42	0	0
Do.	(medium) 20 pairs at Rs. 4-12-0 per pair	..	95	0	0
Do.	(cheap) 25 pairs at Rs. 3-8-0 per pair average.	..	87	8	0
New cut selims, etc. (chrome quality)	60 pairs at Rs. 2-10-0.	..	157	8	0
Do.	(glace kid) 35 pairs at Rs. 3-10-0 per pair.	..	126	14	0
Do.	(fancy) 9 pairs at Rs. 5-8-0 per pair average.	..	49	8	0
Sandals	104 pairs at Rs. 1-7-0 per pair average.	..	149	8	0
Total	..	..	707	14	0
Say	..	..	700	0	0
Less depreciation on soiled stock	10 per cent of Rs. 700.	..	70	0	0
Net realisable amount	..	..	630	0	0

Expenses.

Raw materials	..	..	..	344	12	0
Labour, etc.	..	..	..	196	4	0
Rent	..	..	..	20	0	0
Advertisement and canvassing	..	..	..	20	0	0
Depreciation of tools (Singer machine 5 per cent per annum of Rs. 375 for one month)	..	..	..	1	9	0
Depreciation of small tools and lasts, etc., 20 per cent per annum of Rs. 175 for one month.	..	..	..	3	0	0
Total—Expenses	..	..	..	585	9	0

APPENDIX XVI (a)—contd.

Net monthly profit—Rs. 44-7-0, say Rs. 40.

Net annual profit—Rs. 480.

This works out at about 24 per cent on the capital of Rs. 2,000.

A SCHEME FOR A COMBINED FULL-TANNING AND HALF-TANNING DEMONSTRATION FACTORY IN NORTH BIHAR.

Capacity per month—

- (i) 1,800 pieces cow hides and 300 pieces sheep skins by chrome process.
- (ii) 20 pieces cow hides and 200 pieces sheep skins and 150 pieces buffalo hides by vegetable process (full tanning).
- (iii) 700 pieces cow hides and 500 pieces calf skins by vegetable process (half tanning).

Estimate of expenditure involved.

Block Capital—

	Rs.	a.	p.	Rs.	a.	p.
(I) Land 5 bighas at Rs. 500 per bigha.				2,500	0	0
(II) Buildings				60,000	0	0
			Sq. ft.			
(A) To accommodate (1) Lime yard, (2) Tan yard and (3) Setting tables 150' x 50'.			7,500			
(B) Machine yard 100' x 50'.			5,000			
(C) Disintegrator room 20' x 15'.			300			
(D) Boiler house 15' x 15'			225			
(E) Office 30' x 20'			600			
(F) Stores 40' x 15'			600			
(G) Drying chamber 30' x 15'.			450			
Total			14,675			
of covered area with brick wall, brick on edge floor and corrugated iron roofing on iron structure at Rs. 4 per sq. ft.				58,700	0	0
(H) Service latrines 6 at Rs. 200 each.				12,000	0	0
Total				59,900	0	0
			Say	60,000	0	0

APPENDIX XVI (a)—*contd.*

	Rs.	a.	p.	Rs.	a.	p.
(III) Equipment (masonry pits) ..	..			2,400	0	0
Masonry pits 5'×5'×4' for washing liming, and delimiting hides 20 at Rs. 45 each.	900	0	0			
Masonry pits 4'×4'×4' for washing, liming and delimiting skins 15 at Rs. 25 each.	375	0	0			
Masonry pits 5'×5'×4' for tanning 24 at Rs. 45 each.	1,080	0	0			
	<hr/>					
Total ..	2,355	0	0			
	<hr/>					
	Say	2,400	0	0		
(IV) Drums and machines ..	..			54,000	0	0
4 Big drums 6'×5' each ..	2,000	0	0			
3 small drums 4'×3' each ..	750	0	0			
2 shaving machines ..	4,800	0	0			
2 Buffing machines ..	2,400	0	0			
2 Staking machines ..	4,000	0	0			
2 Glazing machines ..	3,000	0	0			
1 measuring machine ..	3,500	0	0			
1 leather press ..	15,000	0	0			
1 sole leather rolling machine ..	2,000	0	0			
1 no. 1½ Carter's Disintegrator with box and balloon.	1,000	0	0			
1 oil engine 67 H. P. with cooling tanks.	8,500	0	0			
2 10 cwt. Avery platform weighing machines.	700	0	0			
1 small vertical boiler for process steam.	2,000	0	0			
Line shafting pulleys, etc. ..	3,000	0	0			
Tube well and pump ..	900	0	0			
	<hr/>					
Total ..	53,550	0	0			
	<hr/>					
	Say	54,000	0	0		

APPENDIX XVI (a)—*contd.*

	Rs.	a.	p.	Rs.	a.	p.
(V) Tools and accessories	1,100	0	0
2 small scales with weights	30	0 0			
1 holo iron fastener	100	0 0			
16 horse benches	64	0 0			
4 hand stakers	24	0 0			
25 wooden boards 7'×4' each	250	0 0			
8 cork boards	32	0 0			
8 fleshing knives	24	0 0			
8 unhairing knives	20	0 0			
2 shaving knives	9	0 0			
10 fleshing beams	20	0 0			
2 shaving beams	14	0 0			
12 brass slickers	18	0 0			
6 iron slickers	6	0 0			
4 glass slickers	4	0 0			
1½ doz. galvanised buckets	13	0 0			
4 enamelled buckets	12	0 0			
1 doz. enamelled bowls	6	0 0			
12 earthen gamlas (small)	3	0 0			
6 wooden tubs (40 gallon capacity)	24	0 0			
6 wooden tubs, small (20 gallons capacity)	12	0 0			
4 Patent stone tables (7'×4')	60	0 0			
8 wooden tables 7'×4'	120	0 0			
3 wooden table 8'×5'	45	0 0			
2 wooden tables 5'×3'	20	0 0			
3 electric hand irons	30	0 0			
Small tools and furniture	134	0 0			
1 doz. hand knives	6	0 0			
Total	1,100	0 0			

APPENDIX XVI (a)—contd.

	Rs.	a.	p.	Rs.	a.	p.
Working capital—						
(VI) Establishment (general)—				15,528	0	0
1 Expert Tanner on Rs. 750 per month.	750	0	0			
1 Assistant tanner on Rs. 150 per month.	150	0	0			
1 clerk on Rs. 100 per month ..	100	0	0			
2 clerks on Rs. 40 per month ..	80	0	0			
2 Durwans at Rs. 15 each per month	30	0	0			
2 peons at Rs. 15 each per month ..	30	0	0			
1 orderly at Rs. 15 per month ..	15	0	0			
1 market investigator on Rs. 100 per month.	100	0	0			
1 duffary on Rs. 15 per month ..	15	0	0			
2 sweepers at Rs. 12 each per month	24	0	0			
	<hr/>					
Total	..	1,294	0	0		
	<hr/>					
	1294 × 12	..	15,528	0	0	(annual).
(VII) Power plant—Establishment including fuel and lubricating oils, etc.				3,325	0	0
1 oil engine driver at Rs. 40 per month.	480	0	0			(annual).
1 fitter on Rs. 50 per month ..	600	0	0			..
Fuel oil 5,760 gallons at 6 annas per gallon.	2,160	0	0			..
Lubricating oil 50 gallons ..	45	0	0			..
Sundries	40	0	0			..
	<hr/>					
Total	..	3,325	0	0		..
	<hr/>					

APPENDIX XVI (a) — contd.

	Rs.	a.	p.	Rs.	a.	p.
(VIII) Chrome Tanning Section—				1,10,700	0	0
Capacity—1,800 pieces cow hides and 300 pieces sheep skins.						
(a) Cost of hides and skins (annual) —						
1,800 pieces cow hides $\times 12 = 21,600$ pieces at Rs. 5 per piece (average).	1,08,000	0	0			
300 pieces sheep skins $\times 12 = 3,600$ pieces at 12 annas per piece (average).	2,700	0	0			
Total hides and skins ..	1,10,700	0	0			
(b) Chemicals (annual) :—				15,140	0	0
Lime—256 maunds ..	192	0	0			
Sodium sulphide 48 cwts. ..	276	0	0			
Artificial bate—18 cwts. ..	1,458	0	0			
Salt 462 maunds ..	1,155	0	0			
Sulphuric acid—23,415 lbs. ..	975	0	0			
Soda bichromate—165 cwts. ..	4,331	4	0			
Molasses—60 maunds ..	270	0	0			
Borax—40½ cwts. ..	769	0	0			
Soda ash—3 cwts. ..	13	8	0			
Liquor ammonia—150 lbs. ..	46	14	0			
Black aniline dye—285 lbs. ..	356	2	0			
Brown aniline dye—800 lbs. ..	1,500	0	0			
Fustic extract—600 lbs. ..	375	0	0			
Cutch—600 lbs. ..	131	4	0			
Red dyewood extract—300 lb. ..	300	0	0			
Logwood extract—900 lbs. ..	421	14	0			
Titox—585 lbs. ..	950	10	0			
Pigment finishes—195 lbs. ..	156	0	0			
Ready made fat liquor—3,524 lbs. ..	991	2	0			
Kid finishing oil—450 lbs. ..	112	8	0			
Glycerine—4½ cwt. ..	243	0	0			
Formaldehyde—36 lbs. ..	9	0	0			
Misc. chemicals and stores ..	106	4	0			
Total ..	15,140	0	0			

APPENDIX XVI (a)—contd.

	Rs.	a.	p.	Rs.	a.	p.
Labour (Annual) :—				4,104	0	0
1 machine shavers at Rs. 35 each per month.	840	0	0			
2 glazers at Rs. 20 each per month	480	0	0			
2 stakers at Rs. 20 each per month	480	0	0			
3 fleshers at Rs. 20 each per month	720	0	0			
6 unskilled workmen at Rs. 12 each per month.	864	0	0			
4 setters at Rs. 15 per month each	720	0	0			
Total ..	4,104	0	0			
Proportionate cost of power— $\frac{2}{10}$ of Rs. 3,325.	2,992	8	0			
Proportionate cost of general establishment— $\frac{1}{4}$ of Rs. 15,528.	11,646	0	0			
Total—Cost of production (chrome section).	1,44,582	0	0			
Estimated receipts from sale of leathers (chrome section) Box sides 21,600 × 200 = 432,000 sq. ft. at 6 annas 3 pies per sq. ft. (average).	1,68,750	0	0			
Sheep skins—3,600 pieces at Re. 1-4-0 piece.	4,500	0	0			
Total	1,73,250	0	0			
	Rs.	a.	p.	Rs.	a.	p.
Estimated profits—						
Gross estimated receipts from sale of leather	1,73,250	0	0			
Less estimated cost of production ..	1,44,582	0	0			
Less proportionate depreciation on buildings and masonry equipment 5 per cent of Rs. 31,200 (half of the total) ..	1,560	0	0			
Less proportionate depreciation of machinery, 7 per cent of Rs. 51,000 ..	3,570	0	0			
Less depreciation of tools 14 per cent of Rs. 1,100 ..	154	0	0	1,50,366	8	0
Estimated profit net (Chrome section) ..	22,883	8	0			

APPENDIX XVI (a)→contd.

	Rs. a. p.	Rs. a. p.
(IX) Vegetable Tanning Section (Full Tanning)—		7,110 0 0
Capacity—50 pieces buffalo hides, 20 pieces cow hides and 200 pieces sheep skins per month.		
(a) Cost of hides and skins (annual)—		
Buffalo hides $50 \times 12 = 600$ pieces at Rs. 7-4-0 per piece ..	4,350 0 0	
Cow hides $20 \times 2 = 240$ pieces at Rs. 4 per piece ..	960 0 0	
Sheep skins $200 \times 12 = 2,400$ pieces at Re. 0-12-0 per piece ..	1,800 0 0	
Total ..	7,110 0 0	
(b) Chemicals (annual)—		2,550 0 0
Lime—75 maunds ..	57 0 0	
Sodium sulphide—3 cwts. ..	17 4 0	
Acid boric— $3\frac{1}{2}$ cwts. ..	87 10 6	
Myrobalan—228 maunds ..	456 0 0	
Brown aniline dye—60 lbs. ..	112 8 0	
Pigment finishes—30 lbs. ..	24 0 0	
Ready made fat liquor—76 lbs. ..	21 6 0	
Babul bark 775 maunds ..	968 12 0	
Acid oxalic—100 lbs. ..	37 8 0	
Tallow—900 lbs. ..	159 2 3	
Cod oil—62 gallons ..	209 4 0	
Quebracho extract—8 cwts. ..	101 6 0	
Wattle extract—8 cwts. ..	96 0 0	
Til oil—7 maunds ..	168 0 0	
Miscellaneous ..	84 3 3	
	2,550 0 0	
(c) Labour (annual)—		708 0 0
1 flesher at Rs. 20 per mensem ..	240 0 0	
1 setter at Rs. 15 per mensem ..	180 0 0	
2 Workmen at Rs. 12 each per mensem ..	288 0 0	
	708 0 0	

APPENDIX XVI(a)—contd.

	Rs. a. p.	Rs. a. p.
Proportionate cost of Power—1/20th of Rs. 3,325	166 4 0	
Proportionate cost of general estab- lishment 1/16th of Rs. 15,528 ..	970 8 0	
	<hr/>	1,136 12 0
Total cost of production (Vegetable Section full tanning) .. ..	.. ..	11,505 12 0
Estimated receipts from sale of leathers (Vegetable Section full tanning)—		
Bark tanned cost hides (case leather) 240 pieces at Rs. 6-8-0 per piece	1,560 0 0	
Barked tanned sheep skins (lining leather) 2,400 pieces at Rs. 1-4-0 piece	3,000 0 0	
Barked tanned buffalo hides (sole leather) 600 pieces of 24 lbs, each 14,400 lbs. at Rs. 0-9-0 per lb.	8,100 0 0	
	<hr/>	12,660 0 0
Estimated profits—		
Gross estimated receipts from sale of leathers .. .. ..	.. ..	12,660 0 0
Less estimated cost of production ..	11,505 12 0	
Less proportionate depreciation of buildings and masonry equip- ments 5 per cent of Rs. 7,800 (1/8th of total cost)	390 0 0	
Less proportionate depreciation of machinery 7 per cent of Rs. 3,000 (cost of sole leather rolling machine and disintegrator) ..	210 0 0	
	<hr/>	12,105 12 0
Estimated profit net (Vegetable Section full tanning) .. ..	.. ..	<hr/>554 4 0

APPENDIX XVI(a)—contd.

	Rs. a. p.	Rs. a. P.
(X) Vegetable Tanning Section (half tanning)—		
Capacity—700 pieces cow hides and 500 pieces calf skins per month.		
(a) Cost of hides and skins (annual)—		42,600 0 0
Cow hides $700 \times 12 = 8,400$ pieces at Rs. 4 per piece	33,600 0 0	
Calf skins $500 \times 12 = 6,000$ pieces at Rs. 1-8-0 per piece	9,000 0 0	
Total	42,600 0 0	
(b) Cost of Chemicals—		16,620 0 0
Lime—275 maunds	206 4 0	
Boric Acid— $14\frac{1}{2}$ cwts.	356 7 6	
Avaram bark—2,946 maunds	13,072 14 0	
Myrobalan—1,022 maunds	2,044 0 0	
Til oil—37 maunds	888 0 0	
Miscellaneous	52 6 6	
	16,620 0 0	
(c) Labour (annual)—		2,100 0 0
2 fleshers at Rs. 20 each per mensem	480 0 0	
2 setters at Rs. 15 each per mensem	360 0 0	
5 workmen at Rs. 12 each per mensem	720 0 0	
1 half tanning mistry at Rs. 45	540 0 0	
	2,100 0 0	
Proportionate cost of power— $\frac{1}{20}$ th of Rs. 3,325	166 4 0	
Proportionate cost of general establishment, $\frac{3}{16}$ th of Rs. 15,528	2,911 8 0	
	2,077 12 0	
Total—Cost of production (Vegetable Section half tanning) .. ..	..	64,397 12 0
Estimated receipts from sale of leather (Vegetable section half tanning)—		
From cow hides 8,400 pieces at 5½ lbs. each .. ..	..	48,300 lbs.
From calf skins 6,000 pieces at 2 lbs. each .. ..	..	12,000 lbs.

APPENDIX XVI(a)—*contd.*

Classification of yield—

				£	s.	d.
Cow 2nd quality	7 per cent	3,381 lbs.				
24½ d.	..	..	..	345	2	10½
Cow 3rd quality	30 per cent	14,490 lbs.	22 d.	1,328	5	0
Cow 4th quality	35 per cent	16,905 lbs.	20 d.	1,408	15	0
Cow 5th quality	20 per cent	9,660 lbs.	17½ d.	704	7	6
Cow 6th quality	8 per cent	3,864 lbs.	14½ d.	233	9	0
Calf 2nd quality	10 per cent	1,200 lbs.	30½ d.	152	10	0
Calf 3rd quality	20 per cent	2,400 lbs.	28½ d.	285	0	0
Calf 4th quality	25 per cent	3,000 lbs.	26½ d.	331	5	0
Calf 5th quality	25 per cent	3,000 lbs.	28½ d.	256	5	0
Calf 6th quality	20 per cent	2,400 lbs.	15½ d.	155	0	0
Total ..				£5,199	19	4½
at 1 s 6½ d. per rupee ..				Rs. 68,854-12-0.		

Estimated profits—

Gross estimated receipts from sale of leathers	..	..	..	68,854	12	0
Less estimated cost of production	..	64,397	12	0		
Less proportionate depreciation of building and masonry equipment (5 per cent of Rs. 23,400—¾th of total cost)	..	1,170	0	0		
Less cost of freight, etc., to reach the half-tanned goods to U. K.	..	2,512	8	0		
Total ..				68,080	4	0

Estimated profit net (vegetable section—half tanning)	774	8	0
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APPENDIX XVI(a)—concl'd.

Summary of capital required—	Rs.	a.	p.
Block capital—			
I. Land	2,500	0	0
II. Buildings	60,000	0	0
III. Equipment (Masonry pits)	2,400	0	0
IV. Machines and Drums	54,000	0	0
V. Tools and Accessories	1,100	0	0
Total	1,20,000	0	0
Working capital (annual)—			
VI. Establishment (general)	15,528	0	0
VII. Power plant establishment including fuel, lubricating oils, etc.	3,325	0	0
VIII. Chrome Tanning Section—			
(a) Raw hides and skins	1,10,700	0	0
(b) Chemicals	15,140	0	0
(c) Labour	4,104	0	0
(d) Advertisement and propa- ganda, including travelling allowance for the market inves- tigator	500	0	0
IX. Vegetable Tanning Section (full tanning)—			
(a) Raw hides and skins	7,110	0	0
(b) Chemicals	2,550	0	0
(c) Labour	708	0	0
X. Vegetable Tanning Section (half- tanning)—			
(a) Raw hides and skins	42,600	0	0
(b) Chemicals	16,620	0	0
(c) Labour	2,100	0	0
(d) Freight	2,512	8	0
Total	2,23,497	8	0
Say	2,23,500	0	0
(XI) Replacement of tools and machine parts from the 2nd year of the operation of the scheme	1,500	0	0 (annual)

APPENDIX XVI(b).

In planning a factory for the manufacture of rubber goods, there are many points which must be taken into consideration. The most important are the following :—

1. *Fuel and water.*—If the works are far from a colliery or railway, the cost of fuel will increase owing to the heavy haulage charges, while the consumption of water is so very great that it is advisable to have a supply other than the town mains to draw upon. Provision for water must be made by selecting a site near a river or by boring wells. The locality of the works should be free from dust and dirt as these are extremely detrimental to the finished material.

2. *Power.*—The best power to use is electricity, because taken all round it is cleaner and more economical for driving machines than steam or gas. It is advisable to drive each machine by a single motor.

3. *Transport.*—The factory site should be near the industrial centres and shipping posts, as the demand from customers in these places is usually more urgent.

Factory plans.

The plan of a proposed factory capable of an output of the value of Rs. 10,00,000—Rs. 13,00,000 is supplied herewith. In drawing up this plan, careful consideration has been given to curtail unnecessary labour charges for transporting materials from one department to another; for instance, the washing department, drying rooms, powder, drug and batch rooms are situated together and as these usually come under one foreman supervision is easy. The punching department which feeds the beet department, adjoins the mills as does the mechanical department. The latter and the tyre department communicate with the vulcanizing shop at one end and the finished stores at the other. All the buildings are one-storeyed with the exception of a second storey extending over the whole length and breadth of the stores, mechanical, tyre and vulcanizing departments. Communication to the ground floor is by a lift. The boilers are placed in a building which forms part of the engineer's shop and is near the vulcanizing department in order to save steam condensation. As much inflammable material is used in connection with the spreading department, this is placed away from the main building but within easy distance of the stores and mills.

A machine repair section with the following appliances is necessary :—

- (1) One 15"–17" centre back geared, surfacing, sliding and screw cutting lathe.
- (2) One vertical drilling machine to drill holes up to 2".
- (3) One milling machine with platen 18" × 24".
- (4) One planing machine to take about 10' × 4'.

APPENDIX XVI(b)—*contd.*

- (5) One screwing machine, complete with dies for pipes and bolts up to 2".
- (6) One circular saw.
- (7) Band saw.
- (8) Emery grinding wheel.
- (9) Grindstone and trough.
- (10) 12—15 H. P. motor for driving the above machines

Washing Department.

In this department the equipments required are as follows :—

- (1) A cutting machine for cutting up raw rubber into small pieces, the bench being 2'—9" × 1'—6" and having a fixed spindle suitable to carry one 6"—9" knife cutter running in a water trough. The speed of the pulleys, 4"—5" in diameter, should be about 900 r. p. m. and the machine would require one H. P.
- (2) Two galvanized iron tanks, 6' × 4' × 4' fitted with cold water, steam connection and outlet pipes at the bottom.
- (3) One breaking up or masticating mill, fitted with two grooved rolls 24" long and 10" in diameter, revolving inwardly at unequal speeds, the back roll, 12—16 r. p. m. and the front 6—8 r. p. m.
- (4) Another similar washing mill, the rolls being geared to work with greater friction the back roll 15 r. p. m. and the front 5 r. p. m.
- (5) Washing mill, similar to above, both rolls having a smooth surface, the back 15½ r. p. m. and the front 5 r. p. m.

All the machines should have cold water connections fitted above the centres of each pairs of rolls and a collecting tank and sieve fixed underneath. The machines are driven through a line shaft by a motor 15—20 H. P. at 600 revolutions per minute.

Drying Department.

Vacuum drying is usually employed. The plant consists of a pump, condenser and stove, driven by 2½—3 H. P. motor. The drying chamber should be about 4½' × 4½' × 4½' and should contain 12—15 layers of steel steam heating pipes, on which the trays are placed with the materials for drying. Vacuum and steam pressure gauges should be fitted and it is better to have two sets of trays, so that one lot may be filled while the other is in the chamber.

APPENDIX XVI(b)—*contd.*

FACTORY MACHINERY.

Mixing, Warming and Grinding.

These machines correspond in principle to the washing rolls already described but of larger dimensions, 16"—18" in diameter and 50"—60" in length. The rolls work at friction speeds, the front roll rotating at 22½ r. p. m. and the back one 15 r. p. m. For the purpose of removing the compound from the rolls, a scraper is fixed on a steel rod, so that it can be moved along the face of the rolls. The warming up machines are placed in close proximity on the feeding side, so that a continuous supply of material may be at hand. The warming up machines are but another name for the mixing mills, the speeds of the rolls being the same.

The grinding machines are very similar to the mixers in construction but to tear the rubber into shreds, the rolls are so geared that the friction is much greater and the revolutions of the rolls are 24 : 8. All the mixing, grinding and warming mills are fitted with steam and cold water connections. Four large mixers are usually necessary and each is driven by 35—40 H. P. motor. To save floor space the motors are usually placed below the floor level.

Calenders.

The calenders are the most important machines in a rubber factory and are now made with four rolls. Two three-roll calenders will be sufficient for most purposes. Fabrics which have been proofed on a calender are much superior to those prepared by the spreading process. Modern calender rolls run at even speeds and in addition each of them carries a lengthened journal on which are fixed two gears; by inserting a steel pin, the rolls are changed over from even speed to friction speed. Probably the most useful size of the calender is that having three rolls 60" wide on the face and 20" in diameter. At the front of the calender, not the feeding side, apparatus for winding the fabric is fixed at a distance of 5'—6' for the rolls. The best and most suitable form of drive is by means of an electric motor and worm reducing gear; a 30 H. P. variable speed motor will be best while the gear should be such that the calender has a delivery speed of 8—20 yards per minute.

Spreading shop.

There are various kinds of fabrics which cannot be treated on calenders and the proofing of these must be done on spreading machines. The standard width of the proofed fabrics is 72"—84"; three machines are necessary for these widths. In the most modern machines, a spreading roll is provided and over it is placed an adjustable knife or "doctor"; directly in connection with this is fixed a steam heated steel plate which is of the same width as the spreading roll but 12'—14' long. In

APPENDIX XVI(b)—*contd.*

line with the spreaders, a machine for doubling the proofed cloth is installed, the operation being carried out by two rollers which press the two surfaces of the cloth together while passing between them.

Three dough mills with rolls 3' by 16" will be sufficient to keep the three spreading machines going. As para strip is one of the principal articles to be manufactured, a water tank must be provided for the stripping of the rubber from the faced sheet and it should be of galvanized iron 7' x 4' x 4' fitted with steam pipes, water connections and outlet pipes.

Solution machine.

A solution making machine of the beater type, the lid of which should fit very tight to prevent the escape of solvents must be provided. A tank for storing naphtha outside the spreading shop is also necessary. A 40 H. P. motor will be required for driving this set of machines. To remove inflammable vapours good draught fans must be provided at suitable points.

Cloth drying machine.

In connection with the spreading department, a cloth drying machine, consisting of three drums 24"—30" in diameter, 30" long, made of stout sheet tin capable of withstanding a pressure of 20—30 lbs. per square inch steam enters through bearings and steam gauge is fitted reading up to 30 lbs. No power for winding is necessary this being done by hand.

PRINCIPAL RAW MATERIALS.

Para rubber.

The finest and foremost rubber is Hard Fine Para, from South American forests. It is suitable for all classes of goods where strength is an essential requirement. It is one of the cleanest of wild rubber and the washing loss rarely exceeds 5 per cent.

Plantation rubber.

Plantation rubber is exceptionally clean of very good nerve and strength and comes on the market in many cases ready for use. The most reliable plantation rubber is that prepared by smoking for which special plant has been introduced. The rubber coagulated by acetic acid or any other acid process is unreliable as it would appear that the acid cannot be washed out completely which proves detrimental to the goods in which it is used.

Para second grades come on the market under various trade names, such as Scrappy Negroheads, Cameta, Sermanby, etc., the washing losses of these run up to 20 per cent.

APPENDIX XVI (b)—*contd.**Peruvion Ball.*

Peruvion ball, another South American rubber, probably comes next to the Para and Plantation grades in point of quality and is used for the manufacture of high grade goods and proofings. Other raw rubbers which are extensively used, generally being classed as 'medium' grades, are Massai, Borneo, Upper Congo Bell, Malay, Ceylon, etc.

Reclaimed rubbers.

Reclaims which are made under alkali and acid processes, appear to possess more nerve and elasticity than those prepared by other processes. In purchasing it would be an advantage to ascertain the rubber content, free sulphur and specific gravity.

The general class of reclaims are rather unsuitable for proofing purposes as they do not disintegrate in naphtha but acid reclaims are more suitable than alkali grades.

A list of other essential raw materials is given below. A large and up-to-date firm would have to keep a stock of these articles to manufacture different varieties of manufactured goods.

Vulcanized waste.

Floating waste.	Common black waste.
Red waste floating.	Red inner tube waste.
Common red waste.	Grey „ „ „
Common drab waste.	Cab or bus tyre waste.

Fillers, etc.

Zinc oxide.	Lithophone.
Magnesia.	Pumice.
Magnesium carbonate.	Glass powder.
Whiting.	Vegetable black.
Barytes.	Coloured pigments.
Lime	Graphite.
Litharge.	Zinc white.
Zinc sulphide.	Talite.
French chalk.	Asbestos powder.
Red lead.	Antimony sulphide.
White lead.	Ultramarine blue.

Reclaims.

Floating reclaim.	Dark reclaim specific gravity 1.5.
„ red reclaim.	Drab and red reclaim.
Dark reclaim specific gravity 1.25	Cheap dark and drab reclaim.

APPENDIX XVI (b)—*contd.**Vulcanizing ingredients.*

Sulphur.	Vermillion.
Crimson antimony.	French antimony.
Golden antimony.	Black hypo.

Other ingredients.

Dark floating substitute.	Rosin oil.
Light floating substitute.	Paraffin wax.
Shellac.	Ceresine wax.
Ground mica.	Creosote oil.
Red ground substitute.	Linseed oil.
Rape oil.	Glycerine.
Mineral rubber.	Camphor.
Vaseline.	

With reclaims, it should be insisted that all deliveries must be of uniform quality. Sulphur content should not vary for if it does to any considerable extent, trouble is bound to ensue owing to over or under vulcanization of the articles into which the reclaim enters.

Washing, drying and mixing operations.

Raw rubber, on its arrival at the factory, should be stored in a moderately cold, dark room. Before passing on to the washing mills, rubber is usually softened by soaking in hot water for 6 hours. After this softening operation it is immediately passed to the first pair of washing rolls, previously described, a stream of cold water being allowed to flow on to the rubber in order to wash away dirt and impurities, while the process of tearing the rubber up goes on. Moderation at this stage is essential, otherwise the material deteriorates.

It is now put into another tank of cold water and after rinsing is passed to the second pair rolls, where it is broken up into still smaller pieces, a flow of cold water being kept on it the whole time. In this second operation, the rubber is broken up and foreign matter is completely eliminated. It is now transferred to the third pair of rolls and run out into a long sheet, 12" wide, and put on a bench to allow the water to drain off.

Drying washed rubber.

Washed rubber is sometimes dried in a current of hot air. It is advisable, when this is adopted, to raise the temperature slowly to 60°—70°C. Para and better class of rubbers should be thoroughly dried in two days.

APPENDIX XVI (b)—*contd.*

For vacuum drying, the raw rubber is run into very thin sheets, and placed on trays which fit into the shelves of the chamber, the door being closed and the apparatus put into operation, as described before. Care must be taken that the pressure and temperature do not fluctuate very greatly. The drying temperatures for high grade rubbers may be as high as 75°C. Average time of operation—1 hour.

Selection of mixings.

Pure rubber is never employed for the manufacture of rubber goods. It is always mixed with reclaims, fillers, etc. before the final curing operation is undertaken. The principal points to be taken into consideration when making up a compound may be set down as follows:—(1) the use to which the article is to be put whether it must be acid resisting, possess wearing qualities or any other special quality, (2) the specific gravity of the finished product, (3) whether for tubing, machine moulding or open vulcanization, (4) colour desired. If the article is to resist the action of acid and alkalis, French chalk, barytes, talite and sulphur would be suitable fillers in conjunction with good class raw rubber. Should the above be required in a dark or black colour, this can be obtained by use of velvet black, graphite, etc. For imparting toughness to rubber goods, nothing can beat magnesia, white lead, zinc oxide and in the case of dark goods, litharge.

The mineral matter to be incorporated in the mixings must be in a fine state of division. When wax of any kind forms a constituent, it should be melted in a pan and evenly incorporated with the mineral matters.

In the case of gas tubes, etc., which must have a smooth finish waste rubber of any kind cannot be used, as it produces lumps on the surface. Care must also be exercised in the use of reclaims, as some of these are stringy and contain bits of foreign matter. In the latter case the difficulty is got over by suitable additions of lime and magnesia in small quantity.

The actual mixing operation requires a good deal of care and attention. It is well known that raw rubber deteriorates rapidly by overworking on the mixing rolls and by applying too much heat. As regards the actual process of mixing, the rolls are set in motion, sufficient steam being passed through them to facilitate the mixing, and thus obviate prolonged working. When raw rubber, reclaims and minerals form the ingredients, it is advisable to ground the rubber and reclaim separately until they are plastic, when they are mixed together and the mineral added and mixing continued until the whole forms homogeneous mass. As rubber during mastication becomes heated, even if the rolls are cold, allowance must be made for this by having cold water connections fitted to the rolls.

APPENDIX XVI (b)—*cont'd**Vulcanization.*

In this process the vulcanizing plant should be conveniently near the boiler, so that dry steam is available and condensation loss in pipes is reduced. Good ventilation is essential for the health of the workmen and a good draught fan is therefore important for this department.

A list of pans necessary for the manufacture of various classes of goods is given below:—

- (1) Two horizontal pans to take the 'insertion' drums, 5'—6' long and 3'—6" in diameter and fitted with carriages, so that the wrapping drum containing the insertion can be run in and out.
- (2) Two vertical pans 3' diameter and 4' deep to take clamp d moulds, etc.
- (3) One horizontal pan 2½' in diameter and 6' in length, having a tray for chalk and fitted with a run out.
- (4) Two pans 3½' in diameter and 3½' in length for washers, etc.
- (5) One pan 4' × 8' for rollers.
- (6) One pan for motor car inner tubes, 5' in diameter 12' in length and fitted with a run out on which a special stand is erected for holding a large number of tubes.

All these pans should be well insulated. The steam inlet pipes might be connected to a large steam supply pipe from the boiler and if the latter is working at high pressure a pressure reducing valve is necessary. Exhaust steam should be condensed, the pans should be tested to stand a pressure of 100 lb. per sq. inch and fitted with steam pressure gauges. The steam required for these pans may be generated in a boiler about 7½' in diameter and 30' in length, working at 175 lb. per square inch and capable of evaporating 7,500 lb. of water per hour.

There are several methods by which the curing of the rubber goods can be carried out, the most important being steam vulcanization. This method can be divided into four different operations:— (1) Open cure or goods made to shape, embedded in chalk and vulcanized. (2) Articles made to shape generally on a mandrel or similar support, being wrapped in cloth and vulcanized in the pan with steam circulating throughout. This is known as the 'wrapped method' and is used in the case of washers, insertions, sheet, etc. (3) Goods wrapped as in (2) but suspended in a vulcanizing pan containing water, the temperature being raised to the required point by admission of steam. This process is not used to any great extent. (4) Goods pressed to shape in presses, the necessary temperature being obtained by steam circulating through the chambers between which the mould is placed. This is known as 'press-cure' and rubber heels, buffers, motor tyres, motor cycle belts are made by this process.

APPENDIX XVI (b)—*concl'd.*

Under all the above processes, sulphur is the only medium of vulcanization. Sulphur combines with rubber at a temperature of 240° F. For all soft rubber goods, it is advisable to use 5—15 per cent sulphur, on the amount of raw rubber used in the mixing. For the harder class of manufactured goods, a larger proportion of sulphur is necessary, 25—60 per cent.

The time of curing varies with the different articles vulcanised. The following times of curing are recommended for the different classes :—

Open cure for gas tubing, cab tyres, etc.

- | | | | | | |
|-----|------------|----------------|------------|------------|-------------|
| (1) | 15 minutes | rise to 40 lb. | (286·6°F.) | 30 minutes | at 286·6°F. |
| (2) | 30 | " | " | 60 | " " |
| (3) | " | " | " | 90 | " " |
| (4) | " | " | " | 120 | " " |

These times of curing would be applied to wrapped goods, a different pan being used.

Press cure for all moulded goods, rubber heels, etc.

- | | | | |
|-----|----|---------|-----------|
| (1) | 10 | minutes | at 290°F. |
| (2) | 10 | " | " |
| (3) | 60 | " | " |
| (4) | 75 | " | " |
| (5) | 90 | " | " |

CHAPTER XVII.

PHARMACEUTICALS.

Pharmaceutical preparations may be divided broadly into the following groups :—

- (1) Extracts or tinctures of indigenous drugs.
- (2) Preparation of synthetic drugs.
- (3) Preparation of vitamin products.
- (4) Extraction of alkaloids like strychnine, morphine, etc., from raw materials available in the country.
- (5) Preparation of inorganic or organic compounds used in medicine in large quantities, like ether, chloroform, sodium benzoate, sodium salicylate, sodium citrate, sodium sulphate, magnesium sulphate, etc.

Extracts or tinctures of indigenous drugs.—The methods employed in these cases simply consist of boiling the plants in steam heated pans with water to extract the active principles. Very little attempt is made to obtain an extract with uniform strength or concentration and after the addition of some preservative like p-hydroxy benzoic acid, etc., the liquids are clarified and bottled. The cost of a steam jacketed pan capable of holding about one maund on the average is about Rs. 350 and one cooly can attend to 5—6 of these pans at a time. So the labour charge is six annas for six pans of this type.

In the case of tinctures, the solvent employed is alcohol and the loss of this solvent must be prevented by suitable condensing arrangements. A better plan is to employ an extraction plant built on the principle of Soxhlet extraction apparatus, holding 2—3 maunds of raw materials. The loss of solvent in this method is reduced to a minimum. In the next stage, the alcoholic extract is evaporated down in vacuo and the residue is dissolved in a definite volume of alcohol to give a tincture of the required strength. The cost of a plant of this type with vacuum evaporator is about Rs. 10,000 and the wages of workman in charge of this would be about Rs. 1-8-0 per day. The loss of solvent generally is less than 5 per cent.

Synthetic drugs.—The preparation of synthetic drugs can be easily undertaken in Bihar. Although all raw materials have to be imported from abroad, the great difference between the price of the raw materials and the finished product will always leave a fair margin of profit for the manufacturer.

Organic arsenicals like atoxyl, neo-salvarsan, sulpharsenol, stovarsol can be manufactured in fairly large quantities by an experienced chemist at from 4 to 6 annas per gram whereas the present market price is about Rs. 3 per gram. These figures as to cost of production of these drugs have been actually worked out from the result of extensive laboratory experiments at Calcutta.

The Government of Bihar has recently started a campaign against Kala-azar and from reports available, it appears that a large sum of money will be spent in fighting this disease in the next few years. Up till now the most successful specific for the treatment of Kala-azar is urea-stibamine of Sir U. N. Brahmachari. Our Secretary Dr. Neogy has worked for a number of years on organic compounds of antimony, similar to urea-stibamine. If necessary the preparation of this compound may be taken in hand immediately the cost of production being about six annas per gram. As the Government of Bihar will have to pay twelve to fourteen annas per gram for buying this product from the Calcutta firms it is necessary that the attention of the proper authorities should be drawn to this aspect so that the Government of Bihar may effect a large saving on urea-stibamine.

A local anaesthetic of the type of novocaine can also be prepared easily. The starting materials for these are very cheap. Toluene on nitration will give nitrotoluene which when oxidised gives p-nitro-benzoic acid. From this, with phosphorus pentachloride, p-nitro-benzoyl chloride is prepared. Another starting material is ethylene which, on bromination under suitable conditions, gives ethylene bromohydrin. Diethylamine is prepared from diethylaniline, a cheap material, by a process which is well known. Diethylamine with ethylene bromohydrin gives diethyl-ammino-ethanol which on condensation with p-nitro-benzoyl chloride give p-nitro-benzoyl-diethylamino-ethanol. Reduction of the nitro group gives novocaine. According to Dr. Neogy the cost of production of novocaine is about one rupee per gram whereas the price of the imported material is very much higher.

Another important synthetic drug which has been introduced within the last few years, under the trade name prontosil, sulphonamide, etc., can be easily manufactured locally. The chemical formula for the substance is p-amino-benzene sulphonamide. The process of manufacture is simple and the materials are easily obtainable. The cost of manufacture is said to be eight to ten annas per gram.

The above list does not exhaust the list of pharmaceuticals that may be prepared in the province. It merely indicates some of the lines of manufacture.

PREPARATION OF VITAMIN PRODUCTS.

Vitamin A preparation—Trade name Cod-liver oil.

Halibut liver oil.—It contains 120,000 I. U. The product on the market is always associated with vitamin D. Ordinary cod-liver contains per c. c. 2,400 I. U. of vitamin A and 200 I. U. vitamin D.

Indian source.—Fish liver oil like Ruhit, etc. Ruhit liver oil contains about 13,000 I. U. per c. c. Hence it is richer than ordinary cod-liver oil in the market. Method of preparation is simple. The oil can be liberated from the raw liver either by steam heating or saponifying with 5 per cent sodium hydroxide. Yield—20 per cent of the weight of raw liver.

Vitamin B.

Indian source.—Rice polishings obtainable from rice mills. Extraction with water followed by alcohol and absorption by Fuller's earth and elution with acetic acid and finally concentration gives vitamin B concentrate.

Uses.—For beri-beri and respiratory diseases.

Vitamin C.

Indian source.—Fruit juice, e. g., pineapple, guava, etc., is extremely rich in this vitamin. It is used as prophylactic agent against infectious diseases, intestinal diseases, rheumatism, etc.

Alkaloids.—The total quantity of morphine imported into India during the last two years is given below :—

1935-36.	1936-37.
769 oz.	587 oz.
Rs. 23,931	Rs. 18,540

Morphine.—Although India produces a fairly large quantity of opium from which morphine may be extracted yet the extraction of this important medicinal product has not yet been undertaken. The process of extraction is well known and involves no costly plants. An experienced chemist can easily undertake its preparation on a semi-commercial scale.

Strychnine.—The export of nux-vomica seeds from India during the last two years amounted to 17,093 cwt. and 32,763 cwt.

valued at Rs. 94,000 and Rs. 1,95,000, respectively. The total quantity of strychnine that is imported into India cannot be stated with any certainty. The percentage of alkaloid in the seeds is about 2—2.5 per cent of which 70 per cent is strychnine. If instead of exporting raw nux-vomica, it is found possible to extract strychnine and brucine, a very profitable export trade may be set up in the country.

Atropine and Hyocyamine.—The manufacture of these two valuable alkaloids may prove to be a very paying proposition as the plants from which they are extracted are indigenous in India. Although the process of manufacture is somewhat complicated and tedious, yet there is no insurmountable difficulty in attempting the extraction of these alkaloids. A fair return on the capital invested may be safely expected if these industries are taken up by employing experienced hands.

Preparation of inorganic and organic compounds used in medicine.—The manufacture of the products included under this heading will require the establishment of a chemical works. Many of the substances like ether, chloroform, sodium benzoate, sodium citrate have a very large sale in the market. The raw materials for many of these have to be imported but in that respect, Bihar is at an equal disadvantage with all other provinces which have also to depend upon the importation of raw materials. If the coal-tar distillation industry is established in Bihar, we may have a cheap supply of toluene from which benzoic acid and sodium benzoate may be manufactured. Similarly starting from phenol, we may manufacture sodium salicylate which has also a large market. The manufacture of citric acid from citrus fruits may also prove to be a profitable concern. In any scheme for the manufacture of sodium sulphate and magnesium sulphate, a large supply of sulphuric acid is necessary. Unless a sulphuric acid plant is set up it would not be possible to compete with well-established firms in other provinces. The total capital expenditure for starting a chemical factory of this type will be about Rs. 5,00,000 including a 5-ton sulphuric acid plant and Rs. 2,00,000 for working expenses. Allowing Rs. 25,000 per month for the cost of raw materials and Rs. 25,000 for wages, working expenses, power depreciation, etc., and another Rs. 10,000 for office expenses, canvassers, advertisements, etc., the monthly sales may be expected to reach Rs. 65,000—70,000 leaving a margin of Rs. 10,000 for profit. Even with borrowed capital, with 9 per cent interest per annum, the net profit will be about Rs. 1,00,000 per month.

CHAPTER XVIII.

MATCH INDUSTRY.

During the last three decades, several attempts were made to start match factories in various provinces of India. None of these attempts survived, the main causes of failure being—

- (a) want of proper technical guidance,
- (b) want of sufficient capital,
- (c) under-estimates in the cost of machinery and equipment,
- (d) faulty choice of factory sites,
- (e) wrong selection of match machines,
- (f) difficulty in obtaining proper kind of wood for matches,
- (g) inefficient management,
- (h) under-selling by the foreign combines which have now practically the monopoly of the industry in India.

The present time is very favourable for the match industry because the duty imposed by the Government of India has practically stopped the import of foreign matches into the country. The prejudice of the dealers in handling Indian matches has disappeared and the consuming public have grown less fastidious and exacting.

The first essential raw material for the successful working of a match factory is the supply of suitable varieties of wood at a reasonable price. A list of trees which may supply suitable wood is given below. The details have been supplied by the Proprietor, Calcutta Match Factory, to whom our best thanks are due :—

- (1) *Anthocephalus Cadamba*—(Kadam).
- (2) *Caseari Glomerata*—(Barkholi).
- (3) *Callicarpa Arborea*—(Geoblo, Bormala).
- (4) *Holarrhena Antidysentrica*—(Khira).
- (5) *Prunus Persica*—(Aru).
- (6) *Sapium Eugenifolium*—(Siplikhan, Pipalpati).
- (7) *Trema Orientalis*—(Kuel).

- (8) *Elaecarpus Robustus*—(Bepari).
- (9) *Machilus Sp.*—(Mawla).
- (10) *Michelia Sp.*—(Ghogay Champ).
- (11) *Symplocos Sp.*—(Kholme).
- (12) *Acer Sikkimense*—(Lahara Kapasi)
- (13) *Excoccaria Agallocha*—(Genwa).
- (14) *Macaranga Sp.*—(Mallata).
- (15) *Betula Cylindrostachys*, Wall—(Sauer).
- (16) *Michlia Cathcarti*, K. H. F.—(Titechamp).

Most of the species mentioned above have no value as timber and many of them are jungle trees which should be obtainable very cheaply except for transport difficulties.

For practical purposes types of match factories may be divided into six classes :—

- (a) Factories which manufacture splints only.
- (b) Factories which manufacture box veneers or complete boxes.
- (c) Factories which manufacture both the above items.
- (d) Factories which buy ready-made splints, make their own boxes and finish the matches.
- (e) Factories which buy ready-made splints and boxes and make finished matches.
- (f) Factories which are self-contained manufacturing all their requirements in their factories.

The factories classed under (a) should be situated near the supply of wood in the forest area and (f) class factories may have their splint-making department in or near a forest area, the remaining manufacturing processes being carried out in a place close to a commercial centre having means of easy transport to different parts of the province.

Suitable woods for the manufacture of matches are not wanting in the province. What is needed is a definite forest policy that would remove all doubts and difficulties in the way of supplying match wood. It has been represented to our Secretary that Government could forward the cause of the

industry and practically help interested parties in the following way :—

- (1) By securing the rights to obtain match wood from Government forests at reduced royalty.
- (2) By obtaining concession on freights from railway companies for raw materials and finished goods.
- (3) By granting loans.
- (4) By buying local products for Government use.
- (5) By reducing the import duty on chemicals and other raw materials for matches.
- (6) By general technical help and direction.

In view of the competition of the Swedish combine and the failures of the Indian concerns in the past no fresh attempt to establish the industry in the province is recommended without a careful consideration of the causes of previous failures.

Additional information on the subject is given in the appendix.

APPENDIX XVIII

Additional information regarding Match Industry.

Capital outlay.

Items.	1,000 gross.	500 gross.	300 gross
	Rs.	Rs.	Rs.
Match machines	2,50,000	1,00,000	75,000
Equipment and fittings ..	40,000	20,000	10,000
Power and transmission ..	50,000	25,000	20,000
Working capital	2,00,000	1,50,000	1,00,000
Buildings	50,000	30,000	25,000
Preliminary expenses ..	30,000	20,000	10,000

Labour and power.

	1,000 gross.	500 gross.	300 gross.
Labour { Men	60	50	30
Boys	100	80	70
Total	160	130	100
Power	100 B.H.P.	50 B.H.P.	30 B.H.P.

APPENDIX XVIII—*contd.*

Match machines.

Name of machine.	Production per day.		
	1,000 gross.	500 gross.	300 gross.
Cross cut saw	1	1	1
Circular saw	1	1	1
Unbarking machine	1	..	..
Splint and box veneer peeling	4	3	3
Splint chopping	1	1	1
Box veneer chopping	1	1	1
Splint drying chamber	2	1	1
Splint polishing drum	3	2	2
Splint cleaning	1	1	1
Splint levelling	2	1	1
Paste mixer and boiler	1	1	1
Outer case pasting	6	3	3
Inner case pasting	6	3	3
Box closing and labelling	6	3	3
Box drying chamber	3	2	2
Frame filling	12	6	6
Filling frame for splints	3,500	1,800	1,200
Frame trolleys	175	100	60
Chemical sieving	2	2	2
Ball mill	1	1	1

APPENDIX XVIII—*contd.*
Match machines—*concl'd.*

Name of machine.	Production per day.		
	1,000 gross.	500 gross.	300 gross.
Composition grinding mill, conical	4	3	2
" " " eccentric	3	2	2
Frame heater and reheater ..	2	2	1
Paraffining apparatus ..	3	2	1
Hand dipping apparatus ..	3	2	1
Frame emptying	3	2	1
Box filling	3	2	1
Box painting	3	2	1

Cost of production.

—	1,000 gross.	500 gross.	300 gross.
	Rs. a. p.	Rs. a. p.	Rs. a. p.
Match wood	0 3 0	0 3 0	0 3 0
Chemicals, paper, labels, etc. ..	0 6 0	0 6 0	0 6 0
Power	0 1 0	0 1 6	0 1 6
Packing	0 1 0	0 1 0	0 1 0
Labour establishment ..	0 2 0	0 4 0	0 6 0
Miscellaneous	0 1 0	0 1 6	0 1 6
Total ..	0 14 0	1 1 0	1 3 0

APPENDIX XVIII—*conold.*

The above are costs of production per gross of boxes of 60 sticks for different sized factories. These figures have been arrived at in the following way :—

- (1) The price of match wood is taken at 9 annas per c. ft. and one c. ft. will produce 3 gross.
- (2) The price of chemicals, paper, etc., has been calculated at the present market rates, to be imported in bulk.
- (3) Electric motor or steam engine is to be used for motive power. A boiler will be necessary for supply of steam. In forest areas wood fuel is to be used and coal in other places.
- (4) Wood required for 100 gross packing cases is 6 c. ft.
- (5) Labour has been calculated at rather high rates—12 annas for adults and 8 annas for boys ; in Bihar this figure will be considerably lower.

CHAPTER XIX.

ELECTRO-CHEMICAL INDUSTRIES.

The very high range of temperatures attainable in electric furnaces has opened up a large field of chemistry which was previously not accessible. In the case of processes, in which electric current merely acts as a heating agent and is dissociated from any electrolytic action, products such as artificial graphite, highly refractory metals, a large series of compounds known as carbides, artificial abrasives and high temperature and acid resisting substances like fused alumina, have been successfully manufactured.

It is unfortunate that in India no attempt has yet been made to utilise the electric current for the manufacture of products mentioned in the previous paragraph. As indicated in Chapter II of this report, the province of Bihar is fortunate in having within its boundaries many of the raw materials from which these valuable and important commodities may be prepared on a large scale, when the electrification scheme developed by the Government of Bihar is put in operation. With cheap electric current and abundant raw materials, Bihar's position for the development of electro-chemical industries is unassailable and steps should be immediately taken to collect all the necessary informations about the industries discussed in this Chapter. In the limited time at our disposal it has not been possible for the Committee to get in touch with firms abroad for quotations of machineries necessary for the processes but every attempt has been made to give a fairly accurate idea of the cost of production of the articles at suitable sites in Bihar.

It is frequently assumed that the large supplies of electric energy, necessary in electro-chemical processes, cannot be economically generated from steam power and that this class of industry must be confined to large water power centres. However, the position with regard to the generation of electrical energy on a large scale from steam power has undergone a very rapid development within the last 20—25 years and it is now possible with cheap fuel to produce electricity as cheaply as in the most highly developed hydroelectric plants.

Calcium carbide.—The manufacture of calcium carbide was first carried out at the Wilson Aluminium Works, United States of America, in 1891 and later at Meriton and may be regarded as the pioneer of electro-thermal industries. The chemical reaction proceeds smoothly at high temperature in accordance with the equation $\text{CaO} + 3\text{C} = \text{CaC}_2 + \text{CO}$.

The following types of furnace have been employed for the manufacture of calcium carbide at various times :—

- (1) *Intermittent furnace.*—In which blocks of carbide are built up during the operation and are removed after cooling by dismantling the furnace.
- (2) *Continuous operation furnace.*—In which the molten carbide is tapped at intervals, without interrupting the process and allowed to cool and solidify in a separate vessel.

The main disadvantage of intermittent method of working are the uneconomical utilisation of heat and loss of material by dispersal through evolution of vapour. The conversion of the charge is incomplete and the yield is sometimes as low as 50 per cent. Advantages of the intermittent method are that the product is of a better quality and the furnaces can be run to suit the power supply.

Continuous operation furnaces.—These furnaces are rectangular in form, with open top for admission of the charge. The electrodes consist of two or three blocks of carbon, according to the nature of current employed, suspended adjacent to each other above the furnace charge. The molten carbide collects on a common hearth underneath and is removed through tapping holes at the base of the furnace enclosure. The opening is usually stopped by a cone of clay or solidified carbide.

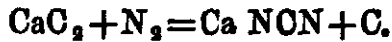
Difficulty is often experienced in opening the tapping hole on account of the high melting point of carbide. In any case, it is necessary to employ an excess of lime in the charge to lower the melting point. Consequently, the product gives a smaller yield of acetylene than the pure product. A further disadvantage with this form of furnace is the accumulation of slag and impurities which cling to the sides and gradually fill up the furnace.

Furnaces now constructed are from 3,500—6,000 K. W. H. capacity and work with three phase alternating current of 25 cycles and with a power factor of 0.9. The consumption of energy per ton of carbide produced is from 4,000—4,250 K. W. H. for a large scale plant. Electrodes of good quality carbon or artificial graphite are generally used. With good quality coke electrodes, the electrode consumption is 33 per cent ~~less~~ than with anthracite. In the latter case, the consumption amounts to 0.02—0.03 ton per ton of carbide.

The raw materials necessary for 1 ton of carbide are the following:—Limestone 1·7 tons. Coal—0·2—0·3 tons for burning limestone, coke or anthracite—0·62 per cent.

A cost sheet for the production of calcium carbide is given in the appendix XIX.

Calcium cyanamide is prepared by the passage of nitrogen over powdered calcium carbide at a temperature between 900°—1200°C.



The discovery of the fertilizing value of this product led to its manufacture on a large scale and in this connection calcium carbide has found its largest application.

The reaction is effected by passing pure nitrogen, under a slight pressure, into a furnace containing powdered calcium carbide at 900°—1200°C. The preliminary heating is effected by internal electric heating and the reaction being exothermic, no further heating is necessary when nitrogen is passed in. Use is made of the addition of certain reagents, like calcium chloride, flourspar, to facilitate the absorption of nitrogen at a lower temperature. The furnaces, now usually employed, work continuously and have a capacity of 15—18 tons of finished product. Time of operation 30—40 hours.

The product is in the form of a solid mass consisting of 63 per cent calcium cyanamide, 2 per cent calcium carbide, 13 per cent lime, 1 per cent calcium sulphate, 11 per cent carbon and smaller quantities of other impurities. The product after cooling is pulverised in an atmosphere of nitrogen to a fineness of 200 mesh. It is then treated with sufficient water to decompose carbide and hydrate the lime and the remaining cyanamide is conveyed to autoclaves for ammonia production.

With this process of manufacture, giving a product of 19·5 per cent nitrogen, the quantity of carbide required for 1 metric ton of nitrogen fixed is about 3·62 metric tons and the power requirement is 8100 K. W. H.

Ferro-alloys.—The growth of ferro-alloy industry is contemporaneous with that of steel but considerable advances have been made in recent years by the application of electric furnace to this branch of industry. Ferro-alloys were formerly prepared in the blast furnace, crucible furnace and to a smaller extent in open-hearth furnace. The limitations imposed in,

these furnaces are that sufficiently high temperatures are not attainable and large quantities of carbon used in the charge do not permit of low carbon alloys to be prepared.

The preparation of ferro-alloys in the electric furnace is free from these drawbacks and no special type of furnace is necessary for the purpose. The temperatures necessary for the manufacture of these alloys vary between 1200°—1900°C.

Ferro-silicon is manufactured in electric furnace from iron ores of high silica content or after admixture with a silicious mineral or by smelting a strongly acid slag from Bessemer or Siemens—Martin furnace. Furnaces of the resistance type are generally used for this purpose. These are lined with fire bricks, sometimes lined with a carbon composition and the exterior of the furnace is usually braced with iron stays. The voltage ranges from 40—75 and the current from 10,000—15,000 amperes. To ensure continuity of working, several electrodes are placed in parallel any one of which may be renewed without stopping the furnace.

Originally the charge was composed of a mixture of (1) iron pyrites or other iron ores, (2) sand or quartzite, (3) carbon in the form of coal or coke with lime as a flux. Owing to the presence of impurities, sulphur and phosphorous, scrap-iron or steel shavings are preferred to iron ore.

Ferro-manganese.—The mineral generally used for the manufacture of ferro-manganese is pyrolusite which, as stated in Chapter II, occurs in Bihar. The difficulties to be guarded against in the electro-thermal production of ferro-manganese are the volatilisation of the metal at high temperatures and its combination with carbon. Generally the alloy is protected from electrode contamination by maintaining a layer of slag on the surface.

Ferro-chromium.—A standard grade alloy, with 6—8 per cent carbon and 60—70 per cent chromium, is generally prepared by smelting a mixture of chromite and carbon in electric furnace, the average power expenditure being 7,000—10,000 K. W. H. for one ton of alloy of the above composition.

Ferro-titanium.—In the electric furnace, the alloy is manufactured with 15·18 per cent titanium and 6 per cent carbon, the ore used being titaniferous iron ore which occurs in Bihar in many places.

Ferro-Vanadium.—Iron ores containing workable quantities of vanadium oxide are found near Chaibassa. In the manufacture of ferro-vanadium, vanadium oxide or vanadate of iron is reduced by smelting with silicon or high grade ferro silicon together with iron, lime and flourspar. An alloy with 33 per cent vanadium is used for steel manufacture.

Carborundum is the name adopted for crystalline silicon carbide manufactured in electric furnace. With smaller units, the consumption of power is excessive, 17.6 K. W. H. for one kilogram of silicon carbide. In a certain experiment with larger units of 746 K. W. H. or 1,000 H. P., a production of 3,150 Kg. of carborundum in 36 hours was obtained, which corresponds to a power expenditure of 8.5 K. W. H. per kilogram.

The charge is made up of the following :—

Sand	..	..	..	52.2 per cent.
Coke	..	..	..	35.4 "
Salt	..	..	..	1.8 "
Saw dust	..	..	..	10.6 "

Saw dust is added to confer porosity and enable the escape of gases while the salt facilitates the removal of iron and alumina as volatile chlorides. The raw materials should be as pure as possible and ground to a fine state of division. The carbon used is in the form of anthracite, petroleum coke or the best furnace coke with less than 10 per cent ash.

During the progress of heating, the resistance of the furnace falls considerably and a regulation of voltage is necessary. Each furnace consumes about 800 K. W. H. with a maximum current of 10,000 amp. and produces about 8,000 Kg. of crystalline carborundum. The transformers receive the primary current at 2,200 volts and 25 cycles and are provided with regulators which vary the secondary voltage from 200—75 volts. It has been calculated that 42 per cent of the electrical energy is consumed in raising the materials to the temperature of reaction and 34.5 per cent in the endothermic chemical reaction, giving a thermal efficiency of 76.5 per cent. 23.5 per cent represents the loss due to radiation and other causes.

Alundum, or artificial corundum, is extensively used as an abrasive to replace natural corundum. The process is to fuse alumina in an electric furnace, allowing the melt to cool slowly. The material is then ground and moulded to form grinding wheels.

The furnace crucible consists of an iron shell, fitting into a base ring which is mounted on the hearth or base. The electrodes, two in number, are suspended from above and are fixed. The base of the furnace can be raised or lowered, according to the position of the molten charge. The operation of the furnace consists in first raising the base plate until contact is made with the electrodes and an arc is formed. Alumina is then fed into the furnace and the base gradually lowered as fusion proceeds until the cylindrical case is filled, when the furnace content is removed from the electrodes. The crucible is 4 feet in diameter and 5 feet high and gives an ingot weighing 2.5 tons.

Graphite.—The pioneering work in this line was conducted by Moissan and the present methods for the manufacture of artificial graphite are based on his researches. Three methods of preparation were discussed by Moissan :—

- (1) Heating carbon in electric furnace.
- (2) By separating from solution in metals on cooling.
- (3) By dissolving carbon in molten iron and then throwing out as graphite by the addition of silicon. Of these, only the first is employed in industrial practice at present.

In an exhaustive investigation by Acheson, it was found that the presence of oxides of silicon, aluminium, iron, calcium and magnesium played a very important part in the process and indicated that reaction took place through the intermediate formation of carbides of these elements.

For the preparation of bulk graphite, the furnace, of 800 K. W. H. capacity, is 9 metres long and 50 × 35 cm. in cross section. A core of granulated coke or carbon plates extends along the furnace, makes contact with the end electrodes and is surrounded by the charge of anthracite coal with 5 per cent ash. The walls of the furnace are constructed of stones lined with carborandum to protect them from fusion. The charge is covered with a layer of sand and coke to prevent oxidation. The resistance of the furnace is high at the outset and as the heating and graphitisation proceed, falls gradually. A quantity of carbon monoxide is generated which burns with a flame coloured yellow by volatile impurities and afterwards with a blue flame. At a later stage, the flames diminish and again become yellow, indicating the decomposition of carbides and volatilisation of silicon.

Moulded articles, such as electrodes, crucibles, dynamo brushes, etc., are prepared by taking finely divided carbon, mixing with suitable oxides and a binding material such as tar or sugar molasses. After incorporating to form a thick paste, the mixture is compressed into a mould of the desired form and then forced from the open end by hydraulic pressure. The articles are then heated to a moderate temperature which renders them compact and are arranged in rows on the hearth of the electric furnace described in the previous paragraph. On the bed of the furnace, a layer of granulated coke is spread and on this the electrodes are arranged transversely to the horizontal axis of the furnace. The space between the layers of electrodes is $\frac{1}{2}$ th of the breadth of each electrode and is filled with granulated coke.

At the beginning of the heating the resistance of the furnace is high. With a 1,000 H. P. unit a voltage of 200 is applied and a current of 14,000 amperes is passed. With the progress of the heating, the resistance falls rapidly at first and later on slowly. When it finally remains constant it is indicated that the transformation is complete. At this stage the current passed is about 9,000 amperes at 80 volts. Duration of run 12—24 hours.

Units of 1,000 H. P. in a run of twenty to twenty-four hours gives 6 tons of bulk graphite from anthracite; with formed articles, the yield is 3—3½ tons. 82·5 per cent of the energy supplied is consumed in raising the charge to the temperature of reaction and 17·5 per cent radiated during the run.

Electrolytic processes with fused electrolytes.—Up till now all the industries which have been discussed may be classified under the name of electro-thermal industries because the electric current is employed for raising the temperature of the materials to a point when chemical reaction, if any, sets in. The production of alkali, alkaline earth metals and aluminium, is brought about by the electrolytic decomposition of their compounds in the fused state. Of these, the production of aluminium is very important as India is importing about 3,000 tons of this metal every year, although there are suitable deposits of bauxite available and electric power may be obtained very shortly at a very low price. But as the proposal of starting an aluminium factory which will be able to supply the entire requirement of this metal, is well advanced, it is not intended to go fully into this question in this report.

Indian bauxites on account of their low silica content are very suitable for the production of aluminium, as in the preliminary process of purification of bauxite by Bayer's process, about 2.5 parts of the alumina are lost for every one part of silica present in the ore. From actual experiments conducted at Calcutta, it has been demonstrated that pure alumina, suitable for electrolytic process, may be manufactured at a price not exceeding Rs. 90 per ton. The only serious difficulty in this enterprise is that no deposits of cryolite are known to exist in India but in this case, India is at an equal disadvantage with every other aluminium producing country of the world, because the only workable deposit of cryolite is in Greenland. It is true that attempts have been made by various parties to prepare cryolite synthetically, starting from flourspar. It has been reported that a good deposit of flourspar exists in Alwar State and serious attempts should be made to utilise this for the manufacture of synthetic cryolite. Suitable petroleum coke for the manufacture of electrodes may be obtained from Messrs. Assam Oil Company and Burmah Oil Company.

Turning now to the question of electric energy, it is almost certain that with coal at Rs. 2 per ton or less, no serious apprehension should exist about the supply of electric energy at a price suitable for aluminium manufacture.

The types of machineries and furnaces for the metallurgy of aluminium are well known and the various stages of the process have been fully worked out at Calcutta. According to the most recent reports available, the current efficiency in aluminium metallurgy is 75—85 per cent and the average output is 0.4—0.5 tons per K. W. Y. or 8760 K. W. H. or about 17,520 K. W. H. for 1 ton of aluminium. The net anode consumption amounts to 0.75 ton per ton of aluminium manufactured.

At present the consumption of electro-metallurgical products, described above, is not very great. But with cheap electric power, the manufacture of these commodities could be taken up as soon as their requirements in the country are sufficient to justify it.

APPENDIX XIX.

Production cost of calcium carbide per ton.

	Rs.	a.	p.
Lime 950 Kg. at Rs. 10 per ton ..	10	0	0
Anthracite 620 Kg. at Rs. 20 per ton ..	8	5	0
Electrodes 25 Kg. at Rs. 220 per ton ..	4	0	0
Repairs	3	4	0
Labour and supervision ..	14	0	0
Depreciation at 8 per cent ..	3	6	0
Interest at 5 per cent ..	2	1	0
	<hr/>		
	45	0	0
Power 0.5 K. W. Y. at Rs. 50 per K. W. Y. ..	23	0	0
Packing	10	0	0
	<hr/>		
	78	0	0
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CHAPTER XX.

COTTAGE INDUSTRIES.

We have been asked to deal with such cottage industries as come within the scope of the subjects dealt with by us in this report.

In the first place we should like to explain the meaning which we attach to the expression "cottage industries". S. C. Mitter in his book "A Recovery Plan for Bengal" defines cottage industry as follows :—

"An industry which is carried on by the worker in his own house and mostly with the help of the members of the family".

We accept this definition. We note that it is of the essence of a cottage industry that no large capital or equipment is necessary. Now what is small capital and small equipment in one country may be large capital and large equipment in another. The result is that what would be regarded as a cottage industry in one country would be regarded as a small-scale industry in another. This difference in outlook which arises from the relative value of things has to be borne in mind in making a comparison between the cottage industry of Bihar with that of certain industrially advanced countries.

The usefulness of cottage industries to an agricultural province like Bihar cannot be over-emphasised. This province is rich in natural resources but the pressure of population on the soil is immense. The density of population in some parts of the province is as high as 642 per square mile. The vast agricultural population is unoccupied for the best part of the year. As soon as the sowing and harvesting season is over the villager has no occupation except gossip, quarrel and litigation. His placid contentment has become a bye-word, his penurious existence a habit second to his nature. He is perpetually in debt which he tries to clear off by contracting more debt or by starvation instead of by finding an additional source of income. If cottage industries of the province could be made attractive to him he would be saved from the evil of laziness at least and from mischief which is never wanting "for idle hands to do". This in itself would be of the greatest value educationally and culturally even though the cottage industry may be proved by expert examination to be "uneconomical".

From the above it will be clear that apart from the question of establishing cottage industries an essential item in the programme should be social and educational propaganda for banishing idleness. As long as one member of a large family continues to consider it his social duty to feed a large number of adults in the family who do not consider it a shameful thing to eat their bread without the sweat of their brow but think it below their dignity to engage in manual labour, so long will poverty continue to dog our foot-steps and to render the establishment of cottage industries more difficult than it would otherwise be.

While we stress the need for the encouragement of cottage industries and of social and educational propaganda in Bihar, we regret to note that considering the backwardness of the heavy chemical industry in India there is very little the chemical industry can contribute at present to the solution of the problem. The manufacture of sulphuric acid, caustic soda, glass, wood pulp, modern plastics, etc., do not lend themselves to treatment on cottage lines. On the other hand their establishment on a large scale is essential to the success of many cottage industries. The encouragement of these basic major industries is therefore one way to encourage small-scale and cottage industries.

That without the establishment of large-scale basic industries cottage industries even if established cannot be truly indigenous will be easily seen from the following costing account of some of the cottage products supplied to us by the Chemical Adviser to the Director of Industries, Bihar :—

Shaving Soap.

Cost of foreign materials	..	..	62 per cent.
„ „ Indian	„	„	38 per cent.

Shampoo.

Cost of foreign materials	..	..	42 per cent.
„ „ Indian	„	„	58 per cent.

Hair oils.

Cost of foreign materials	..	..	56 per cent.
„ „ Indian	„	„	44 per cent.

Face cream.

Cost of foreign materials	..	..	60 per cent.
„ „ Indian	„	„	40 per cent.

Tooth Powder.

Cost of foreign materials	..	..	14 per cent.
„ „ Indian	„	..	86 per cent.

Boot cream.

Cost of foreign materials	..	...	68 per cent.
„ „ Indian	„	..	32 per cent.

Inks.

Cost of foreign materials	..	..	66 per cent.
„ „ Indian	„	..	33 per cent.

It will appear from the above that in the manufacture of boot cream, for instance, as much as 68 per cent of the cost is that of imported goods manufactured on a large scale in up-to-date factories. Face creams, hair oils, shaving soap, inks etc., all show the same tendency. Unless the manufacture of bottles, containers, card-boards, fancy labels, fancy wrapping materials, not to speak of such things as alkalies, acids, dyes, waxes, synthetic perfumes, are started in India the cottage industries based on them will not be of much economic value.

As we have remarked before, many of the chemical industries, although of help in starting other industries, are themselves unsuitable for cottage scale production. There are a few industries, however, which due to certain natural advantages are very suitable for this purpose. These industries were carefully considered by the Bihar Unemployment Committee whose recommendation on this point we quote below :—

“ There is scope for the manufacture on a cottage or small scale of selected chemical products like soap, hair oil, etc., of which there is a local demand and for which most of the raw materials are available in Bihar. Manufacture of washing soap, in particular, has distinct possibilities. Under the present arrangement the Industrial Chemistry Section attached to the Science College trains a few educated young men every year in the manufacture of soap, besides giving advice to those who wish to prepare other chemical products. As a result, a number of small factories manufacturing mainly washing soap have sprung up all over the province, and they are reported to be doing satisfactory business. The Benares Hindu University has also introduced a section for teaching the manufacture of soap, oils, face cream, perfumery, disinfectants, boot polish, heel balls, sealing wax, cork tops, carbon paper, etc., with a fair amount of success. The Bekar Bandhab Samity of Bengal has also taken up the manufacture of

some of these products on cottage lines by unemployed young men, and their local representative stated to us that the sale of these goods on a commission basis was providing a small income to some educated Bengali youths who had no better occupation. While there is a fair prospect of some of these industries being developed in this province and providing subsidiary or whole-time occupation for some of our educated young men, we consider that it is necessary to proceed cautiously in view of the difficulties that they may have to face in the matter of marketing. There is a danger to health in using impure chemical products, and the consumer will naturally be suspicious of using articles produced by the small manufacturer. Mr. Hussain suggested the formation of a central institute for controlling the manufacture and marketing of these articles, but we are of the opinion that such a step would be premature. It is necessary to be sure of the demand before starting an organization of this nature. It would be better to encourage individual students trained in this line to begin on a small scale in the larger towns of the province. We recommend the expansion of the Industrial Chemistry Section under the Department of Industries for training boys in the manufacture of soap and other selected chemical products which have a ready market. To meet the objection that people without some scientific knowledge are not expected to be able to ensure the purity of articles manufactured, the standard of admission to these classes should be raised, if suitably qualified candidates apply in adequate numbers. We consider that the present arrangement, by which the Industrial Chemistry Department forms part of the Science College is of great advantage to all concerned. It helps to give an industrial bias to the students of the Science College and induces the professors and research workers of the college to direct their attention to the solution of industrial problems and to the application of science to the more practical problems of life. The Department of Industries can make use of the facilities provided at the Science College for obtaining scientific advice on industrial matters. The small manufacturers also benefit as they can obtain scientific advice for the improvement of their processes, and can have their products tested. We recommend that this association of the Science College with the Department of Industries should be maintained and developed. Chemistry of oils fats and sugar should continue to be taught at the Science College, for which a proper staff should be appointed, and the college should also, if possible, provide necessary accommodation for the expansion of the classes in small chemical industries."

We agree entirely with the above recommendations of the Unemployment Committee. We understand that Government have already taken steps to give effect to the above recommendation regarding the teaching of soap making and toilet preparation at the Science College and we think that the result of these experiments should be carefully watched before any further steps are taken in that direction.

There are a number of other industries not strictly chemical which are either already well established but in need of help or are suitable for establishment. These are food canning, jam making, syrups, aerated water manufacture, oil pressing, *dahi*, *ghee*, butter and cheese making, dyeing, calico printing, dry cleaning, baking, sweets making, condiment manufacture, indigenous perfumes manufacture, etc. Most of these are farm industries and most suitable for Bihar. The difficulties in their way are (1) non-establishment of the basic large-scale industries in India, (2) want of knowledge and technical advice, (3) want of marketing control which leads to the widespread practice of adulteration and (4) lack of co-operation amongst the workers which produces such evils as the middleman and *mahajan*. It is not easy for us to suggest remedies for these evils but we note that Industries Department is tackling these problems in various ways and if these efforts are continued improvement is sure to result. We would also recommend marketing control to check the evil of adulteration. Perhaps this could be done by co-operative marketing and standardization of the products which could then be sold under the guarantee of a Marketing Board. Financial assistance on co-operative lines might obviate the *mahajan* nuisance. A central testing laboratory would be very helpful in standardization and control of the quality of products and thus inspiring public confidence in the articles marketed.

Recommendations.

(1) Educational and social propaganda in favour of individual responsibility for one's own well-being and for the dignity of labour, is an essential part in the programme for the advancement of cottage industries in this province.

(2) Certain basic chemical industries should be started to help cottage industries

(3) The recommendation of the Unemployment Committee regarding chemical industries should be given effect to.

(4) There should be some sort of marketing control to check adulteration, keep up the quality of products and lay down standards and specifications.

NOTE BY MR. C. K. JAIN, M.L.A.

I owe an apology to the Government for not being able to attend the meetings of the Committee due to unavoidable circumstances.

I have carefully gone through the various chapters of the draft report and, as asked by Mr. A. S. Khan, am submitting my memorandum on the same. The members are quite frank to admit that the figures are merely illustrative and I also would like to emphasise that the report has been prepared with a view to disseminate information about chemical industries rather than to form a basis for industrial enterprises. Any capitalist wishing to take up the industries recommended should first obtain thorough and comprehensive details from experts.

Now that the electrification of Bihar has been decided upon, the omission of the Committee to deal with some of the important electro-chemical industries cannot go unnoticed*. Bihar can have monopoly in the manufacture of calcium carbide, ferro-chrome and ferro-manganese the raw materials being all available near the coal-fields in Bihar. The Committee has done well to recommend the establishment of ammonia industry. I, personally, have been advocating the establishment of this industry in the province since I am in the Assembly; but this can only be safely done as a part and parcel of the electrification scheme whether this be undertaken directly by the Government or handed over to any limited concern. The process most suited to Indian condition is the one in which hydrogen is generated by electrolysis of water and as the consumption of current in this process is very considerable a permanent co-operation and possibly united management of the two industries is desirable. A constant supply of 6,000 K. W., which would be necessary for 20,000 tons of ammonia per annum, will be the greatest asset possible for the power generation scheme. Ammonia industry is not an asset only in the sense that we can produce and distribute fertilisers to the cultivators at a cheap rate, but forms the basis of the explosive industry so necessary for the defence of an independent country. Personally, I would never recommend to the Government to resort to borrowing for financing industrial schemes. For the bigger industries the utmost they can be expected to do is to guarantee a dividend and have direct control of the limited concern by appointing their nominees as Managing Director or Secretary.

*A chapter has since been included on this subject in the report as chapter XIX
—A. S. K.

The utilisation of the national waste of various products in the shape of gases in the coal industry is very necessary. The only possible means is to experiment on the plant designed by Dr. H. K. Sen and the Government should contribute at least half of the amount necessary for putting up a 60 ton a day retort to a reliable firm intending to carry on the experiment. It is only after the success of such small and cheaper retorts that the industry by itself will adopt this method and the province would be able to conserve all these wastes.

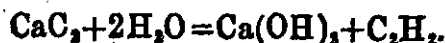
Glass Industry is another industry that can thrive on the soils of Bihar and Dhanbad and its suburbs have ideal sites for the enterprise.

Before concluding, I would like to give below some information about carbide and the allied industries.

Calcium Carbide.—It is made by the interaction of lime and carbon at the high temperature of the electric arc :—



The commercial calcium carbide is dark coloured, but in the pure state it is colourless and transparent. When calcium carbide is treated with water, acetylene is formed :



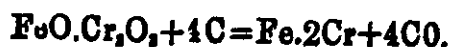
The acetylene is used for illumination, for cutting and welding by oxyacetylene torches and as a starting point for the synthesis of organic compounds such as acetic acid, acetone, and methanol. Calcium carbide is also used for the fixation of atmospheric nitrogen as cyanamide.

The materials used in the manufacture of calcium carbide are carbon, in the form of coke, coal, or charcoal, and lime and to which may be added carbon from the electrodes.

Data on operation of carbide furnaces and their yields for European practice are as follows :—

For the production of 1,000 lbs. of 85 per cent carbide there are required in the aggregate 980 lbs. of lime, 650 lbs. of coke and 20 lbs. of electrode. Furnaces are built in sizes up to 25,000 KVA and over, producing about 17.5 to 20 lbs. lime carbide per K. W. day.

Ferro-chrome.—Ferro-chromium or as it is known by steelmen, ferro-chrome, is made by reducing chromite with carbon in an electric furnace, according to the reaction.



Furnaces are of three phase design with capacities of 2,000 to 5,000 K. W. operating on 90 to 120 volts.

Ferro-chrome is used for the production of chromium steels noted for their hardness, but it is not used very much by itself in alloy steels. Together with nickel and vanadium it is extensively used for armourplate, projectiles, gears and high speed tools and auto parts. It is widely employed in the production of heat-resisting chromium alloys and corrosion-resistant alloys.

Ferro-manganese is employed as a deoxidiser and as an alloying agent in the production of special steels. Steels containing 12 to 14 per cent manganese are very hard and tough. Manganese is also used to the extent of 1 to 2 per cent in engineering steels. The raw materials are manganese ores containing 45 to 50 per cent manganese, carbonaceous reducing agents, iron or iron ore, and in some cases a slag-forming agent.

The furnaces are of the arc resistance type, three phase, with capacities up to 9,000 K.W. using 90 to 110 volts.

N. B.—All these three industries are allied and the furnaces used are, more or less, the same with some modifications. The import of calcium carbide in India is 60,000 cwt. valued at seven lakhs of rupees, out of which the share of Bengal is 35 to 36 thousand cwt. ; these being mostly consumed in the coal areas. The manufacture of ferro-chrome and ferro-manganese will lead to the manufacture of high class steels which are all being imported at present.

NOTE BY DR. V. S. DUBEY, M. SC., PH. D.

While agreeing with all the recommendations of the Committee I feel that the report does not discuss in sufficient detail the practicability of the schemes and the procedure to be adopted for bringing them into practice. A report is of not much use unless it has got prospect of being immediately adopted for practical working. It is with this end in view that this supplementary note has been written.

The first point is that instead of scattering its energy on all industries the Government should take up two or three most important industries and concentrate all its energy to make them a success. When within a period of four or five years these industries are firmly established the Government should take up two or three other industries. Till now the impression in the public mind has been that the Government cannot run an industry and that it should be left to private enterprise. The reason for this belief in the public mind is that in the past majority of the schemes sponsored by the Government have been failures. In order to remove this impression it is absolutely essential that any industrial scheme recommended by the Government should be on such solid foundation that there may be not the least chance of its failure and no factor should remain unstudied. It is preferable to wait for some years for industrialisation and make a thorough study than to start in haste without proper study which may prove to be a failure in the end.

In the report we have recommended two major industries of all-India importance to be taken up by the Government :— (1) Synthetic Fertilisers and (2) Low Temperature Carbonisation of coal. These two industries can only be started in Bihar. The manufacture of $1\frac{1}{2}$ lakhs tons of synthetic fertilisers, distributed among the agriculturists, will increase the agricultural production by more than ten crores of rupees. The second scheme that of Low Temperature Carbonisation of coal will stop a great national waste in the form of gases which are being wasted daily when coal is carbonised in the open for making soft coal. Besides this, a large amount of liquid hydrocarbons will be produced which are very important to the nation as a source of motor and aeroplane fuel, explosives, and as raw materials for manufacturing aniline dyes, etc. The possibility of the fertiliser industry has been studied by the writer up to the minutest details and from the study it is clear that these fertilisers can be manufactured at about one-third the cost at

which they are imported at present. Once this industry is established it has got a tremendous chance of expansion in the agricultural country like India. The writer feels that these two industries are more than enough to occupy the whole attention of the Government for the next five years. Among smaller industries of provincial nature glass is the most important one for Bihar, as here the manufacturing cost will be the least and if the Japanese competition is to be faced and Japanese goods are to be displaced by the goods manufactured in India, it is essential to produce these goods at the lowest cost which can only be done in Bihar. This industry, though not of all-India importance, is still of great importance to the country as it is by the cheaper goods manufactured in this province that Japanese import can be stopped.

After recommending these three industries the writer also thinks it necessary to examine the financial implications of the recommendations, the organisation to be set up to carry out these recommendations and to supervise their working.

No doubt the schemes submitted in the report for these industries have been studied in detail, still the writer feels that before being taken up by the Government they must be examined by a committee of experts who have actually set up such plants and are working them.

For working out these details three expert committees should be appointed—one for Synthetic Fertiliser industries, the second for Low Temperature Carbonisation and the third for Glass Industry. In the case of the first two committees it will be essential to have foreign experts, as these industries have not been started in India till now and so there is no experience available in the country about them. The committee for Low Temperature Carbonisation will also have to study the feasibility of starting this industry at some such centre so that the interest of present manufacturers may not suffer and it will also have to study the question of legislation necessary to supplement the present system making soft coke in individual collieries by the system of having central plants for this carbonisation. These committees should be composed of foreign experts and some Indians having local experience about raw materials and markets, etc. The local members will be able to supply all the local data, while the foreign experts will work on that data, added by their own observations. The committee should submit its report in such detail that on the basis of that report the Government or any industrialist may be able to start the industry immediately. The writer does

not advise the Government to take up these big schemes costing crores without the fullest scrutiny by some of the best experts of the world. Though the process may be costly, but it is the only way to start on a solid foundation.

In the case of the Glass Industry as it already exists in India it will be possible to find all the experts in the country itself. The preliminary expenses for all this detailed investigation may amount to about Rs. 50,000 as these experts will cost quite a lot even though they are called for a few months. It will be worth while to spend this money before taking up such responsibilities of investments of crores of rupees as capital. Convincing details have been given in the report to show that the industries have got the best chance for development, hence the money spent in these investigations will not be a waste.

After this stage the question arises to find capital for these industries. The writer feels that under the present conditions the Government has neither got time nor industrial experience to take up these industries itself by floating a loan. Such a procedure may prove to be disastrous in the end. On the other hand it will be difficult to attract enough private capital to start these industries without some kind of Government help or guarantee. Besides this, it is also not desirable to entrust these key industries to private capital without some kind of real control. The view of the writer is that if the Government after carrying out the detailed investigation at its own expense offers a dividend of about $3\frac{1}{2}$ to 4 per cent on the investment for a period of ten years or so, ample capital shall be coming forward. The condition for the guarantee of the dividend should be that the Government is to participate in the profits over a certain fixed percentage, such as 9 or 10 per cent, and will have some nominees on the Board of Directors. From the talk with several big capitalists the writer is sure that many industrialists will be coming forward to take up these industries on these terms. The total capital required for these three industries is about Rs. 160 lakhs, and the guaranteed dividend at 4 per cent will amount to about $6\frac{1}{2}$ lakhs. This much amount of money will have to be included in the budget. But the 99 per cent chances are that this money will not be required at all, because if the industry is properly investigated it is bound to yield more than 4 per cent of profits. So this $6\frac{1}{2}$ lakhs of rupees allotted in the budget will only be in name and will not be used up at all or at the most a very small fraction of it may be used in any particular time. On the other hand the chances are that the Government may

gain some revenue by this profit-sharing system. If the Government wants to be still more cautious and may not like to allot these 6½ lakhs out of its present revenue some kind of cess on the well-developed industries of the province like those of sugar, cement, coal, refractories, iron and steel and copper may be charged to provide this guaranteed dividend for starting new industries. When once the industries are started and found to work well this sum may be utilised for starting other industries. Thus within each five years it may be possible to start two or three basic industries on a solid foundation. Looking to the importance of these two industries to the nation this amount of 6½ lakhs, to be provided in the budget, is nothing especially when it is seen that there is little likelihood of its ever being used.

It will be difficult for the Government to take up the work and to keep watch over it without providing some kind of organisation of some technical experts. So it is essential that the Government should constitute a permanent board of technical advisers which may meet periodically and advise the Government on all technical matters about these industries. Besides this, it is also desirable that the work of execution of this plan should be entrusted to a paid Government officer with wide commercial experience, who may be either a Deputy Director of Industries or some other independent officer appointed for the purpose.

Besides this advisory board, it will also be essential to have an organisation for research on problems connected with these industries with well-equipped laboratories and competent staff. But such a scheme will prove to be very costly as it will require large amount of capital and recurring expenditure which probably the provincial revenues may not be able to pay. In the opinion of the writer it is possible to take the help of the existing institutions, which may agree to take up all this research work, if given some grant, for example, the Department of Glass Technology of the Benares Hindu University, which is also the headquarters of the Glass Technologist of the Government of the United Provinces. Half a lakh of rupees is being spent every year for research and the development of Glass Industry by the Government of the United Provinces. It will be more economical for the Bihar Government to give it some grant and to entrust all its research work to it than to create its own organisation for this industry. The same thing holds good for fuels, for which there is also a qualified staff and well-equipped laboratory for research work in the Hindu University, Benares.

In short, in order to give practical effect to the recommendations of the Chemical Industries Committee, the writer's recommendations are :—

(1) A sum of about Rs. 50,000 should be allotted in the budget to carry out a very thorough and detailed study of these above-mentioned three industries by the experts.

(2) Three committees—one for Synthetic Fertilisers, the second for Low Temperature Carbonisation of coal and the third for Glass Industry—should be appointed immediately to submit a very detailed report within a period of two or three months. The members of the first two committees should be selected from the best experts of the world in the line. For selecting the personnel of these technical committees the Government may consult such persons as in the Government's opinion may have made a thorough study of these industries.

(3) For carrying out the executive work of this industrial plan the Government should appoint a technical officer with wide technical and commercial experience. This officer may be either a Deputy Director of Industries or some other independent officer.

(4) If after the submission of the report of the expert committee it is found that these industries have got a very good chance in the province, the Government should allot about 6½ lakhs of rupees in the budget to guarantee a minimum dividend of 4 per cent on the investment of Rs. 160 lakhs and should work out in detail the conditions on which this guarantee is to be given. The writer is sure that the capital will be easily forthcoming on these terms.

(5) Every kind of facility should be given to the industry and if necessary legislation should be passed by which it will be made impossible for any foreign company to start this industry in the province ; and the co-operation of the other provinces should be sought to effect the marketing of the products of these industries.

(6) A permanent non-official technical board should be constituted to keep a critical watch over these industries and to advise the Government on all technical matters connected with these industries. It should periodically meet three or four times a year and submit the report to the Government about the progress.

(7) Some arrangement should be made for providing technical aid to solve all the problems in connection with these new industries and for the sake of economy it is better that for these major industries help be taken from the existing institutions in that line by giving them certain grants than to provide a separate organisation and staff for the research work. For the glass and the coal utilisation industries, the Benares Hindu University will be prepared to help the Government.

All these are practical suggestions and it should not be very difficult for the Government to give effect to these recommendations.

NOTE BY MR. A. S. KHAN.

Please see Chapters III and IV of the report.

1. I agree with my colleagues that it is very necessary that the present wasteful method of soft coke manufacture should be stopped; but I feel that before legislative action is taken Government should test the possibility of the process of Low Temperature Carbonisation recommended by the Committee by setting up a commercial scale experimental plant of at least 60 tons capacity per day. The cost of this plant according to Dr. H. K. Sen's experiments will be about Rs. 60,000. This cost could be met partly by Government and partly by voluntary contribution from the Soft Coke Cess Committee and from proprietors of coal mines. If the success of the process can be demonstrated on this scale there will be little reluctance on the part of colliery owners to instal this type of plant near their collieries and to give up the wasteful process of coke-making which they are using now. Any results obtained on a laboratory scale are not likely to create the necessary confidence in manufacturers of soft coke and should not be made the basis of legislation which will be unpopular with small colliery owners and will commit Government to large liabilities for the purchase of tar.

2. As regards nitrogen fixation I share the optimism of my colleagues regarding the prospects of this industry but lest the difficulties are lost sight of I make the following observations on this part of the report:—

In the case of nitrogen fixation the raw materials are really air and water which are available everywhere. Coal is important from the point of view of power production. This is very cheap in India. The next item is plant and machinery.

There is reason to emphasise that great care has to be exercised in its selection. The question of depreciation and the covering of risks is more difficult in this industry than in any other. To this must be added that of want of skilled staff with necessary experience in this line of work. That this subject is of vital importance will appear from the following well-authenticated incident. It is said that in 1919 when members of the British and French Committee attached to the Allied Control Commission visited Oppau where the Haber-Bosch process for nitrogen fixation was being worked successfully they were told by the German chemists that even if they could erect a plant identical with that at Oppau they

would still be unable to manufacture ammonia successfully for lack of the specially trained workers who were absolutely essential to successful operation. That this was not said in a spirit of boastfulness will be amply clear from the difficulty which England had to surmount before the nitrogen fixation industry was successfully established in that country. The plant at Billingham was put into successful operation after many failures and the expenditure of very large sums of money on investigation and research. The chemical control and the most efficient supervision of every operation, which are so necessary in all industries, are indispensable in this industry as the slightest want of skill or efficiency may lead to the utter ruin of the whole plant by a terrific explosion. Since the Haber-Bosch process regime, however, much progress has been made. Plants have been designed which are much simpler to operate and can be placed in charge of engineers without long experience of the process. Also smaller units are now operating than was formerly considered possible. It is said that the Haber process is not likely to be a commercial success with plant capacity much lower than 20,000 tons of nitrogen per annum whereas Casale plants of 5 tons of anhydrous ammonia per day are said to be working successfully in some parts of the world.

The great simplicity of the latest synthetic units has led to the installation of synthetic ammonia plants in most of the nitrogen consuming countries of the world and there is no reason therefore why ammonia synthesis should not succeed in India. But before it can do so very careful consideration of the problem is necessary. Perhaps the resources of Bihar alone will not be able to finance the entire cost of investigation and in my opinion this is a problem in which all the provinces should interest themselves. I accordingly suggest that the Bihar Government should invite the co-operation of other provincial Governments to finance the cost of preliminary investigation which in my opinion is most necessary in this case. This investigation is likely to cost a lot of money, but the importance of the problem is so great that it should not be too much for the combined resources of all the provinces of India to find the necessary funds.

One of the questions to be investigated by the committee, if appointed, should be whether a stand-by plant is essential. If it is, the cost of manufacturing ammonia will be very much higher than is given in the report.

SUMMARY OF RECOMMENDATIONS.

CHAPTER III.

Coal—

- (1) The present wasteful method of soft coke manufacture should be prohibited by legislation and the manufacturers should be asked to instal Low Temperature Carbonisation plants for the purpose. The Government of Bihar should supply technical advice if necessary.
- (2) Tar obtained in the Low Temperature Carbonisation process should be purchased by the Government at a fixed price and utilised for the manufacture of road tar and other products.
- (3) The possibility of establishing a State factory for Low Temperature Carbonisation, in conjunction with the Electrification Scheme, should be explored.

CHAPTER IV.

Manures—

- (1) *Nitrogen fixation.*—The establishment of a nitrogen fixation plant for the manufacture of cheap fertilizer is desirable.
- (2) The Committee recommend that the question of the selection of suitable plants, etc., should be gone into by a special committee of experts appointed for the purpose.
- (3) The suitability of nitro-chalk for Bihar soil should be investigated by field experiments, conducted by the Agriculture Department.

CHAPTER V.

Phosphatic manures.—As a large quantity of bone is available in the province, the committee recommend that the manufacture of superphosphate should be encouraged.

CHAPTER VI.

Heavy chemicals and Sulphuric acid.—The Committee are of opinion that to initiate a heavy chemical industry the manufacture of sulphuric acid, linked up with the production of synthetic fertilisers, is essential.

CHAPTER VII.

Alkali industry.—This industry is feasible in Bihar as a provincial industry only. As two or three firms in different parts of India are contemplating to start alkali factories and a 3-ton plant has already been set up at Dehri-on-Sone the Committee are of opinion that any special efforts on the part of the Government of Bihar in this direction are not necessary. For future development the matter may be left to private enterprise, assisted by such aid which Government may be able to give under the State Aids to Industries Act.

CHAPTER VIII.

Glass ceramics and refractories.—These are important key industries. They are feasible in Bihar on a provincial scale for the present.

CHAPTER IX.

Paper, pulp and card-board.—As there is one factory already erected in Bihar the Committee consider that the existing factory should be encouraged in all possible ways so that a strong paper and pulp industry may be established in Bihar.

CHAPTER X.

Artificial silk and celluloid.—This industry is not feasible at present in this province.

CHAPTER XI.

Belting for machinery.—Two existing factories at Calcutta can supply nearly the whole of the demand of the country. In these circumstances, the establishment of a new factory is not recommended.

CHAPTER XII.

Oil-crushing.—The industry is already fairly well established in Bihar both as a small industry and as a cottage industry. Further expansion is desirable but real improvement is not expected in the near future. Marketing control to stop unbusiness-like methods and adulteration of products will be of some help in putting the industry on a more satisfactory basis.

Soap industry.—Soap is a feasible industry in Bihar and, in the opinion of the Committee, should be encouraged. Its production as a cottage industry should be actively assisted by continuing to give training and technical advice as is being done at the Science College at present.

Tallow, stearine and glycreine.—Raw materials are not available at sufficiently cheap prices and as there is no local demand for the finished products considerable difficulty will be encountered in marketing them.

CHAPTER XIII.

Paint, varnish and lacquers.—The production is feasible in Bihar but as the total consumption of paints in Bihar is not known, the Committee is of opinion that for the present only a small factory capable of further expansion can be recommended for exploitation by private parties.

CHAPTER XIV.

Industrial solvents.—Unless the coal-tar industry and other allied industries for the manufacture of benzol, alcohol, acetone, acetic acid, higher alcohols, etc., are developed, there is little chance of this industry making any great progress in this province.

CHAPTER XV.

Lac industry.—The committee recommend that the industry should be aided by encouraging the establishment of a moulding industry based on shellac, with the assurance that Government requirements would be purchased exclusively from such factories if the goods come upto certain minimum standard. The manufacture of shellac moulding powders should also be encouraged as there are a number of moulding factories in India which can easily utilise this powder.

Synthetic resins.—Government should encourage research work in suitable laboratories on synthetic resins so that when the coal-tar industry and heavy chemical industry are sufficiently developed, the manufacture of synthetic plastics may be undertaken.

CHAPTER XVI.

Rubber industry.—As the raw materials are not available in the province and the large consuming centres are at a distance, any special attempt to establish this industry is not recommended.

Leather industry.—Hides and skins, as also tanning materials are available in the province. The manufacture of leather goods, in the opinion of the Committee, is quite feasible but competition from neighbouring provinces will be very keen. The manufacture of these goods on cottage industry scale deserves encouragement.

CHAPTER XVII.

Pharmaceuticals.—The establishment of a pharmaceutical works will be a profitable industry in the province. It may be left to private enterprise.

CHAPTER XVIII.

Match industry.—In view of the competition of Swedish combine and the failures of the Indian concerns in the past, the question requires to be very carefully considered before a new attempt is made to start this industry.

CHAPTER XIX.

Electro-Chemical Industries.—At present, the consumption of electro-metallurgical products except aluminium is not very great. But with cheap electrical power, the manufacture of these commodities could be taken up as soon as their requirements in the country are sufficient to justify it.

CHAPTER XX.

Cottage industries.—Cottage industries deserve encouragement not only for industrial reasons but also for cultural reasons. As regards chemical industries on cottage lines the Committee is of opinion that the best way to encourage this is to establish the basic large-scale chemical industries. The recommendations of the Unemployment Committee regarding chemical cottage industries should be implemented.

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