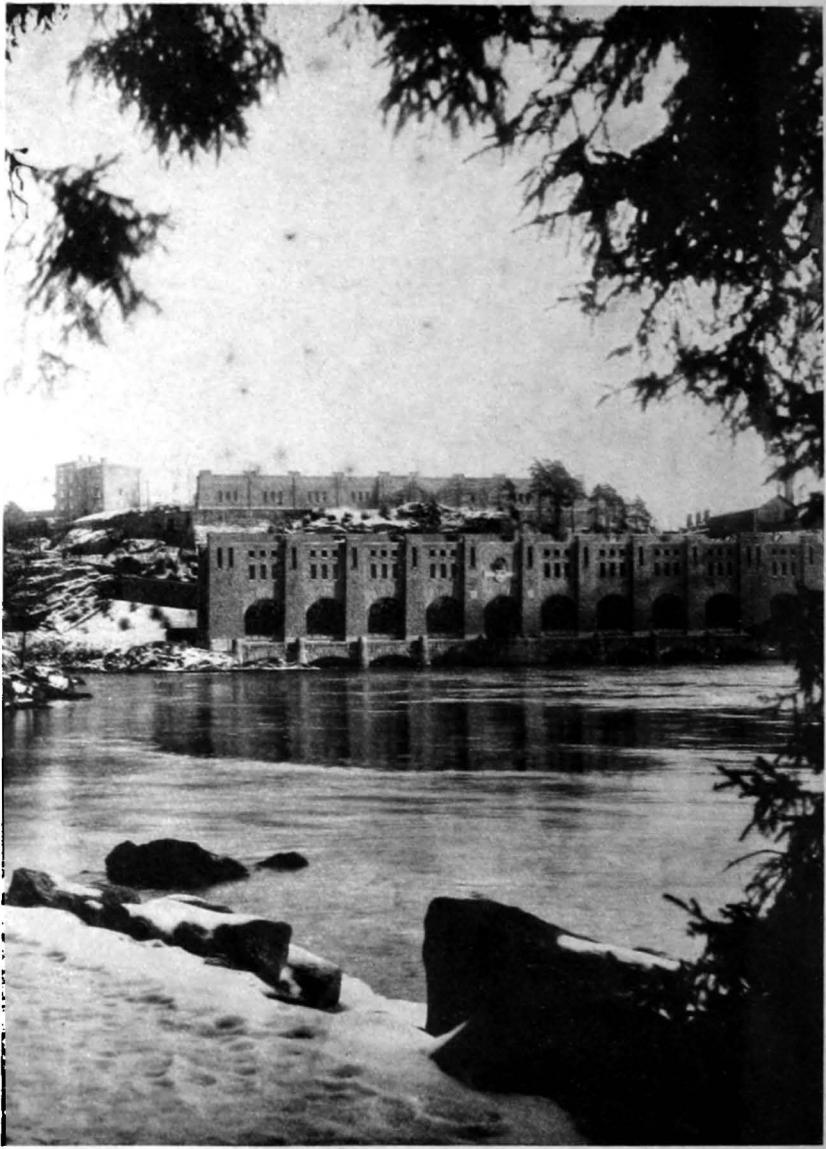




INDUSTRY IN SWEDEN



*The State-owned hydro-electric plant at Trollhättan
The largest supplier of electric energy to Swedish Industry*



INDUSTRY
IN
SWEDEN



PUBLISHED BY
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P R E F A C E

This book is published by the Federation of Swedish Industries to aid persons in English-speaking countries to obtain a more intimate knowledge of Swedish industry, its basic conditions, its organization and its products. It has no technical purpose and simply aims to give a general view of the different branches of industry and of their nature. The work was first published in Swedish in 1926, and the present publication is a translated and somewhat abbreviated version of the Swedish edition. The statistical data are those of the original edition.

Stockholm, September 1927.

V. G. LUNDAVIK,

Managing Director of The Federation of Swedish Industries.

CONTENTS

Part I

SWEDISH INDUSTRIES, THEIR FOUNDATIONS, CONDITIONS AND NATIONAL IMPORTANCE

	Page
Sweden's Natural Resources in Relation to Industry, by <i>Professor Gunnar Andersson</i>	3
Industry and Means of Livelihood, by <i>Professor Sven Brisman</i> .	41
Some Data on Modern Swedish Industry, by <i>Dr. Einar Huss</i> .	56
Swedish Industry in Relation to Research and Inventions, by <i>Kommerseråd Axel F. Enström</i>	68

Part II

THE BRANCHES OF SWEDISH INDUSTRY

The Mining and Metal Industries	77
Mining p. 77. — The Iron and Steel Industry p. 84. — The Metal Industry p. 100. — Iron, Steel and Metal Manufactures p. 102. — Machinery Industry and Engineering p. 115. — The Shipbuilding Industry p. 133. — The Electro-technical Industry p. 136. — The Manufacture of Instruments p. 142. — Gold, Silver and German Silver Wares p. 143.	
Mineral and Stone Industries	145
Coal-Mining p. 145. — The Peat Industry p. 146. — Quarrying and Stone-dressing p. 147. — The Cement Industry p. 151. — The Brick Industry p. 152. — The Chinaware Industry p. 155. — The Glass Industry p. 157.	
The Timber Industries	160
The Sawmill Industry p. 160. — Joinery, Furniture and other Wood-ware Industries p. 173.	
The Paper and Printing Industries	180
The Woodpulp Industry p. 180. — Paper Production p. 186. — The Printing and Stationery Industries, etc. p. 192.	

	Page
Foodstuffs Industries	196
Flour-mill Industry p. 196. — The Bakery Industry p. 198. — The Sygar Industry p. 199. — The Chocolate and Sweetmeat Industry p. 202. — The Margarine Industry p. 203. — Meat preserving, Tinned food, and other Foodstuffs Industries p. 205. — The Brewing Industry p. 207. — The Manufacture of Spirits and Yeast p. 209. — The Tobacco Industry p. 212.	
The Textile and Tailoring Industries	215
The Woollen and Worsted Industries p. 215. — The Cotton Industry p. 220. — The Linen and Jute Industries p. 224. — The Hosiery and Knitting Industries p. 227. — The Tape and Packthread Industries p. 229. — The Clothing and other Tailoring Industries p. 230.	
The Leather, Hair, and Rubber-goods Industries	235
The Tanning Industry p. 235. — The Boot and Shoe Industry p. 237. — The Fur and Skin Industry and the Brushmaking Industry p. 241. — The Rubber-goods Industry p. 243.	
The Match, Oil, Fertilizer, Explosives and other Chemical Industries	246
The Match Industry p. 247. — The Oil and Fat Industry p. 250. — The Fertilizer Industry p. 253. — The Production of Explosives p. 255. — Colour and Varnish, Destructive Distillation, Electro-chemical and other Industries p. 256.	

PART I

SWEDISH INDUSTRIES,
THEIR FOUNDATIONS, CONDITIONS
AND NATIONAL IMPORTANCE



SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY

by

GUNNAR ANDERSSON.

Owing to the comparatively calm and uniform course of her economic life Sweden affords an exceedingly instructive example of how a certain part of the world — if its population increases fast — may in less than a century develop from being primarily a self-sufficing unit into a full-fledged member of the comity of nations, largely dependent on other countries' products while supplying those countries with either its own surplus natural produce or such output of its people's industry as it can afford to spare.

When a work like the present is being compiled, the question arises, in this connection: What are the possibilities for Sweden from a purely objective point of view as compared with those for other countries? What can Sweden produce for the use of her own people and what has Sweden to offer to other countries in exchange for the numerous foreign products that she cannot do without?

The natural resources that any given region of the earth provides for the people who dwell and earn their livelihood within its borders vary very greatly owing to differences in climate, soil, rock-formation, and other natural factors, and the history of peoples has been shaped thereby to a far greater extent than their historians have in general been wont to take into account.

These natural resources, whether small or great, admit of being classed in certain main groups. First there are those derived from

the vegetable and animal kingdoms, which in the earlier stages of human development were everywhere by far the most important. With man's growing mastery over nature, however, the products obtained direct from the soil and the rocks have become of increasing importance in most parts of the world. . On the basis of the mineral yield of the earth the industrial activity that is so highly developed in our days took its rise, passing on in course of time to the manufacturing processes for transforming animal and vegetable products into useful commodities that have almost wholly superseded the old-fashioned home-industry and craftsmanship methods.

The birth of industry in the modern sense was contemporaneous with the discovery of how to generate mechanical energy on a large scale. Man's muscular strength is, of course, quite unequal to the task of producing, manufacturing and transporting goods on the large scale requisite to meet the present-day vast demand for a variety of products. The bulk of the work must be performed by energy generated out of inorganic nature and that is why the problem of energy-production is of such great importance as regards the economic and industrial progress of countries and peoples. Good opportunities for the generation of energy on a large scale at a low rate of expenditure will greatly enhance the value of any natural resources that may exist in a country while the lack of such opportunities often renders even very extensive resources of little or no avail. A reliable and correct estimate of the sources of energy possessed by any given country proves of incalculable value in our days for directing the course of the country's industrial development.

In the long run what determines the value of natural resources and decides whether they can be made use of or not is the degree of intelligence displayed by man in applying them to his needs. That is very specially the case in our own age, the age of industrialism.

SOURCES OF ENERGY AND GENERATION OF POWER.

While Sweden has been developing more and more into a manufacturing country the power requirements have gone on increasing both as regards mechanical energy, and heat or thermal energy. During the earlier phases of the industrial development the power required was

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

mainly produced from fuel of different kinds; but when the great inventions in electric power generation and transmission in the 'eighties and early 'nineties had placed the latent stores of energy in waterfalls and rapids at the disposal of man, Sweden at once became one of the pioneer countries for turning electricity generated by water power to account in industry.

The annual official industry statistics give tabular summaries of the amount of driving power (water and fuel) employed in industry. One such summary is reproduced below, and it gives an at any rate approximate indication of existing requirements. The figures are for 1923 and give the horse-power (HP).

Branches of Industry	Water Power			Fuel Power		
	Direct Drive	Electric Drive	Total	Direct Drive	Electric Drive	Total
	HP	HP	HP	HP	HP	HP
Mining and metal industry	42,100	163,200	205,300	13,400	20,600	34,000
Mineral and stone industry	1,000	1,800	2,800	16,100	16,100	32,200
Timber industry	10,700	4,800	15,500	90,300	22,000	112,300
Paper and printing industries	103,200	143,300	246,500	11,600	62,000	73,600
Foodstuffs industries	29,400	2,400	31,800	26,900	11,800	38,700
Textile and tailoring ind.	6,700	23,500	30,200	3,100	8,800	11,900
Leather, hair and rubber goods industries	700	1,500	2,200	1,400	2,000	3,400
Chemico-technical industry .	400	22,000	22,400	2,700	8,900	11,600
Powergenerating, lighting and waterworks	500	746,200	746,700	6,000	215,600	221,600
Total	194,700	1,108,700	1,303,400	171,500	367,800	539,300

Thus the aggregate horse-power actually made use of amounts to 1,840,000, of which about 1,400,000 HP are used for industrial machines and apparatus, and the remainder for lighting, heating, and the working of railways and tramways.

Water Power. Sweden possesses a considerable amount of utilizable water power. The most reliable computations that have been made give from 4 to 5 million horse-power, continuously available, cor-

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

responding to somewhat more than 32 milliard kilowatt hours kWh. As probably only from 2.5 to 3 milliard kWh of this energy was being utilized in 1925, it is evident that there must still be a considerable latent quantity obtainable by the further harnessing of waterfalls, without making it necessary to resort to the more distant falls or to those which are specially difficult to turn to economic use.

That is true of the country as a whole, but not of the different sections. In the extreme north of the country there is a great superabundance of water power — Norrland has most likely no less than 75 % to 80 % of the total water power resources, whereas in Central Sweden nearly all the more valuable falls have already been converted into generators of power. That is in the main the case as regards the principal part of South Sweden too.

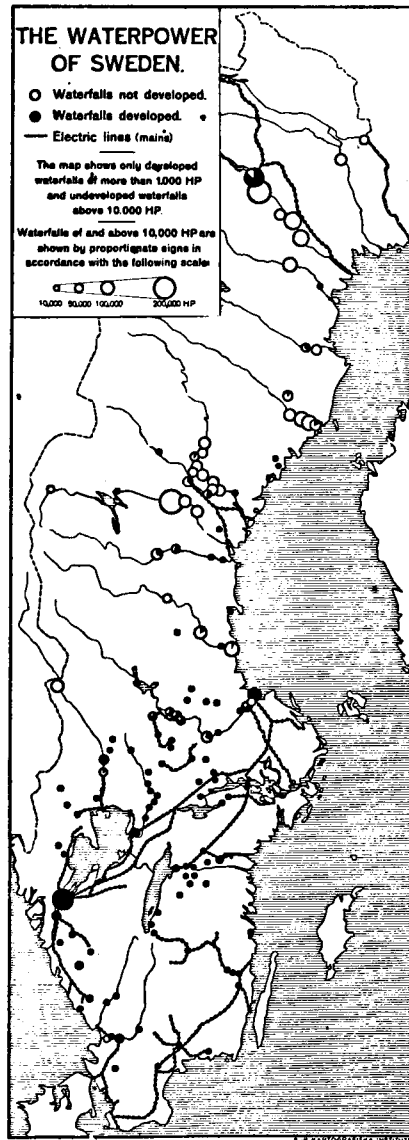
The unequal distribution of water power sources geographically has prompted efforts for the bringing about of an equalization by artificial means, so that every part of the country may command the supply of power that it requires, it being realized that for all industrial work in our days ample and cheap power has become an essential of the first order.

The first large plant for long distance transmission of electric energy in Sweden was erected in 1893. In that year the Grängesberg Company completed a power transmission line from Lake Hellsjön to Grängesberg having a length of 14 km and capable of transmitting 300 HP under 9,500 volts' pressure. During the next decades a large number of independent hydro-electric plants of various systems were erected both by industrial concerns and municipal and other bodies, but it was not until about 1906 to 1908 that the water power industry acquired real importance for Swedish economic life. In those years a number of plants commenced to deliver power to anyone and everyone who might desire to obtain it. Important inventions that were introduced in these years made it possible before the close of the following decade to transmit power over long distances by means of great trunk lines at high voltages and to deliver electric current to the consumers at a reasonable cost. At the present time the voltages on Swedish trunk lines range between 60,000 and 220,000 volts.

At about the same time the newly-created Royal Board of Waterfalls (Vattenfallsstyrelsen) under government administration commenced its operations by constructing a hydro-electric plant at Trollhättan, now

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

of 162,000 HP, and the largest in Sweden. The Gullspång Company built a power-plant in the Gullspång River (27,000 HP), the South Swedish Power Company four in the Lagan River, and the Hemsjö Company its plants in the Mörrum and Helge Rivers — the two latter companies now combined (about 70,000 HP) under the control of a few important towns in South Sweden. The State-owned hydro-electric works have developed rapidly: power-stations have been erected at Älvkarleby (75,000 HP) and Motala (12,000 HP), and also a stand-by steam-power electric plant at Västerås, these now forming the principal centres of power-generation in Central Sweden. With the works just enumerated there co-operate in case of necessity certain other large works, such as the City of Stockholm's Untraverket in the Dalälven River (40,000 HP), and a large number of groups of smaller enterprises. Many schemes have been proposed for transmission of electric current on a large scale from some of the big Norrland falls to the central and southern parts of the country. The furnishing of the northernmost parts of Sweden with electric power





The »Harsprånget» Waterfall in Lappland.

The largest undeveloped waterfall in Sweden (calculated to be able to supply 250,000 HP).

has been inaugurated by the construction under Government supervision of the Porjus works in the Lule River (80,000 HP), and is being continued by the harnessing of the Norrforsen rapids in the Ume River (20,000 HP).

Many of the large power-stations are interconnected by trunk-lines, which renders possible an equalization of the power supply. Thereby power can be obtained at a cheaper rate than if each station were to work independently.

In respect to the development of power from waterfalls in Sweden there are some factors of an unfavourable character, viz. the slight annual precipitation (ranging from 400 mm to 1,200 mm — the latter in the higher altitudes), the inconsiderable height of many of the individual falls (from 3 m to 10 m), the great variations in the natural flow of water (from 1 to 100 second-cub.m per sq. km) and the long

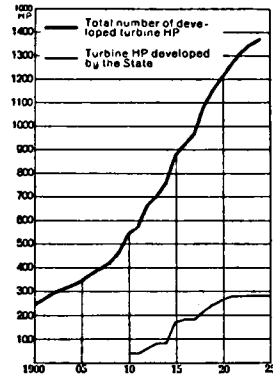
— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

stretches of rapids that necessitate the building of costly dams and other construction work, all factors which raise the capital outlay for the plant, and consequently the cost per unit of current supplied to customers. On the other hand there are some favourable factors, viz. the character of the ground, which is for the most part firm and suitable for foundation work, the abundance of building-stone, the presence of lakes to act as equalizers to the flow of water, and the comparatively great run-off, in the larger rivers from 40 % to 70 % of the total volume of rainfall.

With respect to the price per hydro-electric HP the figures quoted for Norrland range between about 40 and 50 kronor, for South Sweden about double those amounts. If the value of the fall and the cost of the distribution-plant are included, the average cost of construction of hydro-electric plants in Sweden works out at about 320 kronor per electrical HP. The capital invested in water power generating and distributing plants in Sweden in 1924 has been estimated to aggregate 1,000 mill. kr. The hydro-electric power development has proceeded rapidly during the present century, as is shown by the appended graph of developed turbine HP.

What has been said above shows that Sweden's resources in waterfalls is of great importance for her industries, more especially at the present day.

Fuel Power. The growth of industrialization in Sweden is very clearly marked by the increase in the importation of coal. At the beginning of the 1890's, 90 kg of coal were imported per inhabitant and year, and in 1910 812 kg. Owing to the increasing utilization of water power for the generation of electricity, at that time the figure for the import of coal dropped to 765 kg in 1912, and stood at 781 kg in 1924. At the beginning of the 1870's the total import of coal was about 600,000 tons, of a value of nearly 14 mill. kr; in 1916 it reached its maximum, viz. 5.33 mill. tons, for which the country paid 195 mill. kr; in 1920, when coal prices reached their apex, Sweden paid 502 mill. kr for 3.17 mill. tons. In 1924 the im-



— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

part of coal was 4.71 mill. tons for which was paid at the low price ruling at that time about 125 mill. kronor.

These figures have very naturally given rise to a lively discussion more especially in industrial circles as to the possibility of making use of home resources of fuel instead of imported coal. At the present time, however, it would seem to be pretty generally agreed that water power cannot be expected to supersede coal much more than at present. If manufacturing keeps on expanding it is probable that about 5 million tons of mineral coal will still have to be imported every year.

Coal, however, only constitutes about half of the fuel that is consumed in Sweden. In a report over the consumption of fuels of all kinds in Sweden during the period 1913—1917, it was estimated that the total requirements, computed on the basis of the fuel value in mineral coal, had been about 11½ million tons, distributed as follows:

For the generation of steam and driving oil-engines . . .	43 %
of which for industry and commerce, agriculture, etc.	24 %
for railways	9 %
for steamships	10 %
For heating furnaces (iron-production and gas-manufacture)	17 %
For heating dwelling-rooms and for other domestic purposes etc.	40 %

Wood is by far the most important of native Swedish fuels, being in earlier days the primary generator of energy. In proportion as the interest in rational forestry has increased there has grown up a much more complete utilization of forest timber. The forest-owning industrial concerns in particular make great use nowadays of waste and refuse wood for the generation of heat-energy. For pre-war years the estimate of the wood consumed as industrial fuel was about 10 mill. cub.m, of which however only 13 % seems to have been "wood" in the usual sense, the remainder (87 %) being sawdust and other waste. At the present time the consumption is probably less. The price of wood having gone up in consequence of the increasingly wide use of forest products in a variety of ways, its employment as fuel has tended to diminish. Both the demand of the iron industry for charcoal and still more the rapid development of the chemical wood-pulp industry have acted in the same direc-

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

tion. The cellulose industry, however, has provided some compensation, inasmuch as the sulphite spirit, that is being produced from sulphite lye in yearly increasing quantities, can be used with fairly good result as fuel for internal combustion engines.

Sweden is poorly supplied with fossil fuels. Those worth considering are the deposits of mineral coal in the North-West of Skåne, the peat mosses in various parts of the country but of little value for the production of energy, and the combustible alum shales embedded in Silurian deposits, chiefly in Västergötland and Närke.

The section of the Skåne plains, extending from the districts north of Ängelholm to some 10 miles south of Hälsingborg, has beneath the upper surface strata of sandstones, shales and laminated clays containing seams of coal. The mining of this coal has been carried on from as early as the beginning of the 17th century, the valuable fireproof clays accompanying the seams being extracted at the same time as a help towards economy in working. It is only however since the beginning of last century that the work has been done on an industrial scale in the modern sense of the term. The working of these coal-mines has been gradually consolidated in spite of great difficulties and at heavy pecuniary sacrifices and, being well managed, it now yields a moderate profit. All the coal deposits are now owned by the Höganäs-Billesholms A.-B. The difficulty of mining the coal at a profit arises in the first place from the inconsiderable thickness of the coal seams (30—60 cm), in the second place from the difficulty of putting the second-grade coal to any economic use, and in the third place from the clay that for technical reasons has to be mined along with the first-grade coal. Nevertheless the quantity of coal raised has increased continuously. In 1805 it was 10,000 tons, in 1877 100,000 tons, and in 1924 about 440,000 tons, which last figure amounts to just about one tenth of the normal annual consumption of coal in Sweden as a whole. So far as can be seen at present the annual amount of coal raised cannot in the future exceed from 500,000 to 600,000 tons.

The Swedish coalfields that are being worked cover an area of about 67,500 acres. From 1797 to 1924 there were extracted about 15.5 mill. tons of coal, i. e. only enough to satisfy the present requirements of the country for three years. There remain some 100 mill. tons in the coalfields that are now being worked but there are

probably about another 200 mill. tons in the parts of the coalfield not yet explored. Of the latter amount however probably only half is first-grade coal, the other half being of inferior value. Swedish coal cannot qualitatively bear comparison with even ordinary grades of English or German coal, though the best quality Swedish is quite as good as some inferior grades of coal from those countries, such grades being rather extensively used in Sweden.

Considering the limited possibilities of an increased production of coal in Sweden, it is not to be wondered at that a certain number of more or less speculatively minded persons have turned their attention to the indisputably very considerable supplies of energy that are stored up in the Swedish peat-bogs. While the Great War was raging fantastic schemes were very rife and the Swedish Government was then prevailed upon to spend a considerable amount of public money on an official stock-taking of the Swedish peat-bogs situated south of Dalarna (the islands of Gotland and Öland excepted). — Theoretically the matter was extremely interesting but practically entirely valueless.

The purely statistical values furnished by that investigation tell us that the peat-bogs situated in the parts of the country mentioned contain peat that is the equivalent of 1,000 mill. tons of air-dried combustible peat or of 500 mill. tons of coal. It has proved impossible profitably to set free for industrial purposes the very least part of the energy contained in the peat-bogs, though a considerable number of millions of kronor have been devoted to the various experiments made to that end; moreover, in spite of all the fantastic talk indulged in, there is not the faintest hope to be seen of ultimate success. The difficulties in the way of an economically profitable manufacture of peat are in the main two: on the one hand there is the extreme tenacity with which the peat substance retains possession of the 80 % to 90 % of water that the crude mass of peat contains, and on the other hand there is the fact that the combustible material in even the best peats is in reality thin and spread over a large surface.

In spite of all the efforts put forth by the State itself and by various associations and private individuals, it proved impossible even during the war-years when the prices of coal reached a height never before dreamt of and fuel was in very great demand, to work up the total production of peat to more than about 400,000 tons, i. e. about the equivalent of 200,000 tons of coal. The output of the last few years

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

has ranged from 100,000 tons to 125,000 tons. As a means of generating energy for the industries of the country peat is of extremely little importance and there is no reason whatever to suppose that that importance will be appreciably greater within any near future. In certain isolated cases however factories that own well-situated peat-bogs containing very first-rate combustible peat may be able to turn their peat to profitable account in some measure.

Since the close of the 1860's liquid fuel has come increasingly into use in Sweden, as well as elsewhere, in the form of petroleum or rock-oil — which by fractional distillation yields the well-known products: benzene, kerosene, and motor-oil. Since the 1890's those mineral oils have been a large and increasing article of import in Sweden. In 1924 the importation amounted to 255,000 tons to the value of 45.4 mill. kr.

Sweden possesses at all events a theoretical possibility of producing out of its own raw materials some proportion of its requirements of mineral oils, which are so extremely important not only as sources of energy but also as lubricants. Mineral oil can as a matter of fact be produced by distillation out of the black alum shales that are present in great abundance in the Silurian deposits in Västergötland (Mount Kinnekulle), Östergötland and Närke. In favourable cases, if the working is carried on on a large scale, it proves possible to produce from 30 to 50 kg of oil from each ton of shale and also from 7 to 9.5 kg of sulphate of ammonia which is a valuable artificial manure. However, the experience gained from extensive experiments and experimental workings on a factory scale have so far only yielded the result, that fuel oils cannot be extracted from the alum shales with economically satisfactory results as long as the prices of mineral oils remain as low as they have been since the World War. These shales nevertheless form a reserve fund which at some future day it may prove fortunate for the country to possess. There is also a certain degree of probability that at no distant date new inventions may give them a value as respects the generation of power in Sweden that will be exceedingly welcome.

Amongst those people that are best acquainted with the power resources of Sweden there is probably a fair amount of agreement as to the possibility of extracting mechanical energy at a reasonable cost and in sufficient quantity from the waterfalls of Sweden not only for

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

the industries now in existence but also for a considerably enlarged Swedish industry in the future. When it comes to a question of supplying the need of industries and households for fuel for heating-purposes, on the other hand, there is no possibility whatever of managing with what is supplied by the country itself and hence Sweden will necessarily continue to be an importer of coal and mineral oils.

INDUSTRY AS A TRANSFORMER OF AGRICULTURAL PRODUCE.

The primary need of man is the procuring of the necessary amount of food. In the earliest ages that was accomplished mainly by hunting and fishing, but the increase of the population laid the burden of furnishing food more and more on the farmers, a task that they have shown themselves remarkably well able to perform down to our own days.

Although not more than about 44% of the population of Sweden are now employed in agriculture, yet from the beginning of the 1880's that industry has supplied on an average some 82% — measured by nutritive value — of the food of the people; during certain periods it has been more — as much as 86% — during other periods less — as little as 78%. The shortage is in vegetable produce, of which Sweden has to import considerable quantities; cattle-breeding on the other hand yields butter, meat and other products in excess of what the country needs for itself to a value of upwards of 100 mill. kr — a not unimportant contribution (9% or 10%) to the sum of Swedish exports.

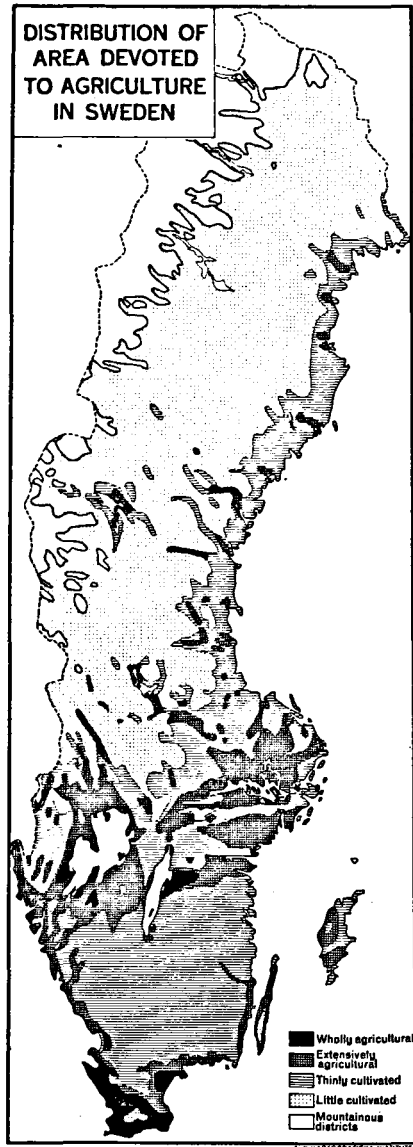
The transformation of the yield of the soil for human needs was entrusted in earlier days to housewives and handicrafts men, but during the last half century this sphere of work has more and more passed into the hands of farsighted industrialists, mainly concerned to supply the home market. On the whole, the process of industrialization has brought with it a raising of the average quality of the goods delivered and a standardization of the kinds of goods offered for sale, but pretty certainly too an elimination of the very best qualities, which a few connoisseurs had known how to have themselves served with. To realize that we need only compare ordinary bakers' bread with the more excellent home-made article. In this category there are

not a few branches of industry that deal principally with raw materials produced in Sweden itself.

The domestic work that has been in a high degree industrialized is firstly the production of food-stuffs and secondly the making of clothing and the preparatory textile operations connected with it. Contemporaneously with the change that was taking place in the old-time farmhouses, there were springing up in towns and other centres tens of thousands of new homes set up by the people employed in the fast developing industries, in goods transportation, in the buying and selling of commodities etc. etc. Those people became the purchasers too of the output of the new factories, which was taking the place of what had once upon a time been produced in the homes of the old-fashioned type.

A short survey may be given here of the industries that have grown up in the way indicated on the basis of Swedish agriculture.

The Swedish people's principal article of food is bread, and it is consumed in increasing amounts from year to year, as is proved by the fact that, while in the seventies, 131 kg of corn



ground to flour went to each head among the population, the consumption per head during the present century has risen to somewhat more than 160 kg, two thirds or somewhat more of which is of Swedish origin. Wheat-flour has now come more and more into request, but as it cannot be produced in good quality from home-grown wheat, Swedish wheat has to be mixed with the more glutinous article grown in other countries. To some extent this circumstance has favoured the rise of the large flour rolling-mills that have been built in some of the Swedish sea-coast towns and have gradually beaten out of the field the old-standing small or moderate-sized "toll flour-mills", which have ground the farmers' own corn for a certain toll or percentage in kind. For rye-flour the latter still have the upper hand (67 %), but for wheat-flour, they are hopelessly left behind (15 %).

Swedish agriculture also supplies the raw materials for the oatmeal and potato-starch industries that are now being carried on in the country. Private households and small-scale bakeries have gradually had to surrender to large-scale undertakings the further transformation of the flour into bread.

The sugar that the Swedish sugar-factories produce is in most cases derived wholly and solely from the sugar beet, that is cultivated chiefly in Skåne but also to some extent in the other coastal provinces of South Sweden.

Swedish agriculture is also the principal purveyor of raw material to the spirit-distilling industry, which is now almost entirely concentrated in Skåne, and of malt which is the chief raw material of the breweries. The yeast-factories' requirements of corn are also supplied out of home produce.

The climate and the nature of Sweden as a whole favour the maintenance of a large stock of domestic animals. The extent to which this has set its mark on the output of Swedish farming was shown very clearly by the result of the calculation as to the nutritive value of edible vegetable produce that the difficult problems with regard to bread-rationing etc. made desirable in 1915. The returns showed that while out of the vegetable produce 1,327 mill. feed-units could be used directly as human food there were 6,334 mill. feed-units for farm animals, no less than 5,100 mill. being straw-fodder, fodder roots, pasture-grass, green fodder, potato-tops etc., which are only available as feeding-stuffs for animals.

From this it can easily be perceived that products yielded by farm

stock must play a great part in Swedish economic life. The transformation of these products into such forms as will admit of their being kept for a greater length of time, e. g. butter and cheese, preserved meats, etc., has come to be a very important item in Swedish industrial life. The actual work involved has been largely transferred from the farms to special factories. The Swedish industrial statistics for 1924 give no less than 1,266 "dairies and goat-cheese factories", while the figure for meat-preserving and sausage factories is 149. The low figure for the latter category shows that the statistics only take cognizance of what are regarded as real factories.

Of special interest is the exchange of products that takes place on a large scale between certain industries and agriculture. A very considerable proportion of the stock of pigs in the country, at present amounting to over a million animals, have their main feed from the refuse products of dairies, distilleries and other similar enterprises. Again, passing by other examples, in certain large districts of Skåne molasses and crushed beet-refuse from sugar-factories are of very great importance as foods for cattle. To summarize what has been said above, we find that Swedish agriculture places at the disposal of industry large amounts of carbohydrates and albuminous substances, which are worked up chiefly for the populations of the towns and townlike communities but also to an increasing extent for the purely agricultural population. In this connection it must not be forgotten that the land in Sweden has already been divided up into such numerous and small parcels of ground that there are three times as many farm holdings whose owners are obliged to obtain a larger or smaller portion of their requirements of cereals by buying from other growers as there are holdings whose owners are in a position to sell their own-grown grain.

The home production of fats is not sufficient for the country's needs. The important industries for which vegetable fats form the main raw material are chiefly dependent on imports, e. g. margarine and cooking-fat and chocolate factories, and also the important industry that produces vegetable oils not only for human and animal food but also for various technical purposes.

The contribution of raw materials for the textile and tanning industries that is made by Swedish agriculture is extremely small. In spite of the fact that the breeding of sheep is now being carried on on an increased scale, the stock of sheep in Sweden, which amounted in 1912 to 1,200,000, only supplied 7% of the country's demand for

wool at that date. Of the tanning industries' requirements of raw material only about one fourth was then covered by hides of Swedish animals, but on the other hand considerable quantities of especially calves hides are exported.

If we survey the position occupied by agricultural production and by the industries based on it in the Swedish economic life of to-day, we shall not fail to be struck by the fact that the production in question, which increased so greatly during the past century, is being increasingly consumed in Sweden itself. This is partly due to the growth of the population but still more to the rapid rise in the standard of living.

The animal world which formerly and indeed until the beginning of the modern age contributed by the export of wild animals' pelts and skins a considerable part of the country's revenue, is now of little importance.

The fisheries, on the other hand, chiefly those of the coast of Bohuslän, yield a far greater return, amounting to 30 mill. kr annually. The bulk of the fish is eaten fresh, but there is one exception that is of no small interest, viz. a variety of the herring ("skarpsill"). It is pickled and constitutes the raw material of the famous anchovy-industry that has been growing up since the middle of the nineteenth century in Bohuslän with its chief-centre at Lysekiel and which is now carried on throughout in large factories. In connection with this manufacture there has sprung up a fish-conserving industry with a large field of activity. To judge by the rapid growth of the corresponding Norwegian fish-canning industry, this should have a promising future before it. The ordinary salting of herrings on the other hand, which once upon a time was of great importance, now plays a continuously decreasing part owing to the small proportion of fat that the Bohuslän herrings contain as compared for instance with those caught off Iceland.

FORESTS AND FOREST INDUSTRIES.

Swedish official statistics assess the land area of Sweden at 410,000 sq. km. Of that area not more probably than at the most about 350,000 sq. km are situated in the climatic region of coniferous forests. Gardens, ploughlands and meadows occupy 48,000 sq. km and the timber-growing land, it is calculated, 246,000 sq. km. The remainder of the land surface is termed "non-cultivable", that is to say consists

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

of peat-bogs, rocky ground etc., to be regarded as negligible from the economic point of view, though considerable parts of it, especially the peat-bogs, will undoubtedly at some future date prove capable of growing forest timber. We may however assume that Sweden possesses roughly 62 mill. acres of forest-land. Of this total not more than two and a half million acres can be expected under the most favourable conditions to admit of ever being brought under the plough, though considerable sections will probably eventually be transformed into rationally kept pasture-lands. The rest of the timber-bearing land, by reason of the large number of boulders and other obstructions on its surface, must definitely remain an exclusively sylvicultural area, and consequently forestry may confidently be expected to be for all time, what it has been during the past three quarters of a century, one of the country's chief industries. On the basis of the material at present existing it is not possible to construct a map to show in a really effective way the distribution of the forests over the different parts of the country, but the one given on p. 15 of the areas under cultivation gives some guidance, inasmuch as the greater the proportion of the land under the plough in any area the less must be that of the land that is forest-clad.

The economic importance of the Swedish forests is traceable not only to the nature and character of the country itself but also to the fact that the countries in the periphery of the Fenno-Scandinavian virgin-forest region are for the most part in configuration low-lying and fertile, inhabited by peoples who are extremely well suited for the pursuit both of agriculture and mechanical industry. As those peoples have increased in numbers and their countries have been brought more and more under the plough, industries have grown up and flourished and large cities have arisen. As a natural consequence large quantities of timber have been required for building and other purposes which the forests of Great Britain and the European Continent proved quite inadequate to supply. Hence there has come about a persistent drain of forest products from the northern countries, in which coniferous forests thrive well, to the great and populous industrial and agricultural regions of North-Western Europe.

The fact that Sweden and the South-East of Norway were the districts in Northern Europe where forest industries developed earliest and most vigorously, is closely connected with their topography. Between forest clad heights and hills the small valleys and stretches

of plain country were cultivated from of old. In the earliest stages of its activity on industrial lines, i. e. from 1840 to 1880 the lumber trade found ready to hand in that race of men a sufficiently large set of workmen, who were thoroughly familiar with life and work in the forests, and quite willing at a low rate of wages to place themselves at its service. In the interior of upper Norrland, it is true, there was but a scanty supply of labour, but nevertheless matters were far less difficult there than in large areas of Northern Finland or in the broad forest-covered plains of Northern Russia.

The portion of the great Swedish forest region that is least easy of access — the northern part of Värmland, Upper Dalarna and the interior of Norrland, comprising in round figures twenty-five mill. acres, was possessed of an advantage unparalleled elsewhere in the world, for, at a cost of some few hundred million kronor, its watercourses proved capable of being transformed into excellent *floating-ways* of an aggregate length of some 30,000 km. The advantages that nature afforded here are principally: a conveniently moderate gradient in the courses of the rivers from the high mountains down to the sea-coasts, a winter with heavy snowfalls and a spring marked by a very high-water-level in the rivers. This high-water period is moreover usefully prolonged in time, firstly — in the case of the big rivers — by the late melting of the snow in the mountains, and secondly — for all the rivers alike — by the abundance of lakes through which the rivers in most cases take their course. The disappearance of the snow and ice is earliest down by the mouths of the rivers and accordingly it is there that the annual floating begins. Gradually, as the temperature rises, the condition of high-water-level extends further up the river system, and the work of floating can be started at points higher and higher up. By means of these floating-ways timber can be transported from practically any point in the interior of the country at a remarkably low cost down to the coast, where thanks to the fringe of skerries protecting it there are numerous excellent harbours for dealing with the timber on its arrival.

The scope and extent which this floating has attained (see the table appended) clearly shows the immense importance that it has acquired and still has for the whole of the Swedish lumbering operations. It is worthy of remark that efforts have been made during the last decade to open up for floating purposes certain sections of the river systems of Central and Southern Sweden. These efforts have moreover been



Lumber-sorting Station at "Tägten" in the Dalälven-River.

In the foreground can be seen quantities of floating logs, and in the upper part of the picture the wood-stores of the Kvarnsveden wood-pulp mill.

almost more successful than was expected, even though the floating-ways there are insignificant as compared with those in Northern Sweden. The figures giving the amount of lumber floated have risen very greatly in course of years and indicate very clearly the revolution that has taken place in the lumber trade as the result of smaller and smaller dimensions of timber having been put to economic use in pulp-mills etc.

The figures in the table for recent years illustrate the great variations caused by fluctuations and cycles in the business world. Let the reader compare for instance the numbers of logs floated in 1921 and in 1922; the latter reflects the violent fall in prices which the great economic crisis of 1920 brought about in the wood market.

The existing pre-requisites with the help of which it has been possible to create the large and profitable enterprises for the export-

	<i>Number of floated logs:</i>
1900	37,700,000
1908—12, yearly	66,937,000
1921	133,467,000
1922	85,544,000
1923	121,810,000

ing of Swedish forest products have been consequently in the main: an abundant supply of timber in a practically untouched virgin-forest region favourable to the growth of pine and spruce, a big demand for timber in countries not too remote, a population exceptionally well fitted to fulfil the varying requirements entailed by the industry and evenly distributed over the region and, lastly, excellent transporting facilities. Those enterprises turn out round timber to some slight extent, but their main output is sawn goods and wood-pulp and also, in recent times, increasing quantities of more completely manufactured goods, e. g. paper and joinery articles.

The forests of Central and Southern Sweden with their focus in the Småland Highlands are smaller in area but, owing to their more favourable climatic conditions, the timber grows more rapidly and they are consequently relatively more valuable. They also contribute in some measure to the sum of Sweden's timber exports, but the bulk of their produce during the last two generations has been used up for the needs of the far-reaching construction work that has been going forward in that part of Sweden during the period in question, where on an average there are 25—35 inhabitants to the sq. km compared to 5 in Norrland and consequently the demand for wood for domestic purposes is several times greater. Moreover the drifting of the population from farming into manufacturing and other callings that are quite independent of farming, has necessitated the extending and rebuilding of towns and municipal communities on an unprecedentedly large scale.

The wood-manufacturing enterprises in Northern and in Southern Sweden respectively have acquired an essentially different character. In the latter there are a large number of establishments — each one often small or only medium-sized — spread more or less uniformly over the whole region; in the former there are a comparatively few, but large mills located at the mouths of the big rivers. It is only in Jämtland, which has an outlet for export to the Trondhjem Fjord by the Swedo-Norwegian railway, that there are a few fairly large works in the interior of the country. In the North of Sweden local requirements of sawn timber are satisfied by small primitive sawmills partaking of the handicraft rather than of the modern industrial type of enterprise.

From the standpoint of the wood-working industries Sweden may suitably be divided into three areas — the virgin-forest region of Upper Norrland, the industrial-forest region of Lower Norrland, Dalarna and Värmland, and the cultivated-forest region of South Sweden.



Woodland Landscape in the North of Sweden.

A view of the River Stora Lule älv, in the Parish of Jokkmokk.

The Upper Norrland virgin-forest region comprises roughly the two most northerly Swedish provinces. In this area coniferous trees may be said to live at the extreme limit of their endurance as regards climatic conditions although, as a matter of fact, in the coast districts the state of things is fairly tolerable. In the large forest tracts of the interior growth is slow: at least, a hundred-and-fifty years must be allowed for the regrowth of saw-timber, and reproduction is difficult and precarious. On the other hand there has been a considerable growth of timber in the course of two or three hundred years. The principal forest owner in this part of the country is the State, no less than 58 % of all the wood lands in the Lapland part of Norrbotten being State-owned and in the coast districts 50 %, while in Västerbotten the corresponding figures are 35 % and 18 % respectively. The lumbering of the forests there however has proved to involve such great expense that neither the State nor the private owners who have experimented with it have had any reason to congratulate themselves on the results, especially in comparatively unfavourable years nor even when normal business conditions have prevailed. In any case the forests in this region will constitute an extensive reserve for the sawmilling industry in Norrland for the next few decades.

The industrial-forest region of Lower Norrland, Dalarna and Värm-

land. Here coniferous trees live under external conditions that are very satisfactory for them, if we leave out of account the higher tracts adjoining and embraced by the great mountain chain on the west. The growth in these forests is so satisfactory that it is possible to count upon a rotation period of 100—120 years for the production of saw-timber; the greater part of the forest land ranges from normal to really good; and the reproduction is comparatively satisfactory.

It is in this region that the sawmilling operations for export, which ever since the 1840's have been so all-important an item in the country's economy, have chiefly come into being and flourished, large sections of the forests — as much as from 39 % to 54 % — formerly in the hands of individual peasant proprietors having been acquired by the lumbering industry interests. It is from this region too that the lumbering industry has taken by far the greater part of the timber, valued at 4,500 mill. kr, that was exported from Norrland and Dalarna during the half century from 1863 to 1912. Accordingly there are no longer any original virgin forests, practically all the heavier timber having been cut off except in a few state-owned parks and other small areas. The irrational thinning which has been very frequently resorted to in conjunction with the logging of an area has resulted in there being at present a much smaller quantity of standing timber in these forests than would be normal. The importance of adopting systematic sylvicultural measures to preserve the forest was generally realized at so late a date that much has been neglected which might and ought to have been done to transform the once cut over forest-areas into rationally managed woodlands, where attention is paid to reproduction. This means that a shortage of timber has already begun to be experienced by the sawmills and will become still more noticeable, for every year that passes for some time to come. It is a fortunate circumstance however, that the majority of the larger mills now carry on not merely sawmilling operations, which are rather tending to diminish in quantity, but also the manufacture of wood-pulp, a branch that is steadily increasing and yields a good return. The wood-pulp business provides means for a better and more rational management of the forests and makes it possible too to use up profitably the smaller-dimension timber, of which there can still be removed large quantities to the great benefit of the forests as a whole.

The cultivated-forest region of South Sweden. This name may be used for the extensive forest areas in the central and southern parts



A Well-kept Forest in Värmland.

Fine specimen of reproduction with stock-trees (mother-trees) still standing. Alkvettern, in the Parish of Bjurkärn.

of the country. They have been already cut over at least once, often twice or thrice and have hence lost their character as virgin forests. Even though the bulk of the forests in this region cannot unfortunately lay claim to being "cultivated forests" in the proper sense of the term — i. e. forests that are well tended and judiciously managed by the hand of man and that are in consequence abundantly timbered — yet the control exercised over them by their owners is so comparatively effective that they may reasonably be said to be part and parcel with Swedish economic life. Many of these forests have long been managed to a considerable degree on a rational system of silviculture, those in Bergslagen, the ancient iron mining district of Central Sweden, having been taken in hand upwards of a century ago. The newly-awakened national interest in the care and management of forests has hitherto resulted mainly in the passing of measures to ensure the maintenance and perpetuation of the timber in South Swedish forests. In certain districts the young forest saplings show by their even and graceful growth full evidence of the care bestowed: some woodlands have reached



What is believed to be the forest that is most prolific of timber in Sweden.

Forest belonging to the Hundred of Jönåker, in Södermanland. Mean heights estimated in 1919 at 31.1 m for pine, 23 m for spruce; cubic volume estimated, in 1918 at 891 cub. m per 2 1/2 acres, and age at 150 years

an age to warrant thinning and that yields a good return in timber suitable for pulp-wood, fuel, props etc. That is more especially the case as regards the larger forest properties, for the peasant's forest-holdings have not yet been brought thoroughly into a well-managed state, though in many places a good beginning has been made thanks to the contributory work afforded by the local Forestry Boards.

In any case the favourable climatic conditions prevailing in this region make the work far easier than further north: rotation periods may run from sixty to a hundred years, almost everywhere there is a good demand at remunerative prices for thinnings and though wages are high there is in most places a sufficiency of labour available for the proper tending of the forests. The sawmill timber from these forests, for reasons which have been hinted at above, will probably for a long time to come be mainly used up in supplying the country's own requirements. Beyond that

however these forests are able to contribute not inappreciably towards the timber products that Sweden exports, mainly in the form of thinnings for props or pulp-wood.

When once the Swedish wood-working industries had got properly started between 1850 and 1880, they turned to account increasingly large quantities decade for decade of the stock of timber which had accumulated in the Swedish forests in previous ages. Since the eighteen seventies the annual demand for lumber has probably increased roughly threefold for exports of round, hewn, sawn and planed wood-goods and wood-pulp. A rough calculation shows that the demand has risen from about 6 to about 17 million cubic m. For a long time past the annual cut has probably increased by 400,000 cub. m, i. e. an increase of 4 million cub. m every ten years, out of which, it is calculated, about 60 % is attributable to increased exports. Though these figures may perhaps leave room for an appreciable margin of error, yet they serve to give an idea of the vigour and energy displayed in cutting the accumulated stocks of Swedish timber. The total yearly cut, it is estimated, amounts to about 42 million cub. m, to which there must be added a loss of about 2.8 million cub. m, owing to timber that has been allowed to rot away in the forests, either as unprofitable for cutting or from neglect for other reasons. The total visible supply of timber has been estimated at something like 1,300 million cub. m, of which a maximum of 400 million cub. m consists of merchantable timber.

If we set these figures over against the present annual increment, which according to the best computations we possess may be assumed to be about 30 or 35 mill cub. m — of which however only about 12 mill cub. m are supposed to represent increment in the larger trees — it would seem as if the wood-working industries of Sweden were in a parlous state. And that is so, too, more especially because the chief increment is among the trees of younger growth, which must go on growing for several decades before they will have attained such a dimension as will render them mature for cutting. From the industry's own point of view the mature forests have undoubtedly been felled too rapidly in many parts of the country — if, that is to say, the industry looks not only to the immediate future but to its continued existence and welfare in years to come. In the peasant-owned forests proper¹, which to a very large extent supply the lumber industries with their timber, there is only 50 % to 70 % of the amount of standing timber that there ought to be, if the management had been on sound

¹ Of forests in private ownership 60 % are peasant-owned, 33.5 % company-owned, while the remainder, about 6.5 %, are owned by the large estate-holders.

sylvicultural lines. In the company-owned forests in the above-mentioned large industrial-forest region in Lower Norrland, Dalarna and Värmland things seem to be better, though even these forests have been overcut and are in many cases badly assorted with regard to age-groups; many of the state-owned parks in the central and southern parts of the country are also in the same plight, owing to their having so largely been purchased when in overcut condition in comparatively recent years.

The opinion among experts is very general and probably with full justification, that the sawmilling industry will experience for some years a setback in its timber supplies both quantitatively and qualitatively. In order to gain a clear idea as to the real state of things, the Government has ordered a comprehensive stock-taking of the forest resources of the kingdom, with the object firstly of establishing by thoroughly scientific methods what may be computed as the total stand of timber in the forests of the country as a whole, and secondly of having certain other matters of vital importance to industry investigated at the same time. The results that have been published so far relating to Värmland, Småland, Dalarna and Lower Norrland, would seem to show that the stock of timber is larger than the pessimists have prophesied.

One important development in recent times is that smaller-dimension timber has come to be practically useful to a far greater extent than was earlier the case, having acquired a greatly enhanced value as compared with a generation ago. This circumstance in conjunction with the rapid transition of the timber-conversion industry from sawmilling pure and simple to a more and more extensive production of wood-pulp and paper as well, may result in the Swedish forest industries proving able to meet the expected scarcity of timber in the coming decades with greater equanimity than many people are now inclined to fancy possible.

THE INDUSTRIAL UTILIZATION OF THE SWEDISH ORES, ROCKS, AND EARTHS.

Sweden's rock-floor consists for the most part of Archaean rocks. The bulk of these are gneisses and granites in very abundant varieties, which in many places are of such a kind that make them

suitable as raw material for the modern stone-industry. In these granites and gneisses are found extensive masses of the series of rocks that is now generally termed 'the leptite formation'. The quantitatively most important of these rocks is the leptite itself, in past times usually known as hälleflint-gneiss or eurite. This group of rocks is regarded by modern petrography as being volcanic surface-rocks, lava-streams and tufas, and partly also sediments, which have in the course of the ages been completely turned about, squeezed together, folded and transformed in a variety of ways.

Ores. For the practical man this leptite formation is of very great interest, for it is almost exclusively in it that there have been found all the valuable ore deposits — besides a large number of less valuable ones — on which the Swedish mining undertakings are based.

Large areas in Eastern Götaland derive their character from the presence of the leptite formation. There are numerous indications of ores, which ore-prospectors have over and over again tried to work. In spite of the fact that copper, iron, nickel and even gold are to be found there, yet — remarkably enough, we may say — not one single really valuable ore-deposit has been found in the course of search pursued for hundreds of years. Of a certainty the millions of Kronor that have been spent on the rocks of South-Eastern Östergötland and Eastern Småland have not nearly been recovered.

The case is very different with the great leptite region that occupies Western Västmanland, Southern Dalarna, Närke and Eastern Värmland. Here, over an area of about 15,000 sq. km, there are indications of ore at hundreds of points. In not a few places larger and smaller ore-deposits occur grouped together in ore-fields of varying size and value. Even during the early Middle Ages, it was discovered that valuable metal resources were concealed here, for the ores embedded in the bed-rock often lay fully exposed and could therefore be easily observed. At about the close of the 13th century a thorough-going mining-system was established in these districts and it soon assumed a form, which for that days may deserve to be called industrial in type. The business arising from the mined ore increased continuously and it may be asserted on good reasons that *Bergslagen* was the cradle of Swedish industry. The ores have yielded iron, copper, silver, lead, zinc and other metals, which have been partly sold in the crude state and

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —



partly worked up and converted into more or less highly finished products. Thus a Swedish metal-industry came into being, and by degrees a race of craftsmen was trained up that was destined to be a factor of vital importance when at the dawn of a new age the mining and metal industries developed into modern largescale concerns.

In addition to the extensive and continuous leptite region in Bergslagen there are several smaller isolated areas, chief among which are the famous Dannemora ore-field in North-eastern Uppland — con-

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

taining what is qualitatively one of the finest iron-ores in the world — and the Ämmeberg field containing a valuable zinc ore.

In Bergslagen proper no fewer than 60 iron-ore fields have been worked in the course of the centuries. Well-known from earlier times and famous in the history of the iron-industry are those situated at Persberg, Dalkarlsberg, Stripa, Stråssa, Grängesberg — from which in recent days large quantities have been exported — Riddarhyttan and Norberg.

With the aid of ancient records it has been possible to calculate with a considerable degree of certainty how much iron-ore was mined in Southern and Central Sweden — mainly in Bergslagen — between 1300 and 1924 inclusive. Altogether the amount of the ore raised in the course of the six and a quarter centuries is about 126 mill. tons.

With this figure may be compared the results yielded by the investigations of the last few decades regarding the stock of ore still existing in these parts of the country, at least 250 mill. tons. Though there is thus a large mass of ore still remaining, it must be remembered that the yearly quantities of iron ore here raised to the surface have grown from not quite 14,000 tons in the 14th century and barely 300,000 tons at the beginning of the 17th century, to an maximum-output of 2,650,000 tons in 1918. The last few years have yielded an output of about 1,600,000 tons, by far the greater part of which emanated from the Grängesberg field.

The Bergslagen ores do not as a rule contain a high percentage of iron. The iron content usually runs at from 45% to 55% though in many cases it is lower. The modern processes for the production of concentrates or dressed ores and their briquetting, have given importance to many ores that previously had only a low or no value. In most cases it is the great purity and other good qualities of the ores that have given them their high value and enabled Swedish iron to attain its high reputation. In Bergslagen however there are also phosphoriferous ores which only began to be utilized after the introduction of the Thomas process, or after the invention of the modern methods for purifying the ores in the concentration process. The most important ore in Bergslagen, the extensively exported Grängesberg ore, with a mean phosphorus-content of 0.98%, belongs to the first-mentioned category.

The iron-ores are all oxide ores — magnetite and hematite —

but numerous sulphide ores, containing iron, copper, silver, lead, zinc and other metals, have also been encountered in the leptite formation. In a detailed account recently published for the Geological Survey of Sweden, by F. R. TEGENGREN, entitled: »Sveriges ädlare malmer och bergverk», the results of six and a half centuries of mining and working of the »more precious» ores — that is to say, with the exclusion of the iron ores — are summarized in the following words:

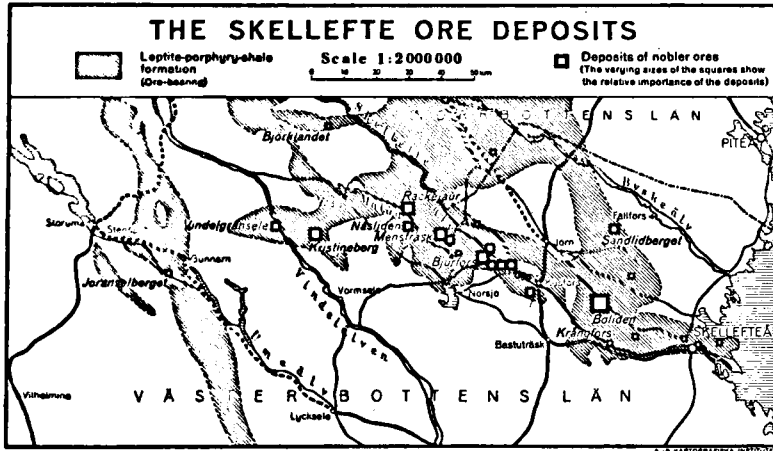
»Of all these mines and quarries only a small number can really boast of having enjoyed any considerable length of life. Most of them after being worked for some few years, often at a loss, have been discontinued and then, when business conditions have been assumed to be more favourable and previous disappointments have had time to be forgotten, they have once again been worked for a short period. As a matter of fact there are only a few workings, chiefly at Falun and Sala, that have been kept going without interruption for several centuries; nor is the number large of those that can show continuous working for a century or more with any considerable output. Even amongst the more important mining enterprises few probably ever yielded their owners any appreciable profit over any considerable length of time.»

The table on the next page shows the magnitude of the total production of metals other than iron and gold (of the latter 2,480 kg have been produced in Sweden since 1751).

Of mining products other than metals there may be mentioned sulphur — of which since 1641 there has been brought to the surface a total quantity, mainly in the form of pyrites, corresponding to 450,000 tons of free sulphur — and graphite, of which there has been obtained since 1915 a total of 4,200 tons (purified).

In conclusion it may be mentioned that what was then for Swedish conditions a very large output of copper from the Falu mine — aggregating 432,000 tons in the course of six and a half centuries — does not amount to as much as half of the world's present annual requirements.

There have not been produced latterly either in Bergslagen or in the mountainous region of Sweden — where also sulphide ores have been encountered — sufficiently large quantities of copper and other metals than iron to satisfy the country's own requirements.



A hope of changed conditions in this respect however has been kindled of late years by the discovery of an extensive area containing sulphide ores, known as the *Skellefte field*. This consists of a field of about one hundred km in extent with a S. E.-N. W. strike, built up of leptites and shales and penetrated by recent granites. As early as the beginning of the 18th century copper deposits were being worked on a small scale in the parish of Skellefteå; but no large deposits of ore were ever found in these districts,

where the rock is thickly overlaid with moraines and other Quaternary deposits. The keen demand for iron pyrites, induced by the World War conditions and the possibilities of successful prospecting for sulphide-ores by the newly invented elec-

The Production of Metals in Sweden until 1925.

	Tons
Copper, from about 1275	510,000
Lead, from 1608	55,000
Silver, from 1600	500
Zinc, from 1858	800,000
Manganese, from 1833	100,000
Nickel, from 1845	1,560
Cobalt, from 1807	300
Molybdenum, from 1887	51
Wolfram, from 1918	26

tric ore-detecting methods, put fresh life into the search for ore in this region. In the year 1920 the Swedish Geological Survey and a private company started systematic electric and geological investigations in this field, which have yielded such promising results that TEGENREEN considers himself justified in stating in the work cited above that there has been found here »Sweden's largest resources of iron pyrites and copper ores as well as considerable resources of

arsenic, zinc, gold and silver, antimony and lead. The Skellefte field has turned out to be the third large ore-region in the country». There is in it an entire absence of iron ore of any value. The extent of the ores has so far, naturally enough, only been provisionally established. But there has already been discovered an ore-area of 55,000 sq. m, of which 41,000 sq. m consist of iron pyrites, partly concentration-ore and partly suitable for direct use, and 13,500 sq. m of copper ore and copper-arsenic ore. The most important copper-ore deposits are the following: Boliden, containing an ore-area of more than 10,000 sq. m with a good percentage of copper and, over a large part of the field, a high percentage of arsenic, silver and gold; Rackejaur with an area of at least 20,000 sq. m with from 1,000 to 1,500 sq. m of copper-ore and 200—300 sq. m of arsenic ore, the rest being iron pyrites. At Vindelgransele there have been found small, but apparently valuable, deposits of zinc, lead and iron pyrites. In some other places ores have been brought to light which justify high hopes. A remarkable feature is the considerable amount of arsenic ores that have been met with, and they appear to be amongst the richest known. The extensive employment of arsenic as a means of destroying insects of various kinds, especially in connection with the cultivation of fruit, has of late years given that substance a high value. So far mining on any very large scale has not taken place but it will probably not last long before the value of the theoretical investigations will be put to practical tests.

The largest and, from present-knowledge, by far the most valuable ore-district in Sweden is the one in *Norrbotten*. It has its two centres in the iron-mountains of Gällivara and Kiirunavaara, which are about 100 km apart. In the districts immediately around the latter there are also some medium-sized deposits and a large number of smaller deposits, all now the property of the Swedish State. Up to the present ore has only been mined at the two large deposits named by a Swedish Company of whose shares the State holds half, at Koskullskulle, which geologically is united to Gällivare, and is owned by an Austrian company, and at Tuolluvara near Kiruna, which is owned by seven ironworks in Central Sweden.

The great Lapland ore-deposits were discovered already during the 17th century, possibly even earlier. During the latter part of last



The Kiirunavaara Iron Mountain from the North.

The parallel terraces show the open cuts along which the mining takes place. The total volume of ore above the level of the lake has been estimated at 240 million tons.

and the earlier part of the present century manufacture of iron was carried on in Upper Norrbotten with ores from these deposits but proved far from profitable. It was only after the completion of the great railway-line, 473 km in length, from Luleå on the Baltic to Narvik on the North-West-coast of Norway, at the beginning of the present century that the working of the mines on a large scale could begin in those northerly regions.

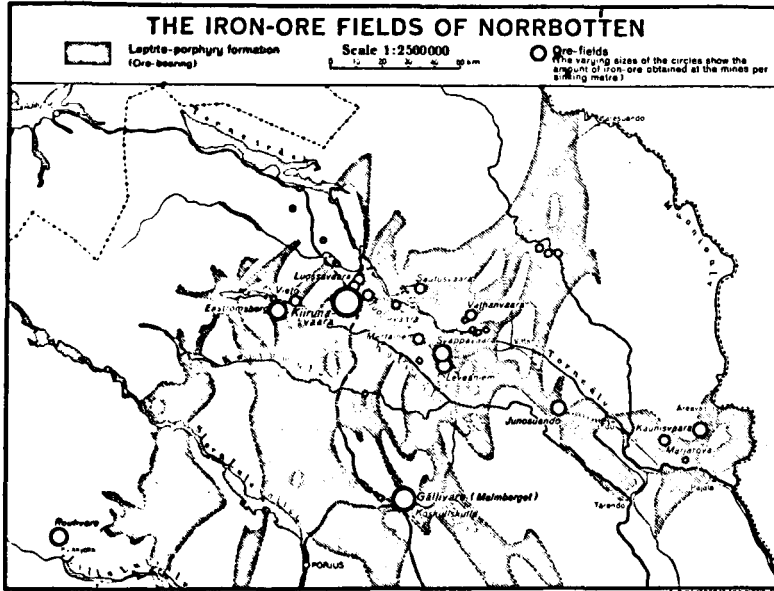
The Gällivare ore consists of a number of larger and smaller sections: the bulk of it contains about 0.8% of phosphorus and a diminutive percentage of sulphur. The Kiruna ore on the other hand, consists of a huge concentrated mass of ore, forming so to say the backbone of a great mountain; as a consequence open-cut working has been possible to a far greater extent than is usually the case with ore-deposits. The bulk of the ore that is mined here contains a high percentage of phosphorus (1%—2%), but considerable quantities, especially at the lower levels, are almost free from phosphorus (less than 0.05%), as are also the previously mentioned small ore deposits at Tuolluvara. This low-phosphorus ore is suited for the manufacture of Swedish charcoal iron, whereas the high-phosphorus ones cannot be used in Sweden owing chiefly to the lack of cheap mineral coal. This has led to an extensive export of ore, principally to the German iron-districts but also to Belgium, England and America, to

supply the needs of iron works manufacturing iron by basic methods. The ore is in great demand, chiefly owing to its excellent qualities and especially to its exceptionally high iron-content (60%—70%).

During the period from 1892 to 1924 inclusive a total of about 87 mill. tons of ore were mined in the Lapland ore-mountains, of which no less than 99.4% was exported. The value of the ore exported was about 750 mill. kr. Both in Luleå and in Narvik extensive storage and loading quays have been constructed, equipped with fully up-to-date plant for the expeditious handling and loading of the ore. The greater part of the ore is now shipped from Narvik. The Lapland ore-fields are to be looked upon as one of the largest and most valuable iron-ore resources in the whole world. As there are certainly from 1,000—1,500 mill. tons at Kiruna at a workable depth and 230 mill. tons at Gällivare, and as moreover the amount mined every year has recently ranged between 3 and 6 mill. tons in the two ore-mountains together, it will be readily perceived that Sweden has natural resources here of such magnitude that there need not be any restriction placed upon the mining of such quantities of ore as can be marketed at satisfactory prices. There are also such large resources of ores free from phosphorus that they will be able to more than satisfy the requirements of the country for a very long time to come.

To sum up in a few words, we may say that Sweden has been, and still is, the great iron-ore country of Europe, as far as high-percentage ores are concerned. Of other metals, on the other hand, Sweden possesses more limited supplies and they have so far proved insufficient even for the country's own industrial requirements.

Bergslagen, the old-standing iron and manufacturing district, is still the main centre of Swedish metal-working. Geologically and historically the situation it occupies is perfectly natural, but from a modern industrial standpoint it is by no means an ideal one. However thanks to the transmission of water power, to the opening up of navigation for ocean-going vessels right to its very borders — to the south by the widening and deepening of the Trollhätte Canal and to the east by the reconstruction of the Södertälje Canal — facilities have been afforded it by the Swedish Government and Parliament that are calculated to remove the disadvantages inherent in the geographical location from which the district has suffered. An extensive network of railways also contributes towards the same end.



It is difficult to penetrate the future and form an idea as to the position that Sweden's metal-industry and especially her iron and steel will occupy in the economic life of the country in coming decades. It would seem at any rate to be manifest that future success is most intimately bound up with its character as a high-quality industry. To mention just one or two of the factors that must have an effect on the course of future development, we do not yet know to what degree advancing metallurgical science will make it possible for other peoples to produce first-class iron from inferior ore, nor whether the present competition for charcoal-wood between iron-works and wood-pulp mills will become still more keen and severe. All we do know is, that so far Swedish steel is the best in the world and that we have engineers and workmen who are able to produce it in a higher and higher degree of perfection.

Stone and Clay. Of the various rocks in the Swedish Archaean group many, chiefly granites and greenstones (»black granites»), have proved to be of great value for building and decorative purposes, for

construction work of a utilitarian kind, for the paving of streets and for other objects. It is fortunate that several of these rocks, especially a number of excellent granites of varied colours and sizes of grain, etc., are found in the immediate vicinity of the coast, where in the shelter of the fringe of skerries safe and convenient harbours can be laid out without excessive expenditure. A considerable stone-quarrying industry has arisen on the basis of rocks of this kind, more especially in Bohuslän and Blekinge but also in certain parts of Halland and Småland.

The «black granites», on the other hand, on which a specially high value is placed, are located mainly up country; they are so greatly esteemed in the trade however that they can afford to bear the cost of railway transportation. The same is the case with a green primitive limestone, known as Kolmården marble, which is exceptionally handsome and extremely suitable for internal decorations; it is quarried in one or two places in Kolmården in Östergötland and also at Gropptorp in Södermanland.

The Swedish sedimentary formations contain sandstones and limestones, of which several have been turned to account in Sweden on a very large scale. To mention a few: the grey and red orthoceratite limestone from Västergötland, Närke, Östergötland and Skåne, certain grey Gotland limestones, red and white sandstones from Skåne, Dalarna and the Gävle district etc. Although these kinds of stone have become of no little importance for modern Swedish architecture, yet they are in no sense superior to the kinds found in other countries and will certainly not acquire any appreciable value as articles of export.

The same may probably be said to be the case with the bricks that have for a long time past been manufactured out of Swedish clays. Certain of these, e. g. a number of the Skåne kinds, furnish an excellent facing-brick; and the fire-proof clay of the Swedish coal-measures yields a first-class fire-proof brick. The exports of these goods have risen considerably but have not attained a very large total.

The first Swedish granite quarry was started in 1844 in the island of Malmö off Lysekil on the West coast. Since then the industry has continued to grow and its export value was put down even before the outbreak of the World War at nearly 14 mill. kr. After passing through a critical time during the war the granite industry has recovered again, especially under the influence of the immense increase in the demand for paving-stone and macadam that has been created by the more general use of mechanically propelled vehicles.

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

Good native material in both clays and limestones suitable for the manufacture of cement is found in many places and this has led to the establishment of a number of cement works in Skåne and Västergötland and in Öland and Gotland. Though the deposits can scarcely be regarded as better than those of neighbouring countries, the Swedish cement-industry has managed not only to satisfy the country's own requirements but also to create a by no means insignificant export trade.

We have now given a survey of the main raw materials that Nature has to offer Swedish industry and can take a backward glance to the viewpoints with which we started. The spread of world-wide commerce brings countries together and in the vast process of the exchanging of commodities from one to another specialization is evolved, whereby each country is at pains to secure a place in the international market for the particular products that she has the prerequisites for producing to the best advantage. Has this been so with Sweden? To be sure it has, if a large view is taken of the course of development.

Let us first turn our thoughts to agriculture. The chief cereal plants Sweden grows are the offspring properly of a climate more genial than hers. Their cultivation in Sweden is more costly and arduous than in more favoured climes, and hence she is unable to place on foreign markets the produce yielded by her cereal crops, either as raw materials or industrial products. As regards the yield of cattle-breeding, that is far less the case, for the herds and flocks are fed in the main on plants indigenous in the Swedish soil which are in consequence both hardier and more amenable in cultivation. Throughout the west and south of Sweden, where the precipitation is normally abundant enough to provide good pasturage, the farmyards yield a considerable surplus of both butter and meat, and it is from this quarter that there comes the contribution made by the agricultural industries towards meeting by exports the constantly increasing tide of imports. Although this contribution has increased substantially in bulk, yet relatively speaking it grows less every year: thus fifty years ago agriculture was answerable for 25 % of the Swedish exports, ten years ago for 17 % and now for only a bare 10 %.

It has already been explained why it is that in the world competition the Swedish forests, the other great producer of raw materials from the vegetable kingdom, is so much more favourably placed than

— SWEDEN'S NATURAL RESOURCES IN RELATION TO INDUSTRY —

the fields and meadows. At the present day it is primarily thanks to the forests that Swedes are able to maintain their relatively high standard of living. In 1863 the share taken by forest products in Swedish exports could be put down at about 13 %, but sixty years later (in 1923) it had risen to nearly 55 %. The industries that are engaged in the conversion of forest products are the largest in Sweden and that is mainly due to the fact that the pine and the spruce really thrive in Sweden.

During the last few decades the output of wood goods has gained increasingly in comparison with the mineral products. The Swedish mines, quarries and, not least in importance the metal industries only furnish altogether about a third of the total amount of the Swedish exports. The most prolific of the ore-deposits, however, are of such excellent quality that they will continue to have an all-important influence upon Swedish commerce. Swedish workmen are moreover so well-equipped for and so skilful at industrial work, that it is quite certain that a considerable manufacturing industry will always be pursued in the country.

Sweden's forests and ore-deposits furnish, together with the industries engaged in the conversion of their products, between 80 % and 90 % of the goods exported to foreign countries. That shows how completely Swedish national economy has been revolutionized during the hitherto comparatively brief industrial era.





INDUSTRY AND MEANS OF LIVELIHOOD

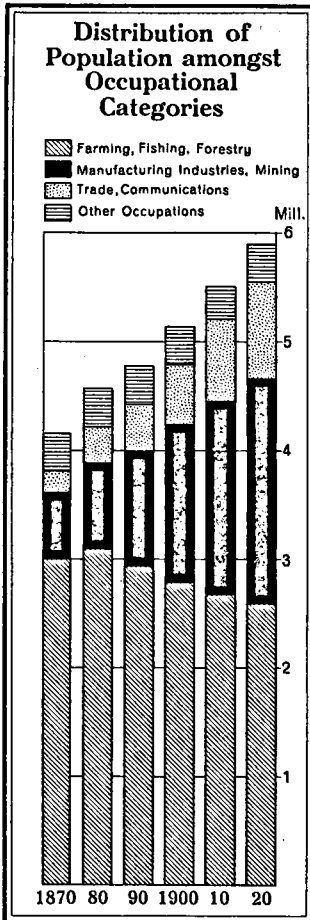
by

SVEN BRISMAN

In the Swedish occupational census returns, which for a long time past have been compiled regularly from enumerations made every tenth year, it has been customary to classify the population under the following four schedules: — Persons deriving their livelihood from (A) agriculture, fisheries or forestry, (B) manufacturing industries or mining, (C) trade or communications, (D) professions or public appointments.

That grouping follows pretty closely the subdivision of human activities that political economists in general adopt, though strictly speaking (D) falls outside the purview of economics proper. Of the remaining three schedules the first covers what economists term "primary production", i. e. the producing of raw products, the second the working up or transforming of those products and the third the distribution of them in time and space. There is indeed one discrepancy between the two groupings, for mining, which the economist would range in (A), is placed by the census statistician for practical reasons in (B).

The proportional distribution of the population amongst the four schedules is shown by the 1920 census figures to be as follows: (A) 44 %, (B) 35 %, (C) 15.2 % and (D) 5.8 %. Manufacturing industry and mining consequently provide the means of livelihood for rather more than one third of the population and, as is shown by the diagram on page 42, their numbers have increased the most from decade to decade. If however we desire to include under the heading "manufacturing industry" all the work done in the country in working up raw products, the figure given above will be too low, since a considerable part of the working up or transforming of raw products is carried on in conjunction with agriculture and within the homes of the people.



The productive activity for instance going on in kitchens is, strictly speaking, of the same character as that which goes on in factories: bread-making as practised in the home is in essence precisely the same type of occupational activity as the making of bread on a large scale in a big modern steam bakery. Even where the parallelism is not so complete as in that instance the activity is nevertheless fundamentally the same: kitchens no less than factories are concerned in the working up of raw products. In the same way there is of course only a formal difference between butter that is churned in a farm dairy and butter that is turned out at a co-operative creamery, between suits or costumes that are made in the wearers' own homes and those that are produced at a clothing factory.

If the term industry were to be taken in this wider sense, our figures would be far below the mark, for a much larger proportion of the work of the people is spent in industry in that sense than is shown by the occupational census returns. The concept "industry" however does not in current parlance carry that purport but quite a different one, viz. the working-up or transforming activity that goes on in

self-contained establishments of a certain given size and compass. Take for instance a manufacturing works; to be included in the Swedish statistics of industry it must be employing a staff of workmen numbering at least ten. Hence there is deliberately excluded from "industry" as understood by the statistics the work done not only by those engaged in working up raw materials on farms and in private homes but also by those employed in the small industries, by those that is to say who pursue some handicraft or other. Then again no notice is taken of such labour as is accomplished at other than fixed stationary establishments,

though that necessarily involves the complete exclusion for instance of building-work which, if it were counted in, would figure as by far the largest of all the various branches of industry.

The question may be asked: Is it justifiable for the statistics of industry to ignore in that way so large a share of the activity devoted to the working up of raw products? Or: Would it not be more logical to group together all the forms of the same type of activity? The answer must be that the method followed is justifiable. The acceptance of the term in the ordinary language of everyday life coincides with the sense that the statistics attach to it: what is in view is not so much the activity in itself as the type of undertaking, for what one has in mind is in fact that creation of the modern age known as an industrial enterprise.

The manufacturing work done by an industrial enterprise differs in a variety of ways from that carried out either in people's homes or in the form of handicraft. It may suffice in this place to mention one point only: the activities last mentioned arise spontaneously in all countries to approximately the same relative extent, coming into existence as a natural consequence of there being a community of people gathered together. An industrial enterprise on the other hand never springs up of itself; for its generation the pre-requisites are: energy, venturesomeness, the faculty of organization and good economic judgment. Hence the question as to whether manufacturing industry is likely to establish itself in a country depends essentially on the presence or absence of that factor of production: the spirit of enterprise. If that is wanting then natural resources will be of little avail no matter how abundant they may be, while if it is there then great results may be achieved with relatively insignificant foundations to build upon. The enterprising spirit alone however is not enough: it must be backed up by efficiency and keenness for work on the part of the workers. Apart from natural resources the success of industry ultimately depends on there being a supply of bold and skilful undertakers and of reliable and proficient workers.

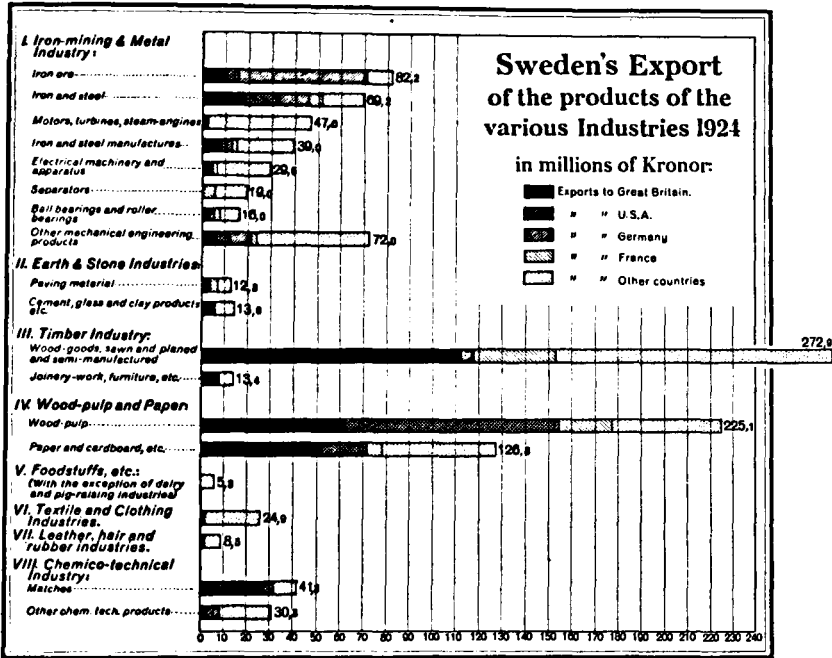
Now enterprising spirit and labour energy differ widely in quality from one country to another and hence there is scarcely any occupational branch that is so variable in its quantity and scope as manufacturing industry. There have been in the past and there still are countries where, in spite of the requisite natural conditions being favourable, industry has not thriven and is for the most part run by aliens,

whereas there are other countries where the state of things is just the reverse. What we now propose to discuss is the position of Sweden in that particular.

In dealing with the Swedish industries it is undoubtedly best not to take them all together but rather in the three main categories into which they naturally fall, viz. (a) *essentially export industries*, (b) *home-market industries* and (c) *specialty industries*.

(a) Most of the countries of the world have been endowed by Nature with more extensive resources of some form of wealth than their peoples require for their own consumption. In some instances it is the soil that is superabundantly fertile: the inhabitants can produce more foodstuffs than they need and in exchange for the surplus can secure the products of foreign countries. In Sweden that is not the case, for the produce of her soil does not quite suffice to meet the food requirements of her people. On the other hand she has two resources to use as a medium of exchange for securing what she needs from abroad, viz. the timber of her forests and the ore of her iron mines.

Of those two resources forest timber is the more important and it is the manufactures based upon the utilization of forest timber or lumber that form the foundation upon which the modern Swedish industrial edifice is built up. Those manufactures fall principally into two groups: (a) sawmills, including planing-mills and joinery-works, and (b) wood-pulp factories, including paper-mills and pasteboard-mills. The first to spring up were the sawmills and it was their rise in the fifties of last century that has contributed most towards bringing about the transformation of Sweden's economic life in recent times. All at once people discovered that goods that up to that time had had no market value could be disposed of at a handsome profit. Their disposal brought a stream of money into the country and helped materially towards rendering the pressing problems of employment more easily solved. The output of these industries grew from decade to decade and more and more labour was absorbed by them. As a matter of course however that state of things could not persist for ever. The sawmill industry owed its origin and immediate success to the existence of virgin forests to be cut and worked up, that is to say of a stock of timber that had been allowed to accumulate undisturbed for generations, and it was only natural that a certain reaction should set in when those immense resources began to be exhausted at about the



turn of the century: the sawmill industry was then at its zenith and has since tended to remain stationary on a somewhat lower level.

Any slight loss of ground experienced by the sawmills has however been more than retrieved by the advance of the wood-pulp mills. The timber that is best suited for their requirements is the smaller dimensions left standing in the forests and trees that are still in process of growth; with those resources to draw upon the wood-pulp industry has gone steadily forward ever since its start and shows no sign as yet of retardation. On assessing the development achieved by these industries in terms of the labour employed, we find that the sawmills by themselves give evidence of a certain decline since 1900 but that if the two industries are combined the figures indicate a continuous increase. From 1900 to 1912 for instance the number of workmen rose by 4,000 and if we compare 1913 and 1924 we find that the total number of employees went up in that period from 68,000 to 75,000. (In 1913 the method of compiling the statistics underwent a change that ren-

ders comparison between figures before and after that date out of the question.)

Now is that constant increase destined to continue in the future or will it yield place to a diminution? That is one of the most interesting questions to which Swedish industrial life gives rise at the present time; it is not however within the scope of the present discussion to answer it. Suffice it to say that it is a matter that is dependent on the yield of the forests and has been dealt with in a preceding chapter of this work. What we have here to ask ourselves is whether the Swedish industries have been and are able to utilize satisfactorily the abundance of raw materials of this description that the country has been and still is possessed of. The reply to that question cannot but be that they have shown themselves able to do so remarkably well. Thanks to excellently devised means of transportation (the timber floating systems), to an organization and technique that are constantly being improved and to a selling-policy that serves its purpose efficiently, Sweden has reached the point of having practically speaking all her forest resources utilized to economic advantage. The processes of working up and manufacturing have indeed been carried further than could have been predicted beforehand as possible, that being more especially the case with respect to the paper industry. As wood-pulp is admitted into most countries duty-free while paper is liable to a heavy duty, it might be expected that people abroad would always find it advantageous to buy Swedish pulp and make their paper themselves rather than to purchase Swedish-made paper; and yet by devising an ingenious system of specialization and turning out papers of superior grades Swedish manufacturers have managed to create a considerably extensive export trade both in paper and pasteboard.

The success that has crowned the efforts of Swedish industrialists to work up and utilize forest products to the full extent, is of very special importance from the point of view of Sweden's foreign trade. The yield of the forests in its various forms constitutes actually more than half of the total goods exported; its true significance however is not fully reflected even by that great preponderance, for among the commodities that Sweden exports to abroad it is practically speaking only those deriving from the forests that substantially exceed her imports of the same or similar class. There is for instance some exportation of farm produce, e. g. bacon, butter etc., but the importation of the same class of goods, e. g. cereals, concentrated cattle-foods etc.,

— INDUSTRY AND MEANS OF LIVELIHOOD —



Ore Steamer on the Luleå Fjord (Northern Sweden)

In the background, Luleå; in the foreground, the ore railway station on the island of Svartö. Between 1 and 2 million tons of Lapland ore are dispatched from this port annually.

is larger; although iron ore is exported in very great quantity yet other ores, e. g. copper, tin, lead etc. or goods manufactured out of them, have to be imported; there are a great number of machines sold annually to foreign buyers but almost if not quite as many find their way into the country from abroad. It is only in forest products that a substantial balance is left over in Sweden's favour; it is in exchange for such products that she is able to purchase those foreign-produced goods that she cannot do without but which it is impossible for her to produce herself, e. g. mineral coal, oils, colonial produce, cotton, wool etc. Hence Sweden's forest products form the backbone of her foreign trade.

Iron yields a balance too, though a smaller one. Nature bestowed upon Sweden a superabundance of ores but unfortunately neglected to add to her favours by providing the requisite mineral coal for working up the ores, so that an utilization of them on the spot in most cases is scarcely to be thought of. The fact is that the Lapland iron ore is predominantly phosphoriferous and cannot be remuneratively converted into steel by the agency of charcoal as a fuel. For its conversion cheaper mineral coal is essential but to establish a large-scale iron and steel industry with imported coal is an impossibility. There is no competing with countries possessed of both coal and ore ready to hand and hence the Swedish ore has to be exported in the crude state, which

however proves a very lucrative business in itself. The ports from which the ore leaves the country are Narvik in Norway, Luleå and Oxelösund. With respect to those iron ores that contain only a small percentage of phosphorus, matters are quite different: an industry arose for their manufacture long ago and, growing to what were for Swedish conditions very considerable dimensions, has been consistently pursued down to the present time. Its period of greatest prosperity belongs however to the age preceding the discovery of the art of iron-manufacture with mineral coal. Thus while in the 18th century Sweden ranked first in the world as an exporter of iron manufactures she has now to rest content with a very low place on the list. Owing to the heavy costs entailed by the production and transportation of charcoal the manufacture of iron and steel by its means is very expensive, although the resulting articles are of an exceedingly high quality and find customers all over the world.

Figures illustrating the compass and the various aspects of the Swedish iron and steel industry are to be found in another section of this volume; what we have to note here is the remarkable circumstance that the products exported by Sweden are predominantly steel and highly finished goods. As a matter of fact all the advantages that Nature has bestowed on Sweden with regard to this particular manufacture affect pig-iron alone. The pure non-phosphoriferous Swedish ores when smelted with charcoal yield a pig-iron of the very highest quality that can possibly be produced, but for transforming that pig-iron into steel Sweden is not endowed with any special natural prerequisites. Now when it is remembered that pig-iron as an imported article is in no country liable to any but a very insignificant duty, being indeed in some cases duty-free, and that steel on the other hand is almost everywhere subject to a very high rate of import duty, it is not unreasonable to conclude that the most economically advantageous plan for foreigners to adopt, would be to purchase Swedish pig-iron and convert it into steel themselves. That is only done however on a very small scale; as a rule barely one fourth part of the pig-iron turned out in Sweden is exported, while the exports of steel are larger than those of pig-iron not only in value but also in actual bulk. The fact is that, owing to specialization having been carried very far and technical skill perfected to a high degree, Swedish steel is of so excellent a quality that customers abroad, rather than purchase the pig-iron for conversion in their own steel-furnaces, prefer to buy the fin-

ished article. Moreover it is not the steel in its simplest form that is exported most largely but rather the products from it that have been subjected to manufacturing processes and even the finished articles issuing from the Swedish engineering and machine shops.

Timber and iron are the two principal resources from which Sweden secures a surplus in her export trade. There are a few others however that deserve to be mentioned: Swedish stone is sent abroad in considerable quantities as are sundry products that may be considered as arising out of the Swedish surplus supply of water-power, viz. calcium carbide, calcium cyanamide and ferro alloys. On the whole it may be fairly asserted that Sweden has succeeded well in availing herself of all the resources that Nature has bestowed upon her wherever there has been any possibility of doing so on a sound economic basis.

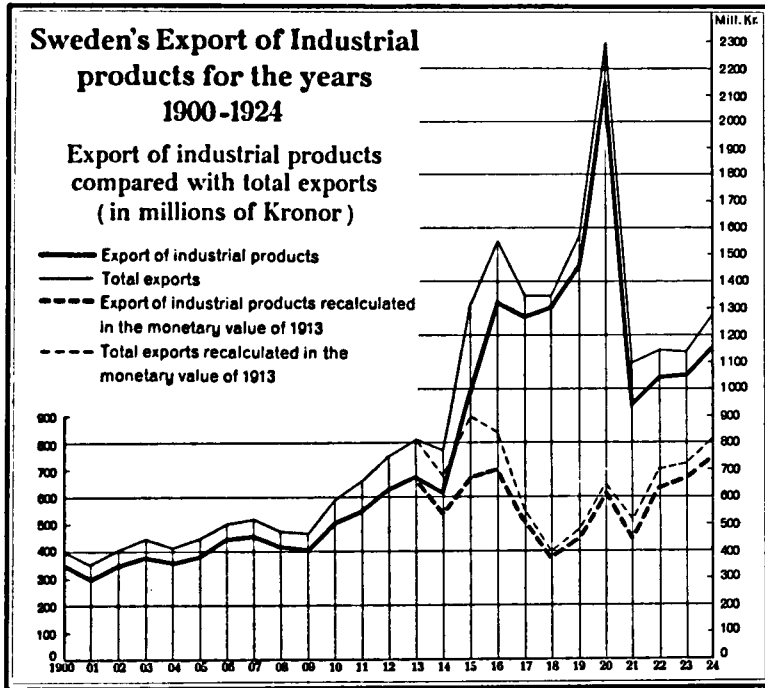
On summing up the number of hands employed in industry in the narrower sense of the term as above defined, we discover that in 1924 the workpeople numbered 380,000 and the administrative staffs 39,000, amounting together approximately to 420,000. If now the members of their families are counted in as well, it will be fair to state that the total covers something like one fourth of the entire population of the country. What proportion of that number would fall under the industries characterized above as "essentially export-industries" it is difficult to say since the borderlines are not clearly defined, but presumably it is about 41% or 42% of the Swedish industrial workers that derive their livelihood from this class of occupations.

(b) The second category of Swedish industries embraces those types of occupation that are concerned wholly or to a preponderating extent in supplying the needs of the home market. In this category we come across those factories that have usurped the functions of the old-standing trades and handicrafts. Foremost amongst them is the group of textile industries, employing 37,000 workpeople; they take rank after the sawmills and the engineering and machine shops. Next comes the boot and shoe industry. Just as textile mills superseded the domestic making of clothing stuffs, so this industry took over the rôle formerly played by village shoemakers. The boot and shoe industry has some 10,000 hands on its pay-rolls but of it and of the textile industries it may be said with truth that their importance cannot be measured merely by the numbers of their workpeople. The fact is that there are hardly any branches of industry in which the machinery equip-

ment has been brought to such a high pitch of perfection, involving a corresponding economy in human labour, as is the case in these two. What that means is brought home forcibly and unforgettably to anyone who has once watched a piece of leather pass through a hundred or so machines of various kinds to emerge finally as a finished shoe, or who has similarly beheld the functioning of the ingeniously devised and practically self-tending machines in a modern textile mill.

In addition to the two industries above named there are a number of others of various kinds that supply the needs of the home market. Some of them, e. g. flour-mills, creameries and sugar-refineries, work up the products of farms and certain others also use raw materials that are Swedish in origin, e. g. brickyards and to some extent glassworks. (Some of the glassworks assign a by no means inappreciable part of their output to export, and hence belong by rights under category (a)). Besides the industries above enumerated there are many others of a varied character, e. g. breweries, spirit-distilleries, tobacco-factories, tanneries, rubber-factories, printing-works, chemical works etc., to which however only this cursory reference is possible. Engineering workshops also come in here in some measure.

As a whole the category probably covers upwards of one-half of all the industrial workers in the country and hence, from the point of view of the numbers employed, may be said to embrace the major part of the Swedish industries. If one wished to pass verdict on this category it might fairly be stated that in general it displays an exceptionally high degree of development, and though that is to some extent discounted by the fact that the industries represented are almost all in enjoyment of some amount of protection, yet it must be pointed out that the protective duties are on a lower scale than those in most other countries and that in many other quarters, in spite of a much higher degree of protection, the industries that supply the needs of the home market have not attained to anything like the same standard of development as the corresponding ones in Sweden. The impression forces itself upon one moreover that, even if an international free-trade system were inaugurated, this category of Swedish industries would be quite capable of maintaining their ground and holding their own along almost the whole line. That impression is further strengthened by the remarkable circumstance that a number of these industries have not been content with supplying the needs of the home market, for they have worked up for their products a by no means insigni-

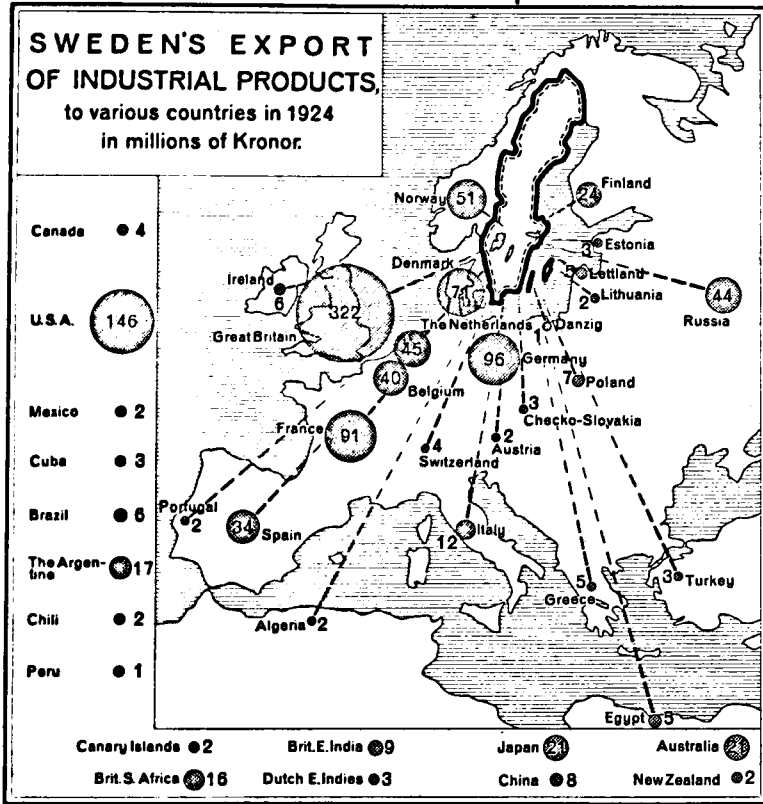


ficant export trade as well. That is primarily true of the Swedish galosh factories but it applies to woollen mills and other enterprises as well.

(c) It remains for us to glance at the third main category of Swedish industries. The two categories already dealt with are types of occupation pursued for a livelihood that arise so to say of themselves and are represented in varying degree in every country. There is however in certain countries a third category of industries, often relatively small but exceedingly important, to which one might give the name of specialty industries. In character these are exporting industries but they are not based upon and have not been called into existence in consequence of any natural resources of which the country in question can boast. The characteristic feature of them is that they are the progeny of three special qualities possessed by the people of the country: faculty of invention, gift for organization and spirit of enter-

prise. Accordingly another very apt designation has been bestowed upon them: intelligence industries. Every people that has any grit has at least one such industry, many have several. England leads the way with her multiplicity of them: in the first instance, her textile industries fall almost entirely under this heading. Then Germany has her dyeing and other chemical industries, while in the United States of North America they would point doubtless to their motor-cars and in Switzerland to their watches. As for Sweden we may fairly say with some amount of satisfaction that she is equipped with a singularly goodly array of undertakings of this type. It is indeed a question whether in proportion to population any country can vie with her in this particular. A beginning was made with matches, the manufacturing of which has gradually developed into a world-wide undertaking. Then there came separators and telephones, to be followed by gas-accumulators, ball-bearings etc. The Swedish engineering workshops come largely under this head, such as for instance the manufacturing of electric motors and oil engines etc. These industries do not perhaps play a very big part quantitatively, as they give occupation to only a comparatively speaking small number of workpeople; from the fact however that they constitute an extra over and above what was so to say to be counted upon, their importance is very great and they bear witness in telling fashion to the stamina and inherent vigour of Swedish industrial life.

The part played by industry in the economic life of a country can be measured in various ways. In the present discussion we have concentrated our attention as regards Sweden on the numbers of the industrial workers and in doing so we discovered that, if handicrafts and minor industries are included, industry gives occupation to upwards of one third of the population, while industry proper is answerable for about one fourth. Those figures give as stated the amount of labour that industry finds employment for, but if we now turn to capital, with a view to making that a criterion, we have a basis to go upon in the figures resulting from the National Wealth Investigation of 1908. Industry was then assessed at a property value (i. e. real estate, engines, machinery, internal equipment, transport appliances, stores and stocks) of 1,914 million kronor out of a total national wealth of over 15 milliards. At that time consequently industry's capital apart from money amounted to 12 or 13 per cent. of the



national wealth, which means that from this point of view industry plays a humbler rôle than it does as an employer of labour; it is not in fact in the proper sense of the word a capitalistic branch of employment, for in proportion to the amount of labour it employs, it requires as a rule far less capital than do other types of occupation. Its strong point is its capacity for employing a large number of work-people.

In another department the significance of industry in Sweden is all the greater, viz. in respect to her foreign trade and especially to her exports. The most salient feature of the Swedish export trade is

the preponderance of the products of industry over all others, the exportation of agricultural and raw products being relatively small. The former constitute probably 90 % of the whole and the industrial life of the country is organized in accordance, no less than 35 % of the industrial workers, it is calculated, being engaged in the production of goods that are intended for export.

To estimate a country's industry properly one must take cognizance of the resources that it has at its disposal. If we do so with regard to Sweden we shall be justified without undue presumption in saying that she has made good use of the gifts with which she has been endowed in the form of natural resources and has known how to avail herself of the possibilities afforded her for opening up industrial activity in a variety of directions. In taking a survey of the whole field one can hardly discover a single gap of any appreciable size where energy and initiative can be said to have been wanting, whereas there are many spheres within which far greater achievement has been attained than one could have imagined in advance would prove possible. The final summing up must in any case be that, having regard to the natural possibilities of the position in which she is placed, Sweden is distinctly one of those countries that have contrived by enterprise and skilled labour to develop their industries in a most effective manner.

The fact of Sweden having attained success in that direction has been of the utmost importance in promoting the prosperity and the material well-being of her people. In order to bring out clearly the degree of that importance, we might perhaps venture upon the mental experiment of imagining what it would mean to Sweden if one of her large and economically well-founded industries were to cease to exist. Let us suppose for instance that Sweden were to be deprived of her forests and her lumber industries. The nation's existence would not thereby be actually imperilled or jeopardized, but the whole of that large body of workers that are now engaged in the lumber industries of various kinds would of necessity have to seek employment in some other walk of life. Other jobs of work would have to be found for them, which in most cases would undoubtedly prove less productive of gain from the greater competition with their fellow-workmen. Sweden would still presumably be in a position to purchase from abroad those commodities that she imperatively needs, even if she had no timber goods to give in exchange, but she would be constrained to

relinquish consuming some of the articles that she now enjoys in order to export them instead, and would besides have to devote herself to the manufacture of other wares for export purposes that she does not as it is find it advisable or profitable to turn out. It is not difficult to realize that great efforts would be necessary in those directions and that a serious decline from the present standard of prosperity in the country would inevitably have to be registered.

Swedish industrial life as a whole has attained an appreciably high standard of efficiency and in the process — in so far naturally as the development rests upon a sound economic basis — it has played an important part in raising the Swedish standards of living and of prosperity to a level that is admittedly high in comparison with those of other countries. Whether that high level can be maintained or no will principally depend upon how the industrial life of the country comes to develop as time goes on. To foretell what is to come is of course impossible but all the premonitory signs would seem to indicate that the economic life of the world as a whole is gradually approaching a critical phase and that we are entering upon a period in which the struggle against the shortage in Nature's provision for man will be severer than heretofore and when the continuous increase of population will put a greater and greater strain on the powers inherent in economic life to expand and develop. There is no reason whatever to assume that Sweden's part and lot in the struggle will in any sense be privileged or specially light to bear; the prospects point rather in the opposite direction. Hence in all probability we have to await the coming of a period in which Swedish commercial and industrial life all along the line will be put to the test more severely than in the past. It is in no sense to cast a slight upon the importance of the other means of earning a livelihood when we assert that in the circumstances foreshadowed industrialists will be placed in the most precarious position and will have the most responsible post to fill. The results however that industry has already achieved justify the confident hope that it will prove in the future as in the past capable of accomplishing the tasks allotted to it and that consequently it will do all that is expected of it in maintaining and maybe in raising still higher the economic standard already reached.





SOME DATA ON MODERN SWEDISH INDUSTRY

by

EINAR HUSS

In the later part of this volume the Swedish industries will be passed in review, one after the other. It will perhaps be easier to obtain a general notion of them if we first refer to some of their external features. The strongest impression made by the reading of the second part of this work is undoubtedly that Swedish industry has advanced by gigantic strides since the middle of the last century. Before we proceed to form for ourselves some idea of the present-day composition of Swedish industry, it may be well to say a few words as to the time when some of the larger industries came into existence.

The industrial revolution which had been visible earlier in other countries, and which can trace its origin back to the invention of the steam-engine, did not really begin in this country until about the year 1850. It was at that time that the first two steam sawmills were built, at Vivsta and Kramfors; and this inaugurated a long period of prosperity for the sawmill industry. Production was increased and cheapened by the erection of one steam sawmill after the other; and the costs of transport were reduced by building these establishments on the sea-coast and by shipping the goods by steamers instead of by the slower sailing-ships. Somewhere about the same time a beginning was made, at the afterwards world-famous factories in Jönköping, of the manufacture of safety-matches, a business which in due time was to give rise to the world-embracing Swedish match industry of our own time.

It was not, however, merely the increased utilization of the forest resources and the introduction of technical improvements in the manu-

— SOME DATA ON MODERN SWEDISH INDUSTRY —

facture which now enabled Swedish industry to forge ahead. Apart from the use of steam-power in navigation, the means of communication were also improved by the construction of railways and canals. Legislation establishing greater freedom of trade swept away powerful obstacles in the way of the development of industry, and fresh legislation concerning limited liability companies facilitated the development of this form of industrial enterprise. Conditions had arisen which were distinctly more favourable for the pursuit of industry on a large scale; and in the older industries of the country, especially the iron industry — whose methods of production also underwent revolutionary changes during the next few decades — operations began to assume greater and greater dimensions.

The first half of the 'seventies was a period of industrial boom in almost all countries, not least in Sweden. In these years old Swedish industries, for instance the textile industry, underwent a rapid process of development. But entirely new branches of manufacture also rose at this time. Then came the first years of growth for the cellulose industry, which has since then doubled the value of its output almost every five years, and which is now one of the chief industries in Sweden. It was at that time, too, that the first cement factory was established at Lomma, in the extreme south of Sweden, the first superphosphate factory at Gäddviken outside Stockholm, and the first shoe-factory at Vänersborg at the south end of Lake Vänern. Even though the real development of these last-named branches of manufacture was of later date, yet the factories last mentioned still take the lead in their respective branches of activity. From the 1870's also may be dated the rise of the Stockholm concerns, Separator and L. M. Ericsson (telephones), which have since become very important exporting enterprises. We have also to reckon from the same time the beginning of the prosperity in the hardware industry that has gained a reputation under the name of the Eskilstuna industry (cutlery).

Under the pressure of a general crisis in European agriculture a period of industrial depression set in during the 1880's. None the less the work of founding new industries continued during that decade, when two of the leading large-scale enterprises in Sweden came into being. Thus the discovery of what is known as the "Thomas process" rendered possible the production of iron from ores rich in phosphorus; and in the beginning of the 'eighties the first steps were taken to exploit the rich deposits of that kind of ore, which are now mined by

the company known as Trafik A.-B. Grängesberg-Oxelösund. At the same time too arose the concern which developed into Allmänna Svenska Elektriska A.-B. (Asea), the first representative of the electric industry in Sweden, which afterwards, in connection with the harnessing of the waterfalls and the electrification of the country, has attained considerable dimensions.

From the following decade, the last in the 19th century, industry all over the world reached its high-water mark, which, with brief interruptions, continued until the outbreak of the World War. Probably this general expansion was for the most part due to the rise in prices which was a consequence of the fact that gold, the measure of the value of money, fell in value in relation to goods as a result of the great new finds of gold in South Africa etc. But technical progress has also been of great importance, especially in the sphere of the problems of electric power and in motor technique.

If this rise in the state of business gave a general impetus in Swedish industry, yet the impetus was especially noticeable within those branches of manufacture which enjoyed the benefit of the customs protection introduced at the beginning of the 'nineties. It was at that time that the sugar industry swelled out into a great enterprise on a large scale. The same applies to the clothing and hosiery industries, the manufacture of leather and shoes, the manufacture of rubber and certain branches of mechanical engineering — all of which enjoyed the support of protective tariffs. Within the branch of manufacture last-mentioned, however, even those concerns which were not protected by the customs tariff but were directed to export trade enjoyed a great period of prosperity. This state of things continued during the earliest years of the new century, the first decade of which was marked by the coming into existence, amongst others, of such enterprises as A.-B. Svenska Kullagerfabriken (S. K. F. ball-bearings) and Svenska A.-B. Gasaccumulator (gas-accumulators for A.G.A. flash-lights etc.). The beginning of the 20th century is also a time of fresh prosperity for the Swedish shipyards, and during the same period the chemical industry begins to assume the forms of large-scale industry.

The following diagram gives one a measure of the variations in the number of industrial workers; and this, amongst other things, confirms the above statement that growth of industry was especially marked during the 'nineties.

— SOME DATA ON MODERN SWEDISH INDUSTRY —

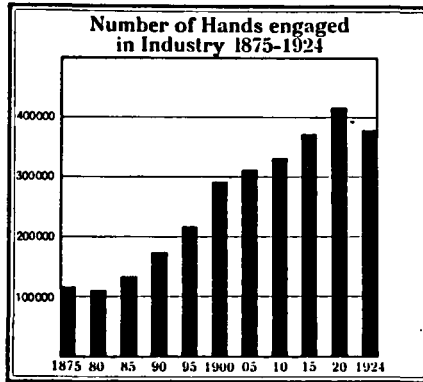
Two natural questions now arise. One is: What is the relation between this advance of industry and that of other occupations? And the other is: Has the industrialization of Sweden during the last fifty years been more rapid or less rapid than in other countries?

The first question has already been touched upon in this work (Diagram p. 42); and so it is only necessary to add the following here. In 1840,

it was calculated that about 8 % of the population of Sweden obtained their livelihood from industry, while somewhat more than 80 % made their living by agriculture. And if we go back another century or so, we shall find the figures the same, on the whole. At the last two censuses, one just before and the other just after the World War — or, more precisely, in 1910 and in 1920 — on the other hand, the conditions had changed to such an extent that industry provided roughly one third of the population with their daily bread, while agriculture provided for scarcely half of the population. Thus since the middle of the 19th century industry has attained four times greater importance in comparison with other occupations and sources of income.

The second question, on the other hand, is more difficult to answer, inasmuch as the census authorities in different countries return the number of the industrial population on different principles, with the result that the figures obtained are hardly comparable as between one country and another. Nevertheless the industrial population, in the sense of the term adopted in the different countries, grew during the period from about 1880 to 1910 by more than 2 % per annum in Sweden, but only by 0.75 % in Germany, 0.40 % in Denmark, and 0.15 % in England. It is difficult to imagine that the considerably greater rise in Sweden to which these figures bear witness is entirely, or even mainly, the result of the different methods of compiling statistics in the different countries.

We may easily convince ourselves that the increase really was greater in Sweden by comparing the consumption of coal in Sweden



with the total world-consumption of coal. The figures available on this point show that the consumption of coal in Sweden after the 1870's grew more rapidly than in all other countries taken together, and that Sweden during the 'nineties increased its share of the world-consumption of coal from 3.2 ‰ to 4.2 ‰. As industry is decidedly the foremost consumer of coal, and as, moreover, Sweden during this time has increased its consumption of water-power for industry to a far greater extent than other countries, we are led by the comparisons we have made to the conclusion that the progress of industry in Sweden in late years has been greater than in any other country in our part of the globe.

It was not until 1896 that the official statistics of industry in Sweden furnished the possibility of a detailed study of the development of industry. Down to the outbreak of the World War, at any rate, industry showed a marked tendency towards large-scale enterprise and the ever-growing use of machinery. The mechanical power which was used in industry, for instance, amounted to 1.3 HP per worker down to 1897, while the corresponding figure was 3.2 HP in 1913 and 4.0 HP in 1920. As regards the magnitude of the individual concerns, it may be mentioned that during the period 1896—1913 the number of the workers at each "place of manufacture" increased on an average from thirty to forty, while the number of enterprises with at least 500 workers had more than doubled.

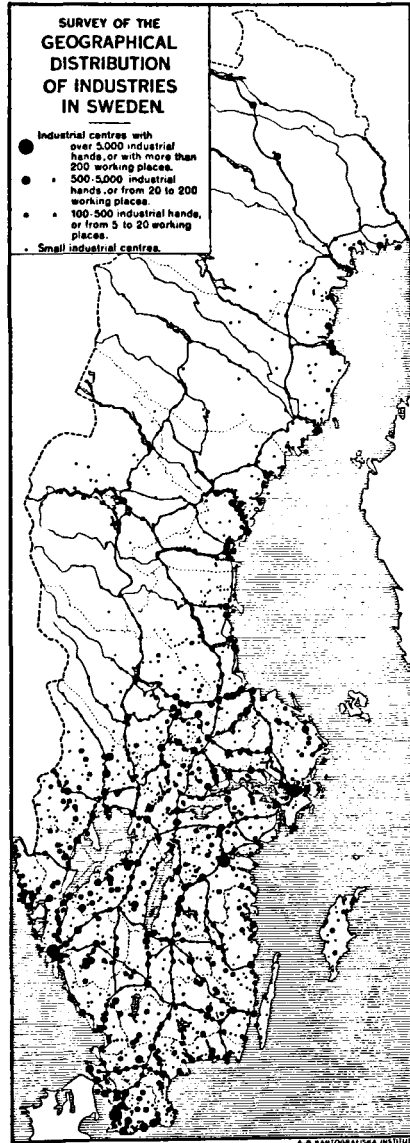
The geographical distribution of industry over the country is illustrated by the general survey map on the next page. If we investigate the question where industry is locally most highly concentrated, it proves that the largest industrial centres are the biggest cities, Stockholm, Göteborg, Malmö, and Norrköping. For the rest, as will be seen by the map, industry is very strongly concentrated to the southern and central parts of Sweden and to the special sawmill and wood-pulp districts in the province of Västernorrland, outside Sundsvall, and along the lower course of the River Ångermanälven. These last two industrial regions are, too, with that in the west of Sweden, the areas in which operations are carried on on a large scale to more general extent than elsewhere.

In different parts of Sweden quite different branches of industry are carried on. Those industries which take a predominant part in

— SOME DATA ON MODERN SWEDISH INDUSTRY —

Swedish export are based upon natural resources, the forests and mines, and they are largely localized in accordance with the position of the latter, that is to say, in Norrland and Svealand, i. e. the northern and central parts of the country. A consequence of this is that manufacture for export has a proportionately larger range in these parts of the country than further south.

Let us now proceed to take from Swedish official statistics some data concerning the *scope and organization of Swedish industry at the end of the first quarter of the 20th century*. Here it will be well to call to mind the fact that the depression following the War was at that time still felt. The annexed table brings together data as to the number of workers and "places of manufacture" in the year 1924, as distributed among different main groups in industry. As appears from the table, Sweden numbered about 380,000 *industrial workers* at the end of the quarter-century in question. In respect of the number of workers employed the timber industries proves to stand in the first place. If we follow the division into groups adopted in the table, we next come to the machinery and



— SOME DATA ON MODERN SWEDISH INDUSTRY —

engineering industry, then to the textile and tailoring industries, and in the fourth place to the paper and printing trades, etc. The smallest group is "power-generating, lighting and waterworks", which group occupies a special position of course and indeed can scarcely be regarded as an industry in the proper meaning of the term.

	1 9 2 4	Number of hands	Number of hands %	Number of places of manufacture
Mining		8,800	2.8	113
Iron and metal works and the manufacture of iron and metals		43,000	11.8	758
Machinery, shipbuilding, electrical and other engi- neering industries		54,100	14.8	1,003
Mineral and stone industries		38,300	10.1	976
Timber industries		57,100	15.0	2,013
Paper and printing industries		48,000	12.7	880
Foodstuffs industries		41,600	11.0	3,361
Textile and tailoring industries		50,600	13.8	632
Leather, hair and rubbergoods industries		17,900	4.7	398
Chemical industries		14,000	3.7	354
Power-generating, lighting and water works		6,200	1.6	705
		Total 379,600	100.0	11,193

In this connection it may be mentioned that, according to an inquiry carried out by the Federation of Swedish Industries, about 28 % of the Swedish industrial workers may be regarded as occupied in the treatment of Swedish forest products, 17 % in the mining and working up of Swedish ores, 9 % in the quarrying and working of various kinds of mineral and stone in Sweden, and 10 % in the working up of the produce of Swedish agriculture. Altogether, therefore, 64 % of the workers may be estimated to be engaged on the production and working up of Swedish raw materials, while the remaining 36 % are engaged on working up foreign raw materials.

Of the industrial workers of the country nearly 20 % consist of women. Female labour is employed on a particularly large scale in the textile and tailoring industry, the boot- and shoe-making industry and certain foodstuffs industries. The number of employees who are not of full age ("children and young people") amounts to about 10 %.

According to the table, the number of "places of manufacture" amounted to about 11,200, and the final sums in this table show that the average number of workers per place of manufacture was 34 at the end of the first quarter-century. A very large proportion of these "places of manufacture"; however, are of far smaller dimensions, because Swedish industrial statistics include undertakings whose annual output is as little as 20,000 kr. in value.

— SOME DATA ON MODERN SWEDISH INDUSTRY —

The branches of industry where small-scale industry does not occur at all, or where the great enterprises predominate even in number, are the sugar, tobacco and match-making industries, together with linen, jute and rubbergoods factories, with an average of more than 300 workers per factory. The size-group with 100—200 workers per "place of manufacture" includes iron and steel works, shipyards, electrical industry, coal-mines, stone-quarries, cement and chinaware factories wood-pulp and paper mills, cotton and woollen mills, and superphosphate factories. Of the well-nigh 1,200 sawmills in Sweden only about one tenth have more than 100 workers per "place of manufacture". Altogether, however, this tenth employs more than half the total number of sawmill workers. In the highly varied machinery and engineering industry also undertakings of all possible magnitudes are at work, from workshops on a very unpretentious scale up to great factory aggregates, where more than a thousand men are engaged. And among the ore-mines too there is a similar mixture of small, medium-sized and very considerable concerns. Quite naturally, on the other hand, various industries with a more or less restricted local market, such as brickyards and bakeries, breweries, flour-mills and dairies and other branches of the foodstuffs industry are mainly on a small scale. Amongst tanneries too the large undertakings are also in the minority, while a larger type is relatively more common amongst shoe-factories and in the ready-made clothing and knitted goods industries. The average size of Swedish factories would seem, as a rule, smaller than in the leading manufacturing countries of the world. And this is readily explainable, of course, in view of the small range of the Swedish market in comparison with the home markets of America, England and Germany. In the competition with foreign countries this state of things is a decided drawback, inasmuch as a great part of Swedish industry, which works more or less exclusively for the home market, cannot diminish its costs of production by mass production to such an extent as to stand against the superiority of foreign countries in this respect. For export industries, of course, the conditions are quite different.

In what has been said above the number of workers has been taken as the basis for judging the magnitude of the industries. But this cannot be regarded as a suitable measure from all points of view. The number of workers chiefly gives the importance of the different

— SOME DATA ON MODERN SWEDISH INDUSTRY —

branches of industry in providing a livelihood for the population, but tells us nothing about the value of the industrial work that has been carried out.

In comparisons concerning the magnitude of the industries in relation to one another figures are sometimes used referring to the value of the output. But the official statistics on this point contain a considerable proportion of double entries, owing to the fact that products of one branch of industry serve as raw material for another and have therefore been included twice over or more in the sum-total of the estimated output value. This makes comparisons between output values of various industries extremely unreliable. In the appended table, therefore, the "*working-up value*" of the chief industrial groups is given instead — that is to say, the sale-value of the industrial pro-

	Working-up value	
	Mill. kr.	%
1 9 1 3		
Mining	59.2	6.8
Iron and metal works, and the manufacture of iron and metals	98.8	11.8
Machinery, shipbuilding, electrical and other engineering industries	149.6	17.1
Mineral and stone industries	64.2	7.4
Timber industries	107.7	12.3
Paper and printing industries	105.1	12.0
Foodstuffs industries	138.8	15.9
Textile and tailoring industries	82.4	9.5
Leather, hair and rubbergoods industries	26.4	3.0
Chemical industries	41.0	4.7
Total	873.2	100.0

ducts after deducting the cost of the raw materials, fuel and power consumed. These figures, which are free from the flaw of counting the same things twice over, thus give *the value of the work performed by the different industries*: hence the name "working-up value". It must be pointed out that these figures refer to the year 1913 and are based upon a special inquiry made for that year, to which there is nothing corresponding for later years. To judge by these figures, more than one third of the industrial work in Sweden was carried out in the industries concerned with mining and with the treatment of iron, metals and machinery, while the corresponding figure for the industries that work up the produce of the forest (the wood and paper industries) was about one fourth.

It now remains to deal with the substantially different development of the various industries since the time before the War. Although, as has already been said, the double entries which occur in

— SOME DATA ON MODERN SWEDISH INDUSTRY —

the output-values in the official statistics make comparisons between different branches of industry on the basis of those values impossible, yet these output-values may be employed as an approximate measure of one and the same branch of industry during a certain period of time. We find that many branches of industry have not yet got back to the productivity of 1913 after the severe depression that followed the World War; this holds good more particularly of the iron industry. On the other hand, some branches, especially the wood-pulp and paper industries, have undergone a distinct development.

In the preceding pages when we have spoken of "the places of manufacture" within the different industrial groups, we have altogether ignored the fact that several such "places" may be found within the limits of the same concern. As a matter of fact there are a large number of undertakings in the country which either own several factories with the same kind of manufacture, or else carry on manufactures of quite different kinds in one or more places.

The reasons for such combined activity are roughly speaking threefold. Thus, it is only natural, of course, if the owner of several kinds of natural resources should himself start different industries for turning these resources to account. Many of our old ironworks have found themselves in this position. In former days they mainly utilized their forests for the production of charcoal for the manufacture of pig-iron; but nowadays, side by side with their ironworking operations, they have taken up sawmilling operations and the manufacture of wood-pulp and paper.

Another equally natural reason for combined activity is that the manufacturer of a certain kind of finished products should acquire his own plant for the production of the half-manufactured articles that he needs for his proper manufacture. Thus, for instance, the pre-eminent properties of the Swedish ball-bearings being largely due to the high quality of Swedish steel, the A.-B. Svenska Kullagerfabriken (S.K.F.) have now their own steelworks for the manufacture of the special steel required for those bearings. Such co-operation between factories in the various stages in the process of producing a certain article (vertical combination) occurs in its most fully developed form in the engineering industry and in the matchmaking and electrical industries.

A third cause of the combination of different factories under common management is to be found in the fact that the working of

factories that produce the same article can be made more economical by co-operation between the factories in the purchase, manufacture and sale of the article for the purpose, amongst other things, of keeping stocks down to the lowest possible level and thereby diminishing the loss of interest on the active capital locked up in the stocks (horizontal combination). A further advantage is gained if work be concentrated in a smaller number of factories, where the process of manufacture can be carried on on a larger scale.

There also exist combinations of industrial concerns, of course, which have come into existence owing to other causes of a more incidental nature. As an example of this kind it may be mentioned that Holmens Bruks & Fabriks A.-B., side by side with large wood-pulp mills and one of the largest paper mills in Sweden, also own one of the larger cotton-mills in the country.

Business combinations during the past few decades have in many cases attained such a wide range that the factories working under a common directorship exercise a predominating influence on the market for their respective products. As examples of such monopolistic combinations under common leadership (Trusts) may be mentioned the Svenska Tändsticks A.-B. (matches), Trafik A.-B. Grängesberg—Oxelösund (iron-ore), Höganäs-Billesholms A.-B. (coal-mines), A.-B. Svenska Kullagerfabriken (ball-bearings), Svenska Sockerfabriks A.-B. (sugar), A.-B. Sveriges Förenade Konservfabriker (canning), A.-B. Stockholms Bryggerier (breweries), A.-B. Sveriges Förenade Triåfabriker (hosiery), and also the fusions, with the co-operation of the State, of the spirit and tobacco industries. In other cases the factories have not been placed under a common direction, but it has been thought sufficient to establish co-operation on the base of more or less far-reaching agreements. There are numerous examples of such groups of industrial concerns that work together (Cartels), ranging from those which are merely intended to prevent unfair competition by agreements regulating common selling terms (*not* prices) up to those which regulate prices or production or both.

Swedish industrial enterprises are to a large extent conducted under the form of joint-stock companies with limited liability. Leaving out small workshops employing less than ten hands, about two-thirds of Swedish industrial concerns were organized as joint-stock companies in 1923 employing in round numbers, 85 % of the total number of workers.

— SOME DATA ON MODERN SWEDISH INDUSTRY —

As was mentioned before, Swedish industrial statistics are based not on concerns but on "places of manufacture". An effort has been made, however, in the case of industries carried on by companies, to bring together the "places of manufacture" in which operations are carried on by the same company, and also to bring together under a single heading those companies which are owned by one and the same "parent" company. This attempt has shown that the 3,300 "places of manufacture" that occur in the industrial statistics for the industries carried on by companies (excluding minor undertakings) correspond to about 2,300 concerns which are independent in the matter of management and which employ more than ten workers at least in one of the "places of manufacture" under their control. This number (2,300 concerns), however, is to be regarded as a maximum figure, inasmuch as we possess only imperfect knowledge as to the extent to which co-operation occurs under the form of subsidiary companies.

The concerns which each have more than a thousand workers are no fewer than 44 in number, employing a total of about 95,000 workers or one-fourth of the total number employed in industry in Sweden. The two largest industrial concerns as regards the number of hands employed, including subsidiary companies, are now the Svenska Tändsticks A.-B. (matches) and Stora Kopparbergs Bergslags A.-B. (iron and steel, wood-goods, wood-pulp and paper), each with about 6,000 workers. Next come the following concerns, each employing about 4,000 hands: Allmänna Svenska Elektriska A.-B. (Asea) (electric machinery and apparatus), Höganäs-Billesholms A.-B. (coal and fire-proof brick-goods), A.-B. Svenska Kullagerfabriken (ball-bearings), Svenska Sockerfabriks A.-B. (sugar), Trafik A.-B. Grängesberg-Oxelösund (iron-ore), and Uddeholms A.-B. (iron and steel, wood-goods, wood-pulp). Among concerns with more than 2,000 workers may be mentioned A.-B. Götaverken (ship-building), Hellefors Bruks A.-B. (steel and woodpulp), Holmens Bruks & Fabriks A.-B. (paper, wood-pulp and cotton fabrics), Husqvarna Vapenfabriks A.-B. (hardware, cycles, etc), Hälsingborgs Gummifabriks A.-B. (rubber-goods), Sandvikens Jernverks A.-B. (steel and steel manufactures), A.-B. Svenska Tobaksmonopolet (tobacco manufactures), A.-B. Sveriges Litografiska Tryckerier (printing, engraving, etc.), and Telefon A.-B. L. M. Ericsson (telephone, telegraph and signalling apparatus) all these being inclusive of their subsidiary companies.



SWEDISH INDUSTRY IN RELATION TO RESEARCH AND INVENTIONS

by

AXEL F. ENSTRÖM

It is said, and it is true, that Swedes in general have a pronounced technical and mechanical bent. In other words, technical ability is one of the important natural resources upon which the nation can rely in its struggle for life. This gift for mechanics in the people is supposed to be the result of centuries of development, inasmuch as from ancient times the people have been accustomed to get their daily bread from tilling a poor soil. This bent is traditional, and traditional also is the endeavour to foster and train it.

As early as 1739, *K. Vetenskapsakademien* (the Royal Academy of Science) was formed with the view not only to foster science proper but also to encourage the practical application of scientific results. LINNÆUS, for instance — one of the most famous botanists of the modern age — devoted himself to extensive investigations in mining and metallurgy. A little later (1747) a special institution was founded to deal with the problems of the most important industry of that time, the iron industry. This institution, *Jernkontoret* (The Ironmasters' Association) assumed the double task of being at the same time a research institution in ironworking and a commercial representative of the same trade with financial activities.

Just a hundred years ago (1827) the first Swedish engineering college — *Tekniska Högskolan* (the College of Technology) — was established in Stockholm, and this was soon followed by another one in Göteborg — *Chalmers Tekniska Institut*.

The need of extended research work in modern times has led to the establishment of several special research institutions, such as *Sta-*

tens Provningsanstalt (The State Testing Laboratory), *Metallografiska Institutet* (The Metal Research Laboratory); and a research institute for the wood-pulp industries is now in process of being organized. In order to co-ordinate the several efforts of scientific and industrial research in the country, a special organization was formed a few years ago, *Ingenjörsvetenskapsakademien* (The Royal Swedish Academy for Scientific Industrial Research).

An excellent index of Swedish research activities is to be found in the engineering literature of Sweden. As to both quality and quantity this literature can fairly claim to be of importance. It must be borne in mind, however, that the volume of such a special literature must be badly handicapped by the narrow limits of the language.

Engineering productivity is also indicated by the frequency of the issues of patents. Since the beginning of the present century about 2000 patents per annum have been issued by the Royal Patents Board. The Board is known to scrutinize the applications most thoroughly and is claimed to be on a level with the very best patent offices abroad.

From the early industrial development in the nineteenth century may be mentioned some prominent Swedish inventors, who are, in fact, pioneers in their own branches.

JOHN ERICSSON († 1889) introduced the screw-propeller for ships and constructed the ironclad warship "Monitor", the success of which proved to be of supreme importance in the American Civil War of the 1860's. Among his numerous inventions may besides be mentioned the sun-radiation steam generator, which perhaps will be of importance in the future.

A. LAGERMAN († 1904) was the ingenious inventor of automatic match-making machines, a real wonder in their time. From these inventions, perfected by many successors, the Swedish match industry has developed its present dominant position in the match trade of the whole world.

T. NORDENFELT († 1920) was the originator of numerous inventions for automatic guns. He also designed and constructed the first submarine boat at an early date.

ALFRED NOBEL († 1896) introduced dynamite and made a series of important inventions in this field, leading to the foundation of big industrial concerns in different parts of the world. In his will he bequeathed his great fortune to various institutions for the benefit of

research work in physics, chemistry and medicine, and to reward achievements in literature and the promotion of peace.

C. D. EKMAN († 1904) made the first practical experiments in the sulphite cellulose process and established pioneer factories.

JONAS WENSTRÖM († 1893) was one of the inventors of the three-phase alternating current system, which was the origin of the modern electro-technical development in the long-distance transmission of energy. Wenström's inventions, followed up and supplemented by ERNST DANIELSSON († 1907) and ARVID LINDSTRÖM, provided the impulse and the background for the Swedish electro-technical high-tension industry.

L. M. ERICSSON († 1926) designed and constructed the first modern commercial type of telephone system and introduced a series of inventions in the practical details of telephone apparatus. This work, followed up by that of numerous other Swedish inventors, created the basis of the Swedish telephone industry.

GUSTAF DE LAVAL († 1913) was the author of a great many ingenious inventions in different fields. He designed a type of steam-turbine at the same time as Parsons, yet on quite original lines. The milk separator was another of his achievements in a wider field. In both cases large Swedish industrial concerns have originated from de Laval's pioneer work.

As pointed out elsewhere in this book, Swedish industry is grouped round the three main natural resources: the iron-ore deposits, the forests, and the waterfalls. Thus the old iron and steel industries, the lumber, pulp and paper industries, the electrical and allied industries are characteristic examples of the industrial activities of the country. It would carry us too far to go into detail as to the technical achievements and inventions that have led to the modern position of these industries from the beginning of this century. Only some few instances can be recorded.

To begin with, emphasis may be laid on the close connection between the waterpower resources, on the one hand, and the development of the electro-technical and allied industries, on the other. Obviously the harnessing of waterpower, the erection of extended distributing systems and the electrification of factories, railways and rural districts — all of which have proceeded rapidly ever since the beginning of the present century — have furnished good opportunities to the manufacturers of electric machines and apparatus, of prime motors and of other machines, to get into close touch with the pro-

blems and collect valuable experience. On the other hand, the paradox is true, that in this waterpower country many most valuable inventions have been made in steam engineering and fuel economy. The reason is that, as a rule, industrial processes cannot be kept going exclusively by waterpower. Heat and steam are also needed for a great many purposes; and only a few of them can reasonably be served economically by electric energy. Thus in any case fuel is needed. Sweden, as is well known, has very little coal and no oil deposits of any importance. The only natural fuel is wood, which is at the same time a most valuable raw material for the lumber, pulp and paper industries, and is consequently rising in price. To some extent wood-fuel is used, but the main bulk of the industrial fuel has to be imported and paid for at a price higher than that paid by competing industrial nations. From what has been said it is easily understood that fuel economy is a problem that automatically forces itself on the attention of Swedish engineers; and as a consequence many inventions and many special industries group themselves around questions such as proper fuel combustion, steam-raising, and steam-consumption.

In the history of the Swedish steel industry the name of J. A. BRINELL († 1925) takes a prominent place. His extensive research work in the treatment of steel and original inventions in testing apparatus have contributed substantially to the development of modern methods in the production and utilization of steel.

As a consequence of the above-mentioned fuel situation of the country, much attention has been paid to the problem of employing electric energy for smelting and refining purposes. The electric blast-furnace, invented by A. LINDBLAD, A. GRÖNWALL and O. STÅLHANE (system "Elektrometall"), has proved successful. Electric steel-smelting furnaces of electrode type have been invented by the same concern, and also by J. RENNERTVELT. An induction furnace type for the same purpose was introduced by F. KJELLIN († 1910).

In the field of ore-preparation a great many inventions have been devoted to ore-separating devices. Mention may here be made of G. GRÖNDAL. This inventor designed a successful type of briquette-burning kiln. In this connection reference may also be made to a series of inventions by A. RAMÉN († 1926), and among these a copper-ore refining furnace on new principles by RAMÉN and K. J. BESKOW.

Recently some very interesting inventions have been made in ore-prospecting on quite new lines. These methods, originated by S.

LUNDBERG and K. SUNDBERG, depend on the fact that a magnetic or electric field, established between poles in the earth, undergoes certain deformations when ore lenses or the like are present. A careful study of such field disturbances has led to sensitive methods of determining the location and approximative extent of ore-deposits; and these have been used with no little success in Sweden in recent years.

In the domain of pulp-making processes the following more definite advances may be cited. The successful extraction of alcohol out of waste sulphite-lyes was achieved by G. EKSTRÖM; and a soda cellulose method, aiming at a complete utilization of the waste products of the process, has been invented by L. RINMAN. In view of the fact that in the normal cellulose processes only 50 % of the raw-wood material could be converted into a saleable product, the rest being wasted, it is easily understood that the problem of recovering valuable products out of the waste must be an important problem for inventors and research-workers.

In the steam-raising and steam-using sphere referred to above, the following facts may be adduced.

The de Laval steam-turbine has already been mentioned. Another invention in this field on quite original principles is that of B. and F. LJUNGSTRÖM. Based as it is on using a radially distributed expansion wheel system, it aims at small dimensions, small losses, and great economy. In fact, no other design of condensing turbine is thought to beat the record of low steam-consumption attained by this Ljungström steam-turbine. The inventors named are also responsible for the development of a steam-turbine condensing locomotive that has shown, on trials, extremely low values for the consumption of fuel and water.

The LJUNGSTRÖM air-preheater is a very effective type of machine. No doubt the appearance of this invention has helped to promote the modern tendency to use preheated air for combustion in order to increase fuel economy.

In steam-boiler practice extra high pressures have been found to be of value for the movement in the direction of greater economy. But the adaption of common types of boilers to such high pressures encountered certain difficulties. A Swedish inventor, J. V. BLÖMQUIST, solved the problem in an ingenious way by designing the steam-raising elements as rotating drums, thus securing a continuous layer of water round the whole inner surface of the walls. Several units

of the *Atmos*-boiler, built on this principle, have been installed in Sweden and have operated successfully at pressures up to 1,400 lbs.

In all kind of steam-plants certain difficulties often arise from the fact that the steam consumption of the plant varies, as a rule, between rather wide limits and not seldom suddenly. The consequence is an expensive margin of steam boiler capacity and a poor fuel-economy. In order to overcome these difficulties, J. RUTHS designed a steam accumulator, fitted with a series of automatic regulating devices, which secures quite considerable variations in steam consumption. This accumulator has been installed and successfully operated in many plants of different kinds, especially in the majority of Swedish pulp factories. It has also proved useful as an emergency device at the end of an electric transmission line, interlinked in the system in such a way that, in case trouble arises, the relays, cutting out the line, automatically introduce a steam turbine, fed by the accumulator, to carry the load.

In all kinds of fuel-burning a control of the flue gases is essential to secure proper economy. An ingenious controlling and recording instrument of this kind of Swedish design is the "Mono"-apparatus, invented by O. RODHE. Another ingenious invention may be mentioned in this connection, an automatic regulating device "Arca", invented by R. CARLSTEDT, which has proved useful in service of different kinds, such as controlling water-flow, air-pressure, electric energy and so forth.

In spite of the fact that Sweden is deficient in native fuel-oils, Swedish inventors have devoted much work to the development of petrol-driven engines, petroleum stoves and other devices. As a matter of fact, the small domestic petroleum stoves frequently found in use all over the world, from the far East to the far West, are of Swedish design and make; and the cheap hotbulb oil engine, which is considered to have started at an early date that "motorization" of the world which is now-a-days progressing so rapidly, was the product of Swedish inventions — by J. WEYLAND († 1925) etc. — Also the progress of the Diesel engine was promoted by Swedish inventiveness and research work (K. J. HESSELMAN, and others).

The fundamentals of Swedish electro-technical engineering have been touched upon above. In addition may be noticed the iron-nickel electric storage battery invented by W. JUNGNER simultaneously with the well-known Edison cell of the same type. Recent develop-

ment in telephone technics could be ascribed to inventions by J. G. HOLMSTRÖM, G. A. BETULANDER (automatic switching station) etc. The Swedish-born engineer ERNST ALEXANDERSSON, who lives in U. S. A., has brought about substantial progress in wireless and radio engineering.

Finally, reference may be made to some inventions which have originated certain important special industries.

The technical equipment of light-houses for navigation has been no less than revolutionized by the inventions of GUSTAF DALÉN, whose work in this field brought him the Nobel Prize. A combination of a refined method of storing acetylene gas in acetone-filled steel cylinders together with a "sun valve", automatically operating the lamp, and a twinkling device, has made the light-house service much more effective and economical than ever before. The system has also been widely adopted in railway signal practice, and has of late been successfully introduced for aerodrome lighting purposes.

The ball-bearing device, bearing the well-known letters S. K. F., is the result of the inventive work of S. WINGQUIST, and at the same time utilizes the high qualities of Swedish steel. The excellent S. K. F. bearing has no doubt definitely accelerated the introduction of this power-saving method all over the world, thus eliminating the waste of enormous quantities of energy.

Modern shop practice requires a very high degree of exactness and precision in manufacture and manufacturing tools. These requirements are met in a wonderful way by the measuring gauges of C. E. JOHANSSON, which make possible a high degree of precision, not before attained even in laboratory work.

In recent years an interesting invention has been made by two young Swedish engineers, B. v. PLATEN and C. MUNTERS, the result of which is a refrigerating machine working without any moving parts. Only a small quantity of heat and some cooling water is needed. The whole process is based on the interaction of gases and vapours within the apparatus. This very ingenious invention is of particular interest, inasmuch as its success is essentially due to scientific knowledge and thorough research work, factors that are becoming more and more indispensable in modern inventions.

As has been pointed out before, such a short review as this could not cover the whole subject, but had to limit itself to a bare enumeration of some of the more remarkable instances of practical Swedish inventions.

PART II
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THE BRANCHES
OF SWEDISH INDUSTRY

The following should be noticed with regard to the industrial enterprises named under the various branches of industry. — As a rule there are given all the more important Swedish industrial enterprises and also those in various parts of the country which, in other respects, are fairly representative of each industrial branch. It has been impossible to allow space in the book for an enumeration of all the businesses concerned. Industrial enterprises carrying on manufacture in several different branches are mentioned only in those sections of the book dealing with their main production.

For further information respecting Swedish industrial enterprises and their manufactures, the reader is referred to the Year-book entitled: "Svensk Industrikalender" (Swedish Industrial Directory).



THE MINING AND METAL INDUSTRIES

MINING

In the great inventory of the iron-ore resources of the world that was compiled for the International Geological Congress held at Stockholm in 1910, the actual reserves of ore that contain more than 60 % of iron were estimated at about 1,300 million tons, whereof Sweden alone possessed 1,095 million tons, i. e. about 84 %. Since then extensive investigations have been made that show that Sweden's resources of such ore — like those of many other countries — are in reality very much greater. Hence Sweden is with regard to high-percentage iron ores one of the most fortunately situated countries in the world. If we include in the calculation all its iron ore, of high and low percentage, Sweden may be put down as possessing about 10 % of the total iron-ore resources of Europe and 5 % of the iron-ore resources at present known in the world.

In his survey of the natural resources of Sweden¹ Professor Gunnar Andersson points out that the country's iron-ore deposits may, broadly speaking, be divided into two groups, separated both geographically and qualitatively, viz. the Lapland group and the Central Swedish group. The first-named group embraces the largest and richest ore-fields, the most important among them being Kiirunavaara and the adjacent Luossavaara, Malmberget (Gällivare), Svappavaara, Leveäniemi and Ekströmsberg.² Of these only the first three are actually being worked; the others are State-owned deposits that are held in reserve. The Lapland ores, famed for their high percentage of iron, are not suited for the production of Swedish charcoal-iron and steel on account of

¹ See pp. 28—37.

² See map, p. 37.



Surface Quarrying at K urunavaara
Loading ore-trucks by means of electric ore-grabs

their being phosphoriferous. They are of great value, however, for use in the so-called Thomas process, and are on a large scale exported, mainly to Germany, where that process has obtained an extensive application.

The Central Sweden group of ore-fields embraces a very large number of deposits that are for the most part comparatively small, situated chiefly in the provinces of Uppland, V stmanland, N rke, Dalarna and V rmland.¹ These ores are somewhat lower in iron than the Lapland ores, but to make up for that they are generally also low in phosphorus, which seldom exceeds 0.02 %, being as a rule lower than 0.01 %. In some instances, as at Dannemora, Bispberg and Riddarhyttan, the percentage actually is below 0.005 %. It is mainly these Central Sweden mines that supply the raw material for the Swedish iron and steel industry.

To this Central Sweden group also belong geographically the Gr ngesberg fields and some other ore deposits (Bl tberget, Idkerberg and Lekomberg), with a higher percentage of phosphorus. The ore from these fields is exported.

¹ See map, p. 30.



Underground Mining at Striberg
Shrinkage stoping with pneumatic rock-drills

Swedish mining has for long time been on a high level from a technical standpoint. The method of mining employed in the Kiiruna-vaara and Luossavaara, and, to some extent, the MalMBERGET fields is still chiefly open cut mining; in the rest of the mines, on the other hand, underground mining is almost exclusively employed.

The crude ore extracted from a mine is normally dressed by hand or mechanically into three different groups viz.: (a) »lump ore», which can be smelted without further treatment; (b) »concentrating ore», the iron-content of which is too low for direct smelting, but which, on the other hand, contains too much iron to justify its being discarded; (c) »waiste», which is too lean for commercial use. Primarily the crude ore is subjected to coarse crushing followed by handpicking, magnetic separation or wet concentrating.

The concentrating process for the low-grade ores was introduced in Sweden during the eighties of the last century, but did not come into general use until the beginning of the present century. The process consists of two operations: firstly the grinding of the concentrating ore in order to release ore particles from the gangue minerals

surrounding them, and secondly the separation of the iron-ore particles from the gangue. The ore is consequently obtained in a finely divided state and is called concentrates. As the iron-ore minerals are either magnetic, as, for instance, the magnetite, or non-magnetic as is the case with the hematite ores, the concentrating methods have been developed along two different lines. For Sweden magnetic concentrating is the more important; it has become highly developed, thanks to ingenious separators invented by Swedish engineers. The magnetic ore separators contain electromagnets to which the magnetic grains adhere, while the tailings are washed away by water. The concentrating method for non-magnetic ores effects the separation of the iron-ore from the tailings by aid of the difference in the specific gravities.

In its finely divided state, the iron-ore concentrates are hardly suitable for the Swedish blast-furnace process. They are therefore made into lump-form by means of sintering or briquetting, in which processes the concentrates are heated to such a temperature that the ore-grains sinter together. In 1924, more than 200,000 tons of briquettes and sinter were produced in Sweden.

Year	Iron Ore	
	Production: mill. tons	Export: mill. tons
1900	2.6	1.6
1905	4.4	3.3
1910	5.5	4.4
1915	6.9	6.0
1920	4.5	3.7
1921	6.5	4.3
1922	6.2	5.3
1923	5.6	4.9
1924	6.5	5.9

The output and export of Swedish iron-ore during the last 25 years is shown in the accompanying table. The figures include "lump-ore" and "concentrate".

The value of the exported ore during recent years has amounted to between 80 and 120 million Swedish kronor annually, i. e. 7—9 % of the total value of the Swedish export.

About three-quarters of total output of iron-ore come from the mines at Kiirunavaara, Luossavaara and Gällivare alone, which are worked by the Luossavaara-Kiirunavaara A.-B. Half the share-capital of that company, the importance of whose activity for the national economy of Sweden has been increasing year by year, is owned by the Swedish State and the other half by a limited liability company, the Trafik A.-B. Grängesberg-Oxelösund. The latter company, which has a share-capital of 119 million Swedish kronor, also owns the Grängesberg Grufve A.-B.

The following is a list of the more important iron-ore mining companies in Sweden:

— THE MINING AND METAL INDUSTRIES —

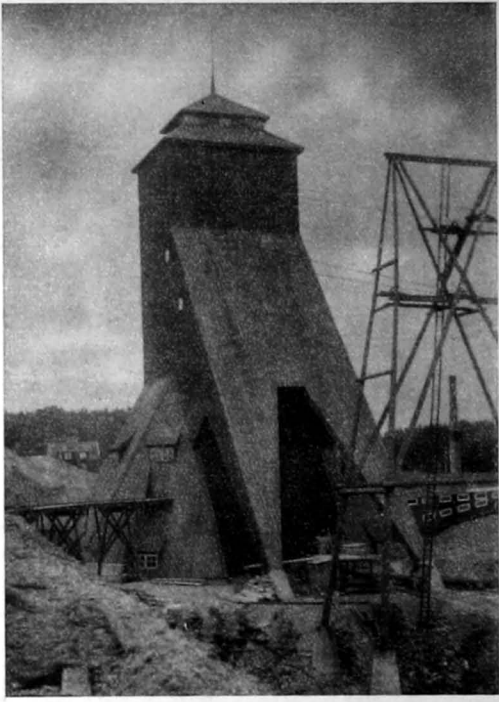


Modern Iron-mine Buildings at Ställberg, in the Province of Västmanland (Ställbergs Gruve A.-B.)

To the right are the mine head-frame house and crushing-plant; to the left, the ore-conveyors and sorting-works.

In Norrbotten the following are active: *Luossavaara-Kiirunavaara A.-B.*, Stockholm, employing 2,500 workmen, *Bergverks A.-B. Freja*, Koskullskulle, and *Tuolluvaara Gruf A.-B.*, Kiruna. Among mining enterprises in Central Sweden the following may be mentioned: *Trafik A.-B. Grängesberg-Oxelösund*, Stockholm, employing about 1,200 workmen at the Grängesberg and Stråssa ore-fields, *Stora Kopparbergs Bergslags A.-B.*, Falun, at the Grängesberg and Idkerberget ore-fields, *Idkerbergets Gruv A.-B.* and *Gruv A.-B. Dalarne*, both at Ludvika, *Bergverks A.-B. Vulkanus*, Blötberget, *A.-B. Mellansvenska Malmfälten*, Häksberg, *Gruv A.-B. Lekoberg*, Sörvik, *Riddarhytte A.-B.*, Riddarhyttan, *Norbergs Gruv A.-B.*, *Kolningsbergs Gruve A.-B.* and *Storgrufve A.-B.*, at Kärrgruvan, *Bisbergs A.-B.*, Bispsberg, *Stora Långviks Gruv A.-B.*, Hedemora, *Stribergs Gruf A.-B.*, *Dalkarlsbergs A.-B.* and *Klacka & Lerbergs Grufve A.-B.*, at Striberg, *Stripa Grufve A.-B.*, *Guldsmedshyttan*, *Ställbergs Grufve A.-B.*, Bångbro, *Persbergs Gruve A.-B.*, Persberg, *Dannemora Gruvintressenter*, Dannemora, *Herrängs Gruv A. B.*, Stockholm and *Boxholms A.-B.*, Boxholm (the Kantorp ironfield).

Sweden's resources of other ores than iron-ore are of less importance. Formerly, however, things were different in that respect. The output from the silver mines at Sala during the 16th century and from the copper-mines at Falun during the 17th century contributed



Mine head-frame, Riddarhyttan.

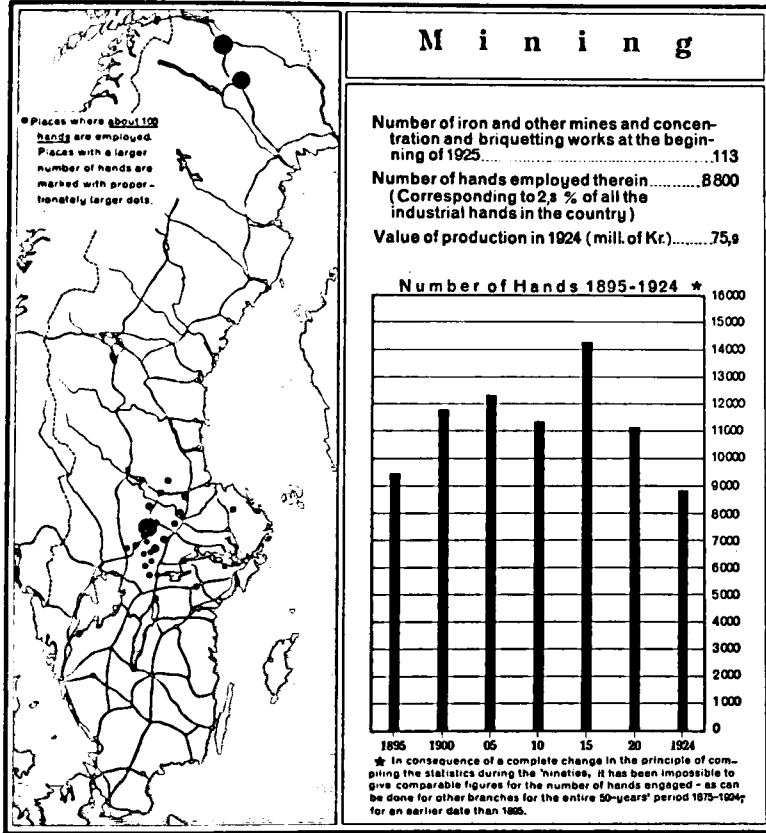
appreciably to uphold Sweden's political position. For a short time indeed the copper mine at Falun supplied nearly the whole world with the copper it needed.

During the 19th century copper ore was also mined to a considerable extent at Åtvidaberg, but at the present time the Sala, Falun and Åtvidaberg mines are not far from exhausted. The Falun mine is still worked, however, to a not inconsiderable extent though not for copper ore, but for zinc and lead and especially for pyrites, of which there are large reserves. The pyrite is used for the production of sulphuric acid and in the chemical pulp industry. At

Sala the old smelting-works still exist but the lead-ore smelted there is obtained from other mines.

In the sixties of the last century a new ore-field became of importance, viz. the Åmmeberg zinc-ore field, which at that period was bought by a Belgian company. The ore at Åmmeberg has a zinc-content of about 40 % and is exported mainly to Belgium. The mining is carried on underground. The lean ore is concentrated and small quantities of lead-concentrate are obtained as a by-product. Zincblende and lead-ore are also obtained, as already mentioned from the Falun mine, from the Ryllshytte and Saxberg mines in Dalarne and from Kaveltorp in the Province of Västmanland.

In 1924 the total production of zinc-ore in Sweden was about 48,000 tons, part of which was refined in the country; the remainder, to the value of 2.8 million kronor, was exported. The total amount



of lead-ore produced was about 3,000 tons; the exported quantity had a value of 1.1 million kronor.

Manganese ore is mined at Långbanshyttan in Värmland, which is well known for its many rare minerals.

The new mining district — the Skellefte-field — in the Province of Västerbotten has not yet been opened up on a large scale (see pp. 33—34).

Of the enterprises where ore other than iron-ore is mined there may be mentioned *Stora Kopparbergs Bergslags A.-B.*, Falun, *Gruvbolaget Vieille Montagne*, Ämmeberg,

— THE MINING AND METAL INDUSTRIES —

A.-B. Zinkgruvor, Falun, A.-B. Svenska Metallverken, Västerås, Gruv A.-B. Långban, Långbanshyttan, and Skellefteå Gruv A.-B., Stockholm.

The diagram on p. 83 shows the number of men engaged in the mining of iron and other ores during the years 1895—1924. It will be seen that the number of hands has decreased somewhat during the last ten years, although the production of ore (see table, p. 80) has, on the whole, remained almost stationary. This circumstance is due to an increase in open cut mining in Norrland, demanding less labour, and to more advanced technical methods. The map on p. 83 shows the distribution of hands among the various mining districts.

THE IRON AND STEEL INDUSTRY

The manufacture of iron has from very early times been considered as the chief Swedish industry. In past centuries, the Swedish production of iron played an important part in the economy of the world both quantitatively and qualitatively. In the last-mentioned respect it may be said to do so still, though quantitatively it is now insignificant, when compared with the iron production of the great industrial countries.

In the middle of the 18th century Sweden was the chief iron-producing country in the world, manufacturing about one-third of the world's total consumption. At that time iron-smelting was everywhere based on the use of charcoal as fuel. Sweden, being well off as regards both ore deposits and forests, possessed an advantage over most other countries. A change in that state of things occurred, however, during the latter half of the 18th century, when coke came to be commonly used for smelting pig-iron in blast-furnaces and the process of puddling pig-iron to soft iron with coal as fuel was invented. Owing to these changed circumstances, England with its abundance of coal soon succeeded in gaining the position of the greatest iron-producer of the world.

Iron produced by means of the puddling-process and in the various types of hearths (e. g. German, Franche-comté, Lancashire and Walloon hearths), is termed wrought iron (wrought metal). Characteristic of wrought iron is that it has not been in a molten state, and consequently contains some slag. The wrought iron produced with charcoal in Sweden has, qualitatively, certain advantages over puddled iron

manufactured with coal as fuel and for that reason long remained indispensable for a number of purposes.

During the last century, however, the machine industries, which were then in course of rapid development, gradually came to demand certain characteristics in the raw material that wrought iron was unable to satisfy, and new methods for the production of iron became desirable. Shortly after the middle of the century methods were discovered (e. g. the Bessemer and Siemens-Martin processes referred to below) that completely revolutionized the production of iron and steel and opened a new era in the history of iron. The product obtained by these methods, commonly termed ingot iron (steel), is in a liquid state, which renders possible the manufacture on a large scale of homogeneous material. Ingot iron can easily be produced with varying carbon-contents, and by the addition of alloying metals its properties can be varied within wide limits.

Among the ingot-iron processes should also be included the old crucible-steel method, dating from 1740—1750, and the electro-steel methods invented at the beginning of the present century; quantitatively, however, these methods have hitherto been relatively unimportant.

The manufacture of pig-iron in Sweden, whether for refining into wrought iron or steel or for casting, is carried out in blast-furnaces, in which the iron-ore is reduced by charcoal. Ore and charcoal are fed continuously into the upper part of the furnace, while hot air is introduced from below. The molten pig-iron formed in the blast-furnace process collects at the bottom of the furnace and is run off at intervals.

While coke is practically entirely used as fuel in the production of pig-iron elsewhere in the world, the making of pig-iron in Sweden is almost exclusively based on the use of charcoal, and this is one of the reasons of the high quality of Swedish iron and steel. On the other hand, the advance in the price of charcoal during the last decades, which must be ascribed, above all, to the increased demand from the pulp industry for wood formerly used exclusively for charring, is the chief reason for the high cost of production of Swedish pig-iron and steel. Much attention has therefore been given to the elaboration of methods that render it possible to decrease the consumption of charcoal without at the same time leading to a deterioration in the quality of the iron produced.

Special attention has consequently been directed to the electric pig-iron furnaces. In these about 60 % of the amount of charcoal

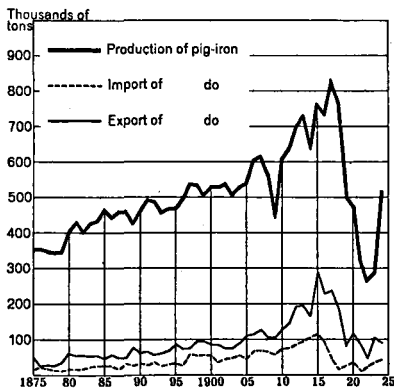
necessary in the ordinary blast-furnaces is replaced by electric energy. In 1924 91,000 tons of pig-iron were produced in such furnaces. In recent years, experiments have been made with other methods which aim at the direct production of soft iron and steel from the ore.

The figures for the output and export of Swedish pig-iron and for the import of pig-iron into Sweden during the last 50 years are shown by the accompanying diagram.

Wrought iron in Sweden is nowadays chiefly produced in the form of *Lancashire-iron* and to some extent in the shape of *Walloon-iron* (in the Dannemora district). In these processes the pig-iron is refined in hearths that use charcoal as fuel. The wrought iron is obtained in the form of soft slaggy lumps (blooms), which are afterwards forged with heavy hammers. As a consequence of the general introduction of the ingot-metal processes the manufacture of wrought-iron has decreased considerably, but Swedish wrought-iron has still a certain market on account of its excellent qualities,

which render it useful for many purposes, viz. its softness, its insensibility to high temperatures, the ease with which it can be welded and its resistance to corrosion. Owing to its purity it is also employed as a raw material for crucible steel.

In 1855 HENRY BESSEMER invented a process which was called after him the *Bessemer process*. The honour of having applied it commercially belongs however to the Swedish industrialist, G. F. Göransson, the founder of the Sandviken steelworks, whose energy and perseverance found the final solution of this difficult problem. The process is carried out in a til-furnace or converter, into which the pig-iron is brought in a liquid state. Air is pressed through holes in the bottom of the converter and through the liquid iron. The carbon, silicon and manganese in the pig-iron are removed with the help of the oxygen of the air, when the oxidation produces the heat necessary for the process. Such Swedish ores, which are poor in phosphorus and rich in manganese, are very well suited for this method, and at soon became extensively used. In recent times Bessemer steel has been to



some extent superseded by Siemens-Martin steel, which, as a rule, is cheaper to produce. The excellent qualities of Swedish Bessemer steel however still ensure it a market for different kinds of edge and hammering tools and for rock-drills etc.

The original Bessemer process (the acid method) was and is still carried out in furnaces lined with so-called acid i. e. highly silicious bricks. This process not permitting the removing of phosphorus, the Bessemer acid process is only applied to non-phosphoriferous ores, the presence of phosphorus making the steel brittle. In 1878 two Englishmen, S. Thomas and P. C. Gilchrist, succeeded in eliminating the phosphorus by using a basic charge and a basic lining in the converter, whereby phosphates etc. are formed as a slag containing practically all the phosphorus of the charge. This process, the so-called "*Thomas-process*", which has obtained an extensive application, especially in Germany, France, and Belgium, has made it possible to utilize phosphoriferous ores, among others those from the Lapland iron-ore fields. Although Sweden possesses enormous quantities of such ore, the lack of coal and the limited home demand for structural steel, i. g. girders, angles etc., constitute an obstacle to a more extended introduction of this method in Sweden. The two ironworks in Sweden where plants for the Thomas-process have been erected (Domnarvet and Bångbro) base their manufacture on the use of imported coke.

The need of a method that would make possible the resmelting of scrap iron was early felt by the iron industry. The solution of this problem came in 1868, when a Frenchman, P. Martin, succeeded with the assistance of Siemen's regenerative principle in obtaining in a reverberatory furnace, a temperature sufficiently high to melt steel.

The Martin-furnace consists of a reverberatory furnace, which is heated by means of producer gas. In order to attain the necessary temperature in the furnace, the producer gas and the combustion air are preheated in so-called regenerators before passing into the furnace. Originally the *Siemens-Martin furnaces* were lined only with acid material (acid Martin process), but very soon basic lining and basic charge were introduced also in the process (basic Martin process) in



G. F. Göransson.
b. 1819 d. 1900.

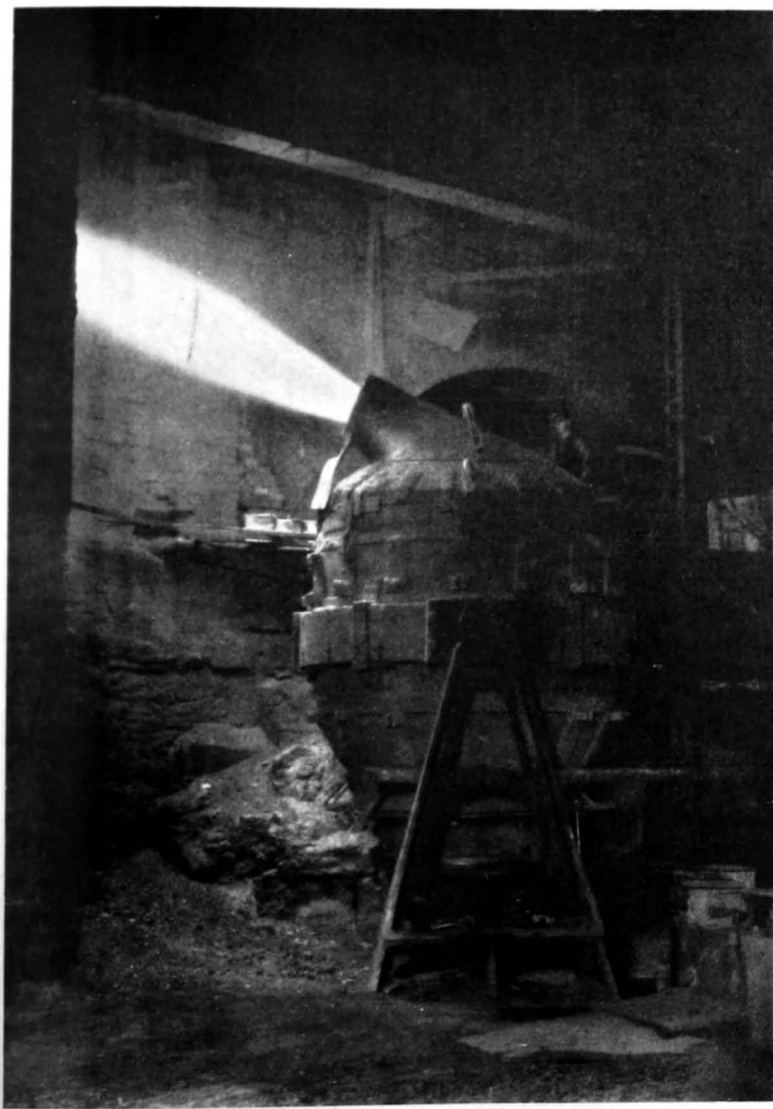
order to make it possible to use phosphoriferous pig-iron and scrap. In consequence of its great adaptability to various working conditions the basic Siemens-Martin process is nowadays quantitatively the most important method in the world for the production of steel. In Sweden, too, it is pre-dominant. It is used chiefly for the production of soft steel. A number of alloy steels, especially chromium and nickel steels, are also advantageously produced in basic furnaces. The acid Martin process however is the method on which the Swedish production of high-quality steel is based to-day. By this process there are manufactured all kinds of hard steels, alloy steels etc. Only the best and purest pig-iron and scrap are used in this process. In both acid and basic Martin furnaces there is also produced a not unimportant amount of steel castings of very high quality.

A small portion of Sweden's production of quality steel consists of so-called *crucible steel*. This is smelted from very pure raw materials in small graphite crucibles, which are heated in regenerative reverberatory furnaces. The steel is distinguished by its high quality, but the cost of production is also rather high. For this reason crucible-smelting can be used only for the production of certain steels of exceptional quality.

During the last two decades *electric steel smelting* — in which process the heat is generated by an electric current — has risen to a certain importance for the manufacture for instance of steel castings. In Sweden conditions are favourable for a more extended use of this method owing to the abundant supply of water-power and of pure raw materials. The electric steel furnaces seem to have advantages over the acid Siemens-Martin process for the production of certain alloy-steels, but the cost of electric current constitutes in many places an obstacle to the adoption of the process. In some other countries the electric method is chiefly used for the purpose of gaining a more complete removal of phosphorus and sulphur in a special refining process, whereby a quality is obtained which in some respects competes with that of Swedish steel.

The following table illustrates the main features of the development or decline of the various methods employed for producing wrought iron and ingot metal respectively in Sweden during the period 1900—1924.

Parallel with the development of the metallurgical methods described above, the further treatment of the iron — its rolling and forging



Blowing a Bessemer charge (Forsbacka Ironworks).
Out of the seething mass of iron the burning gases are blown out through the mouth
of the converter in a long, dazzlingly white flame.

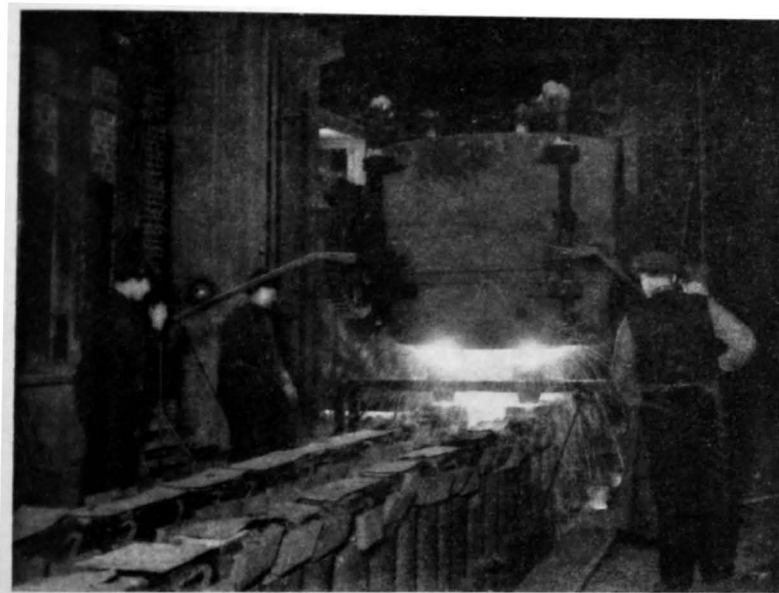
— THE MINING AND METAL INDUSTRIES —

<i>Production in tons. Year</i>	Wrought iron	Bessemer steel (acid)	Thomas steel	Martin steel (acid)	Martin steel (basic)	Crucible steel	Electro- steel
1900 . . .	186,000	61,000	30,000	121,000	86,000	1,100	14
1905 . . .	181,000	46,000	32,000	130,000	158,000	1,300	990
1910 . . .	152,000	44,000	53,000	147,000	226,000	1,800	430
1915 . . .	119,000	26,000	65,000	231,000	273,000	3,400	2,000
1920 . . .	61,000	17,000	36,000	149,000	221,000	1,500	12,000
1921 . . .	24,000	12,000	21,000	73,000	91,000	1,000	13,000
1922 . . .	40,000	16,000	20,000	96,000	161,000	900	16,000
1923 . . .	39,000	14,000	21,000	84,000	134,000	800	17,000
1924 . . .	49,000	20,000	44,000	165,000	234,000	1,300	38,000

— has also attained a high degree of perfection. As late as in 1850—60 all the forging of iron was carried out by means of hammers driven by water-wheels. For machine-forgings and the forging of tool-steel etc. these water-hammers were gradually replaced by steam-hammers etc., while the shaping of the iron into greater lengths was taken over by the rolling mills. The larger steam-hammers are nowadays often replaced by hydraulic forging-presses; for heavy forgings these can effect a pressure of as much as 10,000 tons. Among the products of the Swedish rolling mills may be mentioned, square, round and flat iron, sheet iron of various dimensions, railway tyres, wire-rods, tubes, hollow drill steel, cold rolled strip etc.

Electricity has been of the greatest importance in the development of the iron industry in general. As a rule, the old works were located close to water-falls, from which the requisite power was obtained. The transmission of power by electricity now allows of a wider choice with respect both to the situation and the lay-out of the works, and to the transport facilities, which in a modern ironworks play such an important rôle. Many of the Swedish ironworks have been brought up to date in this respect during the last few years at a very considerable expenditure of capital.

The map and diagram on p. 94 show the distribution of the iron industry in Sweden and the number of men employed during the last 25 years. It will be observed that the ironworks are chiefly concentrated to those parts of Central Sweden where the iron-ore deposits are to be found. In former times a small forge or a ham-



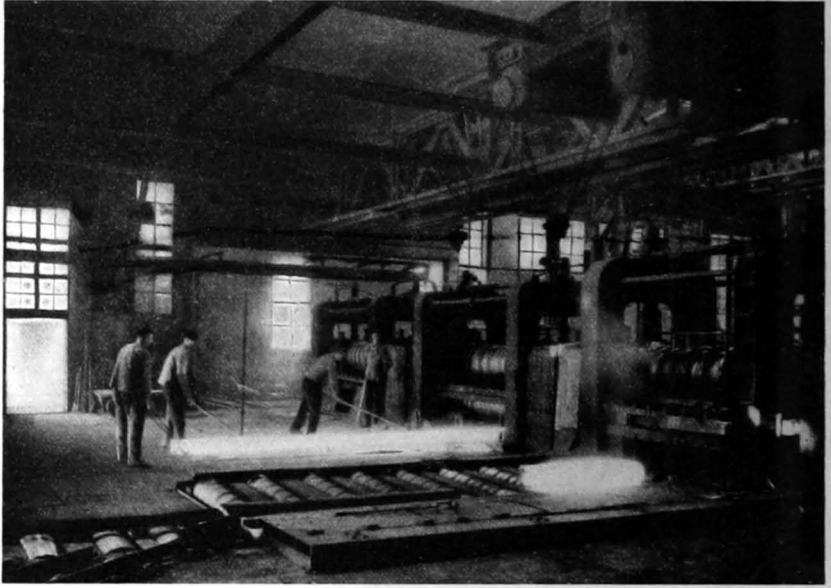
Casting of steel ingots (Östevby Ironworks)

The molten steel has been tapped from the Martin-furnace into a ladle from which it is poured into ingot moulds (chills).

mer-smithy were erected nearly wherever in this region there was access to waterpower and to timber suitable for charcoal-burning. The iron industry and mining were then most intimately connected with each other, frequently under a common management. Although many forges and mills have closed down since then, it is still a characteristic feature of the Swedish iron industry, as compared with that of other countries, that it is carried on at a large number of comparatively small works.

From what has been said already it will be seen that in Sweden the iron industry is indigenous to the country and rests on very solid foundations, with the ore deposits, forests and waterfalls as the cornerstones of the edifice. We may also once more repeat that the Swedish iron industry is chiefly organised with a view to the manufacture of high-quality material.

Sweden indeed also possesses the materials necessary for the pro-

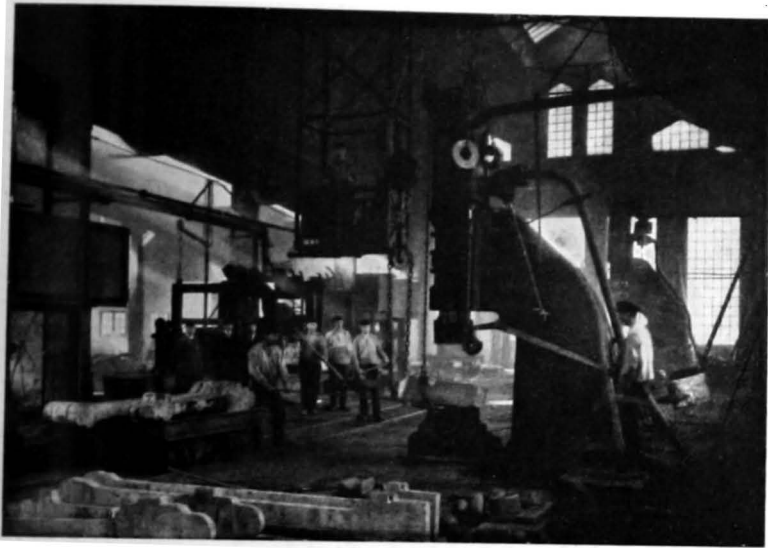


The Rolling of Steel (Sandviken Steelworks)

The white-hot ingot is introduced between the rollers to be elongated and shaped.

duction of high-quality goods. The ores are in this respect unique in the world, a fact which has already been pointed out. Swedish forests supply excellent fuel, free from sulphur and phosphorus, which is employed uncharred for the production of producer gas for the Siemens-Martin furnaces, and charred (as charcoal) in blast-furnaces and wrought-iron-hearths. The high-quality ores and the charcoal contribute to give Swedish pig-iron a superior quality; and this superiority of the pig-iron is the first condition for ensuring the high quality of the final products. The Swedish iron industry imports coal for heating purposes; but this fuel is used only where no danger of lowering the quality can arise.

In the last few years Sweden's waterfalls have been harnessed for the production of electric power and are replacing on a growing scale both Swedish and foreign fuels. Although the utilization of the waterfalls for electro-metallurgical purposes has not yet led to any considerable diminution in the cost of production of iron in Sweden, it has shown one good result, the saving of charcoal and a diminished need

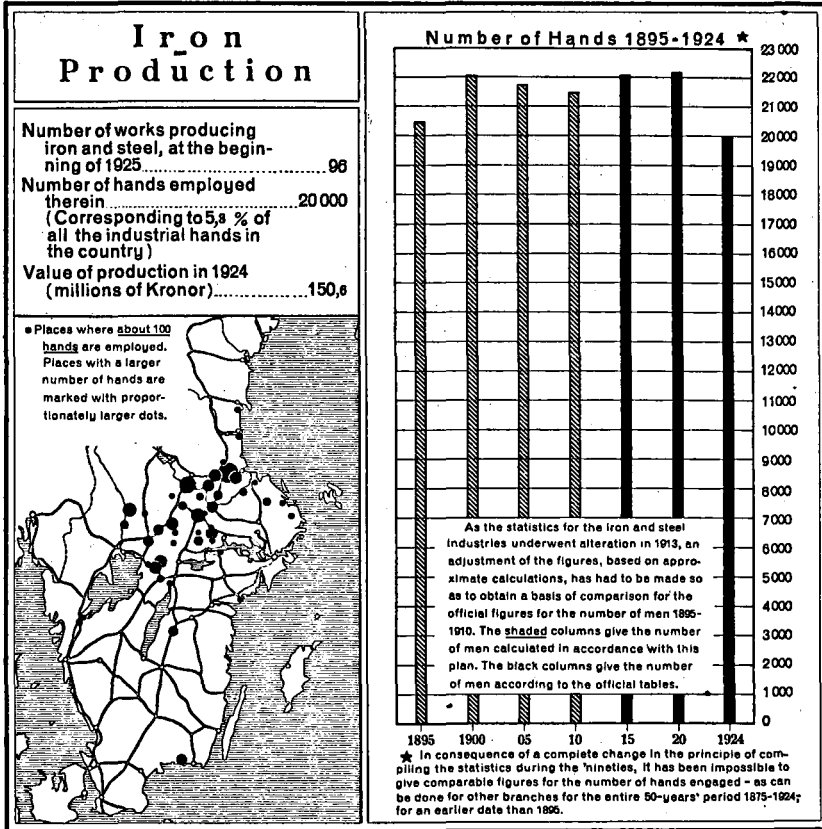


Steam Hammer at work (Bofors Steelworks)

The material on the anvil is handled by means of blocks and tongs.

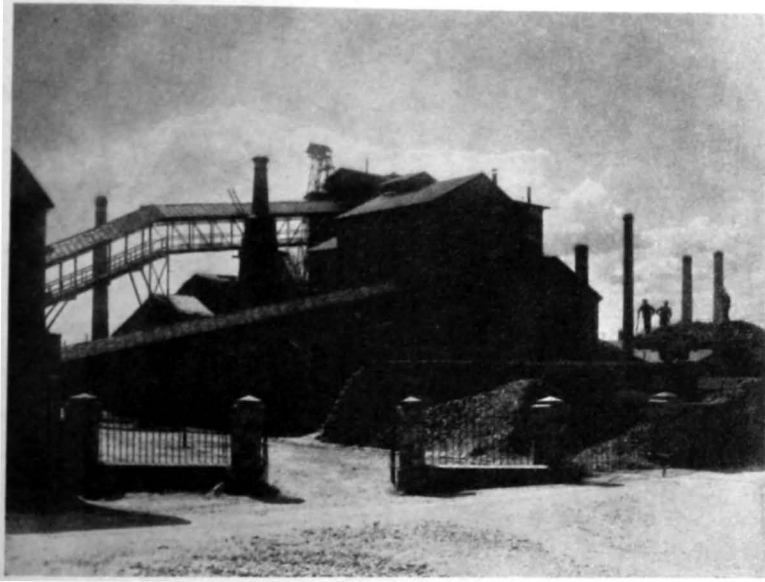
of foreign fuel. As has already been mentioned, the charcoal question in Central Sweden has given rise to considerable anxiety. The charcoal is obtained on an increasing scale from the forests situated farther north; but even there the competing demands of the pulp industry make themselves greatly felt.

The natural bent and disposition of the Swedish people is a factor of the greatest importance in the Swedish iron industry. Since very early times the iron industry has had a supply of capable managers and of workmen imbued with pride in their work, a fact that has found expression in the care and exactitude with which every step in the processes is watched over and carried out, and in the acquired skill which has been transmitted through many generations. The existence of a body of clever and capable workmen is a factor of great value in the Swedish iron industry. It is due to the co-operation between the owners and the men that during the extremely bad conditions of trade of the last few years the iron industry has not suffered to a greater extent than has been the case.



A.-B. KARTOGRAFISKA INSTITUTET

The Swedish iron industry is, and always has been, chiefly an export industry. The export includes both pig-iron and high-quality iron and steel in a more or less manufactured state. The export of pig-iron in 1924 amounted to 90,000 tons of a value of 10.5 million kronor. Wrought iron is usually shipped as rough bars; steel to some extent in the form of ingots, blooms and billets, but more often in a more advanced state of manufacture, such as steel castings, rolled and forged iron and steel of various sections, steel for motor cars etc., steel for ball-bearings, tool steels of many and various kinds, rolled and drawn wire, tubes, cold-rolled strip, etc. The total export of wrought iron and steel amounted in 1924 to about 165,000 tons



Blast-furnace at Långshyttan, Dalarna (Klosters A.-B)

with a value of about 70 million kronor. A very considerable part of the steel produced is used in Sweden for machinery, hardware, etc.

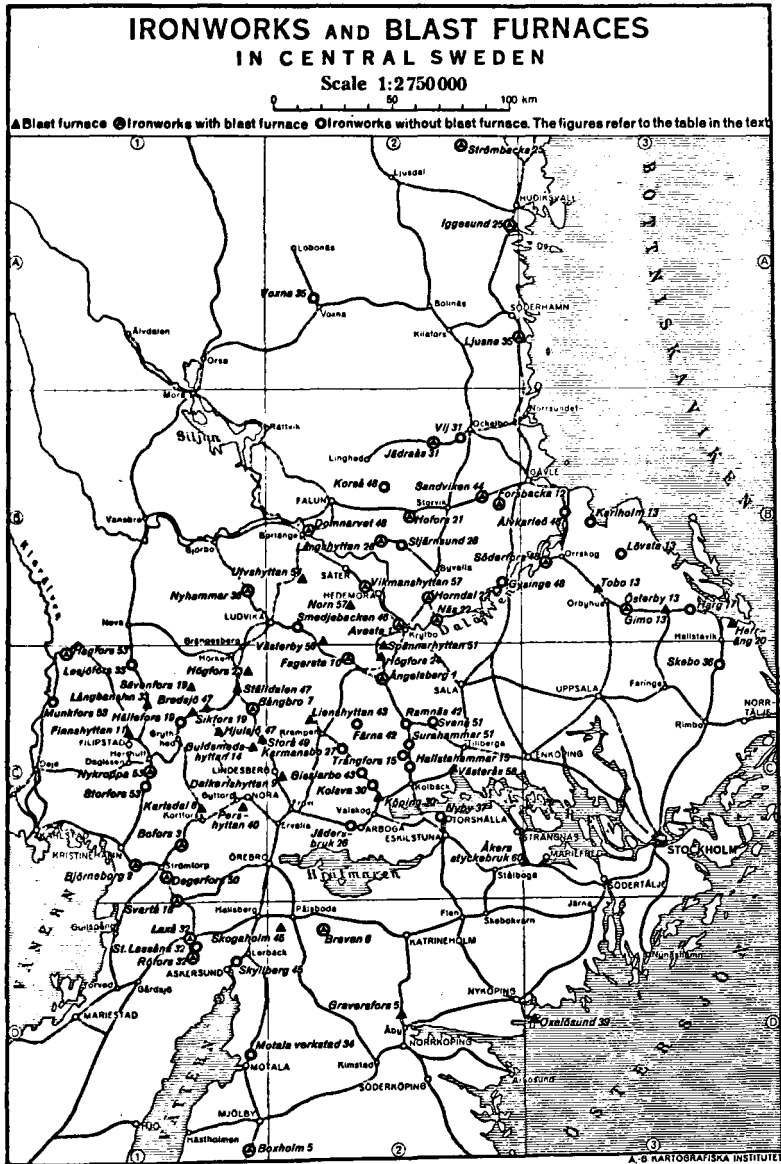
As regards the imports of iron, these consist chiefly of pig-iron for foundry purposes, etc., scrap iron (41,000 tons and 38,000 tons respectively in 1924), rails, structural iron, plates, ordinary commercial iron and other products that the Swedish ironworks cannot produce at a profit. In 1924 these imports totalled about 200,000 tons. The quantity imported was formerly small compared with the export, but is now larger than the latter.

We append here an alphabetical list of the larger ironworks in Sweden. Among these Sandviken, Stora Kopparbergs Bergslag and Uddeholm employ more than 2,000 men each; Fagersta, Hofors, Strömsnäs and Surahammar ironworks have about 1,000 workmen each, and Avesta, Boxholm, Forsbacka, Gimo-Österby, Kloster and Kohlsva ironworks each employ from about 500 to 800 men. (The letters and figures in brackets refer to the map on p. 97.)

— THE MINING AND METAL INDUSTRIES —

1. *Avesta Järnverks A.-B.*, with blast furnaces, Martin works, rolling and stamping mills at Avesta (B 2), blast furnace, Lancashire hearths and rolling mill at Ängelsberg.
2. *Björneborgs Järnverks Nya A.-B.*, Värml. Björneborg, with blast furnaces, Bessemer and Martin works, rolling mills and hardware works at Björneborg (C 1).
3. *A.-B. Bofors*, with blast furnaces, Martin works and rolling mill at Bofors (C 1).
4. *Borgviks A.-B.*, Borgviksbruk, with blast furnace, Lancashire works and rolling mill at Borgvik (not marked on the map).
5. *Boxholms A.-B.*, with blast furnace, Martin and Lancashire works, also rolling mill and hardware works at Boxholm (D 1, 2), blast furnaces at Graversfors (D 2).
6. *Brefvens Bruk*, Kilsmo, with blast furnace and hardware works at Breven (D 2).
7. *Bångbro Rörverk*, with blast furnaces, Thomas and Bessemer works, hot and cold rolling mills, stamping mill and hardware works at Bångbro (C 1, 2) (not running).
8. *Carlsdahls A.-B.*, Karlsdalsbruk, with blast furnaces at Karlsdal (C 1).
9. *Dahlkarlshytte A.-B.*, with blast furnaces at Dalkarlshyttan (C 1, 2).
10. *Fagersta Bruks A.-B.*, with blast furnaces, Martin works, crucible steel mill, electric smelting works, rolling mill and hardware works at Fagersta (C 2).
11. *A.-B. Finshyttan*, with blast furnace at Finshyttan (C 1).
12. *Forsbacka Järnverk*, with blast furnaces, Bessemer and Martin works, rolling mill and hardware forges at Forsbacka (B 2, 3).
13. *Gimo-Österby Bruks A.-B.*, Gimo, with Lancashire works and rolling mill at Karlholm (B 3), blast furnaces at Gimo (B 3), Walloon forges at Löfsta (B 3), blast furnace at Tobo (B 3), blast furnace, Walloon forge, crucible steel mill, Martin works, rolling mill, and hardware works at Österby (B 3).
14. *Guldsmedshytte A.-B.*, with blast furnace at Guldsmedshyttan (C 1).
15. *Hallstahammars A.-B.*, with Martin works, Lancashire works and rolling mill at Hallstahammar (C 2), Lancashire works at Trångfors (C 2).
16. *Halmstads Järnverks A.-B.*, with Martin works, electro-steel mill, hot and cold rolling mill at Halmstad (not marked on the map).
17. *Hargs Bruk*, with Walloon forges, Lancashire works and rolling mill at Harg (B 3).
18. *Hasselfors Bruks A.-B.*, Hasselfors, with blast furnace, Lancashire works and rolling mill at Svartå (C, D 1).
19. *Hellefors Bruks A.-B.*, with Martin works and rolling mill at Hällefors (C 1), blast furnace at Sikfors (C 1), blast furnace at Sävenfors (C 1).
20. *Herrängs Gruv A.-B.*, with blast furnaces at Herräng (B, C 3).
21. *Hofors Bruk*, with blast furnaces, Martin works, rolling and stamping mills and hardware works at Hofors (B 2).
22. *Horndals Järnverks A.-B.*, with blast furnace, Martin works and rolling mill at Horndal (B 2), blast furnace and rolling mill at Näs (B 2).
23. *Högfors A.-B.*, Vinteråsen, with blast furnace at Högfors in Örebro pr. (C 1).
24. *Högfors & Persbo A.-B.*, Högfors, with blast furnaces at Högfors in the province of Västmanland (C 2).
25. *A.-B. Iggesunds Bruk*, with blast furnaces, Bessemer and Lancashire works, also rolling mill and hardware works at Iggesund (A 2), blast furnace and Walloon forges at Strömbacka (A 2, 3).

— THE MINING AND METAL INDUSTRIES —



— THE MINING AND METAL INDUSTRIES —

26. *Jäders Bruks Intressenter*, with Lancashire works at Jädersbruk (C 2).
27. *Karmansbo Bruk (A.-B. Rune & k:i)*, with Lancashire works and rolling mill at Karmansbo (C 1, 2).
28. *Klostern A.-B.*, Långshyttan, with blast furnaces, Bessemer and Martin works, electro-steel works, hot and cold rolling mill, stamping mill and hardware works at Långshyttan (B 2), rolling mill and hardware works at Stjärnsund (B 2).
29. *Kockums Järnverks A.-B.*, Malmö, with Martin hearths, electric smelting works and rolling mill, also hardware works at Kallinge (not marked on the map).
30. *Kohlswa Järnverks A.-B.*, with Martin works, electric smelting works, rolling and stamping mills and hardware works at Kolsva (C 2), blast furnace at Köping (C 2).
31. *Kopparberg & Hofors Sågverks A.-B.*, Ockelbo, with blast furnaces, Lancashire works and rolling mill at Jädraås (B 2), Lancashire works and rolling mill at Vij (B 2).
32. *Laxå Bruks A.-B.*, with blast furnace, Lancashire mill, rolling mill, and hardware works at Laxå (D 1), blast furnace and Lancashire works at Rölfors (D 1), Lancashire works at Stora Lasåna (D 1).
33. *Lesjöfors A.-B.*, with Martin works, rolling mill and hardware works at Lesjöfors (C 1), blast furnace at Långbanshyttan (C 1).
34. *A.-B. Lindholmen-Motala*, Motala Verkstad, with Martin works, rolling mill and stamping mill at Motala Verkstad (D 1, 2).
35. *Ljusne-Woxna A.-B.*, Ljusne, with blast furnace, electric smelting works, Lancashire and rolling mills and hardware works at Ljusne (A 2), Lancashire works and electric smelting works at Voxna (A 2).
37. *Nyby Bruks A.-B.*, with Martin works and Lancashire works, rolling mill and hardware works at Nyby (C 2).
38. *A.-B. Nyhammars Bruk*, with blast furnaces, Lancashire works, rolling mill and hardware works at Nyhammar (B 1).
39. *Oxelösunds Järnverks A.-B.*, with blast furnace at Oxelösund (D 3).
40. *A.-B. Pershyttan*, Nora, with blast furnace at Pershyttan (C 1).
41. *A.-B. Porjus Smältverk*, Stockholm, with electric smelting works at Porjus (not marked on the map).
42. *Ramnäs Bruks A.-B.*, with Lancashire works and rolling mill at Färna (C 2), Lancashire works, rolling mill and hardware works at Ramnäs (C 2).
43. *Riddarhytte A.-B.*, Riddarhyttan, with Lancashire works and rolling mill at Gisslarbo (C 2), blast furnace at Lienshyttan (C 2).
44. *Sandvikens Jernverks A.-B.*, with blast furnaces, Bessemer and Martin works, electro-steel works, stamping mill, hot and cold rolling mills and hardware works at Sandviken (B 2).
45. *Skyllbergs Bruks A.-B.*, with blast furnace at Skogaholm (D 1, 2), Lancashire works, rolling mill and hardware works at Skyllberg (D 1, 2).
46. *Smedjebackens Valsverks A.-B.*, with Martin works and rolling mill at Smedjebacken (B 2).
47. *A.-B. Stjernfors-Ställdalen*, Bredsjö, with blast furnaces at Bredsjö (C 1), blast furnace at Hjulsjö (C 1, 2), blast furnace at Ställdalen (C 1, 2).
48. *Stora Kopparbergs Bergslags A.-B.*, Falun, with blast furnaces, electric smelting works, Thomas and Martin works, hot rolling mill and hardware works at Domnarvet (B 2), works for the manufacture of springs at Älvkarleö (B 2, 3), Lancashire works at Korså (B 2), blast furnace, electric smelting works, electro-steel works,

— THE MINING AND METAL INDUSTRIES —



Fagersta Ironworks in Västmanland.

To the right, the River Kolbäck, and the Strömsholm Canal; to the left the Stockholm—Västerås—Bergslagen Railway.

- Martin works, rolling mill and hardware works at Söderfors (B 2, 3).
49. *A.-B. Stord Masugn*, Vasselhyttan, with blast furnace at Storå (C 1, 2).
50. *Strömanäs Järnverks A.-B.*, with blast furnaces, Martin works, rolling mill, stamping mill and hardware works at Degerfors (C 1).
51. *Surahammars Bruks A.-B.*, with Martin works, electro-steel works, rolling mill, stamping mill and hardware works at Surahammar (C 2), blast furnaces at Spännarhyttan (B, C 2), Lancashire works at Svanå (C 2).
52. *A.-B. Trollhättans Elektriska Masugn*, with blast furnace at Trollhättan (not marked on the map).
53. *Uddeholms A.-B.*, Uddeholm, with blast furnaces, electric smelting works, Bessemer and Martin works, rolling mill and screw factory at Hagfors (C 1), Martin works, Lancashire works, hot and cold rolling mill and hardware forge at Munkfors (C 1), blast furnaces, Martin works and rolling mill at Nykroppa (C 1), rolling mill at Storfors (C 1).
54. *Ulfshytte Järnverks A.-B.*, with blast furnace at Ulfshyttan (B 1, 2)
55. *Wargöns A.-B.*, with electric smelting works at Vargön (not marked on the map).
56. *A.-B. Vesterby Masugn*, with blast furnace at Västerby (B, C 1, 2).
57. *Wikmanshytte Bruks A.-B.*, with blast furnace at Norn (B 2), blast furnace, crucible steel mill, electro-steel works, Martin works, rolling mill and hardware works at Vikmanshyttan (B 2).

— THE MINING AND METAL INDUSTRIES —

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| 58. <i>Västerås Masugns A.-B.</i> , with blast furnace at Västerås (C 2). | 61. <i>Ödeborgs Bruks A.-B.</i> , with Martin works, rolling mill and hardware works at Ödeborg (not marked on the map). |
| 60. <i>Åkers Styckebruk</i> , with blast furnace at Åkers Styckebruk (C 2, 3). | |

It may be mentioned in this connection that Sweden carries on an important ferro alloys industry (principally ferro silicon, silico manganese, silicospiegel and ferro chrome) at works such as *A.-B. Ferrolegeringar*, Stockholm, *Wargöns A.-B.*, Vargön, *Gullspångs Elektrokemiska A.-B.*, Gullspång, and *A.-B. Karlsons Metall- och Maskin A.-B.*, Stockholm, the first-mentioned being the largest manufacturer of ferro chrome in Europe.

THE METAL INDUSTRY.

The 'metal industry' is generally understood to mean the production of non-ferrous metals and alloys thereof, and their working up into semi-manufactured goods.

The metals coming next to iron in industrial importance — copper, zinc and lead — are all produced in Sweden, although not in sufficient quantities to satisfy the home demand. Aluminium, tin, nickel and certain other metals, on the contrary, are obtained in Sweden only by refining scrap. A considerable quantity of different metals must consequently be imported every year.

The production of copper was in former times one of Sweden's greatest sources of income and, even as late as the seventies of the last century, provided a considerable export surplus; during the last few decades, however, it has sufficed to meet only a small part of the demand, which, chiefly in consequence of the development of the electrical industry, has risen enormously. One of the causes is to be found in the violent fluctuations in price caused by the exploitation of foreign copper-fields, the result of which has been that the production of copper from Swedish ore has for some years ceased altogether. It remains to be seen whether it will be resumed in the newly-discovered copper-ore field in the Skellefteå district. The copper produced in Sweden during the last years has been extracted from purple ore, a residue from the manufacture of sulphuric acid, (chiefly from copper-bearing pyrites from Sultälma, Orkla, and other places in Norway). In 1924 the manufacture of the primary product, cement-copper, amounted to about 6,000 tons, a great part of which was exported. In the same year the production of refined copper was about 2,000 tons.



Tube-drawing works of A.-B. Svenska Metallverken, Västerås.

The production of zinc was of small importance until 1910. The zinc-ore mined in the country was mostly exported after roasting. Since the year mentioned, however, the production of zinc has greatly increased, based on the process invented by Gustaf de Laval for obtaining the metal in electric furnaces. In 1924 the production amounted to about 4,200 tons, which corresponds to approximately 70 % of the home demand.

The production of lead during the last few years has amounted to about 500 tons a year, corresponding approximately to 10 % of the consumption in Sweden. The lead is obtained from galena, some of which is imported from Norway.

Industrial enterprises engaged in the production of other metals than iron are 4 in number, employing together 600 men. In 1924 their total produce had a value of 9.9 million kronor.

These enterprises are: *Reymersholms Gamla Industri A.-B.* with copper-works at Hälsingborg, *A.-B. Oskarshamns Kopparverk*, with copper-works at Oskarshamn, *Trollhättans Elektrotermiska A.-B.*, with smelting works for zinc and lead at Trollhättan, and *A.-B. Svenska Metallverken, Västerås*, with a lead-smelting house at Sala.

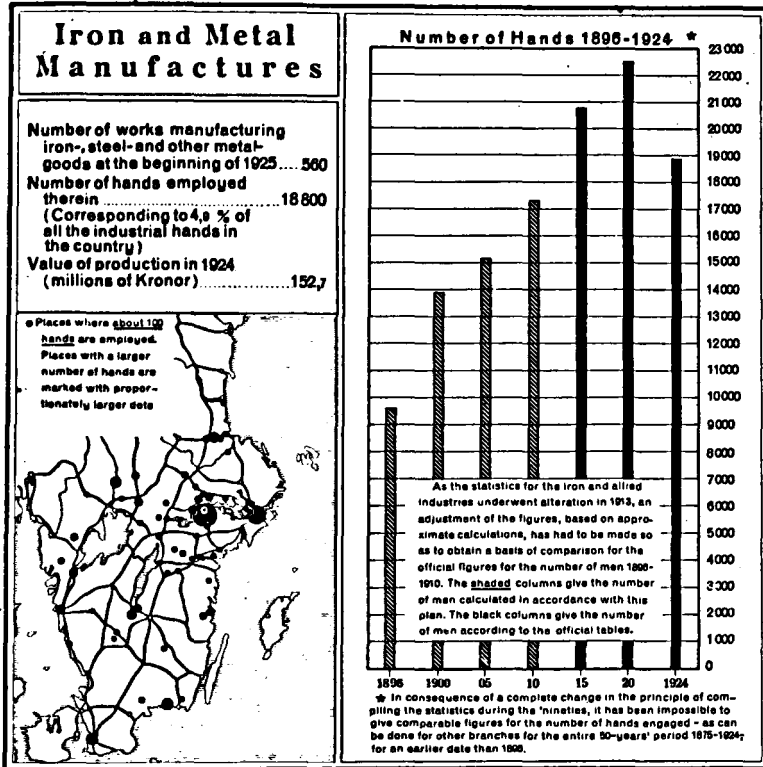
— THE MINING AND METAL INDUSTRIES —

The production of semi-manufactured goods and alloys, which has long been carried on in Sweden from its native or imported copper, zinc, lead, etc., has during the course of the last few decades grown into an important industry. Of considerable importance in this respect was the concentration effected in this branch in 1911, the result of which was that the industry came mainly into the hands of two firms: A. B. Svenska Metallverken, and Finspongs Metallverks A. B. Their production embraces the manufacture (casting, rolling, drawing and pressing) of sheets, bands, tubes, wire, shapes and other semi-manufactured goods of copper, brass, aluminium, bronze, zinc, lead, nickel, tin, etc. In addition, the works in question also manufacture bolts, screws, rivets, nails, carpet-rods, etc., and other finished articles of metal. Technically the above-mentioned Swedish manufactures stand on a very high level, quite equal to that of the best produced in other countries. During the last few years, semi-manufactured copper goods show an export surplus of about 2,000 tons; the output of brass is about 90 % of the home consumption. — In 1924 the total production of semi-manufactured goods and alloys had a value of 30 million kronor.

A.-B. Svenska Metallverken, Västerås, employ about 900 workmen in their works at Västerås and Granefors, *Finspongs Metallverks A.-B.*, Stockholm, employ about 600 workmen in their works at Finspång.

IRON, STEEL AND METAL MANUFACTURES.

The oldest iron and metal products were weapons and the tools for their manufacture. This manufacture was developed to a high degree, especially during the wars of the 17th century. When, in the middle of that century, RADEMÄCHER, a Latvian, established his forges at Eskilstuna, this led to a considerable increase in technical skill in the manufacture of forged goods. The first in Sweden to make use of machinery in this branch of manufacture was KRISTOFER POLHEM, but the employment of machinery remained of but little importance until the middle of the 19th century. It was not until the invention of the steam engine made it possible to obtain a convenient source of power that could be used everywhere that a number of special machines were constructed for the treatment of iron and steel. The development of the modern manufacture of iron and steel is, to a certain degree, due to the progress of mechanical engineering;



but the most fundamental cause of the high level of manufacturing achieved is the professional skill, conscientiousness and integrity in work which the Swedish workman has inherited from his forefathers. The manufacture in question has to a very great extent been associated with the iron production since manufacturing forges made their appearance at an early date in the Central Iron District of Sweden ("Bergslagen"). In many cases both production and manufacture are nowadays united in the same enterprise; in other cases iron production has ceased and only the manufacturing operations persist.

A view of the development of the iron and metal manufacturing industries during the past thirty years is given in the diagram above. It shows how the industry is spread over a great number of different

places in central and southern Sweden, and that it is now specially concentrated at Eskilstuna (the largest dot).

The iron and metal manufacturing industry may be divided into the following main groups: (1) Wire-drawing and the manufacture of wire goods; (2) the manufacture of malleable iron and steel wares, other than wire; (3) the manufacture of castings; (4) the manufacture of fittings and metal goods, and (5) the sheet-metal industry. These groups, in their turn, may be divided into sub-sections, corresponding to special manufactures.

(1) *Wire-drawing and the manufacture of wire goods.*

Drawn wire of iron or other metals is chiefly manufactured by the iron and metal works where the raw material is produced. There exist, however, some ten independent wire-drawing works which, to a certain extent, employ purchased raw materials. This raw material consists of rolled wire rods which are reduced in diameter by being drawn cold through holes of successively smaller diameters arranged in a steelplate. The work is nowadays carried out by machinery, which simultaneously coils the wire. The annual production of iron and metal wire has during recent years amounted to 40—50 million kilogrammes, which corresponds to more than 90 % of the consumption of the country.

Among the wire goods produced in Sweden, *wire ropes and cables* (for transporting purposes, hoists, ships tackle, etc.), play an important part. Their manufacture began about the middle of the 19th century, and has since developed into a well-known Swedish branch of production of high quality, amounting to about 1.5 million kilogrammes per year. These products supply approximately 75 % of the demand of the home market; the export is small. *Wire-nails* now form an important article of manufacture in Sweden. Square wire is the ordinary raw material for this manufactured product. The wire is cut into lengths and headed and pointed by special machines. The output may be considered sufficient to meet the home demand. Among other wire products may be mentioned *wire-gauze* of iron, copper or brass (of special note are the "wires" used by the paper industry), wire-netting, chains, springs and furniture springs and a number of small articles, such as hair-pins, pins, safety-pins, hooks and eyes, paper fasteners, etc., these articles are usually made in automatic machines.

— THE MINING AND METAL INDUSTRIES —

The drawing of iron and steel wire without further working is carried on by *Hallstahammars A.B.*, Hallstahammar, *Sandvikens Jernverks A.B.*, Sandviken, and *Hofors Bruk*, Hofors. Wire-drawing, together with the manufacture of iron and steel rope etc., is carried on by *Blombäcka A.B.*, Lindfors, *Fagersta Bruks A.B.*, Fagersta, *A.B. Garphytte Bruk*, Latorpsbruk, and *Lesjöfors A.B.*, Lesjöfors. Manufacturers of drawn-wire and wire-nails are *A.B. Gryts Bruk*, Hjortkvarn, *Grytgöls Bruks A.B.*, Ljusfallshammar, *Gunnebo Bruks Nya A.B.*, Verkeback (also steel rope in a branch at Varberg), *A.B. Halmstads Spik- och Trådverk*, Halmstad, *Laxå Bruks A.B.*, Laxå, *Motala Järnmanufaktur A.B.*, Motala, *Nya A.B. Hjulsbro Tråddrageri & Spikfabrik*, Hjulsbro, *Skyllbergs Bruks A.B.*, Skyllberg, *A.B. Spik*, Västervik, *Uddeholms A.B.*, Uddeholm, *Åsbrohammar-Spångsholms Bruks Nya A.B.*, Sya, and *Ödeborgs Bruks A.B.*, Ödeborg. To these may also be added *A.B. Svenska Tacksfabriken*, Trollhättan (shoe-nails).

Amongst manufacturers of other iron and steel wire goods the following are the most important: *Gusums Bruks- och Fabriks A.B.*, Gusum (brass-forge with manufacture of wire-gauze and 'wires' for the paper industry, pins, hooks and eyes, and various small products), *A.B. Metallduk*, Bruzaholm (wire-gauze), and *J. H. Tidbeck*, Stockholm (wire-gauze, etc.), as well as *A.B. Stängselfabriken*, Göteborg, and *A.B. Svenska Spiralfabriken*, Stockholm (spiral springs, furniture springs etc.). Several of the wire-nail factories also make wire-netting and other wire goods. *A.B. Borggårds Bruk*, Hällestad, make screw-hooks, clasps, hangers etc. Similar small articles of iron and wire are also produced by a large number of small enterprises, especially at Gnosjö (Jönköping province), where this manufacture is of ancient date.

(2) *The manufacture of malleable iron and steel wares.*

The manufacture of heavier forgings embraces anvils, sledge-hammers and tools for stone-working, chain-cables, carriage- and coiled springs, buffers and other railway forgings, forgings for ships, etc. The production of such goods has, from olden times, been carried on at the ironworks, for in their manufacture a perfect control of the raw material is necessary, and this is most easily obtained by the producers of the iron and steel. The manufacture of chains is one of the branches of the iron-manufacturing industry that, during the 18th century, earliest assumed the form of factory production. The first Swedish chain-cable forge was established in 1757 at Furudal (in the province of Kopparberg); it was later on transferred to Ljusne. Nowadays in the manufacture of certain kinds of chain-cables there are employed mechanical hammers, entirely automatic in action, and electric welding. The production of chain-cables and springs equals 80 or 90% of the consumption of the country. Competition from foreign countries with lower costs of labour is much felt in the manufacture of heavy forgings. The export is of small extent.

Anvils are made by *Söderfors Bruk (Stora Kopparbergs Bergslags A.-B.)*, *Söderfors, Kohlsva Jernverks A.-B.*, *Kolsva*, and *Nydqvist & Holm A.-B.*, *Trollhättan*. The following are manufacturers of sledge-hammers and tools for stone-working: *Fagersta Bruks A.-B.*, *Fagersta*, *Forsbacka Jernverks A.-B.*, *Forsbacka*, *Lesjöfors A.-B.*, *Lesjöfors*, *Sandvikens Jernverks A.-B.*, *Sandviken*, and *Wikmanshytte Bruks A.-B.*, *Vikmanshyttan*. Chain-cables are made chiefly by *Ljusne-Woxna A.-B.*, *Ljusne*, *Ramnäs Bruks A.-B.*, *Ramnäs*, and *Tönshammars Bruk A.-B.*, *Sandarne*. Buffers, carriage-couplings, and other railway forgings are manufactured by *Surahammars Bruks A.-B.*, *Surahammar*, *Kohlsva Jernverks A.-B.*, *Kolsva*, and *Wirsbo A.-B.*, *Virso*. Carriage and spiral springs of various kinds are made by *Fagersta Bruks A.-B.*, *Lesjöfors A.-B.* and *Älvkarleö Bruk (Stora Kopparbergs Bergslags A.-B.)*, *Älvkarleö*, as well as by *Strömsnäs Jernverks A.-B.*, *Degerfors*, *Surahammars Bruks A.-B.* and *Uddeholms A.-B.*, *Uddeholm*. Watch and other main springs are made by the last-mentioned company, as well as by *Sandvikens Jernverks A.-B.* In this connection *See Fabriks A.-B.*, *Sandviken*, may also be mentioned as manufacturers of umbrella ribs, tubes and wheel-fellies for bicycles etc.

The manufacture of nails, screws, rivets, bolts, and the like, and of horseshoes is carried on partly at the ironworks (nails, screws etc., of copper and brass, at the metal works), and also at certain special factories.

Nail-forging was one of the earliest branches of manufacture taken up by the Swedish ironworks. The manufacture of forged nails is nowadays replaced on a large scale by the making of cut nails, i. e., nails cut out of sheet metal and headed, and also of wire nails. Especially towards the end of the nineties of the last century, the manufacture of nails in Sweden increased very much and at present supplies the entire demand of the country; the exports of nails in recent years have had a value of about 1 million kronor annually. The manufacture of wood-screws on a factory scale began already in 1884 at Hagfors. Particularly during the last few decades the production has greatly increased, and nowadays not only is the home market fully supplied, but there is a surplus for export to a value of about 1 million kronor a year. Machine screws, rivets, bolts and nuts are manufactured on a small scale in the engineering workshops for their own consumption; their production has also become a speciality of certain enterprises, especially since the threading was standardized at the end of the last century. The production is sufficient for the home market and exports in 1924 had a value of about 1 million kronor. The manufacture of horseshoe nails, which was formerly carried on at the ironworks, became towards the beginning of the century a special industry, chiefly concentrated in a single factory at Mustadfors, in Dalsland, with a capacity far exceeding the home demand.

— THE MINING AND METAL INDUSTRIES —

Exports amount to a value of about 3 million kronor annually. The manufacture of horseshoes was, until the end of the last century, carried on in almost every blacksmith's shop in the country districts, and still survived until a few years ago as a home industry in the province of Dalarna. Nowadays it is carried on with the aid of machinery at certain ironworks, and also at special factories; the production corresponds approximately to the home demand.

Nails are made, *inter alia*, by *Boxholms A.-B.*, Boxholm, *Kockums Jernverks A.-B.*, Malmö, *Nyby Bruks A.-B.*, Nybybruk, *Skylbergs Bruks A.-B.*, Skylberg, *Stora Kopparbergs Bergslags A.-B.*, Falun, *Strömenäs Jernverks A.-B.*, Degerfors, and *Ödeborgs Bruks A.-B.*, Ödeborg (wire-nails, see p. 105). Screws, bolts, nuts and rivets are made by *Bultfabriks A.-B.*, Hallstahammar, *Eskilstuna Fabriks A.-B.*, Eskilstuna, *A.-B. Göteborgs Bult- & Nagelfabrik*, Göteborg, *John Lindströms Skruvfabrik*, Strängnäs, *A.-B. Priorverken*, Norrköping, *Aug. Stenman, A.-B.*, Eskilstuna, *Uddeholms A.-B.*, Uddeholm, and *Ashammars Bultfabriks A.-B.*, Åshammar. The following are manufacturers of horseshoe nails and frost-nails: *A.-B. O. Mustad & Son*, Långed, and *A.-B. Lidköpings Söm- & Broddfabrik*, Lidköping. Horseshoes are made by *Häfte Bruks A.-B.*, Häfte, *Broby Mtk. Verkstads A.-B.*, Broby, *A.-B. Finspongs Hästskor*, Stockholm, *Hofors Bruk*, Hofors, and *Uddeholms A.-B.*, Uddeholm.

The manufacture of *manual agricultural implements*, such as spades, shovels, pitchforks, rakes, and scythes, for a long time formed a home industry in Sweden, but was also carried on at the ironworks and the older manufacturing works. During the last three decades of the 19th century these branches of industry became more and more concentrated in special factories. As regards scythes, the Swedish production, practically speaking, satisfies the entire home demand, while some of the other manual implements are imported, especially from the U. S. A. and Germany. The value of the exports, chiefly to the adjacent countries, amounted during recent years to about 0.5 million kronor annually, or to about one-fifth of the value of the whole production.

A.-B. Arrika Redskapsfabrik, Arrika, *Nya A.-B. Liljeqvists Sågblads- and Redskapsfabrik*, Eskilstuna, *Wedevägs Bruks A.-B.*, Vedevåg, and *Wiksforss A.-B.*, Stockholm, are engaged in this branch of manufacture. A special factory for scythes and cutters is *Igelfors Bruks A.-B.*, Stockholm.

Axe-forging was formerly carried on in Sweden as a handicraft, but became in the course of time a special manufacture at certain ironworks. During the last few decades the production of these article has been brought up to date and based on American patterns, so that Sweden, which formerly imported a great part of its supply of axes, nowadays not only satisfies the home demand, but also exports axes

to a value of about 0.5 million kronor a year. This increased sale has been achieved thanks to the unsurpassed quality of the Swedish product.

Among manufacturers of axes may here be mentioned *A.-B. Arvika Redskapsfabrik*, Arvika, *Hults Bruks A.-B.*, Åby, *A.-B. Njurunda Industrier*, Njurunda, *A.-B. Sätters Yxfabrik*, Säter, and *C. O. Åberg & Co.*, Edsbyn.

The manufacture of saws and saw-blades is carried on both at certain ironworks and also at special saw-blade factories. A pioneer of the latter type was the factory at Torshälla, later on transferred to Trollhättan. Under the well-known name of *Stridsberg & Biörck* it has become one of the largest manufacturing establishments in this branch. In later years the production of saws and saw-blades in Sweden has had an annual value of 3—4 million kronor, and about half of the total production has been exported. The most important articles are frame saw-blades and circular saws, of which articles the Swedish makes are at present considered the best obtainable.

Among manufacturers in this branch the following ironworks may be noted: *Fagersta Bruks A.-B.*, Fagersta, *Gimo-Österby Bruks A.-B.*, Österbybruk, *A.-B. Iggesunds Bruk*, Iggesund, *Sandvikens Jernverks A.-B.*, Sandviken, and *Uddeholms A.-B.*, Uddeholm; also the following special factories: *A.-B. Stridsberg & Biörck*, Trollhättan, *A.-B. Sågbladsfabriken*, Nora, *Torshälla Sågbladsfabrik*, Torshälla, *Nya A.-B. Liljeqvists Sågblads & Redskapsfabrik*, Eskilstuna; also *A.-B. Lidköpings Vikingsdgar* and *A.-B. Kronsdgar*, Lidköping.

The manufacture of smaller tools, especially edge-tools, is chiefly associated with the term: "Eskilstuna Goods". For a long time past the manufacture of razors and pocket knives, kitchen and special knives used in different trades, table-knives and forks, scissors, files, drills, hammers and tongs, has been largely concentrated at Eskilstuna. Of the manufactures in question, representing an annual value of 7 or 8 million kronor, there is also a considerable export, amounting to about one-third of the total production, especially of the better qualities of knives, scissors and files. It is the excellent raw material, the best Swedish steel, as well as pre-eminent technical and business ability and organization which in combination have made the name of Eskilstuna known over the whole world.

Among manufacturers of knives and scissors may be noted *E. A. Bergs Fabriks A.-B.*, *Eskilstuna Jernmanufaktur A.-B.*, *Eskilstuna Knivfabriks A.-B.* and *A.-B. C. V. Heljestrand*, all at Eskilstuna, as well as *A.-B. Stridsberg & Biörck*, Trollhättan, (machine knives). Chisels and planing irons are made by *B. & O. Libergs Fabriks A.-B.*, Skogstorp. The largest file factory is *C. O. Öberg & Co.s A.-B.*, Eskilstuna, with an output of about four-fifths of the entire production of the country; *A.-B. Norrköpings*

— THE MINING AND METAL INDUSTRIES —

Filfabrik, Norrköping, *A.-B. Sveriges Förenade Filfabriker*, Traryd, and *Gadö Nya Fabriks A.-B.*, Gävle, may also be mentioned. The manufacture of tongs is a speciality of the firm of *F. E. Lindström*, Eskilstuna, and the manufacture of screw-wrenches and pipe tongs of *A.-B. Enköpings Verkstäder*, Enköping. Safety razor blades are manufactured by *A.-B. Svensk Rukklinga*, Sandviken.

The manufacture of locks, hinges and other builders' wrought iron-ware, which nowadays amounts to a value of about 7 million kronor per annum, is also included among the "Eskilstuna Goods". The manufacture of locks was carried on in olden times as a handicraft, and has been the object of many inventors' labours. Kristofer Polhem, for instance, invented a padlock which is still used under the name of the Polhem lock. At the present time the products of the numerous branches of the lock industry occupy a prominent position among the Eskilstuna specialities. Swedish hinges are now used in all countries; more than half of the world consumption is supplied from Sweden.

Among manufacturers of locks and other builders' wrought ironware may be noted *Låsfabriks A.-B.*, *Aug. Stenman A.-B.*, *A.-B. Möbellås* and *Eskilstuna Jernmanufaktur A.-B.*, all at Eskilstuna; also *A.-B. Priorverken*, Norrköping.

(3) *The manufacture of castings (commercial foundry goods).*

The chief production of the pig-iron foundries consists — in addition to machine castings and partly finished products for the engineering workshop industry — of finished goods for household, building and other purposes. All these are usually included in the term "commercial foundry goods".

The manufacture of commercial foundry goods has been estimated to equal about one-third of the production of the Swedish foundries, which in 1924 had a total output of about 110 mill. kg. Among commercial foundry goods, the foremost place has from ancient times been occupied by stoves and ranges of different kinds, frying-pans and pots, etc. Mincing machines are manufactured on a large scale for export; in 1924 these alone were exported to a value of 1.8 million kronor. Other articles which, as a result of the greater domestic demands of to-day, are manufactured to a constantly increasing extent are: radiators (heating "elements") and heating boilers, baths, sluicing tanks, laundry- and washing-up appliances and kitchen-washers, etc., but a considerable import of these productions takes place too. Attention may also be directed to the manufacture of cast-iron furniture, such as restaurant tables, garden seats, balustrade columns, fencings and garden urns, of which products those of Nävekvärn have



Foundry at Karlhäll, outside Stockholm, a section of J. & C. G. Bolinders Mek. Verkstads A.-B.

gained a reputation for their artistic character. Among malleable castings may be mentioned pipes and pipe-fittings, boat-fittings, certain machine parts, small apparatus, etc.

The enterprises which specialise in commercial castings — particularly stoves, ranges, drainers, boilers, pans — are as follows: *A.-B. Ankarsrums Bruk*, Ankarsrum, *J. & C. G. Bolinders Mek. Verkstads A.-B.*, Stockholm, *Husqvarna Vapenfabriks A.-B.*, Huskvarna, *Kockums Jernverks A.-B.*, Malmö, with a foundry at Kallinge, *Norrahammars Bruk*, Norrahammar, *Näfvequarns Bruk*, Nävequarn, and *A.-B. Skoglund & Olson*, Gävle. Practically the same kind of goods are made by *Ebbes Bruks Nya Arrende A.-B.*, Huskvarna, *Aug. Hansons Gjuteri A.-B.*, Halmstad, *Carl Holmbergs Mek. Verkstads A.-B.*, Lund, *A.-B. Klafreströms Bruk*, Klavreström, and *Munktells Verkstads Nya A.-B.*, Eskilstuna. Certain kinds of ranges are made by *A.-B. Malcus Holmquist*, Halmstad, and *A.-B. Sundsvalls Förenade Verkstäder*, Sundsvall. Manufacturers of mincing machines are *J. & C. G. Bolinders Mek. Verkstads A.-B.* and *Husqvarna Vapenfabriks A.-B.* The latter are, amongst others, manufacturers of cast-iron radiators; also *A.-B. Götaverken*, Göteborg, and *Norrahammars Bruk*.

Malleable castings are produced *inter alia* by *A.-B. Järnförädling*, Hälleforsnäs, *A.-B. P. Å. Larssons Gjuteri & Aduceringsverk*, Eskilstuna, *A.-B. Limhamns Aduceringsverk*, Limhamn, *Norrahammars Bruk* and *A.-B. Öfverums Bruk*, Överum.

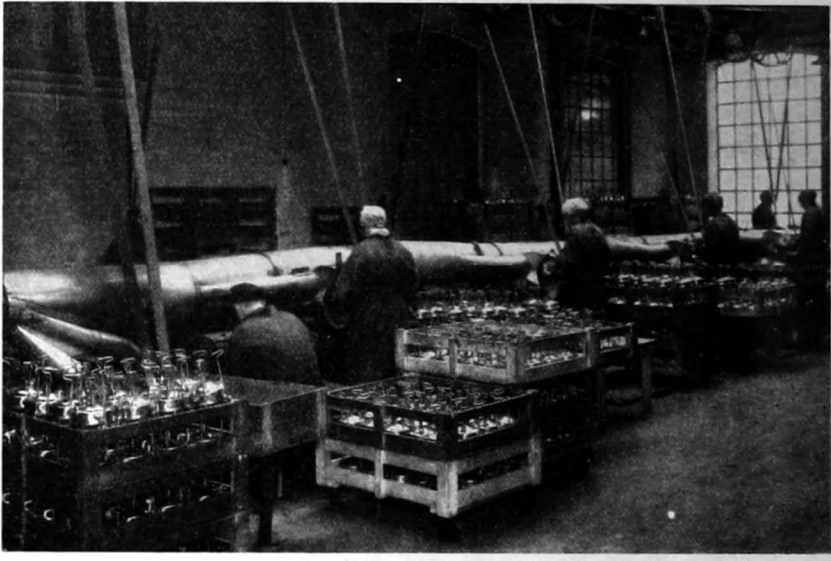
IE, MINING AND METAL INDUSTRIES —

(4) *Fittings and metal goods.*

In this group we include the industry engaged in the production of various finished trade articles of copper, nickel, brass and other metals or alloys, with the exception, however, of goods made from wire and sheet metal. The production of these goods takes place to some extent at the metalworks, but chiefly at about 150 larger or smaller establishments of different types, and occupies about 4,000 men.

The oldest branch of this manufacture, which was an established industry at Skultuna (where it still flourishes) as early as the 17th century, consists of the well-known manufacture of *cooking utensils* and other vessels and apparatus closely allied to the old coppersmith's handicraft. As belonging to this branch we may also mention the manufacture of tea and coffee sets and other household articles and utensils of copper, nickel and brass. This manufacture, which is concentrated to a great extent at Eskilstuna, has grown to such proportions that it supplies nearly the whole demand of the country.

One noteworthy branch of this industry is the manufacture of *petroleum cooking stoves*, which dates back to the beginning of the nineties of the last century, the date when the now world-famous "Primus Cooking Stove" first came on the market. The great success obtained by this last-mentioned article is due not only to the revolutionary Swedish invention of a method of increasing the heating properties of the fuel by the vaporisation of the petroleum before ignition, but also largely to conscientious, accurate work and good organization. A number of different petroleum stoves of the "Primus" type (wickless) are nowadays made by various firms. In 1924 the value of the manufacture of petroleum cooking stoves amounted to 5 million kronor, and these articles were exported to a value of no less than 4.3 million kronor, principally to Egypt, India and the Argentine. Allied manufactures are soldering lamps and paraffin gas lamps, which were exported in 1924 to an amount of 1.3 resp. 0.3 million kr. The manufacture of ordinary paraffin lamps was established at the beginning of the 'eighties as a factory industry. — About the beginning of this century there was started the manufacture of *electric light fittings* which, though subject to great competition, especially from Germany, has nevertheless managed to secure the greater part of the home market, thanks to the high quality and good design of the Swedish articles. To-day these represent a value of 2—3 million kronor annually.



Polishing petroleum cooking stoves (A.-B. Primus, Stockholm).

The fine polishing dust arising in the process is carried off through the suction drum (visible in the picture) so as to prevent the premises from becoming injurious to health.

Fittings for machines, gas, water-pipings and steam embrace various equipments or accessories (valves, cocks, greasing appliances, etc.) for steam-engines, internal combustion-engines, water-heaters, bath and sanitary plants, piping etc. The manufacture of such fittings, which are usually made of brass, copper, bronze, or other metals and alloys, is a branch of production which at the present day occupies a considerable number of firms. The value of the production amounts to no less than about 5 million kronor per year. In this connection may be mentioned the manufacture of *regulators* for steam pressure, gas pressure, electric tension, etc.

Connected with the above branches is the manufacture of divers *metal fittings* for boats, furniture, travelling outfits, etc.

The manufacture in Sweden of *capsules and tubes for cosmetics*, and of *tin-foil* rose during the last quarter of a century to a value of 0.9 million kronor in 1924. The raw materials consist chiefly of lead and tin. The manufacture of *cartridge shells* and *plated bullets* is a not unimportant branch of production, which is carried on at the

Army workshops and also by private industrial concerns (A. B. Svenska Metallverken). During the last few years the value of the production at privately owned factories has amounted to about 2 million kr. annually. Finally, there may be reckoned among the metal manufactures those of *buttons and club badges, medals and plaquettes*, and also of *artcastings* which, in Sweden, have reached a very high level.

Among manufacturers of cooking utensils, coffee and tea sets, and other household articles made of metal may be mentioned *A. B. Svenska Metallverkens* works at Skultuna, also *A. B. Gustaf Erikssons Metallfabrik, Eskilstuna Metall- och Vagnslyktfabrik, A. B. O. H. Lagerstedt, Albert Lindströms Metall & Förnickligningsfabrik* and *Nickelfabriks A. B. Gottfrid Carlsson*, all at Eskilstuna. Manufacturers of petroleum-cooking stoves and soldering lamps are *A. B. Primus, Stockholm, Karl Fr. Erikssons Metallfabriks A. B., Eskilstuna A. B. Optimus, Upplands-Väsby, A. B. Radius* and *Sievert's Lödlampfabrik (A. B. Max Sievert)*, both in Stockholm. Petroleum-stoves (with wicks) are also made by *Husqvarna Vapenfabriks A. B., Huskvarna*. — Electric light fittings are made by a large number of factories, as *A. B. Arvid Böhlmars Lampfabrik, Stockholm, A. B. Karlskrona Lampfabrik, Karlskrona, A. B. Nordiska Kompaniet, Stockholm, Norrköpings Lampfabrik, Norrköping, Nya A. B. Eos, Nässjö, and Upsala Armaturfabrik, Upsala*. — The principal manufacturers of fittings for machines, water-pipings, gas, and steam, are *A. B. Nordiska Armaturfabrikerna, Stockholm*; among other manufacturers in this branch may be mentioned *A. H. Andersson & Co, Ljung, A. B. Armaturfabriken Svea, Kungsör, Armaturfabriken Svevia A. B., Norrtälje, Billmans Fabriks- och Handels A. B., Stockholm, A. B. Färe Armaturfabrik, Sibbhult, A. B. Kjells Armaturfabrik, Bäckerfors, Linköpings Armatur och Metallfabriks A. B., Linköping, A. B. Malmö Armaturfabrik, Malmö, and J. A. Svenssons Metallfabrik, Jönköping; Nordiska Värme- & Ventilations A. B. at Göteborg, A. J. G. Bismarck & Co., A. B., Göteborg, Axel Sjögren & Co, A. B., Stockholm, and A. B. P. A. Sjögren, Stockholm, besides manufacturing fittings they are also contractors for heating apparatus and similar appliances. Regulators for steam, gas, electricity, etc. are made by *A. B. Arca Regulatorer* and *A. B. Lux*, both in Stockholm. Metal fittings for buildings and boats are made *inter alia* by *Låsfabriks A. B., Bröderna Söderbergs Metallgjuteri* and *Alb. Karlssons Metall- och Förnickligningsfabrik*, all at Eskilstuna; also by *A. B. Alcometaller, Örebro, and Sigfrid Janssons Metallfabrik, Mariefred*. Manufacturers of capsules, tubes, etc. are *A. B. Göteborgs Kapsylfabrik, A. B. Hässleholms Kapsylfabrik* and *A. B. Svenska Kapsylfabriken, Stockholm*; lead and tin tubes also by *A. B. Nordiska Tubfabriken, Kungsör*. — A special factory for the manufacture of medals, club badges, buttons, etc. is *Metallfabriks A. B. C. C. Sporrang & Co,* Stockholm; also for printing type *A. B. P. A. Norstedt & Söner* and *Erik Pettersons Stilgjuteri*, both in Stockholm. — Among art-foundries may be noted *Herman Bergmans Konstgjuteri A. B.* and *Otto Meyers Konst-, Metall- & Zinkgjuteri*, both in Stockholm; among tin foundries may be noted *A. B. Schreuder & Olsson, Stockholm*.*

(5) *The sheet-metal industry.*

The manufacture at factories of tin-plate and sheet-metal goods has only become of importance during the past quarter of a century.

At the present day it gives employment to about 3,000 men. Among the goods produced may be mentioned, firstly, culinary and household utensils (enamelled or plain), dairy utensils, sheet-iron radiators and tin-plate packings (cans), of which class of goods the main part is manufactured at a few works which operate on a large scale, employing modern steel-pressing methods for the manufacture. Other articles in the sheet-metal industry consist of various vessels and household articles of galvanized or tinned sheet iron, oil-cans and oil-syringes, toys, semi-manufactured articles for other industries, etc. These goods are produced partly by a few large factories but chiefly by a number of small enterprises in the tin-plate and blacksmith's branch.

The raw material of the hollow-ware metal industry consists chiefly of iron, tin and aluminium sheet-metal. Of this, the entire supply of tin-plate (sheet-iron coated with tin) is imported, while the ordinary black plate and the aluminium plate is for the most part of Swedish manufacture.

Since the beginning of this century the manufacture of hollow-ware and containers has almost tripled in value and, in 1924, reached a value of 22.1 million kronor. The cause of this very greatly-increased production is to be sought, *inter alia*, in the increased demand for tin-plate and sheet-iron packing material in general, and especially as containers for petrol and oils. A relatively considerable export of enamelled goods has also arisen; it amounted in 1924 to two-thirds of the entire export of tin-plate and sheet-iron articles, which had a value of 3.7 million kronor. The value of the imports of such products amounted to 4.7 million kronor, and consisted for the most part of enamelled sheet-metal goods.

Among manufacturers of enamelled culinary and household utensils the most important are *Kockums Jernverks A.-B.*, Malmö, with enamel works at Ronneby, at which are employed over 600 workmen. The following are chiefly makers of dairy utensils: *Eskilstuna Stålpressnings A.-B.* (about 500 workmen), *Svenska Stålpressnings A.-B. Olofström*, Olofström, *A.-B. C. A. Wedholms Mejerikärtsfabrik*, Nyköping, and *A.-B. Rudelius & Boklund*, Lund. Sheet-iron radiators are made, *inter alia*, by *A.-B. Plåt-förädling*, Hälsingborg, and *Luth & Roséns Elektriska A.-B.*, Stockholm. Tin-plate packings are chiefly made by *A.-B. Bleckvarufabriken*, Malmö, *A.-B. Hugo Brusewitz Bleckvarufabrik*, Göteborg, and *Örebro Bleckemballagefabrik*, Örebro. Among other manufacturers of sheet-metal goods may in the first place be mentioned *Carl Lunds Fabriks A.-B.*, Malmö, and *A.-B. Kungsörs Bleckkärtsfabrik*, Kungsör; also *Janne Elgqvist A.-B.*, Nybro, *F. O. Nyströms Bleckkärtsfabrik*, Torshälla, *Stockholms Galvaniseringsfabrik*, Liljeholmen, *Göteborgs Galvaniseringsfabrik*, Göteborg, *A.-B. Wassbergs Metallvarufabrik*, Borås, *Mölntorps Verkstäder A.-B.*, Kolbäck, *Hasselgrens Verkstäder*, Stockholm, *Nya A.-B. Galco*, Stockholm, and *Auto-Metallfabrik*, Sundbyberg.

MACHINERY INDUSTRY AND ENGINEERING.

The engineering industry in Sweden, usually called the mechanical workshop industry, occupies a very prominent place among the industrial activities of the country. That this should be the case and that so many of the products of this industry should have come into great demand on the international market is to be ascribed not only to the circumstance that the country itself has been able to supply the main part of the raw materials — among these, especially, the high-quality Swedish iron and steel — but also to the natural bent for mechanical work which has always been a distinctive feature of the Swedish people. Nor should mention be omitted of the high level which has long characterized technical instruction in Sweden. Already in earlier times Swedes rose to prominence in technical and mechanical spheres; witness to this, first and foremost, is the name of POLHEM. But it is chiefly since the revolution in the engineering industry begun by the discovery of the steam-engine that Sweden has been able to point to a long list of ingenious inventors and prominent mechanical engineers, whose labours have carried technical development forward and in many instances have been of revolutionizing industrial importance. We need only mention JOHN ERICSSON, TORSTEN NORDENFELT and GUSTAF DE LAVAL and, among those of our own times, GUSTAF DALÉN, SVEN WINGQUIST, and the brothers B. and F. LJUNGSTRÖM (see p. 68).

It was not until the forties of last century that the engineering industry became an independent branch of manufacture in Sweden. Its origin must be sought in the workshops of earlier date existing at the ironworks for carrying out divers mechanical work, and also in the repair-shops existing in many parts of the country. Even in earlier times, however, there were a number of independent and fairly large enterprises of the kind, among which may be mentioned the musket-factory at Huskvarna, established in 1689; the Bergsund Works, dating from 1769, and the Motala Works, from 1822.

Swedish machine shops, being at first more or less local undertakings, were compelled to devote themselves to practically every kind of engineering — and repair — work required in their particular district. As time went on, however, a number of enterprises began to specialize in certain articles. This development was brought about by several co-operating influences, chief among which may be mentioned the improved

transportation facilities, whereby the market became enlarged and competition was increased.

It was not until the nineties of last century that the engineering industry really came to the fore. The invention of machine tools, rendering possible production on a large scale, intensified the specialization of industry; factories were enlarged and their work gradually began to assume the scope of large industrial enterprises. One factor that contributed greatly to this development was the protective-duty on machinery introduced in 1892; but another great lever for increased activity was the general industrial expansion which occurred at the same period, leading to an increased demand for machinery and other engineering products. The development in this branch of industry during the last few decades is illustrated by the accompanying diagram of the number of hands employed. It should be pointed out, however, that the diagram does not afford a complete picture of the development, as the output capacity per workman also increased in order as more modern mechanical appliances and better organization of work were introduced. From the beginning of the century to the outbreak of the late war, for instance, the value of the output of the machinery industry almost doubled in value, while the increase in the number of hands employed was only 25 %. In 1920 the value of the products amounted — even taking into consideration the low value of money at that time — to the considerable sum of about 570 million kronor. The general depression which then ensued affected this industry in a specially high degree; and the succeeding years show figures which are considerably lower as regards both the number of hands employed and also the value of the production. Of late, however, an improvement has become noticeable.

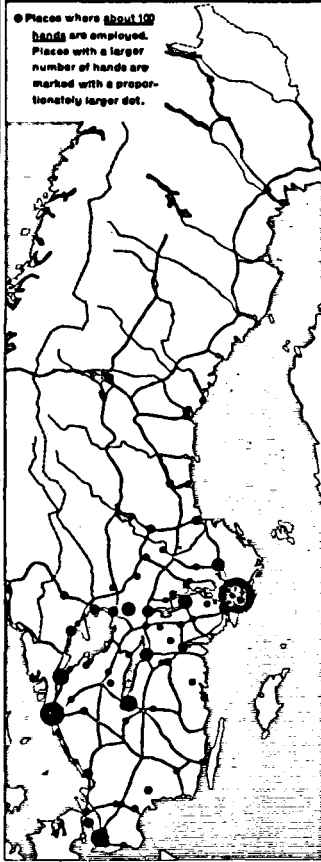
The export of the products of machine and engineering shops during the last few decades has increased considerably, while imports on the other hand have decreased. Whereas at the beginning of the 'nineties exports amounted to only about 15 % of the whole production, they had reached just before the outbreak of the war about 30 %, whilst at the same time the value of the exports had become approximately ten times greater. In 1924 the export of the products of the Swedish machineshops and workshops had attained a value of 117 million kronor, this being about 37 % of the value of the total production.

As will be seen from the map, the engineering and machine shops are very largely concentrated in Stockholm and its environs, and

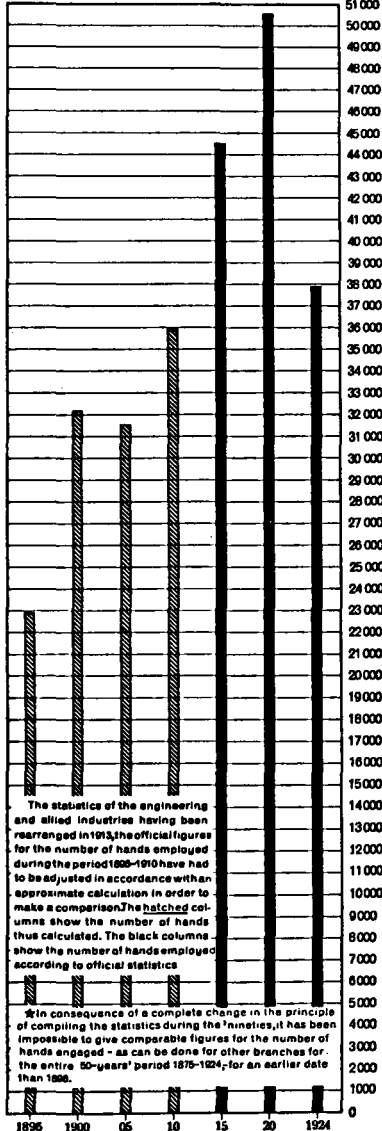
Engineering Workshops Industry

Number of engineering shops at the beginning of 1923.....	857
Number of hands employed therein (Corresponding to 10% of the industrial hands in the country)	37 900
Value of production in 1924 (millions of Kroner).....	312,9

● Places where about 100 hands are employed. Places with a larger number of hands are marked with a proportionately larger dot.



Number of Hands 1896-1924 *



The statistics of the engineering and allied industries having been rearranged in 1913, the official figures for the number of hands employed during the period 1896-1910 have had to be adjusted in accordance with an approximate calculation in order to make a comparison. The hatched columns show the number of hands thus calculated. The black columns show the number of hands employed according to official statistics.

*In consequence of a complete change in the principle of compiling the statistics during the 'nineties, it has been impossible to give comparable figures for the number of hands engaged - as can be done for other branches for the entire 50-years' period 1875-1924, for an earlier date than 1896.

also in Göteborg and Malmö. It will also be seen that this industry is localized to a striking degree in the towns.

The interests of the engineering industry are safeguarded by the Association called "Sveriges Maskinindustriförening", of Stockholm, which was formed in 1911 and which has undertaken and carried out notable work in the sphere of industrial standardization. Standardization has become of ever-growing importance in this branch of industry in consequence of the possibilities it affords for reducing costs of production and of increasing the output. Standardization in the engineering and machine industry signifies, for one thing, that parts in more general use, such as screws, bolts, keys, gears, bearings etc., are made in series of fixed sizes, and further that certain composite parts, apparatus, machines etc., are limited to a few types or series of types. This standardization confers on the manufacturer all the economic advantages in working that can be gained from manufacture on a large scale; the consumer of such products obtains by standardization the advantage of suitable and satisfactory quality, lower prices, more reliable deliveries, more convenient possibilities of replacing worn-out parts, etc. On the whole standardization must be considered as conferring economic advantages of considerable magnitude.

Below we give a brief survey of the various branches of the machinery and engineering industries, their scope and products, etc.

(1) *Steam boilers, steam-engines, steam-turbines, locomotives,
and water-turbines.*

The first steam-engine manufactured in Sweden was made at Bergsund (in Stockholm) in 1807. About the middle of the century practically all the larger engineering shops in Sweden had commenced the manufacture of steam-engines. At that period, of course, all the growing industries of the country had to be provided with these sources of power to replace the old waterpower plants, and at the same time the mercantile marine demanded its share of the production. At the close of the century there came, too, the demands of agriculture for a transportable source of power suitable for its needs, ushering in the manufacture of steam-locomobiles. Since the close of last century, however, development has proceeded along somewhat different lines; and the previous production of steam-engines has fallen off to some

degree — partly in consequence of the invention of steam-turbines on the ingenious principles discovered by de Laval and the brothers Ljungström, and also as a result of the increasing encroachments of oil engines and electric motors. As a result of their higher economic efficiency, of their occupying smaller space, of their smaller weight and their other advantages, steam-turbines are in many branches taking the position once occupied by other types of steam-engine. The manufacture of steam-turbines has now become a speciality in certain works, and during the last few years there has grown up a not unim-



Water-turbine wheel in course of construction (Karlstads Mek. Verkstads A.-B.).

portant export of Swedish steam-turbines. The production in Sweden of steam-engines, steam-locomobiles and steam-turbines etc. amounted in value in 1924 to 2.8 million kronor, the value of the exports being 2.1 million kronor. The imports of the corresponding manufactures were of the value of 1.9 million kronor.

The manufacture of steam-boilers for the generation of power or for heating purposes has gone forward in Sweden side by side with the production of steam-engines. The development is characterized by the manufacture of steam-boilers of ever-increasing pressure for the purpose of obtaining better fuel-economy. Water-tube-boilers which are best fitted for this purpose are now manufactured by several Swedish works. A new revolutionizing construction in the sphere of steam

technique is the steamaccumulator, based on an invention made in 1913 by J. Ruths (see p. 73). In 1924 the value of the production of steam-boilers, preheaters etc. was 4.2 million kronor, which corresponds to about the yearly demand in the country.

The manufacture of locomotives was begun in Sweden as early as 1847 by the Munktell Engineering Works, which soon found followers in several other establishments of the same kind. The rapid development of the Swedish railway system during the latter half of the 19th century gave a great impetus to this industry, which has gradually attained a high level. During the last year or so the Ljungström steam-turbine locomotive has attracted flattering attention in various parts of the world.

Among the firms which carry on the above-named manufactures, the following may here be mentioned. Locomotives are made by *Nydqvist & Holm A.-B.*, Trollhättan, who employ about 1,000 men, *A.-B. Lindholmen-Motala*, Motala, and *A.-B. Svenska Järnvägsverkstäderna*, Linköping (at their branch at Falun). — Steam-turbines are made by *A.-B. de Laval's Ängturbin*, Stockholm, *Svenska Turbinfabriks A.-B. Ljungström*, Finspong, *Jönköpings Mek. Verkstads Nya A.-B.*, Jönköping, and *A.-B. Lindholmen-Motala*. — Steam-locomobiles are made by *Munktells Mek. Verkstads A.-B.*, Eskilstuna, and *Hvilans Mek. Verkstads A.-B.*, Kristianstad. Steam-engines and boilers are made at a number of shipyards noted on p. 135 and also by *J. & C. G. Boländers Mek. Verkstads A.-B.*, Stockholm, *Bohus Mek. Verkstads A.-B.*, Göteborg, *A.-B. Lunds Mek. Verkstad*, Lund, *W. Söderströms Gjuteri & Mek. Verkstads A.-B.*, Norrköping, *A.-B. Åkermans Gjuteri & Mek. Verkstad*, Eslöv, *Jönköpings Mek. Verkstads Nya A.-B.* and *Munktells Mek. Verkstads A.-B.*, Eskilstuna etc. The two last-mentioned firms as well as *A.-B. Götaverken*, Göteborg, are makers of water-tube boilers. Steam-accumulators are designed by *A.-B. Vaporackumulator*, Stockholm.

A natural branch of manufacture for Sweden with her abundance of well-situated waterfalls is the making of water-turbines. The Swedish makers have had numerous opportunities of acquiring experience in the manufacture, and have always maintained this industry in the leading position which they assumed from the very beginning. In almost every country, it may be said, where there are waterfalls, Swedish turbines are employed, thanks to the advantages in working-economy which they afford. The largest water-turbines ever made are of Swedish make. The production of water-turbines and regulators has, during the last few years, amounted in value to 4.3 million kronor annually; on an average about one half of the manufactures has been exported.

Among manufacturers of water-turbines may here be mentioned *A.-B. Arboga Mekaniska Verkstad*, Arboga, *A.-B. Finshyttan*, Finshyttan, *A.-B. Karlstads Mek. Verk-*

— THE MINING AND METAL INDUSTRIES —

stad (branch at Kristinehamn), *Nydvrist & Holm A.-B.*, Trollhättan, *Vaplans Mekaniska Verkstads A.-B.*, Nälden, and *Hällaryds Mekaniska Verkstads A.-B.*, Holsbybrunn.

(2) *Internal Combustion Engines.*

As early as the beginning of the 'nineties, Bolinder's Engineering Works took up the manufacture of internal combustion engines. The engines built at that time were designed for kerosene or petrol fuel. Gradually the problem was solved of driving engines by crude oil, heavy distillates or refuse oils from the refineries. It followed as a matter of course that such engines would find a large market in countries like Russia etc., where there were large supplies of cheap oil-fuel. With this fact in view the J. V. Svensson Motor Works was established in Stockholm in 1899 for the manufacture of two-stroke so-called hot-bulb engines for crude oil and at about the same time Bolinder's Works gave up building their older type and went in for crude-oil engines of a similar type. Other manufacturers in Sweden began the production of internal combustion engines of different kinds and in a few years Sweden possessed a flourishing oil engine-industry, the products of which could be reckoned as one of the foremost machinery export articles of the country.

In addition to these two-cycle crude oil engines there are certain other types of motors manufactured in Sweden, in certain instances with great success. Swedish Diesel engines, for instance, the manufacture of which was begun in Sweden in 1898, have gained a well-deserved international reputation, thanks to the epoch-making designs of JONAS HESSELMAN. It should also be mentioned that during the last few years motors have been designed by Swedish engineers for the employment of sulphite spirit or some spirit mixture as fuel.

The Swedish internal combustion engine industry embraces to-day the manufacture of Diesel engines for marine, stationary, and railway services, two-cycle crude oil engines of the stationary, portable, and marine types and petrol engines for boats and motor vehicles. The question of manufacturing motors for flying-machines is also under consideration. On the whole the Swedish oil engine industry is characterized by a very high quality in technical and mechanical respects.

The production of internal combustion engines of different kinds has indeed attained considerable proportions in Sweden. In 1924 engines

of this kind were turned out to the value of 13 million kronor, and the exports amounted to 8.7 million kronor, as against imports to the value of only 0.6 million kronor.

Among others the following are manufacturers of petrol and spirit engines: *A.-B. Pentaverken*, Skövde, *A.-B. Archimedes*, Stockholm, *L. A. Larssons Gjuteri & Mek. Verkstad*, Kristinehamn, *A.-B. Scania-Vabis*, Södertälje, *Tidaholms Bruks A.-B.*, Tidaholm, *Morgårdshammars Mek. Verkstads A.-B.*, Morgårdshammar, *A.-B. Upsala Motorverkstäder*, Upsala, and *Fabriks A.-B. Bröderna Jakobsson*, Säffle. — Crude oil engines are made by the following firms: *J. & C. G. Bolinders Mek. Verkstads A.-B.*, Stockholm, *A.-B. Avancemotor*, Stockholm, *Skandia-Verken A.-B.*, Lysekil, *Munktelles Mek. Verkstads A.-B.*, Eskilstuna, *A.-B. Atlas-Diesel*, Stockholm, *A.-B. Svenska Maskinverken*, Södertälje, *A.-B. de Laval's Ångturbin*, Stockholm, *Forsviks A.-B.*, Forsvik, *A.-B. Sandbäckens Verkstäder*, Katrineholm, and *Bröderna Nilsson & Co Mek. Verkstad*, Västervik. — Diesel engines are made by *A.-B. Atlas-Diesel*, Stockholm, *A.-B. Götaverken*, Göteborg, *A.-B. Bofors*, Bofors, and *Kockums Mek. Verkstads A.-B.*, Malmö.

(3) *Ball-bearings.*

The great importance of the modern ball-bearing industry lies in the fact that those parts of machinery, vehicles etc. which, as a rule, are subjected to the greatest strains, viz. the bearings, are manufactured at special factories, whereby these parts acquire the greatest possible perfection in economy of power and running. The Swedish ball-bearings, which are known all over the world, are based on Sven Wingquist's designs, which are chiefly characterized by the quality possessed by the bearing of automatically aligning itself to the shaft. The good Swedish steel and extremely careful manufacture both as regards the material and its treatment, have also contributed to the wonderful success obtained by this product on the international market. The Swedish Ball-Bearing Factory Ltd. (*A.-B. Svenska Kullagerfabriken*) was established in 1907, and greatly thanks to the inventor's capacity of organization, both as regards manufacture and sales, there were laid the foundations of the company's development into a world-industry of considerable magnitude. It embraces at present not only the entire industry in Sweden — where the war conditions brought into existence several new enterprises which soon disappeared, however, or were incorporated with "S. K. F." — but it also carries on the manufacture of ball-bearing at factories in England, France, Germany, Russia, and the United States. Altogether there are produced about 12,000,000 ball-bearings yearly, all of Swedish steel. Roller-



The Swedish Ball-Bearing Factory at Göteborg (SKF).
In this block of buildings there are manufactured every day 15,000
ball- and roller-bearings.

bearings of various types also form a part of the company's production. The ball-bearing industry in Sweden produced in 1924 ball- and roller-bearings to a value of about 13 million kronor, mostly for export.

A.B. Svenska Kullagerfabriken, Göteborg, own Hofors Bruk, where the steel for ball-bearings is produced, and besides the factories in Göteborg they also own establishments at Katrineholm (for pulleys and castings).

(4) *Railway-carriages and tram-cars, motor-cars, aeroplanes, cycles, motor-cycles, etc.*

The manufacture of railway-carriages in Sweden was initiated in the 'sixties by Kockum's Engineering Works in conjunction with the building of railroads, which began at that time. During the period of development of the Swedish railway system this production was increased in a great degree, and more and more works devoted themselves to the work. After the outbreak of the war, the Swedish

— THE MINING AND METAL INDUSTRIES —

manufacturers captured the whole of the home market. Since the war, however, severe competition has made itself felt, especially on the part of Germany, and the Swedish works have suffered considerably from the import of foreign railway and tramway material, in spite of the technical and organizational improvements they had introduced. In 1924 the manufacture of railway-carriages and tramcars amounted to 4.7 million kronor; the imports were valued at 1.5 million kronor.

Railway-carriages are made by *A.-B. Svenska Järnvägsverkstäderna*, Linköping, *Kockums Mek. Verkstads A.-B.*, Malmö, *A.-B. Svenska Maskinverken*, Södertälje, *A.-B. Lindholmen-Motala*, Motala, *Landskrona Nya Mek. Verkstads A.-B.*, Landskrona, *A.-B. Hässleholms Verkstäder*, Hässleholm, and *Kalmar Verkstads A.-B.*, Kalmar. Tramcars are made by the three first-mentioned companies and by *Allmänna Svenska Elektr. A.-B.*, ("A. S. E. A.") Västerås.

The manufacture of motor cars in Sweden began during the early years of the century and soon became of some importance. There also grew up a small export trade. During the war this favourable development continued, but production fell off again after the conclusion of peace, both on account of the general depression in trade and of the extremely severe competition from abroad, especially from the United States with its mass-production of cheap cars. To-day, however, an improvement seems to have set in, thanks to the high quality of the Swedish vehicles. At present the manufacture comprises mainly motor-lorries, omnibuses, motor-cars and vehicles for special purposes, such as motor fire-engines and repair cars. The production of these amounted in value in 1924 to 4.4 million kronor. In the same year, however, there was an import of automobiles amounting to more than 30 million kronor.

Manufacturers in this branch are *A.-B. Scania-Vabis*, Södertälje, *Tidaholms Bruks A.-B.*, Tidaholm, and *A.-B. Volvo*, Göteborg.

When, in the 'nineties, bicycles came into more general use in Sweden, the cycle industry, which had previously been carried on more or less as a handicraft, developed into a special industry of considerable proportions. Great attention was paid to the construction of machines adapted to meet the special conditions of the country in respect to character of the roads, so that in time Swedish-built cycles ousted imported ones to a very great extent. The makes of the four chief factories devoted to cycle manufacture are nowadays considered of a very high quality. At Husqvarna the manufacture of motor-cycles

— THE MINING AND METAL INDUSTRIES —



The Huskvarna Factories (Husqvarna Vapenfabriks A.-B.).

was begun in 1912, at first fitted with imported motors, but nowadays with Swedish. These motor-cycles have also attracted attention abroad in consequence of their excellent quality. In 1924 the manufacture of bicycles, motor-cycles and cycle parts amounted to no less than 20.3 million kronor in value, equal to about 90 % of the consumption in the home market.

Manufacturers in this branch are *Husqvarna Vapenfabriks A.-B.*, Huskvarna, *A.-B. Nymans Verkstäder*, Upsala, *Velociped A.-B. Lindblad* and *A.-B. A. Wiklunds Maskin- & Velocipedfabrik*, both the last-mentioned in Stockholm.

Flying-machines were first made in Sweden during the war. A fairly large factory was erected for this purpose at Landskrona, but it had to be closed down in consequence of the subsequent depression in trade. To-day, business conditions having become more stable again, the manufacture of flying-machines has been resumed on a large scale, the factory being located at Limhamn.

The manufacture is carried on by *A.-B. Flygindustri*, Limhamn.

The manufacture of vehicles, carriages, carts and sledges of various kinds is carried on in Sweden as a handicraft but also on a larger scale at some 70 factories, most of which, however, are of no

great size. Altogether about 1,400 hands are employed in the trade. The production corresponds approximately to the demand of the home market. The value of the output (including repair work) in 1924 was about 10 million kronor.

Among manufacturers in this branch may be mentioned *A.-B. Arvika Vagnfabrik*, Arvika, *Oscar Ljungberghs Åkdonfabrik* and *Thulins Vagnfabrik*, both at Skillingaryd, and *Tidaholms Bruks A.-B.*, Tidaholm.

(5) *Agricultural machinery.*

Agricultural machinery occupies a prominent place among Swedish engineering products. The production of such articles dates from the



Gustaf de Laval.
b. 1845 d. 1913.

latter half of the 19th century, when the old, hand-made implements began to be replaced to a great extent by modern machinery for the cultivation of the soil and for harvesting. The oldest industrial manufacture of agricultural machinery in Sweden is that of plough-making, which was begun about 1850. Threshing-machines were first made during the 'sixties. Drills and other machines for sowing, mowers and harvesters began to be made in the 'seventies, while the manufacture of harrows did not begin until the following decade. The manufacture has gradually expanded and now embraces many types of machines, and qua-

litatively it has attained a very high level. In spite of severe foreign competition the agricultural machinery industry goes steadily forward, and certain productions, especially haymaking-machines, have acquired considerable sales in the export trade. In 1924 the value of the output amounted to 16,6 million kr., the export to 5,5 million kr. and the import to 3,4 million kr.

The principal enterprises within this branch of manufacture are *A.-B. Arvika-Verken*, Arvika, and *A.-B. International Harvester Company*, Norrköping; after which come *Munktells Mek. Verkstads A.-B.*, Eskilstuna, *A.-B. Andrew Hollingworth & Co.*, Stockholm, *Kockums Jernverks A.-B.*, Malmö, *Norrahammars Bruk*, Norrahammar, *A.-B. Öfverums Bruk*, Överum, and *A.-B. Joh. Thermanius & Son*, Hallsberg. We may also mention *Bredaryds Gjuteri & Mek. Verkstad*, Bredaryd, *Gjuteri A.-B. Fellingsbro*, Fellingsbro, *A.-B. Gävle Åkerredskap*, Gävle, *A.-B. Lilla Harrie Redskapsverkstad*, Lilla Harrie, *A.-B. Mofors Bruk*, Anderstorp, *A.-B. Olléns Tröskmaskinfabrik*, Flen, *Skogsfors Bruks A.-B.*, Reftete, *A.-B. Westerdsmaskiner*, Morgongåva, and *Ystaads Gjuteri and Mek. Verkstads A.-B.*, Ystad.

(6) *Cream separators.*

In 1878 Gustaf de Laval, after lengthy and untiring experiments, took out a patent for an automatic milk-skimming machine. This laid the foundation of the Swedish separator-industry, the great creation of de Laval and John Bernström. The A.-B. Separator was started in 1883 for the purpose of exploiting the invention, and everyone knows that the business afterwards developed very rapidly and that, thanks to skilful direction and the constant application of new scientific inventions, it has attained an almost unexampled success. For the purpose of increasing its sales and also for the manufacture of separators abroad, the Swedish company has established several branch companies in Europe and America; it has been calculated that, up to date, more than 3,500,000 separators have left the company's factories. During the early years of the present century, at the time when the original patent expired, the manufacture of separators of slightly varying designs was begun by several manufacturing concerns in Sweden. This branch of industry, therefore, made steady progress, the export of Swedish separators increasing continuously until the years of depression which set in after the war, when production naturally had to be diminished. The last few years, however, have shown rising figures, and the leading position of the Swedish separator industry on the international market seems once more to be assured. In addition to separators the production embraces churning and butter-working machines, pasteurizers and other dairy machinery. In 1924 the value of the manufactures in this industry amounted to no less than 23.8 million kronor; the exports were of the value of 19 million kr.

This branch now includes the following concerns: *A.-B. Separator*, Stockholm, with subsidiary Swedish concerns, employing over 3,500 men; also *A.-B. Baltic*, Stockholm, with factories at Södertälje, Bromma and Lund (with 1,000 workmen), *A.-B. Pump-Separator*, Stockholm, as well as *Upsala Separator A.-B.*, Upsala, and *Nya A.-B. Eskilstuna Separator*, Eskilstuna. Among manufacturers of dairy machines (other than separators) may be mentioned *Carl Holmbergs Mek. Verkstads A.-B.*, Lund.

(7) *Special machinery for mining, iron, and metal industries.*

The manufacture of machinery and mechanical apparatus for the mining-industry forms, in Sweden, a special branch in several machinshops, especially in Bergslagen (the Iron District of Central Sweden). The manufacture in question embraces drills, mine-windlasses,

ore-crushers, ore-screens and ore-separators etc. There has arisen a not unimportant export of pneumatic drills.

The making of metal-working machines — such as drilling-, bending-, milling-, planing-, screwcutting- and grinding-machines, rolling-mills, turning-lathes, drop-hammers, steam-hammers and pressing-machines — dates from the 'fifties. A rather important export of such machines has been worked up. The making of tools and utensils (chucks, drills, milling-cutters, chasing-tools etc.) for the machines in question has developed into a special branch of manufacture.

Among manufacturers of mining plant and similar machinery may be mentioned: *A.-B. Arboga Mek. Verkstad*, Arboga, *Morgårdshammars Mek. Verkstads A.-B.*, Morgårdshammar, *Bergverks A.-B. Vulcanus*, Blötberget, *A.-B. Nyhammars Bruk*, Nyhammar, *Nyby Bruks A.-B.*, Nybybruk, and *Sala Maskinfabriks A.-B.*, Sala. Pneumatic rock-drills are made by *A.-B. Atlas-Diesel*, Stockholm.

Among others, the following firms are manufacturers of metal-working machines: *Köpings Mek. Verkstads A.-B.*, Köping, *Lidköpings Mek. Verkstads A.-B.*, Lidköping, *Munktells Mek. Verkstads A.-B.*, Eskilstuna, *Nydqvist & Holm A.-B.*, Trollhättan, *A.-B. Svenska Maskinverken*, Södertälje, and *Solberga Mek. Verkstads A.-B.*, Solberga. Tools for metal-working machines are made by *Eskilstuna Borr- & Verktygs A.-B.*, Eskilstuna, *A.-B. C. E. Johansson*, Eskilstuna, *A.-B. Alfr. Wesströms Verktygsfabrik*, Rotebro, and *Skandinaviska Verktygsfabriks A.-B.*, Tyringe. Foundry machines are made especially by *A.-B. Marcus Holmquist* and *A.-B. Gjuterimaskiner*, both in Halmstad.

(8) *Machinery for the stone and mineral industries.*

Machinery for the stone and peat industries are manufactured in Sweden as are also brick-making machinery. The manufacture of such machines has attained a high degree of development. A certain number of machines for the cement, tile, china and glass industries are also manufactured in Sweden.

Among manufacturers in this branch of industry the following may be mentioned: *A.-B. Åbjörn Anderson*, Svedala (stone, tile and peat machinery), *Landskrona Nya Mek. Verkstads A.-B.*, Landskrona (cement and brick-making machinery), *A.-B. Hässleholms Verkstäder*, Hässleholm (peat machinery), *Halmstads Nya Verkstads A.-B.*, Halmstad (stone machinery) and *Lindås Gjuteri & Formfabriks A.-B.*, Lindås (glass-factory machinery).

(9) *Machinery for the timber industry, and the wood-pulp and paper industries.*

The manufacture of wood-working machinery must be regarded as an essentially Swedish industry. The abundant timber-resources

have given Swedish engineers great experience in the treatment of wood. The manufacture on a large scale of machines for this purpose began in the middle of the 'eighties, Bolinder's taking the lead. The prosperity enjoyed by the Swedish woodgoods industry during the final decades of last century led to an increasing number of concerns devoting themselves to the manufacture of these machines. The production comprises practically the whole range of sawmill and wood-working machinery, including saw-frames, band-saws, planers of many kinds, box-making machines, mortising and moulding machines, lathes, etc. Even before the outbreak of the war there had arisen a not unimportant export, and the period of the war was one of increased prosperity for this branch of manufacture. In 1924 the production amounted to a value of 5.7 million kronor and the export to 2.5 million kronor.

Machinery for woodpulp and paper manufacture is now made in Sweden to a very considerable extent, the country of course possessing great natural facilities for it. The production during the last few years has amounted to nearly 5 million kronor annually. The export has remained constant at about 1 million kronor in value, while the import has been somewhat less.

Among manufacturers of wood-working machines may be mentioned: *J. & C. G. Bolinders Mek. Verkstads A.-B.*, Stockholm, *Jonsreds Fabrikers A.-B.*, Jonsered, *A.-B. Svenska Maskinverken*, Södertälje, *Munktells Mek. Verkstads A.-B.*, Eskilstuna, *A.-B. Karlstads Mek. Verkstad*, Karlstad, *Falkenbergs Nya Verkstads A.-B.*, Falkenberg, *Östersunds Verkstads A.-B.*, Östersund, *A.-B. Göteneds Mek. Verkstad*, Götene, and *Hvellanda Mek. Verkstad*, Vetlanda. Machinery for saw-mills is constructed by *A.-B. Robertsfors*, Härnösand, *Adolf Ungers Industri A.-B.*, Lottfors, *Arbrå Verkstads A.-B.*, Arbrå, and *And. Mattsons Mek. Verkstads A.-B.*, Mora, etc.

Manufacturers of machines for pulp and paper making are: *A.-B. Karlstads Mek. Verkstad*, *A.-B. Hedemora Verkstäder*, Hedemora, *A.-B. Sundsvalls Förenade Verkstäder*, Sundsvall, and *Forsviks A.-B.*, Forsvik. Cylinders and rolls for paper-mills are made by *Åkers Styckebruk*, Åkers styckebruk.

(10) *Ordnance and war material.*

For many centuries Sweden has occupied a prominent position in the manufacture of arms. In many European wars Swedish material has been much sought after. To-day the pride of place in this respect is held by the Bofors Works (*A.-B. Bofors*, Bofors), the heavy guns, mortars and howitzers, projectiles and armour-plate etc. made by the Bofors Company having the reputation of being among the best in the



Assembling hall for heavy guns at Bofors.

world. The export of these articles is still very considerable. The production of small arms and other lighter war material for the use of the Swedish army and navy is nowadays carried on, at the royal arsenals, chiefly at the Eskilstuna small arms factory. There has been some manufacture of this war material by the Husqvarna Vapenfabriks A.B., who are also the makers of high-class shotguns and target rifles.

(11) *Miscellaneous machine shop products.*

In the foregoing pages we have touched on by no means all of the special branches of manufacture embraced in Swedish machinery industry and engineering. Enterprise has created many other fields of work in which Swedish engineering has taken an honoured place.

The ingenious inventions in the field of lighting-apparatus by Dr. Gustaf Dalén (see p. 74) gave rise in 1904 to the foundation of a unique and flourishing industry based on the use of dissolved acetylene for a variety of lighting services, first and foremost automatic beacons and lighthouse equipment. The "Aga" systeme, as it is called, has since been extend to railway and street signalling, marking out air-routes, etc. Apparatus are also designed



The works of the Svenska A.-B. Gasaccumulator, at Lidingön, near Stockholm.

for gutting and welding metals. — Pumps, fire-engines, compressors and other allied manufactures constitute a special branch, in which a number of works have been extensively and successfully engaged. Refrigerating machines and apparatus should also be mentioned in this connection. The manufacture of sewing-machines was begun as early as 1874 at Husqvarna. Sewing machines and hand-knitting machines are now made in Sweden to an annual value of more than 4 million kronor, corresponding to about two-thirds of the annual home consumption, a result which can only be ascribed to the high quality of the Swedish product. The manufacture of calculating-machines and typewriters is a comparatively recent industry in Sweden, the annual output value of which, however, may be put at about 1 million kronor.

Other well-known Swedish special manufactures are safes and strong-room doors, the output value of which in 1924 amounted to 1.3 million kronor, and weighing-machines, the output value of which amounted to 1.2 million kronor. The manufacture of iron bedsteads amounted in value in the same year to 0.5 million kronor. Railway switch gear and points, wind-motors, washing-machines and precision-testing machines, may also be included in the list of the special branches of the Swedish engineering industry.

— THE MINING AND METAL INDUSTRIES —

Among manufacturers of such miscellaneous products the following may be mentioned: *Svenska A.-B. Gasaccumulator*, Stockholm, employing about 500 men in the manufacture of signal apparatus etc. Besides the motor factories mentioned on page 122 amongst others, the following are makers of pumps, fire engines and similar products: *Luth & Roséns Elektriska A.-B.* (also make refrigerators), *A.-B. de Laval's Ångturbin* and *A.-B. Atlas-Diesel*, all in Stockholm, *A.-B. Lunds Mek. Verkstad*, Lund, (also make refrigerators), *Jönköpings Mek. Verkstads Nya A.-B.*, Jönköping, *Tullgarns Gjuteri & Mek. Verkstads A.-B.*, Upsala, (also make refrigerators), *Aug. Hansons Gjuteri A.-B.*, Halmstad, and *Allmänna Brandredskapsaffären (E. Bergström & Co)*, Stockholm, etc. *A.-B. Arctic*, Stockholm, make refrigerators. Sewing-machines are made by *Husqvarna Vapenfabriks A.-B.*, knitting-machines by *Stenholms Fabriks A.-B.*, Huskvarna, and *A.-B. Per Perssons Väv- och Stickmaskin*, Stockholm; adding machines by *A.-B. Original-Odhner*, Göteborg, *A.-B. Facit*, Stockholm, and *A.-B. Optimus*, Upplandsväsby; typewriters by *Halda A.-B.*, Stockholm; safes by *E. A. Rosengrens Kassaskåpsfabriks A.-B.*, Göteborg, and *A.-B. J. Isaksson & Co*, Stockholm and others; weighing machines by *Lindells Vågfabriks A.-B.*, Jönköping, and *A.-B. Ståthmos*, Nynäshamn, and iron bedsteads by among others *Nya A.-B. Göteborgs Järnsängsfabrik*, Göteborg, and *Stockholms Nya Järnsängsfabrik*, Stockholm. Switch appliances are made by *A.-B. Växlar & Signaler*, Örebro, *A.-B. Åtvidabergs Spärvästar & Signalfabrik*, Åtvidaberg, and *Telefon A.-B. L. M. Ericsson*, Stockholm, and rail-switches by the two first mentioned firms and also by *Elektriska Svetsnings A.-B.*, Göteborg; wind-motors are made by *Vattholma Bruk*, Vattholma, *Getinge Mek. Verkstads A.-B.*, Getinge, and *A.-B. Hässleholms Verkstäder*, Hässleholm, and washing- and laundry machines by *Bohus Mek. Verkstads A.-B.* and *Coronaverken A.-B.*, both at Göteborg, as well as by *Värmelednings A.-B. Calor* Stockholm, etc. Testing machines are made by *A.-B. Alpha*, Sundbyberg. Machines for the match industry are made by *A.-B. Siefert & Fornander*, Kalmar, and *A.-B. Gerh. Arehns Mek. Verkstad*, Stockholm; the last-mentioned company, and *A.-B. Formator*, Stockholm, also make machines for the tobacco industry.

A very important part of the engineering industry is engaged in the manufacture of transmission-appliances: lifts, cranes and transport-devices, fans and ventilators, and also the carrying out of iron-constructions and heavy sheet-iron work and the making of heating and ventilation apparatus. In 1924 the total output-value of such work amounted to no less than 30 million kronor, 6.8 million kronor being to the credit of the cranes and transport-devices alone.

Among the numerous enterprises engaged in the manufacture of lifts, cranes, and transport-devices of various kinds, the following may be noted: *Allmänna Svenska Elektr. A.-B.*, Västerås, *Luth & Roséns Elektriska A.-B.*, *A.-B. Elevator*, *A.-B. Nordströms Linbanor* and *A.-B. Bröderna Hedlund*, these four enterprises are in Stockholm; *A.-B. Malcus Holmquist*, Halmstad, *Halmstads Nya Verkstads A.-B.*, Halmstad, *Kockums Mek. Verkstads A.-B.*, Malmö, *Landskrona Nya Verkstads A.-B.*, Landskrona, and *Sandvikens Jernverks A.-B.*, Sandviken (steel-belt conveyors).

Welding is done by *Elektriska Svetsnings A.-B.*, Göteborg, and *Elektriska Svetsnings A.-B. i Stockholm*, the former as well as *A.-B. Wex*, Stockholm, being also makers of welding apparatus.

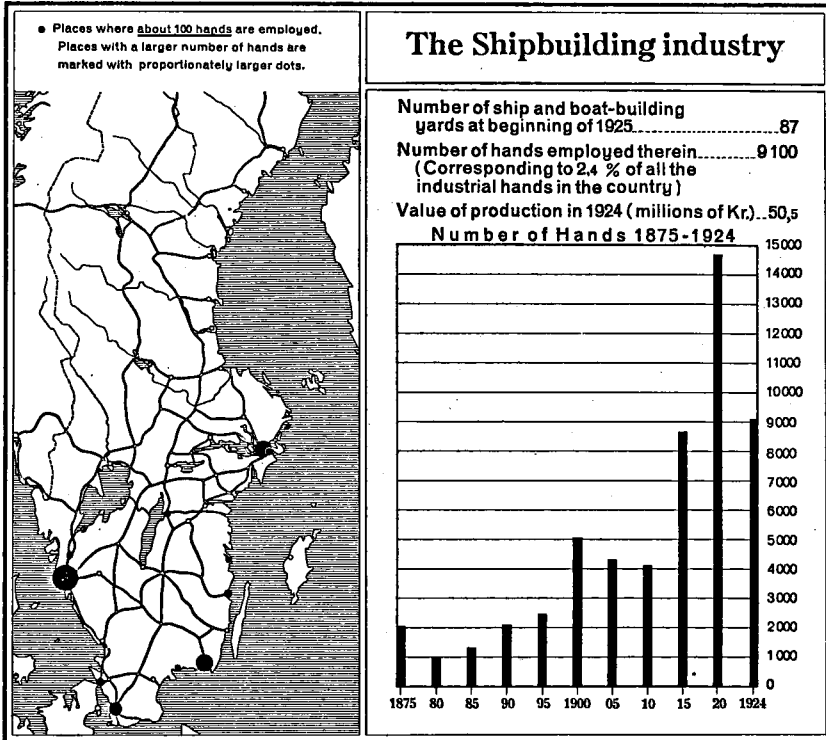
THE SHIPBUILDING INDUSTRY.

A new epoch in shipbuilding began in the first decades of the 19th century when iron and steel began to be employed as construction material, and steam came to be used for propulsion. The first large iron vessel was built at Edinburgh in 1818. After the invention of the propeller by John Ericsson in the 'thirties, the paddle-wheel was gradually superseded by the propeller, and machinery and boilers having been rendered safer in working, the future of the steamvessel was assured. The building of sailing-ships has since then gradually declined, while steamships, and in recent years motor vessels, have been built practically exclusively.

In Sweden during the era of wooden ships practically the entire home tonnage was supplied by Swedish yards. The first Swedish steamboat, "The Witch of Stockholm", was constructed in 1816 in Stockholm by Samuel Owen, but with iron-built and steel-built vessels coming into more general use about the middle of the century, shipbuilding in Sweden began to decline somewhat, and a period of sluckness which — with a brief intermediate period of prosperity during the 'seventies — lasted until the beginning of the present century.

It cannot be said that there existed a Swedish shipbuilding industry in the modern sense of the term until the quarter century that has just elapsed. After the starting of the Swedish transoceanic lines in 1904 interest in home shipbuilding was aroused; and during the years immediately preceding the outbreak of the late war the shipyards had attained such dimensions that several Swedish yards were able to build both passenger and cargo vessels of considerable size, not only for the account of Swedish ship-owners, but also for Russian, Norwegian, French and German customers. From the beginning of the war the Swedish shipbuilding industry developed rapidly and further increased the facilities for building vessels of large size and tonnage. At the present time the Swedish shipbuilding industry has reached a level which, technically and from the point of view of organization, is in no way inferior to similar undertakings in the big shipbuilding countries.

The diagram on the next page shows the variations in the number of hands employed in the Swedish shipbuilding industry during the last 50 years, the royal dockyards included. The comparatively large



A.-B. KARTOGRAFISKA INSTITUTET

number of workmen during the year 1900 is due to the fact that just at that time large shipbuilding orders were being carried out for the Swedish admiralty; and the exceptionally high figures for 1920 represent the temporary high-water mark reached by the shipbuilding industry just after the close of the war. From the map it will be seen that the greater part of the Swedish shipbuilding industry is carried on at Göteborg.

A considerable part of the Swedish tonnage is nowadays built in the country and ship-owners abroad have also shown great confidence in Swedish shipbuilding. During the last few years Sweden has acquired a leading position in the construction of motor ships, and vessels of Swedish build have attracted well-deserved attention all over the world.

That the shipbuilding industry of Sweden has attained its present high level is chiefly due to the ability of Swedish designers, to the in general well-planned and always well executed work, and finally



Launching a vessel at the yard of A.-B. Götaverken, Göteborg.

to the high level of workmanship of the men employed. Nor must we forget the capacity of the Swedish engineering industry to supply propulsion and auxiliary machinery of first-class quality. As regards the material for the hulls of the vessels most of the plate and the sections for the frame work are as a rule imported from foreign countries, where these grades of steel can be produced more cheaply than in Sweden. Swedish high class products are, however, employed wherever possible.

In addition to the ship-yards proper, there also exist in Sweden a large number of small yards and boat-building concerns where the industry is carried on more in the form of a handicraft, and chiefly with timber as the construction material. The yards in question are mostly engaged in the building and repair of sailing-vessels and barges, and of motor-boats, sailing-boats and rowing-boats.

The principal private shipbuilding enterprises in the country are *A.-B. Götaverken*, Göteborg, with over 2 000 workmen, after which come *A.-B. Lindholmen-Motala*, with yards both at Göteborg and Motala, *Kockums Mek. Verkstads A.-B.*, Malmö, and *Eriksbergs Mek. Verkstads A.-B.*, Göteborg, each with over 1 000 men. The following may also be mentioned: *Bergsunds Mek. Verkstads Nya A.-B.*, *A.-B. Finnboda Varf* and *Södra Varvets Nya A.-B.*, all in Stockholm, *Oscarshamns Mek.*

— THE MINING AND METAL INDUSTRIES —

Verkstads & Skeppsdockas A.-B., Oscarshamn, *A.-B. Karlshamns Skeppsvarv*, Karlshamn, *Helsingborgs Warfs & Svetsnings A.-B.*, Hålsingborg, *Nya Varfs A.-B. Öresund*, Landskrona, and *A.-B. Lödöse Varf*, Lödöse. Among smaller ship and boat building yards the following may be noted: *Forsviks A.-B.*, Forsvik, *Skandiaverken A.-B.*, Lysekil, *Stockholms Båtbyggeri A.-B.*, Neglinge, and also *Öregrund's Slip- & Varvs A.-B.*, Öregrund, *A.-B. Mohögs Mek. Verkstad*, Sundsvall, *Hernösands Verkstads- & Varvs A.-B.*, Härnösand, and *A.-B. Lundby Mek. Verkstad*, Göteborg, etc.

THE ELECTRO-TECHNICAL INDUSTRY.

The electro-technical industry — or what is commonly called, the electrical industry — embraces in the ordinary sense of the term such enterprises as are engaged in the manufacture of electrical machinery, apparatus, wire etc., but not the industries that use electricity solely or chiefly for electro-chemical, electro-thermic, and electrolytical purposes.

Although a number of important discoveries and inventions in the electro-technical branch were made as early as the first half of the 19th century, the real foundation of the electrical industry was not laid until the 'seventies. It was at that time that the dynamo machine, the telephone and the incandescent lamp were invented, each of which had a revolutionary effect on the future development of the industry in question. The rapidity with which that development ensued was, as is well known, so great, and its fundamental importance for practically every branch of human activity so far-reaching, that the history of industry can scarcely be said to afford a parallel.



Jonas Wenström.
b. 1855 d. 1893.

In Sweden a vigorous electrical industry sprang up at a comparatively early date, based on the above-mentioned inventions and favoured by several essential pre-requisites in land and people. The abundant, though often remote, supplies of water power could only be utilized by means of power-transmissions, the first step to the realization of which, however, was provided by the invention of the dynamo machine; the situation of the country in northerly latitudes with its long winter nights gave rise to an urgent demand for better lighting, and it was satisfied by the invention of the incandescent lamp. The large area

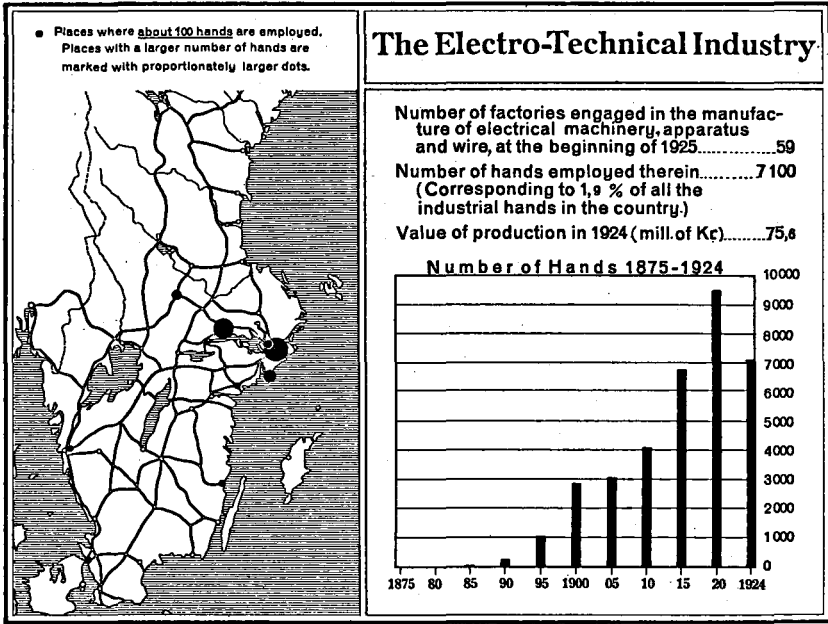
— THE MINING AND METAL INDUSTRIES —

of Sweden and the sparseness of the population constituted favourable conditions for the rapid adoption of the improvement in communications afforded by the telephone. And finally, but not least in importance, the technical bent of the Swedish people and their capability for precision-work promoted in a high degree the foundation and development of an electro-technical industry in the country. It is a remarkable fact that a comparatively large number of Swedes have won international reputation as pioneers in this branch, as witness the names of J. WENSTRÖM, E. DANIELSSON, L. M. ERICSSON, H. T. CEDERGREEN and W. JUNGNER.

The following dates illustrate what has just been said: The manufacture of telephones began in Sweden in 1876 and of electrical machinery in 1883; the earliest Swedish electric central station was built in 1885, i. e. only two years after the erection of the first European electric central station at Milan; from the same period date the earliest attempts to manufacture incandescent lamps in Sweden; the origin of the electric-cable industry in Sweden is placed in 1888; and, finally, power-transmission by means of three-phase current was carried out as early as in 1893, when it was first applied in the ingenious and revolutionizing system invented by Jonas Wenström, which enabled an economic transmission of power for long distances by means of electricity.

The electrical industry has now for a long time past been divided into two branches; the strong-current, and the weak-current industry. The former designates manufactures involving the employment of electric current for motors, lighting, heating and other purposes, which demand comparatively strong currents and high voltages, while the latter is applied to the manufacture of telephone and telegraph apparatus, and other material required for purposes for which relatively feeble currents and low voltages are sufficient. Between these two there stands the most recent branch of the far-spreading tree of electrical industry — the radio (wireless) industry.

In the strong-current industry Sweden occupies a prominent place in many respects. The oldest and the leading electrical engineering works, the Allmänna Svenska Elektriska A.-B. (Asea), has won an international reputation by its manufactures of large three-phase generators. Its record achievement is a generator of 30,000 HP and 350 tons weight. Worthy of notice, too, are the transformers that the firm has made with insulation for 220,000 volts, the highest voltage that has up to

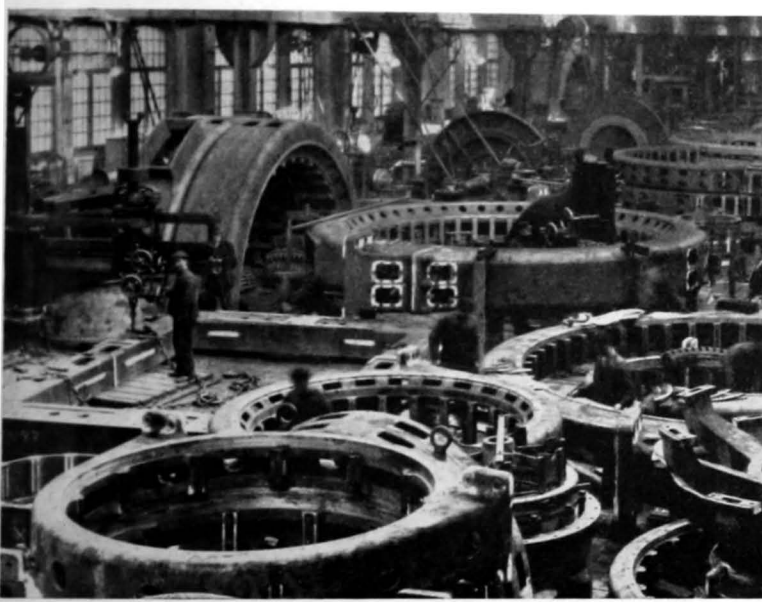


the present been employed. The most prominent representative of the Swedish electric-cable industry, Sieverts Kabelverk, has accomplished remarkable work in its own branch of the industry, such as for instance three-phase cables made in lengths of 3,000 metres for submarine laying at a depth of 360 metres.

In the weak-current industry Sweden has won a world-wide reputation thanks to the manifold activities of the Telefon A.-B. L. M. Ericsson. That concern, which has been a pioneer in telephone construction in many directions, still maintains its leading position, owing for one thing to the system of automatic exchange, that is evolved some fifteen years ago and has been perfecting ever since and which has recently been gaining a foothold in one country after another.

The "wireless" industry in Sweden is of such recent date that it has not yet attained a position comparable with the above-mentioned branches.

The accompanying diagram of the number of hands employed affords a picture of the rapid growth of the Swedish electrical industry



Assembling hall for large electrical generators at the Asea Works (Allmänna Svenska Elektriska A.-B., Västerås).

— with the very prosperous year 1920 as an exceptionally high record. As regards the earlier periods, it should be remarked, the picture is a little misleading, as this new branch of industry was not immediately included in the official statistical returns. The annual manufacturing values present, on the whole, a similar picture of rapid growth. A glance at the latter figures to discover how they are subdivided between the strong-current and the weak-current industries shows that the latter was in the ascendant up to about 1910 after which year the high-tension industry began to secure an equal position and during and after the war forging ahead to the first place.

The total annual value of the manufactures, about 75 million kronor, represents, it is true, rather a modest part of the total industrial production of Sweden, but the importance of the electrical industry should not be judged solely by the above figures, for this branch of industry, to employ a term created during the war, is a “key industry” for Sweden, its products being essentials for other industries, for trans-

portation and for the industrial life of the country as a whole. A few figures may be quoted to illustrate the importance of the electrical industry: About 90 % of all the existing turbine HP of the Swedish waterfalls are nowadays employed for the generation of electric energy; electric motors represent 75 % of the total motor power employed in industry. An estimate of the consumption of electricity in the service of agriculture has shown that 40 % of the cultivated land of the country (based on the area of the fields) now use electric energy on a larger or smaller scale. Not less than 7—8 million incandescent lamps are employed for lighting-purposes in Sweden. Stockholm is the principal telephone-using town in the world, with approximately one apparatus to every fourth person. Finally it may be mentioned that the capital invested in electric plant of different kinds in Sweden amounts to at least 1,250 million kronor. These figures bear incontestable witness to the importance of the electrical industry in the economic life of the country.

From the beginning the products of Swedens electrical industry have found their way into foreign markets. Already in the year 1894 about 30 % of the production was for export. This proportion has since then risen, and 1924 the value of exported goods amounted to 30 million kronor. Stockholm and Västerås are the chief centres of this industry.

Allmänna Svenska Elektriska A.-B. (Asea), Västerås, is the principal electro-industrial enterprise in Sweden, employing about 4 000 workmen in the manufacture of electric machines and apparatus, railway and tram material, etc. in factories at Västerås and Ludvika. Other firms manufacturing strong-current electrical machinery are *Luth & Roséns Elektriska A.-B.*, Stockholm, with about 800 workmen, manufacturing goods of a similar nature; further may be noted *A.-B. Lux* (electric vacuum-cleaners, etc.), *A.-B. Elevator* (lifts and measuring instruments), and *Järnhs Elektriska A.-B.* (röntgen and other medical apparatus), all three in Stockholm, *Svenska Elektromekaniska Industri A.-B.*, Hälsingborg, *Nya Elektriska A.-B. Chr. Bergh & Co.*, Svalöv, *Elektriska Motorfabriken Eck*, Liljeholmen (Stockholm), and *A.-B. Svenska Transformatorfabriken*, Linköping.

Telefon A. B. L. M. Ericsson, Stockholm, employs near 3 000 men in the production of telephone, telegraph, radio and signalling apparatus, electrical interlocking machines, cable, wire, line and similar material. Radio apparatus is also made by *Svenska Radio A.-B.* and *A.-B. Baltic*, both in Stockholm, and others.

The following are makers of electric cables and wires: *Sieverts Kabelverk (Max Sieverts Fabriks A.-B.)*, Sundbyberg, employing about 500 men, *A.-B. Liljeholmens Kabelfabrik*, Liljeholmen, and *Fabriks A.-B. Eris*, Stockholm.

The manufacture of incandescent lamps is carried on by *A.-B. Skandinaviska Glödlampfabriken*, Nyköping, and *A.-B. Elektraverken*, Stockholm (which also make heating apparatus, etc.). Accumulators are made by *Svenska Ackumulator A.-B.*

— THE MINING AND METAL INDUSTRIES —



Head-office of the Allmänna Svenska Elektriska A.B., Västerås.

Jungner, («Nife-ackumulatör»), and *Akkumulatorfabriks A.-B. Tudor*, both in Stockholm, also *Nordiska Akkumulatorfabriken*, Malmö. — Among the remaining electro-technical works may be noted *A.-B. Arvid Böhlmarks Lampfabrik*, Stockholm, (lighting fitting), *Elektriska A.-B. Volta* and *Elektriska A.-B. Helios*, both in Stockholm, (heating and cooking apparatus), *Rylander and Rudolphs Fabriks A.-B.*, Henriksdal (dry batteries and electrodes), *A.-B. Elektrodkontoret*, Örebro, *Svenska Dynamoborsfabriken*, Vadstena, *A.-B. Elektroapparat*, Göteborg, and *A.-B. Svenska Elektromagneter*, Åmål.

THE MANUFACTURE OF INSTRUMENTS.

The manufacture of instruments is subdivided into two essentially different branches which have scarcely anything in common except the name. These branches are, on the one hand, the manufacture of musical instruments of various kinds, and, on the other, the production of scientific and technical instruments, surgical, physical, nautical etc.

In the manufacture of musical instruments the chief place is occupied by upright and grand pianos, organs and harmoniums; these began to be made in Sweden in the 'forties. The production was at first carried on mostly as a handicraft; but after the imposition of a protective duty, it rapidly increased and assumed the character of an industry, while at the same time the increased general prosperity of the inhabitants led to a multiplying of the home demand for harmoniums and upright pianos. The imports of these instruments, however, have always been very considerable, especially from Germany. The fusion in 1917 of six of the largest factories will probably enable them to face this foreign competition with greater confidence. One distinguishing feature of the Swedish piano is that the factories themselves make the sounding-boards, which is not always the case with foreign manufacturers. The keyboards and strings etc. that are required for the instruments, on the other hand, are generally imported. The manufacture of other musical instruments than those just mentioned amounts to only 2—3 % of the entire production, calculated according to value. Brass instruments are manufactured chiefly by one factory in Stockholm, which also manufactures bugles and drums. A factory in Göteborg makes stringed instruments. Altogether 600 hands are employed in Sweden in the manufacture of musical instruments at some forty factories.

— THE MINING AND METAL INDUSTRIES —

The following are the principal makers of pianos and organs: *A.-B. Förenade Piano- and Orgelfabriker*, Göteborg, with five factories, viz: *J. G. Malmjö A.-B.* and *C. H. Billbergs Pianofabriks A.-B.*, both in Göteborg, *A.-B. Östlind & Almquist*, Arvika, *Pianofabriks A.-B. Gustafsson & Ljungqvist*, Norrköping, and *A.-B. A. G. Rdlins Orgel- & Pianofabrik*, Åmål. Further may be noted *A.-B. Gävle Orgel- & Pianofabrik*, Gävle, *A.-B. J. P. Nyströms Orgel- & Pianofabrik*, Karlstad, *A.-B. G. Ekström & Cos Pianofabrik*, Malmö, *J. O. Baumgardts Pianofabrik*, Linköping, *Aug. Hoffmans Pianofabriks A.-B.* and *C. J. Svahnqvists Pianofabrik*, both in Stockholm, and *Åkerman & Lunds Nya Orgelfabriks A.-B.*, Sandbyberg. Brass instruments are made by *Ahlberg & Ohlssons Instrument A.-B.*, Stockholm, guitars, mandolins, and lutes by the firm of *H. C. son Levin*, Göteborg.

The manufacture of surgical and medical instruments has long stood on an admittedly high level in Sweden. Of other instruments manufactured in Sweden there may be mentioned nautical, hydrographical, physical instruments and also measuring-instruments of various kinds. The precision-measuring sets and tolerance-gauges manufactured by *C. E. Johansson* at Eskilstuna, have gained world-wide renown in consequence of the wonderful exactitude with which they are made. The manufacture of the various instruments of this kind is one which is peculiarly suited to the Swedish ingenuity and temperament, but the home market for such articles is too small for a large industry ever to be based upon it.

Surgical instruments and medical appliances are made by *A.-B. Stille-Werner* and *Kirurgiska Instrument Fabriks A.-B.*, optical, nautical and hydrographical instruments by *Instruments Fabriks A.-B. Lyth*, physical (such as pressure-gauges, pyrometers, vacuum-gauges etc.) by *A.-B. Nordiska Armaturfabrikerna*, *Adolf Kihlströms Manometerfabrik*, *A.-B. Svenska Manometerfabriken* and the firm of *Rudolph Grave* (thermometers), all these firms in Stockholm. Precision measuring sets are made by *A.-B. C. E. Johansson*, Eskilstuna, ordinary lineal measures by *Svenska Mått- & Tumstockfabriken*, Hultafors, odometers and taximeters by *Fabriks A.-B. Haldataxametern*, Stockholm, gasmeters by *A.-B. Gasmätare*, Stockholm, *A.-B. Kungsörs Bleckkärlsfabrik*, Kungsör, and *A.-B. Svenska Metallverken*, Västerås, fluid-gauges by the last-named, *A.-B. Nordiska Armaturfabrikerna*, and *A.-B. Mackmeter*, Midsommarkransen (in Stockholm).

GOLD, SILVER, AND GERMAN SILVER WARES.

One of the very earliest branches of human skilled art to be exercised was that of the goldsmith, in which is included the working not only of gold but also of silver and other precious metals. Owing to the resistance of these metals to the ravages of time, the finds of gold and silver objects that have been made from time to time in the

bowels of the earth have made the goldsmith's art a typical index of the development and level of culture prevailing at different stages throughout the ages. In Sweden the goldsmith's art has had many exponents well known for their great artistic skill; and the strict control on the part of the State, to which the manufacture of gold and silver articles has been subjected since 1752, has of course contributed to placing this manufacture in a class by itself.

Alongside goldsmith's work carried on as a handicraft there began in the 'sixties the production of gold and silver articles on a factory scale. At about the same time the alloy called German silver, made of a mixture of brass and nickel, began to make its appearance as a substitute for silver, especially for table-services. During the last few decades the production of gold, silver and German silver articles in Sweden has increased considerably, the years during the war especially leaving their mark in the form of a considerably increased demand.

The Swedish factories, which in mechanical equipment are quite on the level of the best foreign establishments, are renowned for their solid and artistic productions.

The more important gold and silver ware manufacturers are *C. G. Hallbergs Guldsmeds A.-B.*, Stockholm, *Guldsmeds A.-B. i Stockholm* and *Guldvaru A.-B. G. Dahlgren & Co.*, Malmö. Further may be noted *A.-B. Hovjuvelerare K. Anderson*, *A.-B. Bernhard Hertz*, *Juvelerare A.-B. John Petterssons Eftr.*, also the firms of *W. A. Bolin*, *C. F. Carlman* and *A. G. Dufva*, all in Stockholm, as well as *K. G. Markströms Guldsmeds A.-B.*, Uppsala, and *A.-B. Erlandsson*, Kristianstad. In addition to the majority of the enterprises already mentioned, the following, among others, are makers of German silver ware: *Matsilver A.-B.*, Sundbyberg, *Joh. Rönqvist & Söner*, Örebro, *A.-B. C. R. Carlströms Nysilverfabrik* and *Östberg & Lenhardtsons Nya A.-B.*, both in Stockholm, *Nysilverfabriken Aurora*, Göteborg, *A.-B. Gustaf Erikssons Metallfabrik* and *Albert Lindströms Metall- & Förnicklingsfabrik*, both in Eskilstuna, and *Malmö Nysilverfabrik*, Malmö.





MINERAL AND STONE INDUSTRIES.

COAL-MINING.

The coalfields of Skåne, in the south of Sweden, were known of as early as 1571; but it was not until a couple of centuries later that coal-mining took place on any large scale. This industry has been carried on ever since 1797 and has developed more and more during the last few decades, so that to-day the output of the Swedish coal-mines is more than 400,000 tons yearly (see accompanying Table). Of this amount, however, it is only the best, or about 60 %, that is mined for selling purpose, the remainder being utilized for the other industries and the power-works of the coal-mining company. The power-station at Nyvång for instance, erected in 1917, produces about 10,000 HP electric energy, which is distributed among the company's own mines and workshops and to the surrounding country districts and a big power company, Sydsvenska Kraft A.-B.

As we have already seen in Professor Gunnar Andersson's article on the natural resources of Sweden (p. 11), the Scanian coal occurs in relatively thin layers, usually lying above, or superimposed by, fireproof clays and coal-bearing slate, which are mined together with the coal. These layers lie at a depth of from 30 to 100 metres.

Coal-mining at Höganäs has been carried on since the close of the 18th century and at Billesholm since 1865; at Bjuv and Skromberga it was begun in the 'seventies of last century, and at Hyllinge in 1900. The fields at Ormastorp and Gunnarstorp were first worked in 1910 and 1914 respectively. At the beginning of 1925 there were about 2,400 hands employed, and the value of the coal obtained was estimated at 5.8 million kronor.

All the coal deposits, which were previously owned by different independent companies, have belonged since 1918 to *Höganäs-Billesholms A. B.*, Höganäs. This firm also carries on an extensive manufacture of fire-proof brick-goods and other products of the clays obtained in the course of mining operations, which is facilitated by the supplies of cheap fuel in the form of the lower-grade coal.

THE PEAT INDUSTRY.

The digging of peat for household fuel purposes has long been carried on in those parts of Sweden where there is little growing timber. About the middle of the 19th century this pursuit began to attain the rank of a manufacturing industry; but it was not until the 'nineties that, thanks to the mechanical improvements invented by A. ANREP, work could develop on anything like a large scale. The rise in the price of coal that took place at the close of the century occasioned an increased demand for fuel-peat for industrial purposes; and at the same time the Government and Parliament began to display great interest in the peat-question. Peat-engineers were appointed, a peat-school was established, and a peat loan-fund was created. When, however, after a few years, the price of coal fell again, interest in the peat-industry diminished, and it remained feeble until the Great War broke out, when the fuel-question again became acute in Sweden. With the price of coal rising to a hitherto unheard-of height, the production of peat rose considerably, and in 1920 attained such a relatively high figure as 385,000 tons. Owing to the falling prices of coal during the last few years, however, the industrial production of peat in 1924 amounted to no more than 84,000 tons.

In Sweden, the preparation of peat can only be undertaken during the summer months; and even then the quality and the quantity are greatly dependent on the weather.

For information regarding the extent and importance of the fuel peat-bogs of Sweden the reader is referred to p. 12, where Professor Gunnar Andersson gives an account of this subject. The peat-bogs are situated chiefly in a belt extending from the north of Skåne through the provinces of Halland and western Småland up to Bohuslän, although there are also the peat-bogs of Norrland, which are at present a somewhat unknown factor. The manufacture of peat on a large scale has been carried on at several places, especially in Skåne, in western Småland and in the neighbourhood of Borås. Mention may

also be made of a number of ironworks in the provinces of Östergötland and Örebro which have at times employed peat, taken from their own bogs, as fuel.

In addition to the supplies of peat suitable for fuel, there exist all over Sweden numerous bogs or mosses containing a type of peat that can be used as litter, which since 1886, when the first peat-litter factory was established, has been employed industrially on an ever-increasing scale. Peat-litter is of great importance as a preserver and increaser of the natural manure supplies used in agriculture; and it is also employed among other things as a disinfectant in scavenging work, as filling material for double floors and as a packing material for preserving fruit in transit.

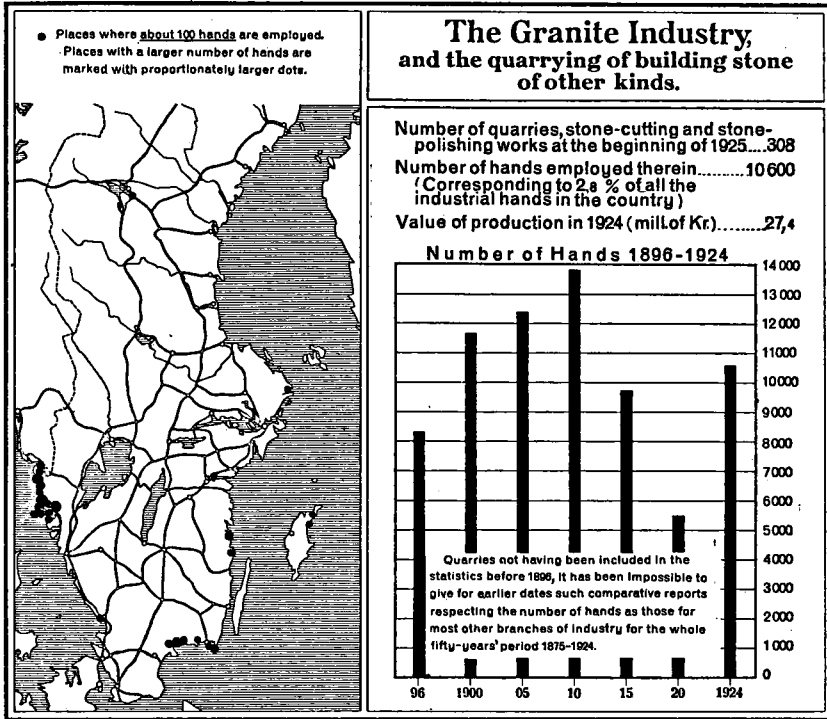
The principal producers of peat are *A.-B. Smdlands mossar*, Forsheda, *A.-B. Vakö Torvpulverfabrik*, Almhult, and *Närikes Torv A.-B.*, Mosås.

Among moss-litter manufacturers the following may here be mentioned: *A.-B. Karbo Torvströfabrik*, Falköping, *Torfströ A.-B. Ryttaren*, Sandhem, *Jerle Torv A.-B.*, Järle, and *Bjernums Torvströfabriks A.-B.*, Vittsjö, also *Skånska Lantmännens Andels-torvströförening*, Sjöholmen, and *Köpinge Myrs Andelstorfströförening*, Perstorp.

QUARRYING AND STONE-DRESSING.

Even during the Middle Ages the limestones and sandstones of Sweden were quarried and dressed for building-stone used in the erection of churches and castles. The numerous churches in the island of Gotland, for instance, bear witness to the strength of the material and the skill of the old stonemasons. Since then periodical decline in the art of architecture in Sweden has been faithfully reflected in the stone-dressing industry; and it was not until after the middle of the nineteenth century, when granite began to be employed for various purposes, that a fairly permanent modern stone-industry began to flourish in Sweden.

The Granite Industry. Even in olden times granite was used for important engineering and fortification works, but it was only when the increasing traffic in the streets and harbours led to a demand for a more durable paving and quay-building material, that a keen demand arose for granite. This induced C. A. KULLGREN, a merchant, and NILS ERICSON, the well-known Swedish canal-constructor, to establish in 1844, on the island of Malmön in the province of Bohuslän, what was the earliest granite-quarry and cutting-works in Sweden; six years later,



A.-B. KARTOGRAFISKA INSTITUTET

F. H. WOLFF, a German inspector of buildings, started stone-quarrying at Tjurkö in Blekinge. In this way was begun the utilization of the deposits of primary rock in Sweden, which are both extensive and favourably situated for exportation.

The so-called primary granite or granitic-gneiss and the fine-grained gneiss, supply the stone best suited for quarrying, though the "black granite" (diabase, diorite, and other rocks of volcanic origin) to be found here and there is also utilized for the block-stone industry. In consequence of its beautiful colour and structure, the granite of Bohuslän has come largely into use not only for paving purposes but also for building and ornamental work.

The Great War led to a very considerable interruption in the Swedish granite industry. The yearly output, which before 1914 had amounted to 1.4 million tons, was rapidly reduced to about half, and exports fell proportionately still more. Not until 1924 did

— MINERAL AND STONE INDUSTRIES —

the production again reach 1 million tons, 0.7 million being exported. Germany having greatly restricted its import of stone since the war, the greater part of the exports goes to France, England, Denmark and Holland, but some Swedish granite goes as far as U. S. A., the Argentine and Cuba. In 1924 the Swedish stone exported had a value of 14.8 million kronor, 75 % being paving-material.

The oldest enterprise in the granite industry is *Granit A.-B. C. A. Kullgrens Enka*, Uddevalla, with about 900 men. Other leading firms are *Skandinaviska Granit A.-B.* and *A.-B. Förenade Granitindustrier* at Göteborg, *A.-B. Bohuslänska Granit-kompaniet* and *Granit A.-B. Georg Lüttense* at Strömstad, and *A.B. A. K. Fernströms Granitindustrier* and *A.-B. Karlshälls Granitindustri* at Karlshamn. The quarries belonging to these enterprises are situated chiefly in Bohuslän and Blekinge, and also in Halland, Småland, and Uppland.

The manufacture of building-stone of sandstones, limestones and other rocks.

Sandstone is one of the chief natural building-materials. That is due to the relative ease with which this rock can be quarried and dressed and also to the resistance it offers to atmospheric action. Sandstone is quarried in many places in Sweden, e. g. in the neighbourhood of Motala, at Övedskloster in Skåne, at Burgsvik and Kettelviken in Gotland, and at Kallmora in Dalarna. It is employed not only as building material but also for millstones, grinding-stones and whetstones. Limestone is the rock which, next to sandstone, is the one most widely employed for building. It certainly is far inferior to granite and sandstone as facing-material, as it weathers more readily, but it is specially adapted for interior uses, such as for stairs, floors and ornamental work. Limestone occurs in two distinct varieties, viz. marble and what are called "dense limestone". The marble is quarried chiefly in Östergötland ("Kolmården marble") and also at Gropptorp and Mölnbo in Södermanland. The home demand for marble however is largely supplied from abroad. The dense limestone is quarried at several places in Sweden. Potstone, which is worked at Handöl in the province of Jämtland, owing to its fireproof qualities and great specific heat, is specially suited for stoves and as the interior facing of smelting-furnaces. Shale, which is used for making tiles, is quarried in the province of Västmanland.

The largest firm in the sandstone industry is *A.-B. Lemunda Sandstensbrott*, Motala, also *Stenhuggerifirman Bröderna Gustafsson*, Stockholm, with a sandstone quarry at Kettelviken on Gotland. Prominent contractors for limestone for building

— MINERAL AND STONE INDUSTRIES —

purposes are: *A.-B. Ignaberga Kalksten*, Ignaberga, *Yxhults Stenhuggeri A.-B.*, Kumla, *A.-B. Goßlands Kalkverk*, Stockholm, and *A.-B. Gusta Stenförädlingsverk*, Brunflo. The following enterprises may be mentioned in connection with marble-quarrying: *Nya Marmorbruks A.-B.*, Kolmården, and *Gropptorps Marmor A.-B.*, Katrineholm. The Jämtland potstone is worked by *Handöls Nya Täljstens & Vattenkrafts A.-B.*, Stockholm, and the deposits of clay-slate at Grythytted are worked by *A.-B. Grythyttte Skifferverk*, Stockholm.

Limestone-burning. Besides being employed as building-material direct, limestone is also used in ore-smelting, in glassworks, cement-works and other chemical factories, and for the making of quicklime. Some 3 or 4 million hectolitres of lime are used in Sweden every year for the improvement of the soil and in the making of mortar. Limestone-burning is a very ancient industry and has become of steadily growing importance with the increased employment of lime. At certain places in the provinces of Västergötland and Närke there are rich beds of oleaginous schists which are quarried with the limestone, these being used as fuel in the burning of the limestone. These schists form a not unimportant fuel-reserve.

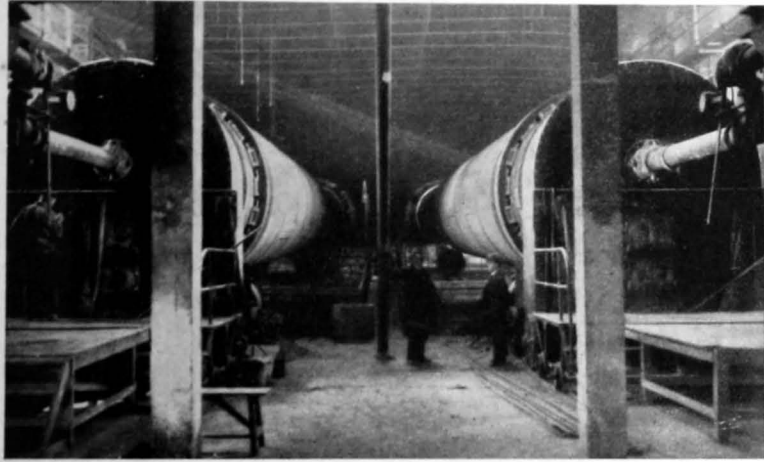
In the industry in question *A.-B. Västergötlands Förenade Kalkindustrier*, Falköping, is the largest enterprise, employing about 400 workmen at a dozen lime-works in the province of Skaraborg. Further may be mentioned *A.-B. Karta & Oaxens Kalkbruk*, Stockholm, *A.-B. Strå Kalkbruk*, Sala, *Tomens Kalkbruks A.-B.*, Torbjörntorp, *Klagshamns Cementverks A.-B.*, Klagshamn, *Skånska Cement A.-B.*, Malmö, *Båstads Kalkindustri A.-B.*, Malen, and *A.-B. Skattungbyns Kalkbruk*, Mässbacken.

Quartz- and felspar-quarrying. Quartz and quartz-sand are used as raw material in the china and glass industries, and as reducing-agents in the making of iron. Felspar is an important raw material in the manufacture of china. The mining of these rocks takes place in various parts of Sweden, in the Stockholm archipelago, for instance, where the Ytterby felspar quarry is thought to be the most ancient in the country.

Among enterprises in this branch the following may be mentioned: *Margrethelunds Gruv A.-B.*, Stockholm, and *Annenäsets Kalkbrott (Setterberg & Co.)*, Stockholm.

Chalk-manufacture. The working and elutriation of chalk has been carried on since the 'sixties of last century at some chalk-works in the vicinity of Kvarnby to the east of Malmö. The chalk is used for the manufacture of schoolroom-chalk and for various purposes in chemical industries, in chinamaking and in the rubber-goods industry

The chalk-works are owned by *A.-B. Kritbruksbolaget* of Malmö.



Cement kilns at the Skånska Cement A.-B., Limhamn, Skåne.

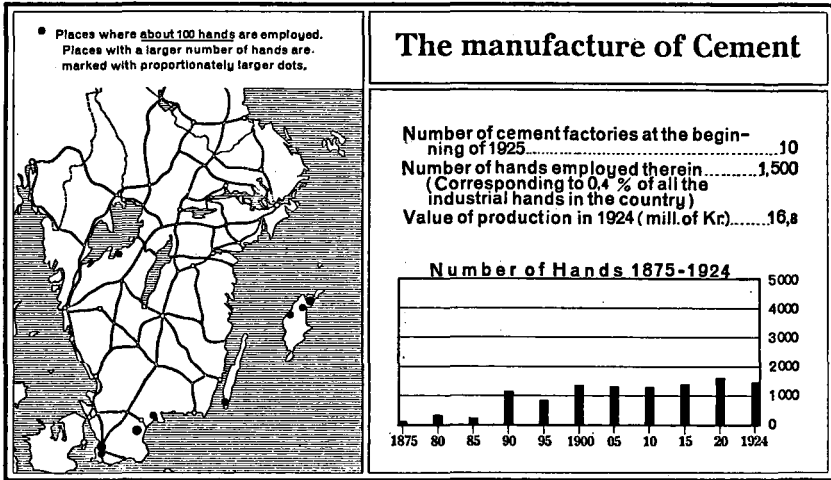
In each of the rotation kilns, which are 75 metres long, and in which the burning of the cement-materials is carried on by blowing in pulverized charcoal, there are produced 1,500 barrels of cement every day.

The Grinding Material Industry. The manufacture of grinding material on a large scale in Sweden was begun in the 'nineties. The products consist of grinding-slabs, whetstones, polishing-cloth and sand-paper, polishing-powder etc. During the war the production of these articles increased very rapidly; since then it has declined somewhat, although it approximately satisfies the home demand.

Among enterprises in this branch of industry the following may be mentioned: *A.-B. Svenska Naxos*, Lomma, *A.-B. Slipmaterial*, Västervik, *A.-B. Svenska Smergelskiffabriken*, Höganäs, and *Smärgelskiffabriken Norden*, Baskarp.

THE CEMENT INDUSTRY.

The manufacture of cement originated in England, where the making of Portland cement was started on a large scale as early as the 'twenties of last century. The first Swedish cement-factory was built at Lomma in Skåne in 1872, but it was not until the close of the 'eighties, after the imposition of an import-duty on cement, that the industry became of any great importance. Since then it has gone



— MINERAL AND STONE INDUSTRIES —

tiles, are made out of the ordinary more or less impure surface clay.

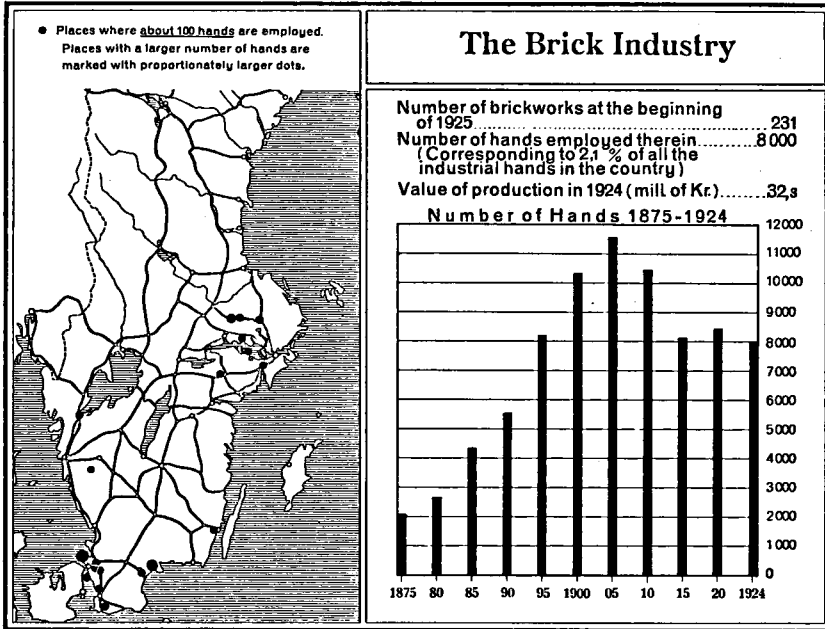
Another group of brick-products is obtained from the fireproof clays of Skåne mined either along with coal or in the north-east of the province as china clays. Among the bricks of this class may be mentioned chamotte-bricks, which are made of raw, fireproof shale mixed with a calcined pulverized material of the same kind (chamotte or grog); they are used for blast-furnaces and for all other industrial purposes. In this group may be also classed vitrified bricks, such as floortiles, pavement-tiles and acid-proof bricks etc. The raw material for these products consists of certain shales which are burnt to vitrification giving a product capable of offering great resistance to mechanical wear and tear and to chemical action. There may be also mentioned glazed sanitary-pipes made of a raw material which is something between fire clay and vitrifying clay.

In a third group there are usually classed certain products, the raw material of which consists chiefly of silica, e. g. silica bricks or Dinas, which are manufactured out of pure quartz, quartzite or sandstone along with some lime. Sandlime bricks may also be mentioned.

The manufacture of common bricks, which is of very ancient origin, was at first a subsidiary occupation of farmers the bricks being sold in the districts in the vicinity of the brickyards. It was only during the latter half of the nineteenth century that brickmaking began to develop into an independent industry. The drying-process being dependent on climatic conditions, brickmaking is usually a distinctively seasonal industry in Sweden, it being of rare occurrence for the manufacture to be carried on all the year round. The brickyards have been set up in the immediate vicinity of the principal deposits of the raw material and in places where there exists a large demand for bricks in the neighbourhood. The basin of Lake Mälaren and the province Skåne are centres of this industry, though large or small brickyards exist in all parts of the country.

The foreign trade of common bricks is of comparatively subordinate importance, although at an earlier date there existed a certain import from Norway and in the post-war years a temporary import — due to the then existing state of the rates of exchange — from Germany. Fireproof and vitrified bricks, on the other hand, are Swedish export articles.

The Swedish Brick Industry Association (Sveriges Tegelindustri-



A.-B. KARTOGRAFISKA INSTITUTET

förening) in Stockholm watches the common interests of the industry and deals *inter alia* with the question of standard qualities and sizes, a matter of great importance to the industry in Sweden.

The two principal enterprises in the brick industry are *Höganäs-Billesholms A.-B.*, Höganäs, noted for their fire-proof bricks, vitrified bricks and glazed sanitary pipes, manufactured at Höganäs, Bjuv, Skromberga, Hyllinge and several other places, and *A.-B. Mälardalens Tegelbruk*, Stockholm, where various kinds of bricks for building purposes and drainage pipes are made at about twenty works round Lake Mälaren. In the provinces surrounding Lake Mälaren and Hjälaren there are also a large number of brickyards such as *Uppsala-Ekeby A.-B.*, Uppsala, *A.-B. Heby Tegelverk*, Heby, *Tegelbruks A.-B. Walla-Katrineholm*, Katrineholm, *A.-B. St Eriks Lervarufabriker*, Uppsala, *Sala Tegelbruks A.-B.*, Sala, *Harge Bruk*, Hammar, *A.-B. Marks Tegelbruk*, Örebro, Vrena Tegelbruk owned by *Backa-Hosjö A.-B.*, Sparreholm, *Lundqvist & Huddéns Tegel- & Trävaru A.-B.*'s brickyards at Knivsta and Vittinge, *Fyrsvalls Tegelbruk*, Uppsala, and *Kungshagens Tegelbruks A.-B.*, Nyköping. Apart from the above-mentioned Höganäs-Company, the Skåne clay deposits are utilised at a number of works, among which the following may be noted: *A.-B. Iföverken*, Bromölla, *A.-B. Lomma Tegelfabrik*, Lomma, *Börninge and Yddinge Tegelbruk*, Börninge, *Minnesbergs Tegelbruks A.-B.*, Trälleborg. Among the brickyards in the west of Sweden the following may be mentioned: *Stekens Tegelbruk*, Agnesberg, *A.-B. Nabbensbergs Tegelbruk*, Vänersborg, *A.-B. Forssa Tegelbruk*, Borås, *Slottsmöllans Tegel-*

— MINERAL AND STONE INDUSTRIES —

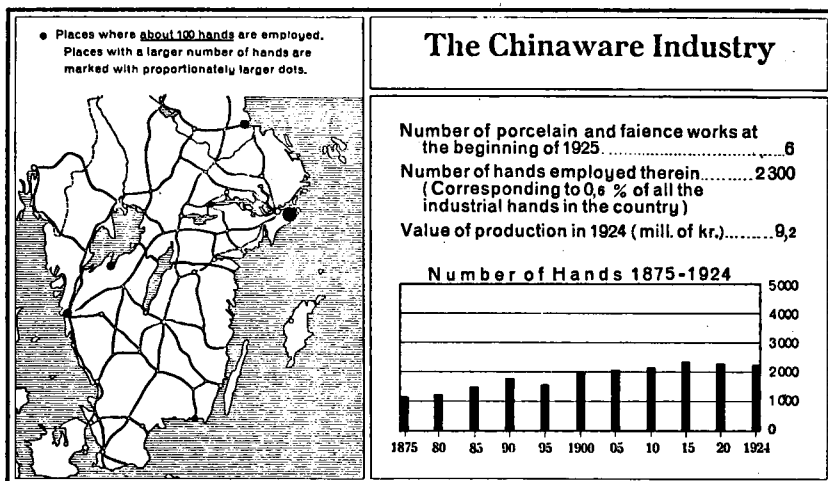
bruk, owned by *Wallbergs Fabriks A.-B.*, Halmstad. In Småland and Östergötland may be noted *Nygårde Tegelbruks A.-B.*, Smedby, and *A.-B. Förenade Tegelbruken*, Linköping. Finally the chimney-building firm of *N. Lundgren*, Gävle, may be mentioned, which makes bricks for chimneys at Upsala Norra Tegelbruk.

THE MANUFACTURE OF DUTCH TILES, EARTHENWARE AND COMMON POTTERY. These branches of industry are very closely allied to brickmaking and are frequently carried on by the same makers. The manufacture of dutch tiles has its principal seat in the Upsala district, the raw material employed consisting of the calcareous marl or glazed-tile clay present in the soil there. The production embraces chiefly tiles for the exterior or interior facing of stoves and walls etc. The manufacture of ›tile-stoves‹ (generally used in Sweden for domestic heating purposes), which during the 'eighties and 'nineties of last century reached a great height of prosperity, has during the last few decades diminished in consequence of the increasing employment of domestic radiators. The manufacture of earthenware and common pottery is carried on at several tileyards and brickyards and also at some smaller earthenware factories. The output consists mainly of flower-pots, dishes, basins, vases and other pottery products, both plain and ornamented.

Among the branches of industry in question the following enterprises may be noted, some of which have been already mentioned under the brick industry: *Höganäs-Billesholms A.-B.*, *Upsala-Ekeby A.-B.* and *A.-B. S:t Eriks Lervarufabriker*; and also *Kakelfabriks A.-B. i Karlskrona*, *Karlskrona*, *Sandbäcks Kakelfabriks A.-B.*, *Kalmar* and *A.-B. Nittjö Stenkärlsfabrik*, Rättvik, etc.

THE CHINAWARE INDUSTRY.

The manufacture of what is called ›real china‹ is supposed to have originated in China, where it was carried on as early as 200 years before the Christian era; but the thin, transparent Chinese porcelain was not successfully imitated in Europe until the beginning of the eighteenth century, when the suitability of china clay for the purpose was discovered by chance. A factory was built at Meissen in Germany, and it placed its chinaware on the market for the first time at the Leipzig Fair held in 1715. The manufacture of ordinary chinaware (faience) was carried on in Europe as early as the Middle Ages; but it was not until the middle of the eighteenth century that the



— MINERAL AND STONE INDUSTRIES —

prominent Swedish artists, low-priced articles for everyday use have been given a more artistic form and the Swedish output of such goods has gained the highest international recognition.

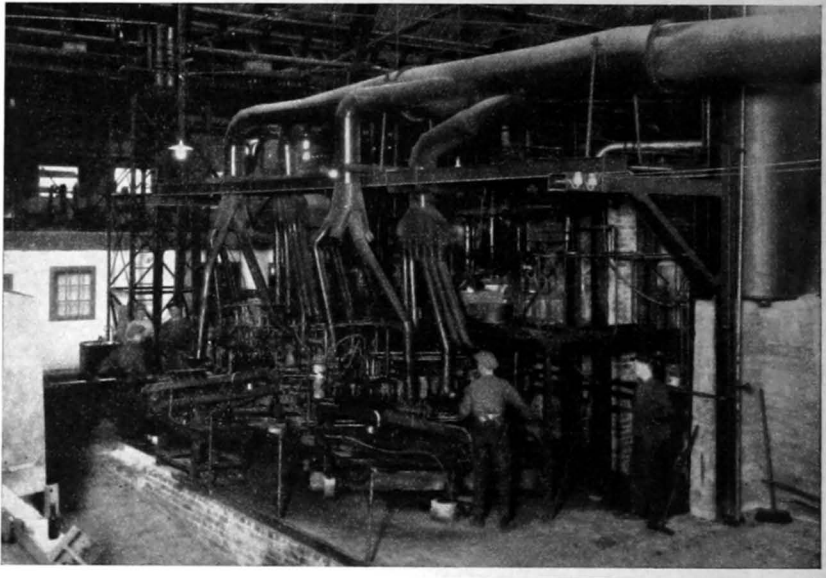
By the increased use of mechanical aids and of improved methods of manufacture the Swedish chinaware industry has about doubled its production during the last quarter of a century. About two-thirds of the home demand is nowadays supplied by the Swedish factories. Exports are of comparatively small importance.

The two above-mentioned principal factories in this branch are now owned respectively by *A.-B. Gustavsbergs Fabrikintressenter*, Gustavsberg, and *A.-B. Rörstrands Porslinsfabriker*, Göteborg. Between 1911 and 1918 three other enterprises were established in this branch, viz. *A.-B. Lidköpings Porslinsfabrik*, Lidköping, *Gävle Porslinsfabriks A.-B.*, Gävle, and *A.-B. Karlskrona Porslinsfabrik*, Karlskrona.

THE GLASS INDUSTRY.

The manufacture of glass may be described as one of the most ancient industries of Sweden, for it is stated that "glass-masters" were working there as early as the fifteenth century. The first Swedish glassworks that is known of obtained its privileges from King Johan III at the close of the sixteenth century; and during the following century charters were granted for the establishment of new glassworks. In the eighteenth century great endeavours were made to stimulate industrial activity in Sweden in many directions and amongst others in the art of glassmaking. During this latter period a number of new glassworks were set up in various parts of the country, among these being the still-existing factories at Limmared (1740) and Kosta (1741). Finally during the course of last century additional glassworks were built, more especially in Småland, in order to satisfy the then rapidly increasing demand — which has since kept up — for simple varieties of household glass, lamp-glasses, bottle-glass and window-glass.

Since nearly all the raw material for the glass-industry has to be imported — it is only window-glass and bottles that can be made of Swedish glass-sand — it is remarkable that the industry should have developed as much as it has, especially as countries with supplies of cheap coal must possess far more favourable conditions than does Sweden for the maintenance of an industry that requires such a large amount of fuel. The explanation of this is considered to be the technical skill of the Swedish workman, allied to his predilection for work



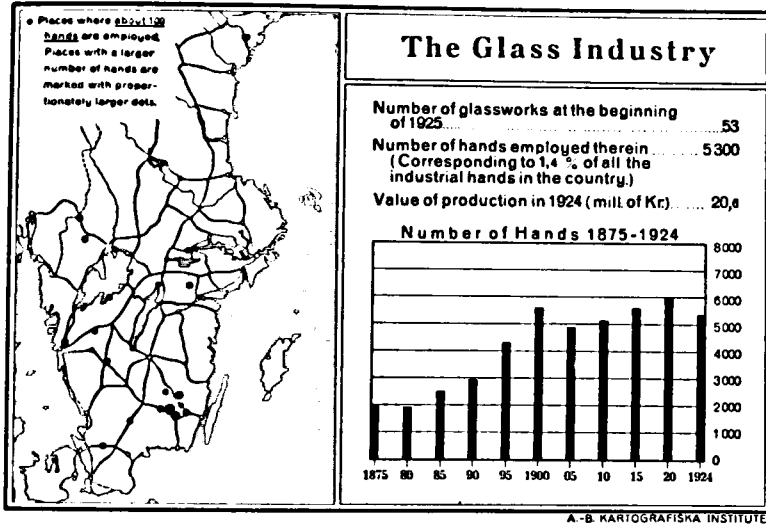
Bottle-glass machine at work (Surte Glassworks).

demanding that great accuracy which is of such pre-eminent importance in the glass-industry. Other factors are the technical managers' skill in organization and their other qualifications for their work.

The grouping of so many glassworks in the eastern part of the province of Kronoberg is supposed to be due to the fact that during the course of years the technical skill of the employees and staff at the Kosta Works has gradually spread to the neighbouring districts and has there been utilized by other enterprising business men with a fund of initiative; there is also the fact that the forests in the vicinity furnish large supplies of fuel at small cost.

The Swedish glass-industry is able on the whole to satisfy the entire home demand for household glass and bottle-glass and the greater part of the demand for window-glass. Thanks to the extremely high quality of the Swedish product there also exists a by no means negligible export. The Swedish ornamental glasses, especially from Orrefors and Kosta, have gained a world-wide reputation owing to their highly artistic form and their decorativeness.

The manufacture of household glassware, ornamental glassware, and lamp-glasses, is carried on by about 20 different works, among which the following are the principal:



Kosta glasbruk in Småland and *Eda glasbruk* in Värmland, — both owned by *A.-B. De Svenska Kristallglasbruken*, Stockholm, — *Orrefors Bruks A.-B.*, Orrefors, *Pukebergs glasbruk*, owned by *A.-B. Arvid Böhlmarks Lampfabrik*, Stockholm, *A.-B. Johansfors Glasbruk*, Emmaboda, and *Limmareds bruk*, the latter owned by *A.-B. Fredr. Brusewitz*, Limmared, and *Foglaviks glasbruk*, owned by *Örnberg & Anderssons A.-B.*, Göteborg. Also the following: *A.-B. Hofmantorps Nya Glasbruk*, Hofmantorp, *A.-B. Rosdala Glasbruk*, Norrhult, *Skrufs Nya Glasbruks A.-B.*, Skruv, *A.-B. Åfors Glasbruk*, Emmaboda, *Skånska Ättikfabrikens glasbruk*, Perstorp, *Sölvesborgs Glasbruk*, Sölvesborg, and *Hjärtsjö glasbruk*, which is owned by *A.-B. Kristallverken*, Eslöv.

The manufacture of bottle-glass is carried on by some ten works, of which *A.-B. Surte-Liljedahl*, Surte, is the largest. The following may also be mentioned: *Ärnäs bruk*, Österång, *Arboga Glasbruk*, Arboga, *Hammars Glasbruks A.-B.*, Askersund, and *Sunds Glasbruks A.-B.*, Ång. Within this branch a certain concentration has been effected, by which the majority of the enterprises have entrusted their sales to *Buteljglasbrukens Försäljnings A.-B.*, Stockholm.

The Swedish window-glass works number 13 in all. Six of them, among which are the two largest, viz. *Glava glassworks* in Värmland and *Sandö glassworks* in Väster-norrland, are owned by *Fönsterglasbrukens A.-B.*, Glava glasbruk. The following may also be mentioned: *A.-B. Emmaboda Fönsterglasbruk*, Emmaboda, and *Karlstads Glasbruk*, Karlstad.



THE TIMBER INDUSTRIES.

THE SAWMILL INDUSTRY.

The sawmill industry is the most important of all the Swedish industries. The value of the sawmill products exported annually constitutes one-fifth of the total exports for the whole kingdom. The total number of persons engaged in this industry, including sawmill hands, tree-fellers and floaters, is not far short of 100,000. Sweden possesses all the natural resources for this industry, as has been shown in detail by Professor Gunnar Andersson in the article he contributes to these pages on "Sweden's Natural Resources in relation to Industry" (see p. 3).

During the first half of the nineteenth century the sawmill industry was transformed at a rapidly increasing rate from numerous small mills into large-scale industrial enterprises. At the same time, the industry moved steadily northwards into Norrland with its virtually untouched timber resources, and what were for that period large water-driven sawmills were erected close to waterfalls and rapids. When at a later period steam-power commenced its triumphal march through the world, and sawmills came to be driven by steam, the timber industry underwent a complete revolution. The sawmills no longer needed to be near waterfalls but could be removed to shipping ports at the river mouths, thereby eliminating the costly transport of the sawn goods. At the same time steam-sawing led to increased production and better products, while shavings and waste timber provided cheap fuel for the boilers.

The first steam sawmill in Sweden was erected at Vifsta Varf in 1848. In the course of the following decades the number of mills increased rapidly, and at the same time the expansion of the wood-goods industry was facilitated by favourable changes in commercial

— THE TIMBER INDUSTRIES —

policy. The Swedish export duty on sawn goods was abolished in 1863, and the British and French import duties on Swedish deals and boards were removed a year or two later. Moreover, the establishment of joint-stock companies greatly facilitated the financing of costly steam sawmill plants and the acquisition of forests.

The perhaps somewhat too rapid expansion of the sawmill industry was interrupted in 1874, when a heavy decline in the prices of woodgoods set in, that led to a violent and protracted crisis. However, this crisis had the effect of forcing the companies to adopt more rational methods, such as a more careful utilization of the timber in the forests, the introduction of up-to-date methods in the sawmills, the output of more completely finished woodgoods, and a more complete utilization of waste products. Most of the sawmills at present existing in Norrland were established in the 'seventies and 'eighties, and during the past quarter of a century these have kept consistently abreast of technical development. Steam has now to a large extent been replaced by electric power, especially at places where the waste can be employed more profitably in the manufacture of woodpulp than as fuel.

The construction and development of the floatingways have formed an important factor in the history of the Swedish sawmill industry. Some 200 million kronor have been expended on their improvement by dredging the rivers, straightening the river-banks and constructing timber-flumes for carrying the logs past rapids and falls; and the result is a network of excellent waterways for transporting timber, that has probably no equal anywhere in the world. The extent of this net may be gauged by the fact that the average distance from felling-place to waterway in the Norrland forest areas has been estimated at less than two and a half miles. The total length of the timber-floating ways is not less than twice that of all the Swedish railways together. The floating of the timber is generally carried out by a floating association for each waterway, the members of which are the timber-owners; the association carries out the floating at cost price. The number of such associations is now about 200.

The sawmill industry obtains the greater part of its raw material from its own forests (in Norrland 55—60 %; in central and southern Sweden 65—70 %). The remainder is purchased in the form of either felled timber or standing trees on Crown or private domains. The trees to be felled are marked in the summer, whilst the "driving", i. e.,



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Current timber floating in Norrland.

The most important task of the floater is to "keep the timber moving".

the felling of the trees and their conveyance to the river, takes place in the winter, when the wood is at its best and the snow facilitates transportation. After the logs have been brought down to the river, they are duly measured as to dimensions.

When the ice breaks up in spring, the floating begins. Altogether some 20,000 men are engaged in the various operations connected with timber floating, such as rolling the logs down into the water; preventing and clearing jams at rapids, bridges and other critical points; assisting in the towing or hauling out of the logs, collected within boomtraps in lakes and other still waters, by means of floating capstans, etc. Some of the men are detailed to clear the rivers of logs which have beached along the banks or fouled in the rapids. It is estimated that every year from 1½ to 2 % of the logs sink or are otherwise lost on their journey to the coast. The final stage in the floating is the sorting of the logs, which as a rule is done at sorting-places near the mouths of the rivers. Some of these are very extensive; one at Sandslån, in the river Ångermanälven, employs no less than 900 men. The logs belonging to the various owners are sorted out by the aid of marks driven into

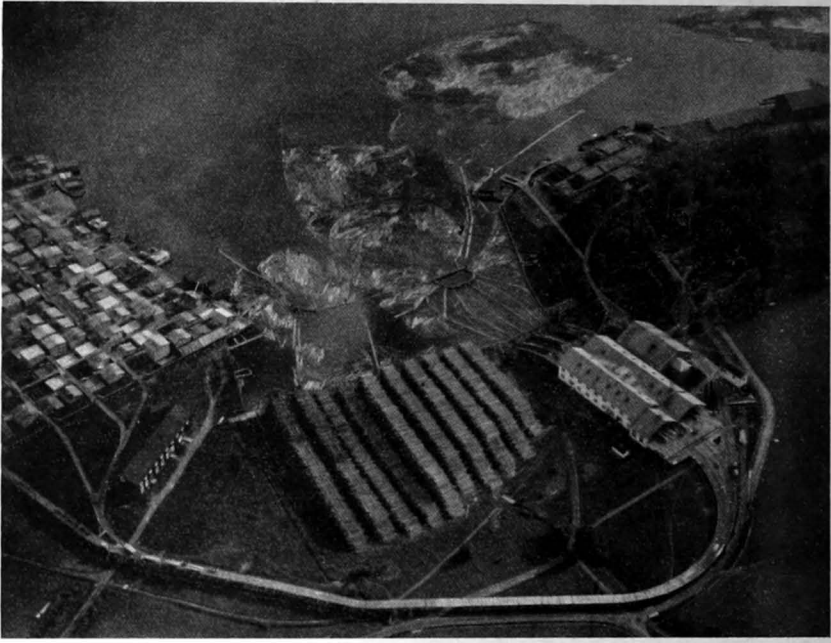


Raft-building on Lake Fryken.

The timber is collected and clamped together into rafts, for towing across the still waters.

the ends of the logs before they are floated. The logs are then towed away to their respective mills.

Here the logs are received in an enclosure in front of the saw-mill shut off by booms, whence they are moved up to the arched runway on which chain-conveyors draw them into the mill, where they are immediately sawn up. The timber to be sawn during the winter is usually rolled on shore in the autumn and piled up near the mill. The transformation of the logs into deals and boards takes place in machine-driven gang saws, provided with saw-blades corresponding in number to the number of deals, battens or boards to be obtained from the log. When large timber has to be "square-sawn", the logs are first of all levelled on two sides, after which they are turned a quarter of a turn before the sawing proper begins in the next gang saw. The timber is then carried automatically to circular saws to be edged. After being sorted according to dimensions and qualities, the sawn goods are brought out either into the woodyard where they are piled to be seasoned and dried for one or more months, or, less frequently, to drying kilns, where they are dried by steam. Before shipment, the goods are finally graded and marked.

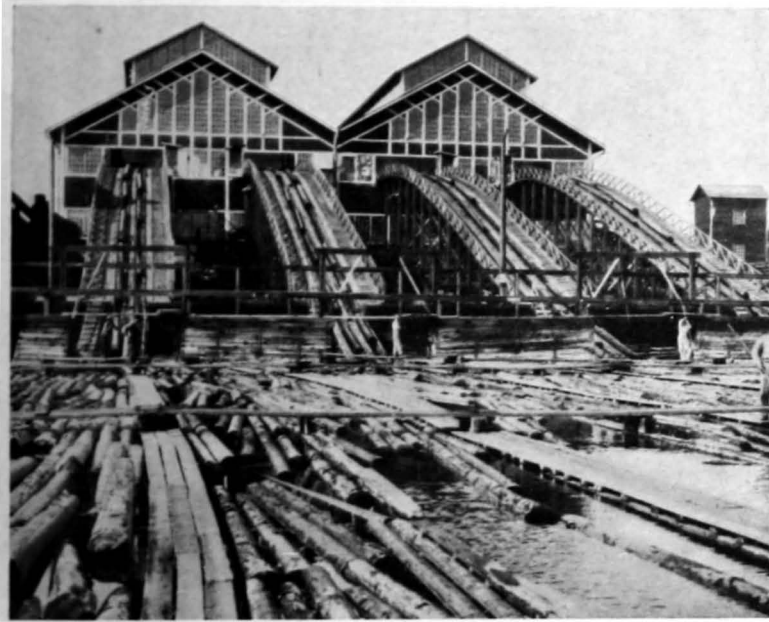


The Bollsta Sawmill on the River Ängermanälven (Gräningsverken A.-B.).
From the timber enclosure with its sorting channels, visible in the centre, the logs are conducted into the mill on the right, whence the sawn goods are transported on an elevated track to the woodyard on the left. In the centre at the bottom of the photograph are seen log piles for winter sawing.

The small wood produced during sawing operations is converted by means of re-sawing- and cross-cut saws into boxboards, staves, laths, broomstick squares or other small articles. Waste wood can be cut up by special machines for either boiler-fuel or pulpwood; it can also be used for making charcoal. Several sawmills have long been producing charcoal for the Swedish iron industry, either in kilns or in special charcoal furnaces.

Many Swedish sawmills have planing-mills, where the wood-goods after careful drying are subjected to further finishing processes before shipment.

The output of the Swedish sawmills, which increased rapidly during the last few decades of the nineteenth century, has not, on the whole, been maintained in the present century, for the rate of timber-



The exterior of the sawmill building at Skoghall near Karlstad and the timber-basins (Uddeholms A.-B.).

felling had reached, and even exceeded, the annual regrowth of the forests. To some extent, this excessive felling has been justified by the ample supply of old trees, but when this once has been exhausted, there is a danger that the regrowth will not suffice to fill the demand, and that the sawmill industry will be obliged to restrict its activities. This problem has been dealt with in some detail by Professor Gunnar Andersson on pp. 27 and 28. Determined efforts have therefore been made to assure future timber supplies by means of a more rational forest culture. A pioneer in this direction was Dr. Frans Kempe. In addition to his successful management of the Mo & Domsjö A.-B.'s sawmills he set on foot extensive phyto-biological investigations and did valuable work by draining marshy woodland and bogs in Norrland and converting them into productive forest-lands.

Swedish exports of sawmill products (deals, battens, boards, box-boards and planed goods) have undergone great variations in the past



Interior of a modern sawmill with three-level floor.
(Skoghall Sawmills, Uddeholms A.-B.)

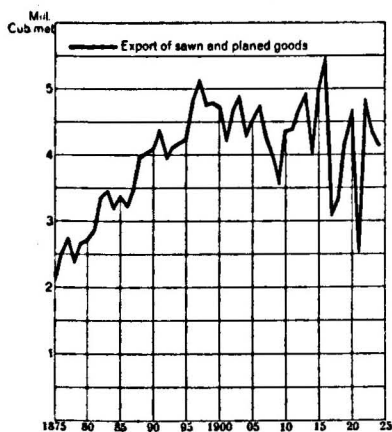
— THE TIMBER INDUSTRIES —

quarter of a century, as may be seen from the accompanying graph. In 1924 they totalled one million standards, or 4.2 million cubic metres, with a total value of about 250 million kronor. The exports in that year amounted to about 70 % of the production. In addition, exports of unmanufactured and hewn woodgoods, such as pitprops, sleepers, spars and masts, were recorded to the value of nearly 24 million kronor. Of the foreign markets for Swedish woodgoods, England and France come first, followed by Holland, Germany, Belgium, Spain and Denmark.

The diagram on p. 168 shows that the number of hands in the sawmill industry as registered by the statistics has been fairly uniform for the last twentyfive years at about 40,000, except in 1900 and 1920, when the demand for woodgoods necessitated a temporary increase. In estimating the number of individuals depending on this industry for employment, regard should also be had to the tree-fellers and the log-floaters as well as to those employed in the woodpulp and iron industries. Forest work gives employment in the winter season to about 150,000 men, the greater number of which are farmers, and for the floating operations in the summer months some 20,000 men are required.



Frans Kempe.
b. 1847 d. 1924

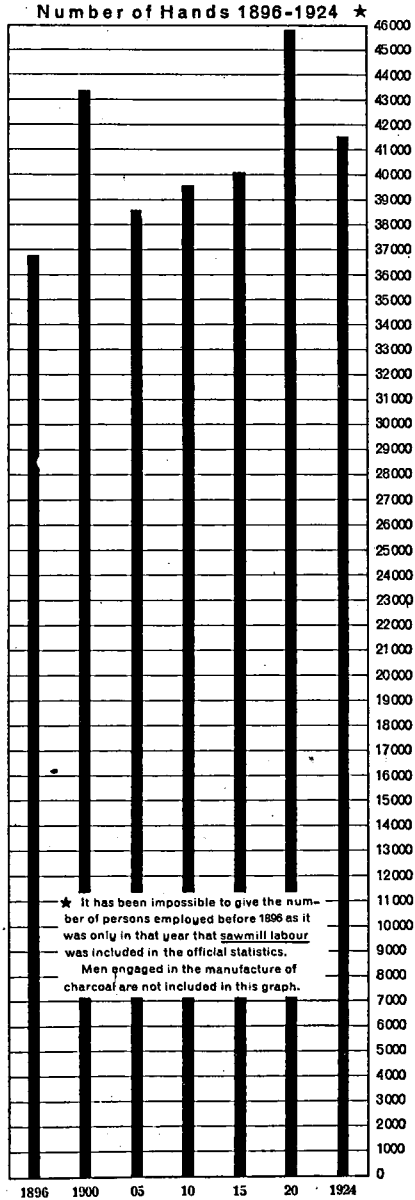
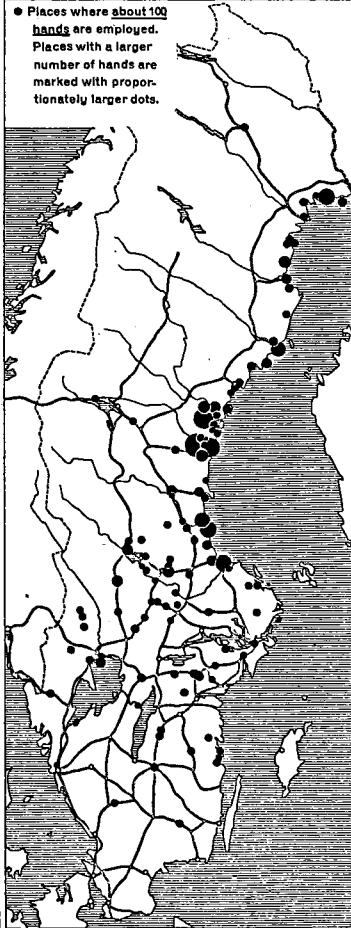


The interests of the sawmill industry are looked after and promoted by the Swedish Wood Exporters' Association (Svenska Trävaruexportföreningen) Stockholm, founded in 1906. The Association watches the trend of the woodgoods market, sends its members periodical reports of timber sales, records the development in foreign markets, etc. From the map on the next page it will be seen that the sawmill industry is centred largely along the Norrland coast and particularly in Västernorrland, where a fourth of the total sawmill labour in the country is employed. Here we find the two largest

The Sawmill Industry

Number of sawmills and planing mills at the beginning of 1925.....1 185
 Number of hands employed therein.....41 500
 (Corresponding to 10,9 % of all the industrial hands in the country)
 Value of production in 1924 (millions of Kronor).....336,2

● Places where about 100 hands are employed. Places with a larger number of hands are marked with proportionately larger dots.



A.-B. KARTOGRAFISKA INSTITUTET

— THE TIMBER INDUSTRIES —

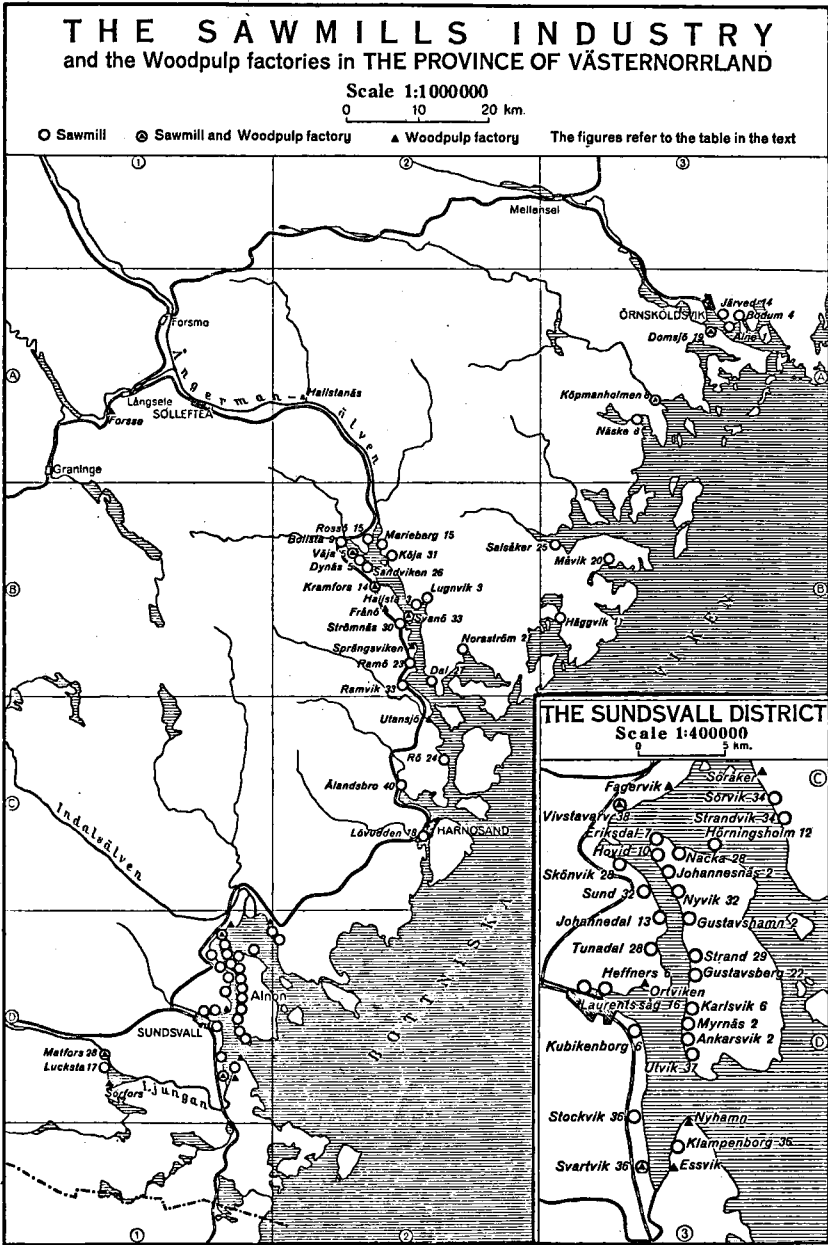
sawmill districts: that of Härnösand, along the lower course of the river Ängermanälven, and that of Sundsvall, around the mouth of the river Indalsälven. But in other parts of Norrland, too, notably in the province of Gävleborg, the timber industry has attained considerable proportions.

The principal saw-mill enterprises in the provinces of Norrbotten and Västerbotten are as follows: *Munksunds A.-B.*, Luleå, with saw-mills at Munksund, Storfors and Bergövik, *Svenska Trävaru A.-B. Kemi*, Seskarö, *Bergdom, Swanberg & Co. A.-B.*, Kalix, *Fortuna Sägverk (H. Pedersen)*, Båtskärsnäs, *A.-B. Scharins Söner*, Umeå, with saw-mill close to Skellefteå, *Sävenäs Nya A.-B.*, Kallholmen, *Bure A.-B.*, Bureå, *A.-B. Robertsfors*, Robertsfors, *Holmsunds A.-B.* and *Sandviks Ängsdgs A.-B.*, both at Holmsund, and *Nordmalings Ängsdgs A.-B.*, Nordmaling. — In the province of Jämtland the following may be noted: *A.-B. Tegefors Verk*, Järpen, with saw-mills at Trångövik and Pilgrimstad, *A.-B. Ocke Ängsdg*, Ocke, *Hissmofors A.-B.*, Hissmofors, and *Bräcke Ängsdg (E. Edling)*, Bräcke.

The more important saw-mills in the province of Västernorrland may be found on the special map appended, and are given below in alphabetical order. (The references in brackets are to the map.)

1. *Alne Ängsdg (A. Strandberg)*, Örnköldsvik, with saw-mill at Alne (A 3).
2. *Ankarviks Ängsdgs A.-B.*, Sundsvall, with saw-mills at Ankarövik (D 3), Myrnäs (D 3), Johannesnäs (C 3) and Gustafshamn (D 3).
3. *Björkd A.-B.*, Björkäbruk, with saw-mill at Lugnvik (B 2).
4. *Bodums Ängsdg*, Örnköldsvik, with saw-mill at Bodum (A 3).
5. *Dynäs A.-B.*, Väja, with saw-mills at Dynäs (B 2) and Väja (B 2).
6. *J. A. Enhörnings Trävaru A.-B.*, Sundsvall, with saw-mills at Kubikensborg (D 3), Hefner (D 3) and Karlsövik (D 3), employing a total of 900 men.
7. *Eriksdals Nya Trävaru A.-B.*, Sundsvall, with saw-mill at Eriksdal (C 3) (not running).
8. *Fors A.-B.*, Köpmanholmen, with saw-mills at Köpmanholmen (A 3) and Näske (A 3).
9. *Graningeverkens A.-B.*, Bollstabruk, with saw-mill at Bollsta (B 2).
10. *Hoftids Trävaru. A.-B.*, Sundsvall, with saw-mill at Hovid (C 3).
11. *Häggviks Sägverks A.-B.*, Nordingrå, with saw-mill at Häggvik (B 3).
12. *Hörningsholms Trävaru A.-B.*, Sundsvall, with saw-mill at Hörningsholm (C 3).
13. *Johannedals Trävaru A.-B.*, Sundsvall, with saw-mill at Johannedal (D 3).
14. *Kramfors A.-B.*, with saw-mills at Kramfors (B 2) and Jerved (A 3), employing a total of 800 workmen in this branch.
15. *Kungsjärden-Mariebergs A.-B.*, Stockholm, with saw-mills at Marieberg (B 2) and Rossö (B 2).
16. *A.-B. Erik Laurent*, Sundsvall, with saw-mill in the town of Sundsvall (D 3).
17. *Lucksta Ängsdgs A.-B.*, with saw-mill at Lucksta (D 1).
18. *Löfuddens A.-B.*, Härnösand, with saw-mill at Löfudden (C 2).
19. *Mo & Domsjö A.-B.*, Härnösand, with saw-mills at Domsjö (A 3) and

— THE TIMBER INDUSTRIES —



— THE TIMBER INDUSTRIES —



The Mo Sawmills, Norrbyskär (Mo & Domsjö A.-B.).

- Norrbyskär (Västerbotten pr.), employing a total of 700 workmen in this branch.
20. *Måvika Ångsågs A.-B.*, Nordingrå, with saw-mill at Måvik (B 3).
 21. *Noraströms Ångsågs A.-B.*, Nyadal, with saw-mill at Noraström (B 2).
 22. *Norrviks Ångsågs A.-B.*, Sundsvall, with saw-mill at Gustavsberg (D 3).
 23. *Ramövikens A.-B.*, Sprängsviken, with saw-mill at Ramö (B 2).
 24. *Rö Sågverks Nya A.-B.*, Oringen, with saw-mill at Rö (C 2).
 25. *Salsåkers Ångsågs A.-B.*, with saw-mill at Salsåker (B 3).
 26. *Sandvikens Sågverks A.-B.*, Dynäs, with saw-mill at Sandviken (B 2).
 27. *Sandö Sågverks A.-B.*, Nyadal, with saw-mill at Dal (B 2).
 28. *Skönviks A.-B.*, Skönvik, with saw-mills at Skönvik (C 3), Nacka (C 3), Tunadal (D 3), Matfors (D 1) and also at Stavre and Åsarne (both the last-mentioned in the province of Jämtland), employing a total of 800 workmen in this branch.
 29. *Strands Nya A.-B.*, Sundsvall, with saw-mill at Strand (D 3).
 30. *Strömnäs A.-B.*, with saw-mill at Strömnäs (B 2).
 31. *Ströms Trävaru A.-B.*, Oringen, with saw-mill at Köja (B 2).
 32. *Sunds A.-B.*, Sundsvall, with saw-mills at Sund (C 3) and Nyvik (C 3).
 33. *Svanö A.-B.*, Svanöbruk, with saw-mills at Svanö (B 2) and Ramvik (B 2).
 34. *Sörviks Träexport A.-B.*, Sundsvall, with saw-mills at Sörvik (C 3) and Strandvik (C 3).
 35. *Torpshammars A.-B.*, with saw-mill at Torpshammar (not marked on map).
 36. *Trävaru A.-B. Svartvik*, with saw-mills at Svartvik (D 3), Stockvik (D 3) and Klampenborg (D 3), employing a total of 700 men in this branch.
 37. *Utviks Trävaru A.-B.*, Sundsvall, with saw-mill at Utvik (D 3).
 38. *Wifstavarfs A.-B.*, with saw-mill at Vivstavarv (C 3).
 39. *Viskans A.-B.*, with saw-mill at Viskan (not marked on map).
 40. *A.-B. Ålandsbro Ångsåg*, with saw-mill at Ålandsbro (C 2).

— THE TIMBER INDUSTRIES —

The largest saw-mill enterprises in the province of Gävleborg in order from north to south are as follows: *Ströms Bruks A.-B.*, Strömsbruk, *A.-B. Iggesunds Bruk*, Iggesund, with several saw-mills in different parts of the province, employing a total of over 700 hands, *Adolf Ungers Industri A.-B.*, Lottefors, *Runemo Sägverks A.-B.*, Runemo, *Marma Sägverks A.-B.*, Marma, *Långrörs A.-B.*, Söderhamn, *A.-B. Ad. F. Hillman*, Söderhamn, *Bergvik & Ala Nya A.-B.*, Söderhamn, with saw-mill at Ala, employing over 600 men, *Åsbacka Trävaru A.-B.*, Sandarne, *Ljusne-Woxna A.-B.*, Ljusne, *Kopparbergs & Hofors Sägverks A.-B.*, Ockelbo, with saw-mill at Norrsundet, and also at Näs and Linghed in the province of Kopparberg, employing a total of 700 workmen in this branch, *A.-B. F. Jonson & Co Eftr.*, Ockelbo, and *Korsnäs Sägverks A.-B.*, Gävle, with nearly 800 workmen in this branch.

In Central Sweden, the sawmill industry is, quite naturally, best represented in the extensive forests of Dalarne, Värmland, and parts of Västmanland. In the other provinces of Central Sweden sawmills are to be found here and there, being often working in combination with some other industry, such as iron production, joinery, etc., whilst the Norrland sawmills are seldom associated with any other activity than woodpulp production. The greater part of the central Swedish mills are situated farther up country, in the neighbourhood of railway junctions, or rivers. Many of them mainly supply purely local requirements and are only occasionally in a position to export their products.

In the province of Kopparberg the principal firm is *Stora Kopparbergs Bergslags A.-B.*, Falun, with several saw-mills, one for instance at Skutskär (near Gävle), which is Sweden's largest saw-mill, employing over 1 100 workmen. The following may also be noted: *Trävaru A.-B. Dalarne*, Vansbro, with saw-mills at Vansbro and Mora etc., *Insjöns Sägverks A.-B.*, Insjön, *Bro Ångsdgs A.-B.*, Vansbro, *Harvikens Trävaru A.-B.* and *Siljans Sägverks A.-B.*, both at Mora Noret, *A.-B. Norsbro Sägverksägare*, Leksand, *Klosterns A.-B.*, Långshyttan, with saw-mill at Stjärnsund, and *Backa Sdg- & Tegelverks A.-B.*, Korsnäs.

In the province of Värmland the following may be noted: *Billeruds A.-B.*, Säffle, with five separate saw-mills, employing a total of 500 men, *Uddeholms A.-B.*, Uddeholm, with the Skoghall saw-mill at Karlstad, *Trävaru A.-B. N. Chr. Jensen*, Karlstad, and Tullholmen's saw-mill at Karlstad belonging to *Säfvedns A.-B.*, Stockholm, and also *Säffle Sägverks A.-B.*, Säffle, *A.-B. Rottneros Bruk*, Rottneros, and the saw-mill at Töcksfors owned by *Sannes Söners A.-B.*, Uddevalla.

Among the enterprises which operate saw-mills in other parts of the country those situated in the provinces round Lake Mälaren may be noted first: *Gimo-Österby Bruks A.-B.*, Gimo, with 3 saw-mills in North Uppland, *A.-B. Läby Ångsdg*, Uppsala, *Olsson & Rosenlunds A.-B.*, Stockholm, and *Lundqvist & Huddéns Tegel- and Trävaru A.-B.*, Stockholm, the two latter with several saw-mills in Uppland; also *Backa-Hosjö A.-B.*, Sparreholm, *Forssjö Bruk* and *Forssjö Trävaru A.-B.*, both at Katrineholm, *Brevens Bruk*, Kilsmo, *Skyllbergs Bruks A.-B.*, Skyllberg, *Laxå Bruks A.-B.*, Laxå, *Hasselfors Bruks A.-B.*, Hasselfors, *Hellefors Bruks A.-B.*, Hällefors, *Skinnskattebergs*



Skutskär Sawmill at the mouth of the River Dalälven (Stora Kopparbergs Bergslags A.-B.).

The largest sawmill in Sweden. In the centre of the picture are seen the sawmills and the piles of sawn goods; further to the left the sulphite and sulphate mills; in the foreground workmen's dwellings.

Bruks A.-B., Skinnskatteberg, Ferna Bruks A.-B., Färnabruk, and Surahammars Bruks A.-B., Surahammar. — In the province of Östergötland may be noted Trävaru A.-B., Norrköpings Exporthyfteri, Norrköping, with several saw-mills, Fiskeby Fabriks A.-B., Norrköping, with two saw-mills, and Bozholms A.-B., Boxholm. The largest saw-mill enterprises in the province of Småland are Blankaholms Sägverks A.-B., Skäftet, Solstadströms A.-B., Solstadström, and A.-B. Fogelfors Bruk, Fogelfors.

JOINERY, FURNITURE, AND OTHER WOOD-WARE INDUSTRIES.

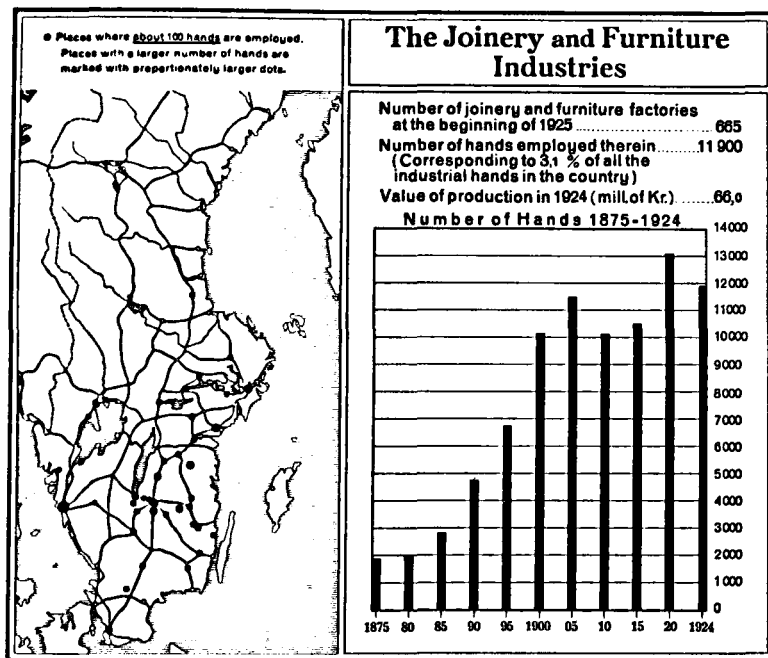
This group of industries — which use sawmill products as their raw materials — has now become of no small importance in Sweden. Their main activities are the manufacture of builders' joinery (doors, window-frames, panels, parquetry flooring material, sectional wooden houses, etc.) and furniture; in addition, there are a number of specialties of minor importance, such as barrels (cooperage), boot-lasts, veneer, etc. The development of these industries, as a whole, is indicated in the diagram on p. 175

giving the number of workers employed in the two principal industries. It has been impossible to separate the manufacture of builders' joinery and that of furniture, as a large number of works are engaged in the production of both. As will be seen from the map, these industries are largely concentrated in the provinces of Småland and Östergötland.

The manufacture of *builders' joinery* on a factoryscale came into being in Sweden in the late 'sixties, but it did not assume considerable proportions until the 'nineties, when a heavy demand arose, particularly in Germany, for builders' joinery. A host of new undertakings grew up and the favourable conditions led to a rapid development, combined with keen competition among the home factories. But with the exception of a temporary increase in 1920, the industry has since progressed more quietly. The annual output of builders' joinery for the last few years has represented a value of from 20 to 25 million kronor. About one-quarter of the production has been exported, mainly to England, South Africa and the Argentine. Ever since its inception, the industry has aimed at mass-production and has been characterized by entirely mechanical methods of production and a high standard of technique. Energetic efforts have been made to attain a well-balanced standardization of the production so as to bring down costs, and secure for the industry increased competitive capacity. During the last few years, parquet flooring material has rapidly come to the fore, and its production is tending more and more to develop into a special branch of the industry.

The joint interests of the Swedish makers of builders' joinery, more especially as regards foreign trade, are looked after by the Swedish Joinery Exporters' Association (Sveriges Snickerielexportförening u. p. a.) in Stockholm.

The principal industrial enterprises engaged entirely, or for the most part, in the manufacture of builders' joinery, are as follows: *Bark & Warburgs Förnyade A.-B.* and *A.-B. Strömman & Larsson*, both in Göteborg, *Trävaru A.-B. Fr. Cöster & Co.*, Uddevalla, and two firms producing ready-made wood-en houses, *Forssjö Trävaru A.-B.*, Katrineholm, and *A.-B. Träkol*, Vansbro. — *Svenska Snickerielexportörernas Försäljnings A.-B.* Stockholm, has charge of the export sales of the following enterprises: *A.-B. Fogelfors Bruk*, Fogelfors, *Westerviks Trävaru A.-B.*, Västervik, *A.-B. Jönköpings Snickerifabrik*, Jönköping, *Hjeltevads Nya Träförädlings A.-B.*, Hjeltevad, *A.-B. Öfverums Bruk*, Överum, *Linde Snickeri- & Trävaru A.-B.*, Lindesberg, etc. Further may be mentioned *A.-B. Vänerns Träförädlingsfabrik*, Lidköping, *Ångsfors Snickerifabrikers A.-B.*, Hovslätt, *Sandhems Trävaru A.-B.*, Sandhem, *A.-B. Rantens Snickerifabrik*, Falköping-Ranten, and *Finnés Snickerifabrik*, Lingbo, and the following situated in their respective towns: *Alingsås Trävaru A.-B.*,



A.-B. KARTOGRAFISKA INSTITUTET

A.-B. Avesta Snickerifabrik, A.-B. Karlstads Snickerifabrik, Kristinehamns Träförädlingsfabrik, A.-B. Norrtälje Snickerifabrik, Uppsala Industrifabrik (Öhrman & Forsberg), Upsala Mek. Verkstads & Snickerifabriks A.-B. and A.-B. Västerås Träförädling and also Snickerifabriken Kondoren at Norrköping. The following may also be mentioned in this connection: Brännlands Nya Träförädlings A.-B., Brännland, Fagersanna Ångsdg, Fagersanna, and A.-B. Ulfsby Snickerifabrik, Ulvsby. The manufacture of parquetry flooring material is a speciality of the following: A.-B. Åtvidabergs Industrier, Åtvidaberg, A.-B. Tannin, Västervik, Limhamns Träindustri A.-B., Malmö, and others.

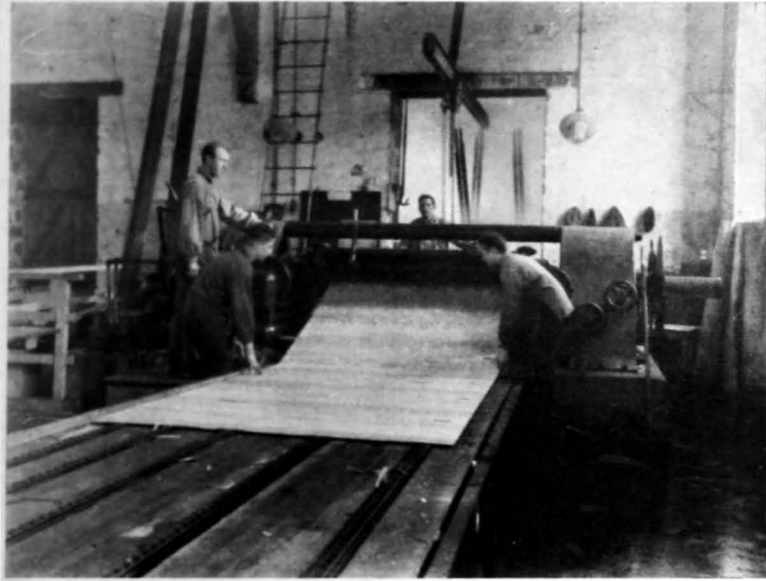
The Swedish *furniture industry* does not date farther back than the 'eighties, for it was not until then that industrial methods of production were introduced into the country. But even at the close of the century, the industrial production differed from the handicraft mainly in its extensive scope. Subsequently a readjustment in the direction of specialization of production took place, and the factories gradually concentrated themselves on the manufacture of limited classes of

— THE TIMBER INDUSTRIES —

furniture, chiefly dining-room, study, and bedroom suites in oak, birch, and deal, and also office furniture, whilst other kinds of furniture were still chiefly made by independent handicraftsmen. The annual values of the output show that this industry was a thriving one until the trade depression came in 1921, when it declined rapidly for a year or two. At the present time, however, it is once more improving. Sweden is favourably situated for the industrial production of furniture, one advantage being the ample and easily accessible supply of raw material. In recent years, furniture manufacturers, by the adoption of improved methods of surface finish, have been able to make a more extensive use of home-grown wood. An investigation has shown that, in point of value, about 85 per cent of the wood used in furniture production is of Swedish origin. Qualitatively, the Swedish furniture industry stands on a very high level, being, in general, second to none as far as solid and well-executed work is concerned. To a very great extent, the models are the work of furniture designers of high artistic merit. The industry suffers, however, from overcrowding and its consequent evils.

The following are the largest industrial enterprises which are occupied, entirely or for the most part, in the manufacture of furniture: *A.-B. Svenska Möbelfabrikerna*, Bodafors, with several factories in various parts of the country, *A.-B. Nordiska Kompaniet*, with workshops in Stockholm and Nyköping, *A.-B. Åtvidabergs Industrier*, Åtvidaberg, *Gemla Fabrikers A.-B.*, Diö, *A.-B. Nässjö Stolfabrik*, Nässjö, and *Oscar Edv. Ekelunds Snickerifabriks A.-B.*, Virserum. The following may also be mentioned: *A.-B. Förenade Möbelfabrikerna*, Linköping, *Tidaholms Bruks A.-B.*, Tidaholm, *A. Selander & Söner A.-B.*, Göteborg, *Trands Möbelfabriks A. B.*, Tranås, *A. B. Nyköpings Ekmöbelfabrik*, Nyköping, *A.-B. Walfrid Svensson & Co.*, Karlstad, *A.-B. Säfte Möbel-fabrik* and *Fabriks A.-B. Bröderna Jakobsson* at Säfte, *A.-B. Th. Linder & Co.*, Eksjö, *A.-B. Gustaf Flinta*, Hedemora, and *A.-B. Hägglund & Söner*, Örnsköldsvik.

Of other industries in the woodgoods group, the first place is held by the *coopering industry*, which has developed out of an ancient handicraft. This industry began to increase greatly during the 'eighties, partly in connection with the rapid growth of the dairy industry, which required an ever-increasing number of casks for butter exports, and partly in consequence of the increased demand from the Bohus fisheries for a rationally conducted mass-production of barrels. The principal products of the industry consist of herring- and meat barrels, butter casks, snuff- and soft-soap kegs, tar barrels, and casks for ferro-alloys, chemical products, etc. In this connection it may be



The turning of deal veneer at the Ljusne Plywood factory (Ljusne-Wozna A.B.).

mentioned that many of the Swedish sawmills produce considerable quantities of barrel staves for export.

The rise and development of the Swedish boot and shoe industry has given birth to a not inconsiderable production of *boot-lasts*. It may be said that the annual production satisfies the home demand; during the last years an export of boot-lasts has grown up.

The manufacture of *plywood* is the most important branch of the veneer industry. Pine plywood (three-ply or five-ply) is mostly used for building purposes, panels, doors, etc.; fir plywood is chiefly an export article for tea and coffee chests and chocolate packing boxes. Birch plywood is employed for more decorative purposes, for chair seats, etc. The advantages of plywood, as compared with deal-boards, are that it does not crack or warp, and that it can be supplied in comparatively large sheets without joints.

The more important and better-known enterprises in the above-mentioned wood-working industries are as follows. The principal barrel factories and cooperies are: *Udderalla Tunnfabriks & Trävaru A.-B.*, *Uddevalle*, and *A.-B. Åstorps Tunnfabrik*,

Åstorp, *Alviks Mek. Tunnbinderi*, Stockholm, belonging to the firm of Lars Montén, of that town. The leading enterprise in the manufacture of boot-lasts is *Svenska Skolästfabriken*, Stockholm, with factories at Järrestad (Kristianstads pr.) and Örebro; further may be mentioned *A.-B. Malmö Skolästfabrik*. — The principal makers of veneer are *Ljusne-Woarna A.-B.*, Ljusne, *Helgums Fabriks A.-B.*, Helgum, *A.-B. Broholms Threeply Fabrik*, Ålem, *A.-B. Bohman & Johansson*, Blomstermåla, *A.-B. Tannin*, Västervik, *Skandinaviska Träimport A.-B.*, Stockholm, *Vimmerby Fanérfabrik*, Vimmerby, and *Edsbyns Träförädlings A.-B.*, Edsbyn.

Finally, with regard to other special branches of the woodgoods industry, it need merely be said that the manufacture of *box-boards* and *packing cases* has assumed substantial proportions in Sweden, being represented not only by the box-board production for export engaged in by the sawmills, already referred to above, but also by the output of mills specializing in box-board production. The manufacture of *frame mouldings* is carried on by some ten firms in Sweden, to an extent which just about covers the home demand. The production of *cotton spools* and *bobbins* for the home and foreign markets is now also a Swedish industry of some note. Other specialties in the woodware class are *cart-wheels*, *tool-handles*, *sporting goods* and *toys*, *perambulators*, *basket-ware* and *wood-wool*.

Box-boards are made by the majority of the larger saw-mills. Among the factories which specialize in the manufacture of boxes the following may be noted: *Särfvedns A.-B.*, Stockholm, *Färjenäs A.-B.*, Göteborg, *A.-B. Strömman & Larsson*, Göteborg, *Trävaru-A.-B. Dalarne*, Vansbro, and *A.-B. Nässjö Låd-fabrik*, Nässjö. — Among frame moulding factories the following may be mentioned: *A.-B. Ferm & Perssons Förgylleri-etablissement*, *A.-B. Göteborgs Guldlistfabrik* and *Förenade Guldlistfabrikernas A.-B.*, all at Göteborg, *A.-B. Exportlist*, Nyköping, *J. A. Edenholm*, Gustafs, *A.-B. Sjögren & Ahlberg*, Stockholm, and *A.-B. Svenska Guldlistfabriken*, Karlstad. — Bobbins are made by following firms: *A.-B. Splintfabriken*, Vara, and *Tostarps Träförädlings A.-B.*, Uddebo; cart-wheels by *A.-B. Åtvidabergs Industrier*, Åtvidaberg, and *A.-B. Hjul- & Parkettfabrikerna*, Hanaskog, and tool-handles by *A.-B. Arvika Redskapsfabrik*, Arvika, and *Stockamöllans A.-B.*, Stockamöllan. Among makers of sporting goods and toys the following may be mentioned: *Gemla Fabriker A.-B.*, Diö, and *A.-B. Gemla Leksaksfabrik*, Gemla, *A.-B. A. W. Nilssons Fabriker*, Malmö (especially perambulators and basket goods), *A.-B. Västerds Träförädling* and *Bröderna Sandströms Skidfabrik*, Stockholm. Cigar-boxes are made by *Pehr Fricks Fabriker A.-B.*, Malmö, wooden fittings and frames by *Reiners Ramfabrik & Konstindustri*, Mjölby.

THE CORK INDUSTRY. In close connection with the woodgoods industry there is the production of cork goods, which has been carried on in Sweden for a long time, chiefly in the form of the manufacture of bottle-corks. This was formerly a handicraft, but to-day it

— THE TIMBER INDUSTRIES —

is done almost exclusively by ingenious bottle-cork machines. The raw material is cork-bark imported mainly from the cork-tree forests of Spain and Portugal. Out of cork-bark there are also made swimming- and life-belts, floats, boot-soles and hat-linings; while cork-clippings are compressed into insulating material against heat and cold. A subsidiary to the cork industry is the manufacture of linoleum, the bulk of the raw material of which is ground cork.

The principal enterprise in this branch is *A. B. Wicanders Korkfabriker*, Stockholm, with factories both in Stockholm and in Göteborg, as well as in several places abroad. Further may be mentioned *Nya Korkfabriken* (proprietor Herman Mårtensson) and *Korkindustriolaget Harald Schröder & Co.*, both in Stockholm.

Linoleum is made by *Linoleum A. B. Forshaga*, Göteborg.





THE PAPER AND PRINTING INDUSTRIES.

THE WOODPULP INDUSTRY.

One of the most characteristic features of the economic development of Sweden during the last few decades has been the wonderful expansion of the woodpulp industry. This industry has grown in less than fifty years from insignificant beginnings into the second largest Swedish export industry.

As early as the middle of the eighteenth century the Swedish paper-mills began to suffer from a shortage of linen rags for paper-making. This led to some drastic legislation intended to remedy the difficulty; but, in the hundred years that followed, the demand for raw material for paper steadily increased until, in the 'fifties, quite a paper famine set in. The newspaper press in particular clamoured for more and cheaper paper, which made the situation difficult. Then came the discovery, by KELLER, of a method of making paper from wood. By grinding wood to pulp he succeeded in 1844 in releasing the wood fibres and in producing paper from these. A few years later another method was found out in America of liberating the fibres by chemical action. Continued efforts to obtain woodpulp in this manner led to the invention of the so-called sulphate and sulphite methods, the credit of developing the latter of these being chiefly due to a Swedish engineer, CARL DANIEL EKMAN. Thanks to his indomitable energy he succeeded in 1873, after many years of untiring experiments, in producing sulphite pulp, the commercial production of which was begun the following year at the Bergvik mills in the province of Gävleborg. This was the beginning of the sulphite pulp industry, which has become of such special importance to Sweden.

The method of manufacturing mechanical woodpulp is briefly as follows: The stripped log is ground on rotating grindstones while

— THE PAPER AND PRINTING INDUSTRIES —

water is poured over it, thereby producing a thin pulp that is afterwards freed from coarser particles; the water is then run off and the pulp is pressed between rollers into thick sheets, which are made up into bales. Mechanical pulp is marketed either as wet pulp, containing about 50 per cent of water, or as dry mechanical pulp, in which, by a special drying process, the percentage of water has been reduced to 10 per cent. If, before grinding, the wood is softened by steam, a brown pulp is obtained, which has longer and softer fibres; on account of its colour however it is only suitable for the manufacture of dark wrapping paper, cardboard, etc.

Chemical woodpulp, or cellulose, is obtained by boiling under pressure barked wood-billets together with various chemicals, the wood being thereby disintegrated and the fibres separated. The boiling is effected by steam, in erect or horizontal boilers of considerable dimensions. In sulphate-boiling, a mixture of certain alkalis (soda and sodium sulphate) is employed; sulphite-lye, on the other hand, consists of a solution of sulphurous acid and calcium bisulphite, which is passed through acid-towers, often of as much as 40 metres in height. If the boiling is of longer duration and under slighter pressure, so-called "kraft"-pulp is obtained, from which the well-known Swedish kraft-paper is made. After boiling, the knots and other lumps are removed, and then the pulp is pressed into sheets, dried and, if desired, bleached. The chemical pulp is usually sold "air-dry", i. e., containing 8—12 per cent of moisture.

In making sulphate pulp, both pine and fir may be employed, but the sulphite pulp industry can use only fir, as pine contains too much resin.

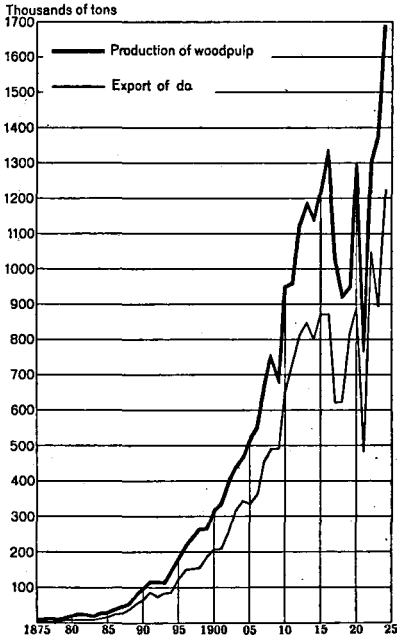
The first mechanical pulp mill in Sweden was built in 1857. At the beginning of the 'seventies about ten such mills were in operation, but it was not until a decade later that the mechanical woodpulp industry began to forge ahead. In the 'nineties interest centred more and more on the chemical method of production, and the result was a period of prosperity for the cellulose mills. The sulphite industry secured the greater share of this success, but the sulphate mills have, neverthe-



Carl Daniel Ekman.
b. 1845 d. 1904

— THE PAPER AND PRINTING INDUSTRIES —

less, also gone rapidly forward, thanks to their ability to utilize saw-mills' refuse and low-grade timber. The extraordinarily rapid development of the woodpulp industry, temporarily interrupted by the after-effects of the Great War, is shown by the accompanying graph of the movements in production and exports for the years 1875—1924. In a



general way the same movements may be followed in the diagram on p. 184, showing the variations in the number of workers employed.

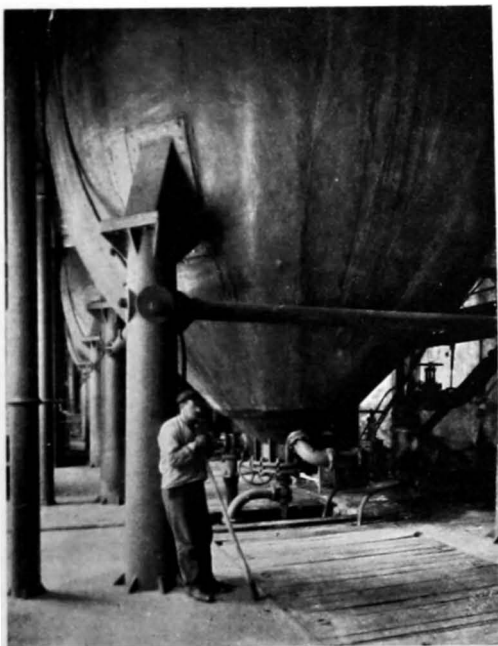
The value of the Swedish woodpulp exports, which comprise about 75 per cent of the production, has, for the last few years, amounted to about 200 million kronor, or 17 per cent of the total value of Swedish exports. Sweden is the third largest woodpulp-producing country in the world, only the U. S. A. and Canada being ahead; and its exports are greater than those of either of those countries. In spite of its own vast production, the U. S. A. is the principal buyer of Swedish woodpulp, Great Britain comes next, and considerable quantities go to France, Spain, Italy and other European countries, and

markets do in fact exist for it in every quarter of the globe.

A new field for exploiting cellulose has arisen by the discovery during recent years of its extreme suitability for the manufacture of artificial silk.

An important problem for the chemical woodpulp industry is the utilization of the valuable constituents of the waste lyes. In sulphite production only about half of the wood-pulp is utilized in the form of cellulose; the remainder was run off with the waste lyes, incidentally polluting the rivers. Intense scientific research has, however, been in progress for years with a view to solving this problem, and to-day several bye-products are utilized, the most important being resin and turpentine in the sulphate industry and ethyl-alcohol in the sulphite. This latter is termed sulphite spirit, a product

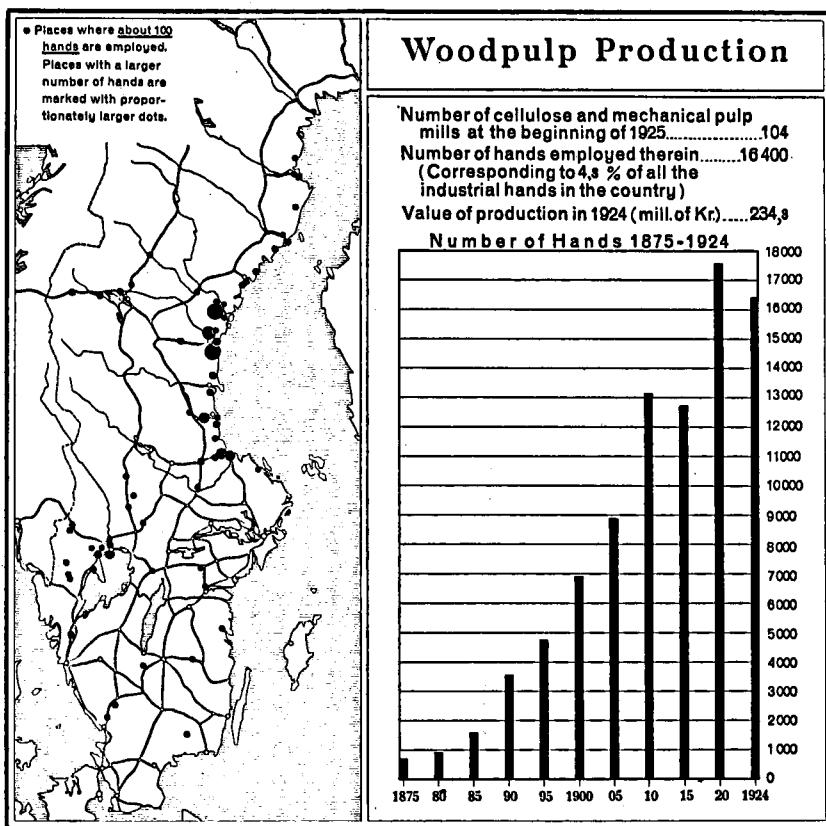
which will probably come into extensive use as a motor-fuel, for which purpose it is mixed with petrol. The objections formerly raised by the temperance party against the general use of sulphite spirit as motor-fuel have now to a great extent been removed, since the discovery of a suitable means of rendering the spirit non-potable by the admixture of croton aldehyde. Sulphite spirit is produced by the purification of the lyes, and the subsequent fermenting and distillation of the product pretty much by the same methods as those employed in ordinary distilleries. The production has not, as yet, attained large proportions (in 1924, about 3 million litres of 96—99% spirit); but distillation plants have now been erected at 22 cellulose mills in Sweden, with a total annual capacity of about 20 million litres of sulphite spirit. Finally, it may be pointed out, that in recent years the waste-lyes have come into use as a road surface material, in consequence of their dust-laying properties.



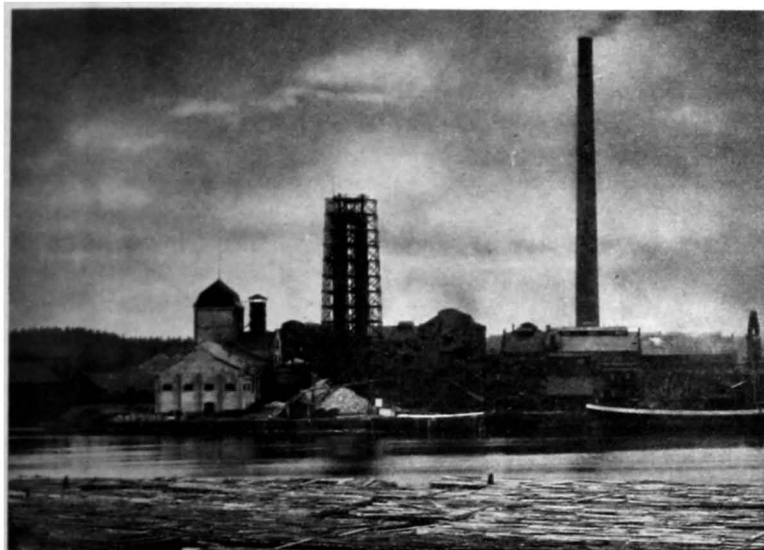
Sulphite-boiler at Karskär (Korsnäs Sågverks A.-B.).

But many more means of utilizing these waste-lyes will probably be discovered in the future.

Two organizations intimately co-operating with each other have been founded for the purpose of promoting and safeguarding the interests of the woodpulp industry, viz., the Swedish Cellulose Association (Svenska Cellulosaföreningen) and the Swedish Woodpulp Association (Svenska Trämasseföreningen), both with their headquarters in Stockholm. The former represents the chemical pulp industry, and the latter the mechanical.



The following are the most important enterprises in Norrland: In the provinces of Norrbotten and Västerbotten: *Munksunds A.-B.*, Luleå, with sulphate mill at Munksund and pulp-grindery at Byske, *A.-B. Scharins Söner* with pulp-grinderies at Skellefteå and Umeå, *Öhrvikens A.-B.*, with sulphite mill at Kallholmen, *A.-B. Robertsfors*, with sulphite mill at Robertsfors, and *Holmsunds A.-B.*, with sulphate mill at Obbola; in the pr. of Västernorrland (see map on p. 170): *Mo & Domsjö A.-B.*, Härnösand, with sulphite mills at Hörnefors and Domsjö and sulphate mill at Husum, *Kramfors A.-B.*, with sulphite mill at Kramfors and sulphate mill at Frånö, *Wäfstavarfs A.-B.*, with sulphite mill at Fagervik and sulphate mill at Wäfstavarf, *Skönviks A.-B.*, with sulphite mill at Ortviken and pulp-grindery at Matfors (the last four large companies each employ over 500 men in this branch), *Fors A.-B.*, with sulphite mill at Köpmanholmen, *Graningeverkens A.-B.*, with pulp-grindery at Forsse, *Björkd A.-B.*, with pulp-grindery at Hallstanäs, *Dynäs A.-B.*, with sulphate mill at Väja, *Svanö A.-B.*, with sulphite mill at Svanö, *Nensjö Cellulosa A.-B.*, with sulphate mill at Sprängsviken, *Utansjö Cellulosa A.-B.*, with sulphite mill at Utansjö, *Sunds A.-B.*, with sulph-



The Iggesund Sulphite and Sulphate Mills in Hälsingland (A.-B. Iggesunds Bruk).
In the centre, the acid tower, where the sulphite boiling lye is prepared. The tower to the left belongs to the sulphite-spirit plant.

ite mill at Söråker, *Trävaru A.-B. Svartvik*, with pulp-grindery at Sörfors and sulphite mill at Svartvik, *Nyhamns Cellulosa A.-B.*, with sulphite mill at Nyhamn, *Torpshammars A.-B.*, with pulp-grindery at Torpshammar and *Sundsvalls Cellulosa A.-B.*, with sulphite mill at Essvik; in the province of Jämtland: *Häfreströms A.-B.*, with sulphite mill at Ulriksfors, *A.-B. Tegefors Verk*, with sulphite mill at Järpen, *Hissmofors A.-B.*, with sulphite mill at Krokomb, *Äggfors A.-B.*, with pulp-grindery at Mörsil, and *Högbroforsens Industri A.-B.*, with pulp-grindery at Häggenås; and in the province of Gävleborg: *Bergvik & Ala Nya A.-B.*, with sulphite mill at Bergvik and sulphate mill at Sandarne, *Korsnäs Sägverks A.-B.*, with sulphate as well as sulphite mills at Karskär (the two last-named companies each employ over 500 men in this branch), *Ströms Bruks A.-B.*, with sulphite mill at Ström, *A.-B. Iggesunds Bruk*, with sulphate and sulphite mills as well as pulp-grindery at Iggesund, *Adolf Ungers Industri A.-B.*, with pulp-grindery at Lottefors, *Bergfors A.-B.*, with pulp-grindery at Bergfors, *Sulfit A.-B. Ljusnan*, with sulphite mill at Vallvik, *Kopparbergs & Hofors Sägverks A.-B.*, with sulphate mill at Norrsundet, *Mackmyra Sulfit A.-B.*, with sulphite mill at Mackmyra and *Storriks Sulfit A.-B.*, with sulphite mill at Storvik.

In the province of Kopparberg the following enterprises may be noted: *Stora Kopparbergs Bergslags A.-B.*, Falun, which, besides the sulphite mill and pulp-grindery belonging to Kvarnsvedens paper-mill, own sulphite and sulphate mills at Skutskär

— THE PAPER AND PRINTING INDUSTRIES —

(prov. of Upsala), employing 600 workmen, *Trävaru A.-B. Dalarne*, with pulp-grindery at Eldforsen, *Wikmanshytte Bruks A.-B.*, with sulphite mill at Turbo and *A.-B. Fors Bruk*, with sulphite mill at Östanfors.

Whilst the majority of the great exporting undertakings in the Swedish woodpulp industry are situated in the northern part of the country, there are pulp-mills in central and southern Sweden, but they are mostly combined with paper-mills, which convert the whole or the greater part of the pulp-output into the finished article paper. The more important woodpulp mills, situated south of Dalarne, the production of which are wholly or partly sent out in the market, are as follows:

In the province of Värmland: *Billeruds A.-B.*, Säffe, employing over 1,000 men in this branch at five pulp grinders, one sulphate and four sulphite mills in different parts of the province, *Uddeholms A.-B.*, employing over 700 men in this line at sulphite and sulphate mills at Skoghall, *A.-B. Mölnbacka-Trysil*, with sulphite mill at Klarafors, pulp grindery at Mölnbacka and sulphite mill at Forshaga (this belongs to the sister company *Forshaga Sulfit A.-B.*), pulp grindery at Dejefors (belonging to the sister company *Dejefors Kraft och Fabriks A.-B.*) and pulp grinders at Frykfors and Edsvalla (belonging to the sister company *Frykfors A.-B.*). The following may also be mentioned here: *A.-B. Kroppsstadfors Bruk*, with pulp grindery at Noreborg and Kroppsstadfors, *A.-B. Rottneros Bruk*, with pulp grindery at Rottneros, *A.-B. Edsvalla Bruk*, with sulphite mill at Edsvalla, *Kohlsäters A.-B.*, with pulp grindery at Kohlsäter, *Lennartsfors A.-B.*, with pulp grindery at Lennartsfors and *Adolfsfors A.-B.*, with pulp grindery at Adolfsfors. — In the province of Älvsborg the following may be mentioned: *Bengtssfors Sulfit A.-B.*, with sulphite mill at Bengtssfors and *A.-B. Upperruds Trämassefabrik*, with pulp grindery at Upperrud, *Sulfit A.-B. Göta*, with sulphite mill at Göta and *Ljungaskogs A.-B.*, with pulp grindery at Svenljunga; and in the province of Skaraborg: *Forsviks A.-B.*, with pulp grindery at Forsvik. In the province of Stockholm may be noted: *Forsmarks Bruk*, with sulphate mill at Forsmark; in the province of Örebro: *Hellefors Bruks A.-B.*, with sulphate and sulphite mills at Annefors and pulp grindery at Hällefors, *Laxå Bruks A.-B.*, with sulphite mill at Laxå and *Rockhammars Bruks A.-B.*, with pulp grindery at Rockhammar; in the province of Jönköping: *Ohs Bruks A.-B.*, with sulphite mills at Habo and Ohs, *Nissafors Träsliperi (G. Lord & Co.)*, with grindery at Nissafors, and *Rydö Bruks & Fabriks A.-B.*, with sulphite mill at Rydöbruk; in the province of Kalmar: *Eds Cellulosafabriks A.-B.*, with sulphate mill at Edsbruk; in the province of Kronoberg: *Konga A.-B.*, with sulphite mill at Konga, and *A.-B. Bökscholms Sulfitfabrik*, with sulphite mill at Åsheda; and in the province of Halland: *Oskarström Sulphite Mills A.-B.*, with sulphite mill at Oskarström.

PAPER PRODUCTION.

The manufacture of paper in Sweden has been carried on for almost four hundred years. The industry may be regarded as the

— THE PAPER AND PRINTING INDUSTRIES —

twin-brother of the printing craft. During the above-mentioned period the conquest of the world by the printed word has led to a growing demand for paper and a consequent rapid development of the paper-making industry.

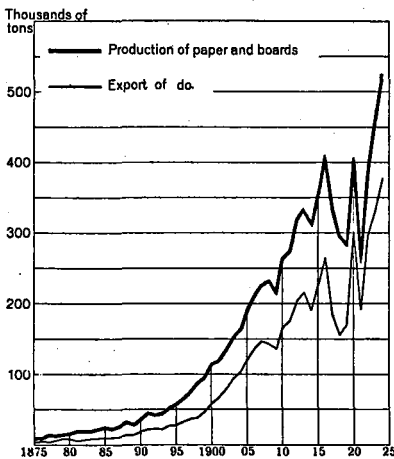
The difference between olden times and our own is so great that modern paper production cannot be said to go farther back than the time when the paper-making machine came into use, and woodpulp was first utilized as a raw material. Although the first paper-machine in Sweden was set up as early as 1832, and mechanical woodpulp came into use in 1857, it was not until the 'eighties that a general transition took place at the more enterprising mills to an up-to-date production of paper, aided by modern technical improvements. Simultaneously, many of the smaller mills were closed down, so that the total number of paper-mills, which about the middle of last century exceeded 80, had declined at the close of the 'eighties to about half that number, to rise again, in our own time, to nearly the above-mentioned figure. In the course of its development, the paper industry has become divided into two somewhat different branches, viz., the fine paper mills, manufacturing chiefly writing, drawing and book paper, and those mills which produce wrapping and newsprint paper.

The production of wrapping paper, newsprint and cardboard dominates the Swedish paper industry. Of the various classes of wrapping paper may be noted the well-known Swedish kraft paper, which is made of partially boiled, and then ground sulphate cellulose. Newsprint paper is usually manufactured of 75—80 per cent mechanical pulp and 25—20 per cent unbleached sulphite cellulose. Among the boards produced may be specially mentioned pulp-boards, building boards, roofing boards, carpet-lining and leather boards.

The fine-paper production embraces writing, drawing and book papers both of the best and of the medium qualities. The most important is the "wood-free" paper, by which is meant such as contains no mechanical woodpulp. "Normal" paper is paper complying with certain fixed standards for official documents; it is made in four qualities and each sheet must be water-marked with the name of the makers and the words "Svenskt normal", as well as particulars of quality and year of production. Water-marks as a guarantee of quality are of old standing; they are made by means of raised or impressed designs in the moulds for hand-made paper, and on a special roller in the paper-machine for machine-made paper. In addition to the classes of paper

above referred to, there are also made in Sweden a large number of special papers, such as tissue paper, blotting paper, impregnated paper, wallpaper, etc.

Before the employment of woodpulp as a raw material, the Swedish paper industry produced almost exclusively for the home market. The paper industry expanded with the rise of the woodpulp industry, and its position as a staple industry may be said to have begun early in the present century. The vigorous development which — apart



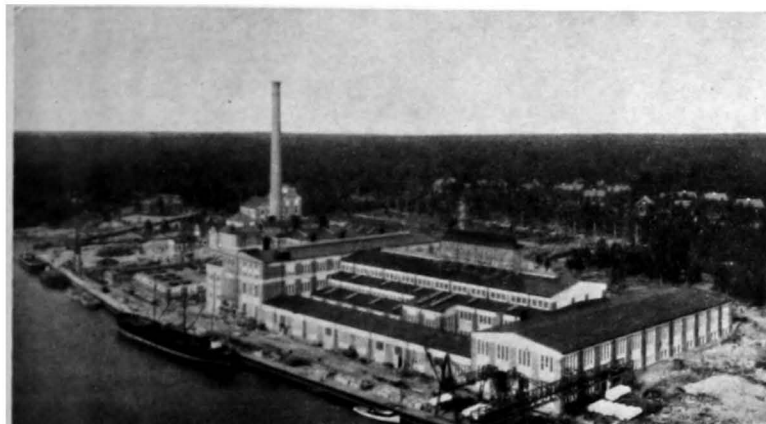
from temporary setbacks during the war and other crises — has characterized both production and export during the fifty-year period 1875—1924 is shown by the appended graph. Of the 524,000 tons produced in the latter year, no less than 383,000, or 73 %, were exported. The value of these exports was 123 million kronor, representing 10 per cent of the total exports of the country. About one half of the export value is made up of wrapping paper, and one-third of newsprint. Next to Canada, Sweden is held to occupy the leading position

among the paper-exporting countries of the world. Swedish paper is shipped to almost every part of the globe, the chief markets being England, U. S. A., Japan and France.

Imports of paper and boards are small, and consist chiefly of fine paper, such as note, writing and extra quality paper, photographic paper, etc.

The Swedish paper industry has long enjoyed an excellent reputation, and stands at present on a very high level, from both a technical and an administrative point of view. It stands in intimate connection with the woodpulp industry; to-day, the bulk of the paper mills obtain their pulp from their own pulp mills. As yet there is no such collaboration between these industries and the printing and bookbinding trades. Fruitful co-operation between Swedish machine shops has succeeded in considerably reducing the former ascendancy of foreign makers of the necessary machinery. Altogether, there would

— THE PAPER AND PRINTING INDUSTRIES —



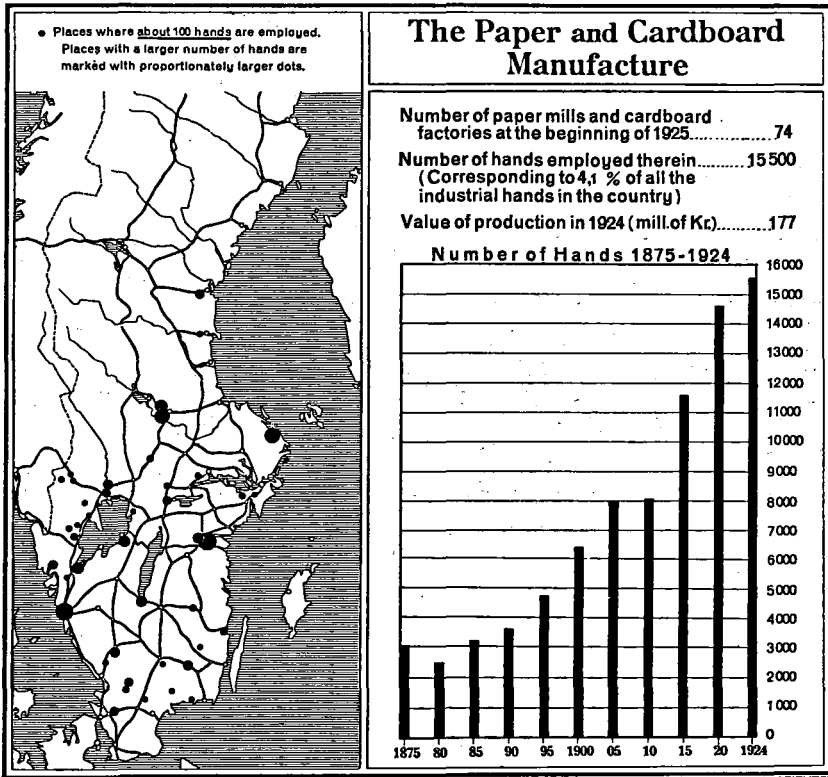
The Hallsta Paper Mills, in north-east Upland (Holmens Bruks- & Fabriks A.-B.). One of the two largest paper mills in Sweden, driven by electric power from the Älvkarleby Falls. The annual output is more than 50,000 tons of newsprint paper.

seem to be every reason to expect a continued favourable development of this industry, which is of such great national economic importance to Sweden.

Most of the paper mills are situated in central and southern Sweden. As will be seen by the map on p. 190, the largest centres are Norrköping and district, Kvarnsveden and Grycksbo in the prov. of Dalarne, Hallstavik in Upland and Göteborg and vicinity. It would, of course, be of great economic advantage if the paper manufacture could be carried on, on a larger scale than hitherto, at the woodpulp mills in Norrland.

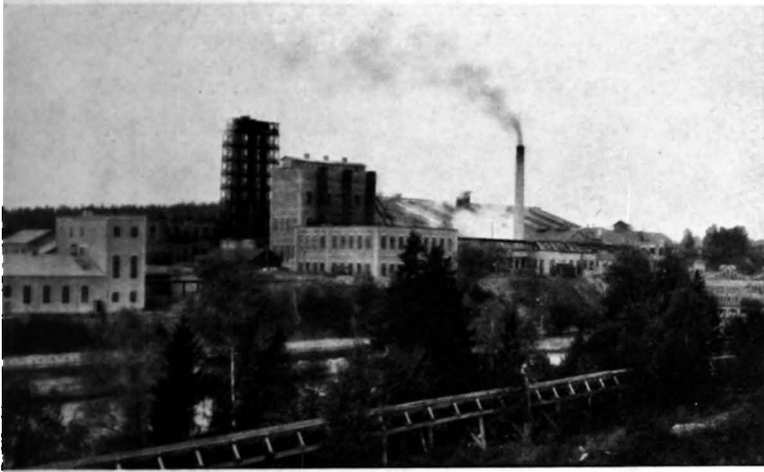
To look after the joint interests of the paper industry the Swedish Paper Mills Association (Svenska Pappersbruksföreningen) was founded in 1898 in Stockholm. This association publishes a trade journal for the paper industry, the "Svensk Papperstidning". It has also done valuable work in co-ordinating selling regulations in the paper industry, and in unifying price quotations for certain uniform qualities of paper. — Three mills making fine paper have a joint selling organization — the "Finpappersbrukens Försäljnings A.-B.", Stockholm.

The following enterprises are usually reckoned among the fine-paper mills: *A.-B. Papyrus*, Mölndal, *J. H. Munktells Pappersfabriks A.-B.*, Grycksbo, *Lessebo A.-B.*



Lessebo, A.-B. Klippans Finpappersbruk, Klippan, Munkedals A.-B., Munkedal (which also makes boards), A.-B. Brusafors-Hällefors, Lönneberga, Gransholms A.-B., Gemla, and Tumba Pappersbruk, Tumba.

Of the coarse-paper mills the following are the principal: *Holmens Bruks- & Fabriks A.-B.* manufacturing newsprint at Hallstavik and also wrapping paper, printing paper and newsprint at Norrköping, *Stora Kopparbergs Bergslags A.-B.* with works for newsprint and wrapping paper at Kvarnsveden, *Fiskeby Fabriks A.-B.*, Norrköping (boards, newsprint and printing paper) with mills at Skärblacka, Fiskeby and Ljustfors, A.-B. *Mönbacka-Trysil*, Forshaga (wrapping paper), with mills at Deje and Klarafors, *Munkajö A.-B.*, Jönköping (boards and wrapping paper), *Vargöns A.-B.*, Vargön (newsprint and wrapping paper), and *Katrinefors A.-B.*, Mariestad ("match-paper"); each of the above-mentioned enterprises employs over 500 men in this branch. Among the coarse-paper mills the following may be mentioned as makers of wrapping paper and newsprint: *Billeruds A.-B.*, with paper-mills at Billerud, Brättne and Jössefors, *Skönviks A.-B.*, with paper-mill at Matfors, A.-B. *Billingsfors-Länged*, with paper-mills at Billingsfors and Länged, *Häfreströms A.-B.*, Häverud, with paper-mills at



The Kvarnsveden Paper Mills, Dalarne (Stora Kopparbergs Bergslags A.-B.).
One of the two largest paper mills in Sweden. Embraces a pulp-grindery, a sulphite mill and a sulphite spirit plant. Annual production of paper 60,000 tons.

Håvernd and Åsen, and *A.-B. Nykvarns Bruk*, Nykvarn; two more chiefly or solely manufacture newsprint, viz.: *Östana Fabriks A.-B.*, Glimminge, and *A.-B. Tollare Pappersbruk*, Stockholm, and two manufacture boards as well as wrapping paper, viz.: *Örebro Pappersbruks A.-B.* and *Lagamills A.-B.*, Timsfors.

Of the remaining enterprises which principally make wrapping paper the following may be noted: *Hylte Bruks A.-B.*, Hyltebruk, *Strömnäs Bruks A.-B.*, Strömnäs, *A.-B. Emfors Bruk*, Påskallavik, *Lilla Edets Pappersbruks A.-B.*, Lilla Edet, *Nyboholms A.-B.*, Nyboholm, *Pauliströms Bruk*, Järforsen, *Göteborgs Pappersbruks A.-B.*, *A.-B. Göteborg-Dals Pappersbruk* and *Gamlestadens Pappersbruks A.-B.*, all three at Göteborg, *Fengersfors Bruk (J. Fenger-Krog)*, Tösse, *Gustafsfors Fabriks A.-B.*, Skåpafors, *Koppoms Pappersfabriks A.-B.*, Åmotfors, *Åmotfors Pappersbruks A.-B.*, Åmotfors, *Bäckhammars Nya A.-B.*, Värmlands-Björneborg, *Hånsfors Bruk*, Töcksfors (owned by Sannes Söners A.-B., Uddevalla), *A.-B. Stjernfors-Ställdalen*, Ställdalen, *Frövifors Bruks A.-B.*, Frövi, *Sörstafors Pappersbruk*, Kolbäck, belonging to the Surahammars Bruks A.-B., and *Dynäs A.-B.*, Väja.

Boards are manufactured at those of the above-mentioned mills, where special attention has been drawn to the fact, and by the following enterprises: *Fridafors Fabriks A.-B.*, Fridafors, *Djupafors Fabriks A.-B.*, Djupadal, *Alstermo Bruks A.-B.*, Målerås, *A.-B. Finsjö Pappersbruk*, Finsjö, *Qvills Bruks A.-B.*, Kvillefors, *Långasjönäs Pappersbruk*, Kisa, *Nissaströms A.-B.*, Halmstad, *Marbücks Fabriks A.-B.*, Marbäck, *Inlands Nya Pappfabriks A.-B.*, Lilla Edet, *Kohlääters A.-B.*, Värmlands Nysäter, *Forshaga Sulfit A.-B.*s mill at Ransberg, *Oppboga A.-B.*, Fellingsbro, and *Forsså Bruks A.-B.*, Näsvisken.

The manufacture of *vulcanized fibre* is a special industry, closely related to paper-making and using cotton rags as raw material. The paper obtained from this is treated with certain chemicals, whereby a viscid cellulose is formed, which, at high pressure and temperature, binds the layers of paper inseparably together. The number of layers of paper depends on the thickness of vulcanized fibre desired. The product, when finished, has a horny consistence, and is made in sheets with a thickness of from 0.1 mm. to 35 mm. In consequence of its strength, elasticity and lightness, it is used in the manufacture of travelling requisites, packings, cog-wheels, etc. Vulcanized fibre is also used with advantage as an electric insulating material.

Vulcanized fibre and products thereof are made by *A.-B. Tidan*, Mariestad.

THE PRINTING AND STATIONERY INDUSTRIES, ETC.

In Sweden the art of printing was first practised in 1483. The earliest book printed in Swedish, bearing the title "*Aff dyäfwlsens frästelse*" ('Of ye temptacions of ye devil'), was produced by a Stockholm printer and bears the date 1495. Before that, however, a number of letters of indulgence had been printed in Swedish. In the early part of the 16th century, various books for ecclesiastical use, school-books, legends, etc., were printed at Upsala; and in 1523 the famous Bishop Brask established a printing shop at Söderköping, which, however, was closed a few years later by order of King Gustavus Vasa, who considered that it adversely affected the success of a rival printing establishment which, "at great expense", had been founded in Stockholm in 1525. During the 17th century printing-works sprang up at Västerås, Strängnäs, Kalmar, Linköping, Nyköping, Lund, and other Swedish towns, and by the middle of the following century there were 18 printing establishments in Sweden, a number which, by the beginning of the 19th century, had risen to 50.

The increasing demand, in the progress of civilization, made for the "printed word", and the great technical advances of the past century have brought about a tremendous development of the printing trade in the last hundred years. In 1896 — the first year in which statistical records of the printing trade were kept — there were in Sweden 287 book-printers and block-makers, employing 5,800 hands. At the

beginning of 1925, the number both of establishments and of employees had almost doubled, there being at that date 542 printing-works employing about 11,000 people and 3,700 printing presses.

The printing trade has long been centred in the towns as, by the Press Laws, printing-works might only be established in towns or within a radius of 3 miles from a town, or in boroughs. For various reasons the printing-works have to a great extent been concentrated in Stockholm, where at present about one-half of the printing operatives in Sweden are employed. Next in order as centres of the printing trade come Göteborg, Malmö, Upsala and Norrköping.

The industrial and commercial improvement during the 'eighties led to a greatly increased demand for packings, and side by side with the printing industry, a special industry grew up for the manufacture of cartons, boxes, paper bags and envelopes. The development of this new industry was considerably helped by the decline in paper prices just at the time and by the growing employment of wood as a raw material in the production of paper. The manufacturing processes of this industry consist chiefly in the cutting, scoring, folding and mounting of paper and cardboard and, in a lesser degree, of printing. It is closely connected with the bookbinding industry, and has, in part, become amalgamated with the latter. To begin with the methods of manufacture were somewhat primitive, but they have gradually been highly modernized by the adoption of technical improvements. This development is in no small measure due to the concentration and specialization brought about by numerous enterprises affiliated into a large Company (A.-B. Sveriges Litografiska Tryckerier). The number of factories and works in this industry amounted at the beginning of 1925 to 150, of which 113 were bookbinding establishments and box factories, and 23 paper-bag and envelope makers, employing altogether about 4,600 hands, two-thirds of whom were women or girls.

The paper manufacturing industry also includes the production of corrugated paper and board which is mainly turned into boxes of various sizes, used for packing purposes instead of wooden boxes.

The Swedish printing trade makes great demands on technical skill and cultural insight. Swedish art-printing, lithographic work and bookbinding have gained ample recognition for their artistic merit even outside the country. Newspaper printing is also marked by its superior work, which is far in advance of that of the average foreign press. It may be said, therefore, that the Swedish printing trad

worthily carries out its task as a promoter and disseminator of intellectual development.

The Swedish Bookprinters' Association (Svenska Boktryckareföreningen), Stockholm, is the spokesman of this industry. The Association aims at the improvement of the industry, and at the application of sound economic principles in contractual relations in the trade.

The largest printing and paper-manufacturing enterprises in Sweden are *A.-B. P. A. Norstedt & Söner*, Stockholm, and *Lithografiska A.-B.* at Norrköping, each employing about 500 hands, *A.-B. Centraltryckeriet* (printers) and *A.-B. P. Herzog & Söner* (principally book-binding), both in Stockholm and each employing about 400 hands. Of the remaining firms in this branch, the following may be noted. Stockholm: *Iduns Tryckeri A.-B.*, *A. Börtzells Tryckeri A.-B.*, also proprietors of an important lithographic establishment, *Svenska Tryckeri A.-B.*, *Isaac Marcus' Boktryckeri A.-B.*, *Victor Pettersons Bokindustri A.-B.*, *Normans Bokbinderi A.-B.*, *Stockholms Kartong- & Litografiska A.-B.*, *Ivar Hæggströms Boktryckeri- & Bokförlags A.-B.*, *A.-B. Hasse W. Tullberg*, *K. L. Beckmans Boktryckeri*, *Bröderna Lagerström A.-B.*, *A.-B. Egnellska Boktryckeriet*, *Wille Hedbergs Tryckeri A.-B.*, the book-binding firm of *Gust. Hedberg* and *N. Bernh. Anderssons Bokbinderi A.-B.* In Göteborg: *Wald. Zachrissons Boktryckeri A.-B.*, *Göteborgs Litografiska A.-B.*, *Gustaf Melins A.-B.* (book-binding), *Elanders Boktryckeri A.-B.*, *N. J. Gumperts Pappershandel* (office books) and *A.-B. John Antonsons Boktryckeri*. At Uppsala: *Almqvist & Wiksells Boktryckeri A.-B.* and *Edv. Berlings Nya Boktryckeri A.-B.* At Malmö: *Skånska Litografiska A.-B.*, *Az. Seiersen & Co* and *A.-B. Köhnkes Kartongfabrik*. In other places: *A.-B. J. O. Öberg & Son* (lithographic productions and playing cards) at Eskilstuna, *Johnssons Pappersindustri A.-B.* at Hälsingborg, *Berlingska Boktryckeri & Stilgjuteri A.-B.* at Lund, *Jönköpings Litografiska A.-B.*, *Jönköping, Linköpings Litografiska A.-B.*, *Linköping, Skriv- & Ritboks A.-B.* at Arlöv, *Johnson & Hill* at Örebro, *A.-B. Sydsvenska Biljettryckeriet*, *Landskrona, A.-B. Sture Ljungdahl & Co.*, *Nybro, Lilla Edets Pappersbruks A.-B.*, *Lilla Edet* (bags) and *Alingsås Industri A.-B.*, *Alingsås* (bags). — In conclusion a few of the more important publishers, who entirely or partly have their own printing works, may here be mentioned, viz. the above-mentioned firm of *A.-B. P. A. Norstedt & Söner*, the firm of *Albert Bonnier* and *Åhlén & Åkertunds Förlags A.-B.*, all in Stockholm. Mention may also be made here of the fact that the majority of the newspaper enterprises in the country have their own printing establishments, of which a few do outside work also.

Corrugated paper and board is manufactured by *Stockholms Wellpappfabrik*, Stockholm, *Thorsviks A.-B.*, Norrahammar, and by *Stockholms Kartong & Litografiska A.-B.*, Stockholm.

Among separate photo engraving establishments the following may be mentioned; in Stockholm: *Cederquists Grafiska A.-B.*, *A.-B. Grohmann & Eichelberg*, *J. Lindholms Klichéfabrik & Grafiska Anstalt*, *Warner Silfversparres Nya Grafiska A.-B.*, *A.-B. Kopia* and *A.-B. Kliché*; in other districts the following may be noted: *Wald. Zachrissons Boktryckeri A.-B.* and *Lindstedts Kemigrafiska Anstalt* in Göteborg and *Kemigrafiska A.-B.* in Malmö.

THE WALLPAPER INDUSTRY. The production of machine-printed wallpaper commenced in Sweden in 1848, but it was not until the 'sixties that wallpaper printing-machines came into general use. Handprinting of wallpaper is no longer carried on in Sweden.

The paper required for wallpaper manufacture is made in Sweden, but the colouring materials necessary for the production of wallpaper colours are imported.

On the initiative of the Swedish Sloyd Association (Svenska Slöjdföreningen), it has become customary during recent years for Swedish artists to be commissioned to design wallpapers. The Swedish wallpaper of to-day is consequently distinguished for its good quality and great variety of patterns. Part of the production is exported, mainly to England.

The wall-paper factories of the country are: *A.-B. Kåbergs Tapetfabrik* and *A.-B. Stockholms Nya Tapetfabrik* in Stockholm; *Göteborgs Tapetfabrik* and *J. Dahlander & Co's Tapetfabriks A.-B.* in Göteborg; *Norrköpings Tapetfabrik* and *A.-B. Ljungqvists Tapetfabrik* at Norrköping; *A.-B. Kalmar Nya Tapetfabrik*, Kalmar, *A.-B. Nordiska Tapetfabriken*, Arvika, *Borås Tapetfabriks A.-B.*, Borås, and *Emmaboda Tapetfabrik*, Emmaboda.





FOODSTUFFS INDUSTRIES.

FLOUR-MILL INDUSTRY.

The modern Swedish flour-mill industry sprang up contemporaneously with the growth of industrialism in Sweden during the last decades of the nineteenth century. With the increasing movement of the population from agricultural pursuits to industrial occupations there arose a growing necessity for the importation of grain. Enterprise was then directed to the milling of this grain; and thus there have been established, in seaport towns especially, large flour rolling mills which, using at first steam-power and to-day electricity, have carried on the business on a considerable scale. At an earlier date there were only water-mills and, on the plains, windmills, for the grinding of the grain from the surrounding districts. Such mills — which grind grain brought to them at a fixed tariff-rate or “toll” — are still to be found in great numbers everywhere in the country.

More than half the rye and wheat grown in Sweden is ground at such “toll” flour-mills or at quite private ones, which means that the domestic milling of corn products is still considerable. Today, however, many farmers find it advantageous to sell their grain to a milling enterprise, and afterwards to buy flour for their own needs, the flour produced by the large mills being, as a rule, superior in quality to the homeground meal. This is because these mills mix grain from various parts of the country with foreign grain, which is richer in gluten, and by this means a considerably better average flour is obtained.

Of the flour produced in Sweden during the last few years, somewhat more than 60% was wheat-flour and 37% rye-flour; of course-ground products 65% was oats.

The greater number of the flour-mills of Sweden are affiliated to the Swedish Flour-Mills Association (Svenska Kvarnföreningen), Stock-



The Flour-mills of A.-B. Saltsjökvärn (outside Stockholm).

As a rule, the work is carried on day and night with three shifts, and about 3,000 sacks of flour are produced every day.

holm, which endeavours to regulate prices and to safeguard the interests of its members. As a rule, the larger Swedish flour-mills compete with each other not as regards price, but only in quality and kinds. The flour-mill industry has thus to a high degree become a so-called trade-mark business.

The most important flour-mills in Sweden are *A.-B. Saltsjökvärn*, Stockholm, *A.-B. Malmö Stora Valskvarn*, Malmö, *Kalmar Ångkvarns Kommanditbolag*, Kalmar, *A.-B. Märten Pehrsons Valskvarn*, Kristianstad, and *Qvarn A.-B. Tre Kronor*, Stockholm, all employing from 100 to 200 workmen. The other large mills situated in their respective towns are *Trelleborgs Ångkvarns m. fl. Industriens A.-B.*, *Hälsingborgs Ångkvarns A.-B.*, *A.-B. Falkenbergs Elektriska Valskvarn* and *Kvarn A.-B. J. G. S.*, Norrköping. Among the medium-sized mills the following may be noted: *Upsala Ångkvarns A.-B.*, *A.-B. Upsala Valskvarn*, both at Upsala, *A.-B. Tre Lejon*, Göteborg, *A.-B. Nyköpings Storhuskvarn*, Nyköping, *A.-B. Molkoms Kvarn & Grynverk*, Molkom, *Berte Qvarn A.-B.*, Slöinge, *A.-B. Örebro Kvarn*, Örebro, *Alsters Valskvarn*, owned by Handels A.-B. P. G. Jansson, Kristinehamn, *A.-B. Landskrona Valskvarn*, Landskrona, *A.-B. Gävle Valskvarn*, Gävle, *Mjölby Kvarn A.-B.*, Mjölby, and *Ståhlbom & Co. A.-B.*, Norrköping. — Among the grain mills the following

may be noted: *P. O. Stokkebyes Kvarn A.-B.*, Göteborg, *A.-B. A. Heyman*, Vårgårda, and *A. Wilh. Petris Grynfabriks A.-B.*, Vetlanda.

THE BAKERY INDUSTRY.

The bakery business in Sweden is carried on chiefly as a handicraft. During the last few decades, however, the industry has begun to develop more and more on a factory scale. Illustrative of this change is the circumstance, that the number of bakeries included in the industrial statistics has multiplied more than eight times during the course of the past quarter of a century. This development has resulted from the placing on the market of a number of newly invented machines and appliances for baking. Motor-driven kneading and dough-weighing machines with the necessary transporters are now very common in the large bakeries. Considerable constructional improvements in the ovens have also been introduced, aiming at fuel economy and ease of handling. Special attention may be directed to the so-called rotating-ovens, in which the dough is put in at one end of the oven and comes out as ready-baked bread at the other.

In the bakery industry a distinction may be drawn between two main types of enterprise: on the one hand, bakeries run as factories for the supply of local demands, and manufacturing chiefly "soft", fresh bread; on the other hand, "hard" bread and biscuit factories supplying a larger market. The manufacture of hard bread is almost peculiar to Sweden, the hard bread generally eaten in the country being practically unknown elsewhere. In England, however, it is now being made and sold under the name of "ryebriek". During the last few years a certain export of Swedish hard bread especially to U. S. A. has sprung up.

Among the factories where hard bread is made the following are the principal: *A.-B. Öhmanska Bageriet*, Stockholm, *Kommanditbolaget Spis- & Knäckebrödsfabriken Kronan*, Sundbyberg, *A.-B. Arvid Pettersons Brödfabrik*, Eskilstuna, *A.-B. Nordstjernans Elektriska Knäckebrödsfabrik*, Linköping, and *A.-B. Nya Spis- och Knäckebrödsfabriken*, Oskarshamn. Of the remaining bakery enterprises, some of which also make hard bread, the following may be mentioned. In Stockholm, *J. C. Schröder* and *C. W. Schumacher* and *A.-B. Westerdahl & Karsten*, *A.-B. Sven Engdahl* and *Reinholds Nya Ångbageri- & Konditori A.-B.*; at Göteborg, *Olof Asklunds Ångbageri*, *Göteborgs Ångbageri- & Ångkvarns A.-B.* and *A.-B. Majornas Ångbageri*; at Malmö, *A.-B. A. Pahlssons Bageri*; and at Örebro, *A.-B. A. P. Kjellgrens Bageri*. Biscuit-making is carried on by *Göteborgs Kexfabriks A.-B.*, Kungälv, and *A.-B. Örebro Kexfabrik*, Örebro.

THE SUGAR INDUSTRY.

The sugar industry of Sweden ever since its origin has been the object of the very special attention of the State, having been at first carefully fostered and subsequently heavily taxed and jealously watched.

The refining of imported cane-sugar began in Sweden as early as 1647 and, from the very beginning, enjoyed many privileges. About the middle of the eighteenth century the importation of refined sugar was even forbidden, a protection which lasted until 1849. Thanks to this kindly care, the industry thrived greatly, so that at the close of the eighteenth century there were no less than 14 sugar refineries in Sweden, among them the still existing Tanto sugar-mills in Stockholm. During the Napoleonic wars at the beginning of last century Sweden acted as an intermediary for the English sugar trade; and it was then that the still existing Carnegie refinery at Göteborg was established.

The Swedish sugar industry in the present sense of the word, however, did not begin until the middle of the nineteenth century, when the efforts to produce sugar-beets with high percentage of sugar were successful. A native raw-sugar production, localized chiefly in Skåne (in the south of Sweden) began rapidly to flourish, thanks especially to the initiative and the far-sighted labours of Justus Tranchell of Göteborg. It was his son, CARL TRANCHELL, who was the pioneer in the technical development of the sugar industry, and for several decades this new leader was the moving power in this industry and he also brought about

Production of refined sugar:

Year	Tons
1900	86,000
1905	98,000
1910	122,000
1915	137,000
1920	142,000
1921	145,000
1922	144,000
1923	159,000
1924	153,000

its financial consolidation. The increase of the protective duty imposed in 1879 contributed in some degree to the development of the sugar industry; and the result was that the decades immediately preceding and succeeding the end of the century were characterized by an enormous growth of this industry. The importation of cane-sugar ceased entirely, and ever since the close of the last century the demand for sugar in Sweden has, on the whole, been satisfied by the home production of beet sugar, except on the occasions when the beet crop failed. The development of the industry is shown by the accompanying

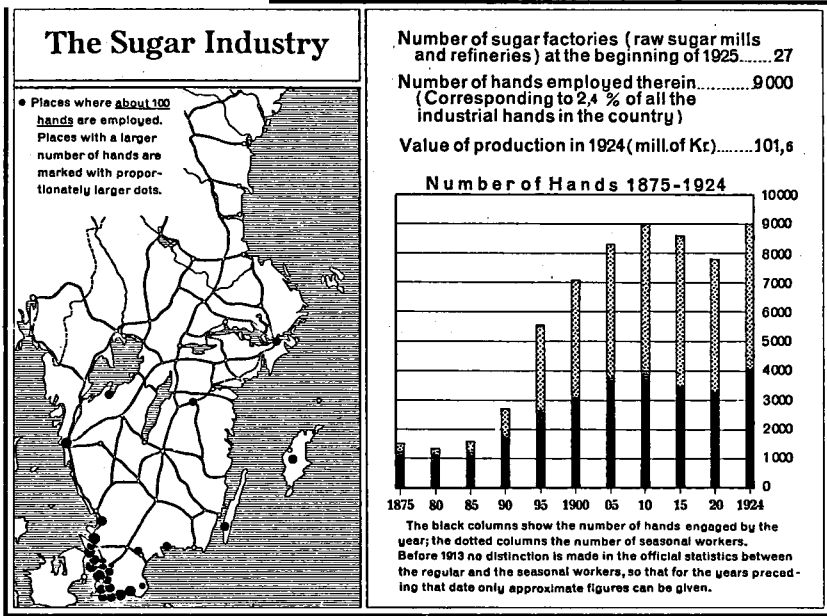


table of production, and by the diagram above showing the number of hands employed. As there has been no export of sugar, the table gives at the same time a picture of the great increase in the consumption of sugar which has accompanied the growing prosperity of Sweden. In addition to the quantities of sugar mentioned in the table, we should include, as by-products, some hundreds of tons of syrup, and about 30,000 tons of molasses every year. A valuable waste product obtained in the manufacture is beet-pulp which as well as molasses, is employed as fodder for cattle; the molasses is also employed for the manufacture of "German" yeast. The production of raw sugar is, in a high degree, a seasonal industry, more than twice as many hands being employed during the autumn months (15 Oct.—15 Dec.), the "beetcampaign", as during the rest of the year.

Ever since 1873, the manufacture of beet sugar has been burdened with a special tax, intended to replace the previous duty on imported raw sugar. At first the tax was based on the quantity of beets utilized, but this was changed in 1906 to an assessment on the amount of refined sugar sold, and in this connection the protective duties were



Arlöv Sugar Factory (Svenska Sockerfabriks A.-B.).

To the right, the raw sugar factory and beet-storehouse; to the left, the refinery.
In the middle foreground the transport road for the pulp.

revised. During the last two decades the protective duties on both sugar and syrup have several times been lowered. It should be noticed that the present duty aims chiefly at the protection of beet cultivation, and only to a small extent benefits the sugar factories interested.

Technically the Swedish sugar industry is acknowledged to occupy a prominent position. The percentage of raw sugar extracted from the beets in Sweden is considerably higher than that gained in France, and quite as high as that obtained in Germany. The Swedish refined sugar is regarded as one of the purest products of the chemical factory-industries, often containing more than 99.95 % of saccharose. The sugar industry has become of great economic importance for Sweden; by the cooperation between industry and agriculture, which it involves, a kind of trade has been created which not only yields the State a considerable revenue, but has also improved agriculture and increased the general well-being in a not inconsiderable part of the country.

Since 1907 the sugar industry is greatly concentrated. A number

of previously distinct enterprises have been fused into two concerns, one of which embraces not less than 90 % of the entire sugar production of the country.

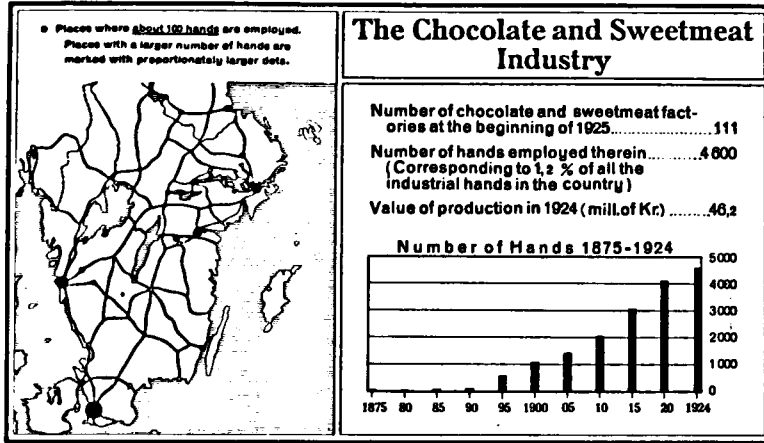
Svenska Sockerfabriks A.-B., Malmö, employs during the beet season over 8,000 hands and embraces raw-sugar factories at Arlöv, Hasslarp, Hälsingborg, Hököpinge, Jordberga, Karpalund, Kävlinge, Köpinge, Skivarp, Staffanstorp, Svedala, Säbyholm, Trälleborg, Ängelholm and Örtofta, all in Skåne, and at Karlshamn, at Genevad and Roma (on the island of Gotland), as well as sugar refineries in Stockholm, Göteborg, Landskrona and Arlöv. *Mellersta Sveriges Sockerfabriks A.-B.*, Lidköping, employs during the season more than 900 workmen and own raw-sugar factories at Lidköping, Linköping and Mörbylånga, and a refinery at the first-mentioned place.

THE CHOCOLATE AND SWEETMEAT INDUSTRY.

During the middle of the nineteenth century the manufacture of sweetmeats in Sweden was chiefly carried on in connection with the confectionery and bakery business. At a very early date, however, there developed a factory production of sweets. When, later on, cocoa and chocolate came more and more into use, certain businesses began to produce these articles. In the 'nineties this industry made rapid strides forward, thanks to the lowering, in 1892, of the duties on the raw material — cocoa beans — and to the simultaneously greatly increased consumption of chocolate. Several new factories were established and the output was multiplied. This favourable development continued after the beginning of the new century, and has increased during the last few years at a rapid rate, especially as regards the manufacture of chocolate and cocoa-powder.

At present two different types of undertaking may be noticed in this industry. The one is represented by comparatively small enterprises for the supply of sweetmeats and chocolate to the local market, and, *inter alia*, producing such of these articles as must be sold fresh and do not allow of being kept for any great length of time. The other type consists of large enterprises which manufacture cocoa-powder, chocolates and pastilles for consumption all over the country. In spite of the comparatively small number of works, this latter type predominates by reason of its large production.

At the present time, the Swedish chocolate and sweetmeat industry has a production within the country which satisfies no less than 95 % of the demand. Qualitatively also the industry stands on a

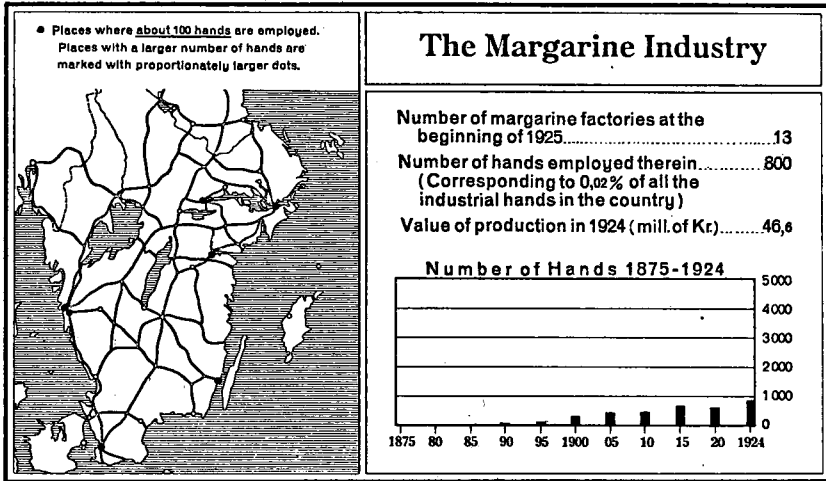


high level. Formerly it was thought that the best chocolate was made in Switzerland, and France, but to-day an article of equally good quality may be obtained from Swedish factories.

The largest and at the same time the oldest chocolate factory in the country is *Malmö Chokolad- & Konfektfabriks A.-B.* (Mazetti), Malmö, founded in 1888 and employing about 600 workmen. Other important chocolate factories are *Svenska Chokoladfabriks A.-B.* (Cloetta), Ljungsbro (Östergötland), *Bröderna Kanold A.-B.*, Göteborg, *A.-B. Chokoladfabriken Marabou*, Sundbyberg, *A.-B. Förenade Chokoladfabrikerna*, Stockholm, and *A. B. Svea-Chokolad*, Norrköping. Also *A.-B. Göteborgs Chokolad- & Konfektfabrik*, *Cap Chokolad- & Konfektfabrik A.-B.* and *Axel Forsberg Chokolad-, Karamell- & Konfektfabrik*, all three at Göteborg, *Ljungs Chokolad & Cacao-Fabrik* and *A.-B. Carl P. Pålssons Chokolad- & Konfektfabrik*, both at Malmö, *Nya A.-B. Chokoladfabriken Fyris*, Uppsala, *A.-B. Kalmar Konfekt- o. Karamellfabrik*, Kalmar, *A.-B. Nordiska Chokoladfabriken*, Alingsås, *A.-B. Ringstorps Chokoladfabrik*, Hälsingborg, and *A.-B. Chokolad & Konfektfabriken Freja*, Gävle. The following are sweet-factories: *A.-B. Nissens Manufacturing*, Norrköping, *Pir A.-B.* and *A.-B. Pastill* (Läkerol), both at Gävle.

THE MARGARINE INDUSTRY.

A distinction is drawn between animal and vegetable margarine according to the nature of the raw material employed. The former is made from the products obtained from melted beef-suet and pork-lard, with the addition of some suitable oil. Vegetable margarine on



the other hand does not contain any such animal fats but is made of the fatty materials obtained from vegetables, chiefly coco-nut oil and ground-nut oil.

The manufacture of margarine on a factory scale began in France in the 'seventies. The industry came to Sweden in the 'eighties and gradually developed after the imposition of a protective duty in 1888 and after the rise in the price of butter caused by the growing butter-export to England. The continued development after the close of the century was due to the general adoption of vegetable margarine in place of the animal product, when coco-nut and palm-kernel oils made their appearance in the market. Vegetable margarine was cheaper and forms a better substitute for table butter, while animal margarine is more suitable for certain branches of the bakery industry.

The output of the Swedish margarine factories is about equal to the home demand. The exports have as a rule been unimportant. The competition between the various Swedish factories has in a high degree been directed to the production of a steadily improving article and it is acknowledged that Swedish margarine is as a rule of excellent quality.

Since 1885 the manufacture of, and trade in, margarine have been subject to State control, in order to prevent its being sold as butter, which would be to the detriment of the dairy industry.

— FOODSTUFFS INDUSTRIES —

Of the margarine factories in Sweden the following are the best known: *A.-B. Pellerins Margarinfabrik* and *A.-B. O. Mustad & Son*, both at Göteborg, *Margarin A.-B. Zenith*, Malmö, *Nya Margarin A.-B. Svea*, Kalmar, *Arboga Margarinfabrik*, Arboga, *A.-B. Agra Margarinfabrik* and *A.-B. Vandenberghs Margarin*, the two last-mentioned in Stockholm, and *Kooperativa Förbundets Margarinfabrik*, Norrköping.

MEAT-PRESERVING, TINNED FOOD, AND OTHER
FOOD-STUFFS INDUSTRIES.

The Meat Trade. The erection of modern slaughter-houses in the larger towns of Sweden has led to the meat trade becoming in some degree industrialized. In the official statistics, however, only the pig-killing and meat-preserving factories are at present included among the industries of the country. The pig slaughter-houses are closely connected with the agriculture; the greater number and the largest of them are allied to the Farmers' Co-operative Associations, which sell the produce of the pig-breeding farms; most of the latter are situated in Skåne and the west of Sweden. Exports of pork go mostly to England. Meat-preserving factories are generally localized in the towns or other large centres of population, where they are frequently combined with the retail business. The manufacture consists chiefly of sausage-making and meat-curing. The work is carried out almost entirely by machinery.

Among the more important meat-preserving factories the following may be mentioned: *Slakteri A.-B. Norrmalm*, *Slakteri A.-B. i Stockholm*, *Carl Larssons Slakteri A.-B.* and the firms of *Aug. Falk* and *Bröderna Kessler*, all in Stockholm; *Slakteri A.-B. Gota* and *A.-B. D. Hasselblads Charkuteri* at Göteborg; and *Oscar Johansons Slakteri A.-B.* at Norrköping.

The Tinned Food Industry. The greater part of the Swedish tinned food industry is located to the west coast, where the tinning of fish is done on an ever-increasing scale. The oldest manufacture is that of anchovies. This well-known product, of which sprats are the raw material, seasoned according to certain methods, is chiefly localized in the neighbourhood of Lysekil, north of Göteborg. The manufacture of tinned fish goods of other kinds, of which herrings, mackerel, cod, salmon, lobster, etc., form the raw materials, is carried on at some ten factories. About the same number of firms, chiefly located in the southern part of the country, preserve

fruits and vegetables. Tinned meat and pork goods are produced by only a few firms.

The tins used in the process are manufactured by the larger firms themselves; the smaller firms obtain them from tin-goods factories; the tin-plate is imported from abroad. Swedish tinned foods have gained recognition for careful and hygienic treatment in the various processes.

Although it does not come under the heading of the tinned food industry in the strict sense of the word, mention should here be made of the fact that the salting, curing and drying of fish is carried on at special establishments working on a large scale.

A.-B. Sveriges Förenade Konserverfabriker, Göteborg, is the largest enterprise in this branch, with about 300 men, and is employed in preserving fish, meat, and also vegetables. The making of various kinds of conserves is also carried on by *Stibergs Konserverfabriker A.-B.*, Göteborg, and *A.-B. Molinderska Konserverfabriken*, Stockholm, and the preserving of meat by *Bröderna Kessler*, Stockholm. Of anchovy factories the following may be mentioned: *A.-B. Hugo Hallgrens Konserverfabriker*, Ellös, and *A.-B. Gust. Richter and Alfr. Bovik & k:i* at Lysekil. Fruit and vegetables are preserved by *Svenska Fruktföreningen*, Stockholm, *A.-B. Ruuthsbo Konserverfabriker*, Ystad, *Gustaf Bong*, Ystad, and *A.-B. Önos*, Tollarp and others.

In this connection it may be mentioned that mustard, soya and vinegar are made by *A.-B. Th. Winborg & C:i*, Stockholm, and *A.-B. Vinägron*, Göteborg; vinegar also by *Liljeholmens Ättiksfabrik & Handels A.-B.*, Stockholm, etc. Dairy produce (rennet, butter and margarine colouring matter etc.) is made by *A.-B. S. Barnekows Tekn. Kem. Laboratorium*, Malmö.

Dairying. The dairy industry of Sweden is, to a large extent, carried on as a factory occupation, but economically it is so intimately connected with agriculture that it must be considered as lying entirely within the sphere of the latter. The dairy industry must be considered a subsidiary industry of agriculture, so that such matters as State supervision are controlled by the State Department of Agriculture and its subordinate institutions. The dairies are distributed all over the country, and as a rule belong to the large estates or to co-operative associations of small farmers.

Starch manufacture. The manufacture of starch in Sweden is based almost exclusively on the potato as a raw material. It is carried on at some 80 small factories, the majority of which belong to co-operative associations of farmers in the provinces of Blekinge and Kristianstad, where the cultivation of the potato is pursued with great success. The annual production is chiefly employed for household use,

— FOODSTUFFS INDUSTRIES —

the remainder going to the manufacture of yeast and in the textile industries etc.

Macaroni and Sago Manufacture. The manufacture of macaroni is carried on with wheat as the principal raw material and that of sago with potato-starch. The production may be said to suffice for the home demand.

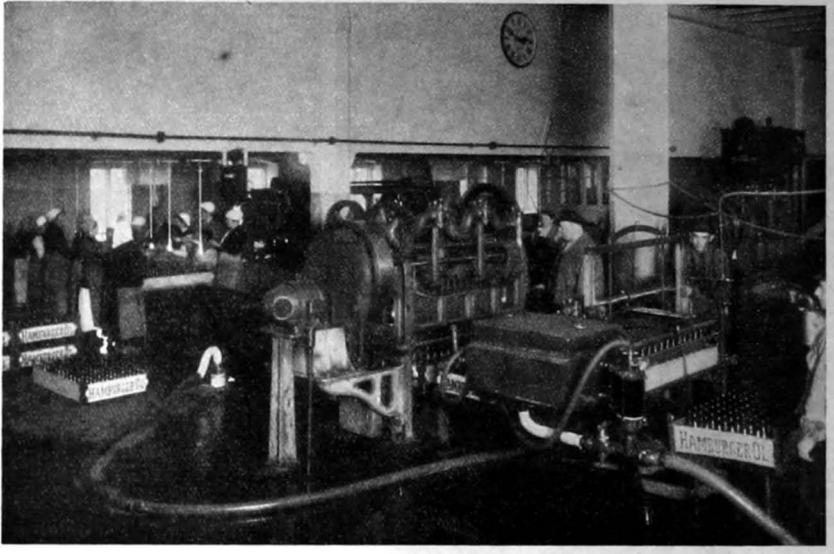
Among enterprises in this line the following may be mentioned: *A.-B. Stockholm Maccaronifabrik*, Sundbyberg, *Norrköpings Makaronifabrik*, Norrköping, *Thomsons Fabriker A.-B.*, Göteborg, *A.-B. Karlskrona Makaronifabrik*, Karlskrona, and *A.-B. Gävle Makaronifabrik*, Gävle.

THE BREWING INDUSTRY.

In Sweden the brewing of ale is of very ancient date. In olden times brewing was carried on exclusively in the home; it developed during the 16th and 17th centuries into a regular business; and in the middle of the 19th century it began to assume an industrial form. The production of beer attained its zenith immediately after the beginning of the present century. The diminution in the quantity brewed which ensued after that date was caused by the legislative restrictions introduced after 1905 on the manufacture of malt liquors.

The raw materials necessary for the malt-liquor industry — barley, hops and water — must satisfy severe tests respecting their purity, etc., if the brew is to be of a good quality. The greater part of the malt required for brewing is produced by the Swedish breweries themselves from barley grown in the country. In 1923 it was calculated that about 14% of the Swedish barley crop was employed for this purpose. The hops required on the other hand are nowadays imported, chiefly from Bavaria and Bohemia. Up to the middle of the 19th century hops were cultivated in Sweden on a large scale and in the old "Building Code" the regulation was laid down that "soccage-farms" must have a hop-garden. This law was repealed, however, because the quality of the Swedish hops was not equal to that of the foreign article.

As far as the larger brewery establishments are concerned, this industry is, in technical respects, one of the most perfect in the country. Ingenious and efficient machinery is employed in the manufacturing processes, and in most places even the cleaning, filling, and the corking and labelling of the bottles is nowadays effected by automatic



Bottling-hall at the Hamburger Brewery (A.-B. Stockholms Bryggerier)

To the right is seen the bottling of the ale — some 10,000 bottles being filled per hour. The machine in the middle of the picture is the corking apparatus. To the left the bottles are being inspected and labelled.

machinery. Extremely careful supervision of the various processes has been enforced so as to maintain the sensitive product at a high level of quality, success in which is to a considerable degree dependant on the personal experience and skill of the various brewers. A very great deal of scientific work has been devoted to the perfection of the many intricate processes in the manufacture of beer.

In accordance with the requirements of the law, malt liquors are divided into three classes. Class I includes malt liquors with a low percentage of alcohol and a low extract percentage of wort (small beer), and also alcohol-free malt liquors with a somewhat higher percentage of extract. Class II (Pilsner beer) is the commonest malt liquor, with a maximum alcohol-proportion of 3.2 weight-percentage and an extract-percentage not exceeding 10.5%. Class III (export ale) embraces other kinds of malt liquors that may only be manufactured for export and for certain special purposes. The excise duty distinguishes between excise-free and excisable breweries. At the former only small beer may be made.

— FOODSTUFFS INDUSTRIES —

The common interests of the breweries are safeguarded by the Swedish Brewery Association (Svenska Bryggareföreningen), Stockholm, established in 1885.

Incomparably the most important brewery enterprise is *A.-B. Stockholms Bryggerier*, which owns Hamburger, Münchens, Sanct Eriks and Grönwalls breweries in Stockholm (the two first-mentioned are the largest in the country), and employs no less than 1,100 men. The following brewery in Stockholm may also be mentioned: *Gustaf Fichls Bryggeri A.-B.* — The principal enterprises in Göteborg are: *A.-B. Pripp & Lyckholm*, which own breweries at Göteborg, Vänersborg, Trollhättan, Strömstad and Uddevalla, and *Munchens Nya Bryggeri A.-B.* — At Malmö: *A.-B. Malmö Förenade Bryggerier*, which is an amalgamation of three separate enterprises in the town. *A.-B. Skåne-bryggerier*, Hälsingborg, control breweries at Eslöv, Hälsingborg, Karpalund, Klippan, Kristianstad, Landskrona, Ängelholm and Sölvesborg. Among the remaining enterprises the following may be mentioned here: *A.-B. Klosterbryggeriet* at Ystad (the oldest brewery now existing in Sweden), *A.-B. Norrköpings Förenade Bryggerier*, Norrköping, *A.-B. Förenade Bryggerierna* at Carlsrona and Lyckeby, Karlskrona, *A.-B. Nya Centralbryggeriet*, Linköping, with breweries at Linköping, Oskarshamn, Vimmerby, Västervik and Hultsfred, *Uppsala Bayerska Bryggeri A.-B.*, Uppsala, *Ångbryggeri A.-B. at Gäfle*, *Porterbryggeri A.-B. at Gefle* and *Gefle Bryggeri A.-B.*, all at Gävle, *Sundsvalls Ölbryggeri A.-B.*, Sundsvall, *Hernö Bryggeri A.-B.*, Härnösand, *Södertälje Bryggeri A.-B.*, Södertälje, *Eskilstuna Bryggeri A.-B.*, Eskilstuna, with which among others *Åmdls Nya Bryggeri A.-B.* at Åmål and *Ångbryggeri A.-B. Svea* at Filipstad are amalgamated, *Bryggeri A.-B. Falken*, Falkenberg, *Nässjö Bryggeri A.-B.*, Nässjö, *Krönleins Bryggeri A.-B.*, Jönköping, *A.-B. Nya Bryggeriet* and *Sandwalls Ångbryggeri*, both at Borås, *Bryggeriet Nordstjernan* at Skövde, *Norlings Bryggeri A.-B.* at Örebro and *Norr-tälje Ångbryggeri A.-B.*, Norrtälje. — Stout is made by *Porterbryggeri A.-B. D. Carnegie & Co.* at Göteborg and others.

THE MANUFACTURE OF MINERAL WATERS AND NON-ALCOHOLIC DRINKS. — The first factory for the manufacture of artificial mineral waters was started in Stockholm as early as 1799. To-day, the manufacture of such water and of non-alcoholic drinks is carried on at about sixty special establishments and at a number of breweries in the country.

Of the more important enterprises in this line the following may be mentioned: *Apotekarnas Mineralvattens A.-B.* and *A.-B. Nordstjernans Mineralvattenfabrik* in Stockholm, *A.-B. Apotekarnas Förenade Vattenfabriker*, Göteborg, *A.-B. Malmö Vattenfabriker*, Malmö, *Norrköpings Apotekares Mineralvatten A.-B.*, Norrköping, and *A.-B. Ramlösa Hålsobrunn*, Ramlösa.

THE MANUFACTURE OF SPIRITS AND YEAST.

The manufacture of spirits (*aqua vitae*) has since time immemorial been carried out by the fermentation of saccharine liquids, in which

process the sugar is partially transformed into alcohol and the fermented liquor is afterwards distilled. The raw material employed nowadays consists chiefly of potatoes, white beets and grain, so that the manufacture of spirits has become more or less subsidiary to agriculture.

Originally aqua vitae was produced only for household consumption but afterwards it became an article of commerce. In the middle of the 17th century the monopoly of the sale of spirits in Sweden was granted to the "Brewers' Guild" and at the same time an excise duty was levied on spirits, whether made for home consumption or for sale. This duty was increased from time to time and ultimately became a source of considerable income to the State. Gustavus III (1771—1793) made the business a State monopoly as regards both manufacture and sale, in order still further to utilize spirits as a source of revenue for the State; but the Crown distilleries did not yield anything like such a large revenue as had been calculated and the monopoly was soon abolished. In 1856 home-distilling was prohibited and the manufacture then began to be carried on more and more under industrial factory conditions. The later development of the distillery industry has to a very great extent been dependent on the measures that have been adopted for the promotion of national temperance. A long series of restrictive legal enactments concerning not only the manufacture but especially the sale of spirits, has more and more limited production. At the same time this industry has become to a very great extent concentrated. The number of distilleries, which in the years following the abolition of home-distilling amounted to more than 4,000, has since gradually declined, and at the beginning of 1925 was only 108, situated for the most part in the province of Kristianstad, and mostly belonging to large estates or to co-operative associations of farmers.

In the manufacturing year 1924—1925 the production of spirits amounted to about 38 million litres of a normal strength of 50% alcohol; 23.8 million litres of this were produced at the agricultural establishments, 3.5 million at the yeast factories, and 11.2 million at the sulphite-spirit factories. The spirits from the agricultural establishments are employed for the manufacture of different kinds of aqua vitae, for the fortification of eau de vie and whisky, etc., and for the manufacture of punch and liqueurs; the spirits derived from the yeast and sulphite factories after being methylated are chiefly employed for technical purposes. Both the refining and the methylizing of the spirits takes place at the rectification works.

The consumption of spirits now amounts approximately to only 4 litres per person yearly. In 1850 the corresponding figure was 22 litres.

The present excise duty on manufactured spirits amounts to 65 öre per litre of spirit of normal strength. Altogether the amount of the excise duty on spirits in 1924—25 amounted to 17 mill. kronor. The largest income obtained by the State from spirituous liquors however is that from the retail-tax, which yields from 60 to 70 mill. kronor every year.

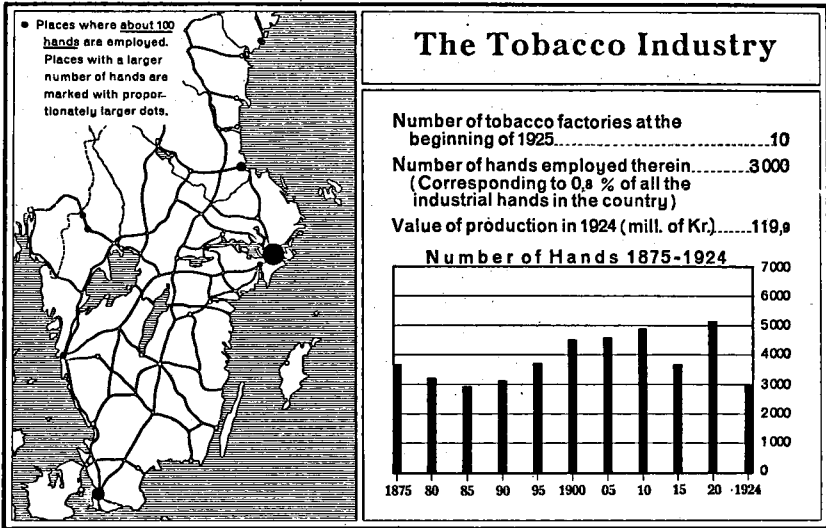
The Swedish agricultural distilleries and yeast factories are affiliated to the Distillers' Association of Sweden (Sveriges Bränneriidkare-förening), Kristianstad. The sulphite spirit factories are associates in the Company called A.-B. Svensk Sprit, Stockholm, whose function it is to watch over the interests of the sulphite spirit industry and to extend the home and foreign markets for the article. All the rectifying establishments are the property of the company called A.-B. Vin- och Spritcentralen, Stockholm, formed in 1917, to which with its subsidiary company A.-B. J. D. Grönstedt has also been entrusted all the retail trade in wines and spirits.

A.-B. Vin- och Spritcentralen is engaged in the refining of spirits at the rectifying works at Reymersholm (Stockholm), Södertälje, Eslöv, Åhus and Ödåkra, and the making of punch and liqueurs at Karlshamn. The company employs altogether 700 men.

The Manufacture of Yeast. In former times only a leaven was employed in baking for producing fermentation. Later yeast was used, which was obtained chiefly from the manufacture of spirits and ale. When the distillation of spirits however began to be restricted, about the middle of the 19th century, and when at about the same time ale was first brewed by what is known as the "Bavarian" method, which gives a yeast unsuitable for baking, it became necessary to begin the making of yeast on a factory scale. Surface yeast, as it was called, was then produced as a primary product, instead of, as previously, a by-product of the fermenting industry.

Modern yeast manufacture is, in reality, a modified form of spirit distillation, arranged in such a way as to yield more yeast and less alcohol. By means of very ingenious technical arrangements the Swedish yeast factories have succeeded during the last few years in trebling the amount of yeast produced in proportion to the spirit.

The largest enterprise in this line is *Svenska Jästfabriks A.-B.*, Stockholm, which makes about 70% of the supply of the country at four factories. Other enterprises are: *Bageriidkarnes Jäst A.-B.*, Stockholm, and *Upsala Ångkvarns A.-B.*, Upsala.



THE TOBACCO INDUSTRY.

The use of tobacco came into Sweden during the early half of the 17th century. At first the tobacco was imported ready for use and it was only at the close of the century that what were called tobacco-twist works were established in the country. The manufacture of tobacco developed greatly during the 18th century and the trade soon began to play an important part in the economy of the country. Among the factories of which the official statistics take note for the period 1760—1770, the tobacco-factories stood second in output-value being only beaten by the textile industry; the amount was about 12 % of the entire production-value of the Swedish industries. The cultivation of the tobacco-plant was begun in Sweden at that period; Jonas Alströmer was a pioneer in this as in so many other branches of Swedish industry. During the 19th century the development of the tobacco industry continued favourably, but, as was only natural, its relative importance gradually diminished. It was not until the beginning of last century that the manufacture of cigars was begun in Sweden while that of cigarettes was not started until the close of the century.



Cigar-making at the new tobacco-factory, Stockholm.

The imports of finished tobacco products are small in comparison with home manufactures. By the terms of the law of 1914, which established a State tobacco monopoly in Sweden, the State reserves to itself the sole right of manufacturing tobacco and of importing raw tobacco; and this right has been transferred to a special company — A.-B. Svenska Tobaksmonopolet. Of the capital of this company the State owns 89 %. The importation of manufactured tobacco is permitted not only to the Tobacco Monopoly Company but also to all dealers in tobacco. The latter however are obliged to pay a certain licence duty on the goods that they import. The taxes on tobaccos are collected and accounted for by the Monopoly Company. The income derived by the State from tobacco (tobacco-tax, dividends on the state-owned ordinary shares, import duties and taxes) amounts to about 65 million kronor annually.

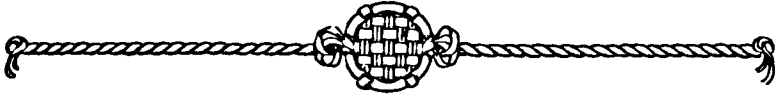
The cultivation of tobacco is under the supervision of the Board of Control. The annual crop of Swedish tobacco is inconsiderable, amounting to only about 600 tons, as compared with some 5,000 tons of imported raw tobacco consumed in the country. Swedish tobacco, which is chiefly cultivated in the province of Kristianstad, is considered of low quality and is used nowadays chiefly as an ingredient

in snuff. Of the imported raw tobaccos the main part comes from America. Other large suppliers of raw tobacco are the Dutch Indies, Greece and Turkey.

During the time the Tobacco Monopoly Company has been in existence a considerable concentration has taken place in the Swedish tobacco industry. When the monopoly was first introduced, there existed more than a hundred tobacco factories and an almost equally large number of businesses which might be classed as handicrafts and home industries. At the present time tobacco is manufactured at no more than ten factories. The Monopoly Company has directed much energy to the introduction of mechanical methods of working, thereby effecting economies in both labour and space. In the manufacture of cigars and snuff manual labour has to a great extent been replaced by efficient machinery and in the manufacture of cigarettes the mechanical equipment has been considerably extended. With the ingenious "complete machines" it is now possible to produce perfectly made cigars entirely by machinery, thus effecting great economy, for while a cigarmaker working by hand can produce only 300 cigars per day the machine in question can turn out 3,400. In the making of higher-grade cigars however the work is still done by hand. Of the total number of hands engaged in the tobacco industry about 50% are employed in the making of cigars. The capacity of a cigarette machine varies between 13,000 and 20,000 cigarettes per hour, while the same work done in the same time by hand would necessitate the employment of 50—100 hands. The packing in boxes is also carried out to a great extent by machinery.

In the tobacco industry no less than 75% of the hands employed are women or girls.

A. B. Svenska Tobaksmonopolet own a factory in Stockholm that employs no less than 1,500 hands, where all the various kinds of tobacco goods are made (except chewing-plug); they have also an important factory at Malmö for the manufacture of cigars and cigarettes, a factory at Härnösand for cigarettes, pipe-tobacco, and snuff, one at Gävle for cigarillos, one at Södertälje for cigarettes, one at Arvika and one at Charlottenberg, both for the manufacture of pipe-tobacco and chewing-plug. The Company also makes snuff at Göteborg and in small factories at Karlskrona and Norrköping.

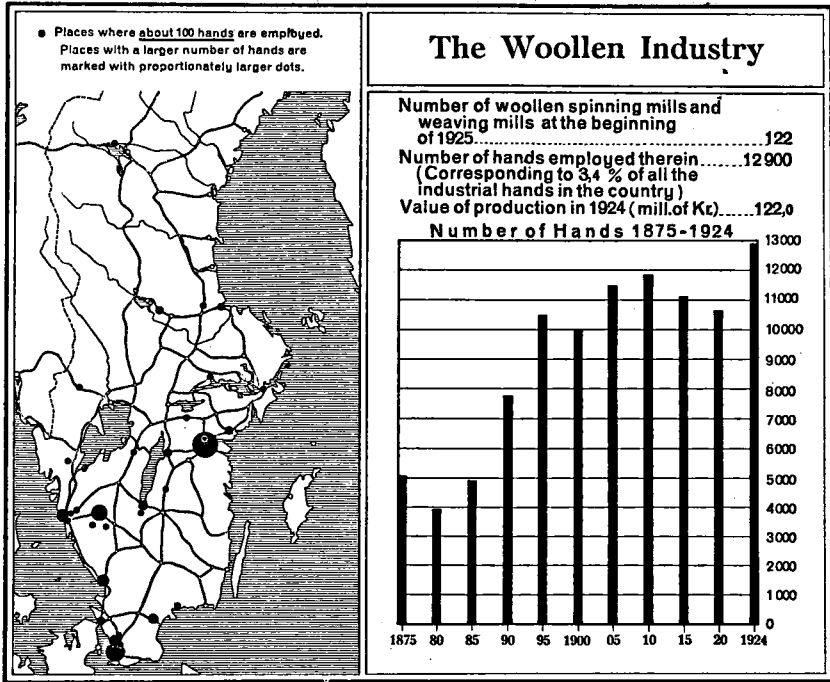


THE TEXTILE AND TAILORING INDUSTRIES.

THE WOOLLEN AND WORSTED INDUSTRIES.

To judge by ancient Egyptian grave-finds wool must have been the earliest article used by man for clothing. Wool could be easily spun, and woollen cloth proved to be an excellent clothing-material. The implements employed for it were the simple hand-spindle, the distaff and the weaving loom in its primitive form; they must have been in use from time immemorial for thousands and thousands of years, when the spinning-wheel was invented in 1530 and when, in the latter part of the 18th century, the spinning-machine and the mechanical loom came into existence and together brought about a complete revolution in the textile industry. It was an English weaver named Hargreaves who in 1767 achieved the invention of the spinning-machine, a mechanical contrivance for the simultaneous spinning of a large number of threads with very little supervision requisited by the worker. By means of Hargreaves's machine, the "spinning jenny", more than 100 spindles could be tended by one girl. A couple of decades later Cartwright, a clergyman, constructed the mechanical loom which at once meant a trebled output per workman. The inventions mentioned were more directly intended for the cotton industry but they were soon adapted so as to be available for woollen manufacture also. Then during the nineteenth century there followed a succession of new or improved textile machines until finally Northrop, an American, produced an automatic, self-feeding loom which, enabling as it does up to some twenty looms to be managed and tended by a single person, has effected an output per employee that is forty times greater than was possible in Cartwright's time.

The woollen manufacture, which in ancient times attained a high degree of development in the East and in Italy and which was pursued



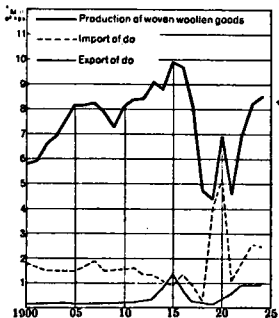
during the Middle Ages in Europe principally by Germans and Netherlanders, was in Sweden an object of special solicitude to the Vasa kings. During their reigns (16th and 17th centuries) and still more during the so-called "Period of Liberty" (1720—1770) the cloth-making industry was generously supported by Government and Parliament and attained a high degree of prosperity. Towards the close of the 18th century there ensued a long period of decline, but about the middle of the 19th century the cloth-making trade once more began to develop vigorously as a consequence of the spread to Sweden of the new textile machinery. Since then there has been manifest a growing tendency in the woollen industry towards concentration in a few large enterprises. A number of the small mills have been closed down, while production has increased considerably in the larger concerns.

Only a small part of the raw material of the woollen industry — sheep's wool — is obtained in Sweden itself, not more than about 7—8 % at most. Sheep-breeding however, after having for a long

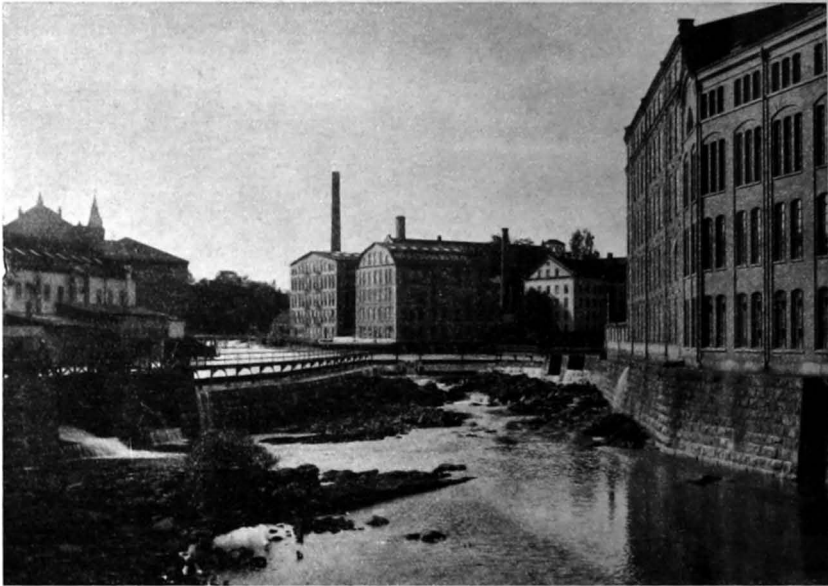
— THE TEXTILE AND TAILORING INDUSTRIES —

time diminished in extent, has during the last few years once more shown an increase, so that a greater production of wool may be expected. The imports of wool during the last few years have amounted to somewhat more than 7 million kilograms annually. But besides natural wool, the woollen industry employs as a raw material, especially for lower-grade goods, so-called artificial wool, which is obtained by the tearing up of old woollen goods. The better kind of this mixed product, "shoddy", is obtained from unfulled woollen fabrics, hosiery articles etc., while "mungo" is made from the rags of fulled woollen articles. Artificial wool is made in Sweden on a considerable scale but about half the demand has to be satisfied by imports.

The earlier woollen industry in Sweden belonged entirely to the carded goods (woollen) branch but since the eighties of last century there has sprung up a not unimportant combing-wool (worsted) industry. In this latter branch the spinning-mills often form independent businesses, quite distinct from the weaving-mills, whereas the carding-goods factories are usually of the combined type, embracing both spinning and weaving. It should be noted however that there exist no strictly defined limits between the carding and the combing industries, for carded woollen goods and combed woollen articles are often manufactured at one and the same factory, the former being made from short, curly wool and the latter from long-fibred, straight, glossy wool. In this connection it should also be observed that the woollen industry makes use on a considerable scale of cotton or cotton-yarn for its products, sometimes to such an extent that it becomes difficult to decide whether to classify such factories among the woollen or the cotton mills. A special class of undertaking is the vigogne spinning-mills, which manufacture yarn out of wool or artificial wool and cotton, chiefly for use in the hosiery industry. In the woollen industry many of the smaller factories carry out work to order, i. e. do the spinning and weaving of native wool which has been sent them for the purpose by a sheep-farmer. About 60 % of the hands employed in the industry are women and girls.



The accompanying graph of the production, importation and exportation of woollen fabrics shows the growing success with which the Swedish woollen industry was coping with the home demand for woollen cloth,



Textile Factories at Norrköping.

To the left, cotton factories belonging to Holmens Bruks & Fabriks A.B. and Norrköpings Bomullsväveri A.B.; in the centre, Drag's woollen factories; to the right, a woollen factory belonging to A.-B. Förenade Yllefabrikerna.

a small export trade having even begun, when the Great War broke out. This caused violent changes, the disastrous results of which however have been repaired during the last few years. Exports of woollen fabrics in 1924 had a value of no less than 12.2 million kronor. Swedish woollen goods are well known for their general excellence and good wearing qualities. During the last few years they have displayed a greater variety of pattern and methods.

The centre of the Swedish woollen industry has long been the town of Norrköping, which is also the home and meeting-place of the Swedish Woollen Manufacturers' Association (Svenska Yllefabrikantföreningen), which is entrusted with the interests of this branch of industry. John Lenning's Weaving-School at Norrköping is an institution which not only gives instruction to intending manufacturers, foremen and designers in the textile branch, but also holds special courses of instruction for apprentices and factory hands who desire to train to become foremen.

— THE TEXTILE AND TAILORING INDUSTRIES —



Spinning-hall (Stockholms Bomullsspinneri och Väveri A.-B.).

Of the woollen manufacturing concerns in Sweden *Malmö Yllefabriks A.-B.* is the largest, employing about 1,800 hands. Second comes *A.-B. Förenade Yllefabrikerna*, Norrköping, with about 1,400 hands. In Norrköping the following may also be noted and, like those just mentioned, comprise spinning and weaving mills, viz.: *Drags A.-B.* (this factory was founded in 1650), *A.-B. Törnell & Ringström*, *A.-B. Nyborgs Yllefabrik*, *J. F. Södergren & Sons Fabriks A.-B.*, *Gamlabro A.-B.*, *Wadström & Indebetou*, *A.-B. Max Hellmann*, *A.-B. Herman Månsson* and *Knut Hagberg Fabriks A.-B.*; and also, outside the town, *A.-B. Freese & Bruno*, Åby. Among similar undertakings in other districts the following may be mentioned first: *Wallbergs Fabriks A.-B.*, Halmstad, *A.-B. Skånska Yllefabriken*, Kristianstad, *Bords Yllefabriks A.-B.*, Borås, *A.-B. Fors Ullspinneri*, Nyköping, *Falu Yllefabriks A.-B.*, Sägmåra, *A.-B. Fredr. Asp*, Motala Verkstad, and *Sahlströmska Fabrikens A.-B.*, Jönköping, all employing more than 300 hands; also *Stockholms Yllefabriks A.-B.*, Stockholm, *A.-B. Göteborgs Yllefabrik*, Partille, *Hedefors Väveri A.-B.*, Lerum, *Stigens A.-B.*, Färgelanda, *Nordiska Maskinfilt A.-B.*, Halmstad, *Västergötlands Yllefabriks A.-B.*, Tidån, *Schullström & Sjöströms Fabriks A.-B.*, Högsjö, *Marieholms Yllefabriks A.-B.*, Marieholm, *A.-B. C. O. Borgs Söners Fabriker*, Lund, *A.-B. Gestriklands Yllefabrik*, Järbo, *Västerås Ullspinneri- & Ängfärgeri A.-B.*, Västerås, *Arvika Ullspinneri & Väfveri A.-B.*, Arvika, *Trands Nya Väveri A.-B.*, Tranås, *Tabergs Yllefabriks A.-B.*, Smålands Taberg, *Smålands Yllefabriks A.-B.*, Lagan, *Näldens Ullspinneri A.-B.*, Nälden, *Matfors Yllefabriks A.-B.*, Matfors, and *Salanders Fabriks A.-B.*, Lund.

The largest undertaking which is entirely devoted to wool-spinning is *Göteborgs Kamgarnsspinneri A.-B.*, Göteborg, with about 500 workmen. Among similar undertakings the following may also be mentioned: *A.-B. Lana*, *A.-B. Jakobstads Kamgarns-*

— THE TEXTILE AND TAILORING INDUSTRIES —

spinneri, both in Göteborg, *Spinneriet Kronan (Gustaf Rydin)*, Borås, and *A. Ferd. Sjöberg A.-B.*, Gävle. Vigogne-spinning mills are: *A.-B. Fr. Kürzel*, Malmö, and *Spinneri A.-B. Hermann Kürzel*, Göteborg.

Among the firms which specialize in the weaving branch the following may be mentioned: *Kilsunds A.-B.*, *A.-B. Bords Klädningstyggsfabrik*, *Manufaktur-A.-B. Svea* and *A.-B. Merinos*, all at Borås; also *Hälsingborgs Jacquard Väveri A.-B.*, Hälsingborg, *Gävle Ängväveri A.-B.*, Gävle, and *Wahlqvistska Klädesfabriken (C. A. Svahn)*, Svängsta.

In conclusion it may be mentioned that the manufacture of blankets is carried on by *A.-B. Malcus Holmquist*, Halmstad as well as by several of the above-named firms.

THE COTTON INDUSTRY.

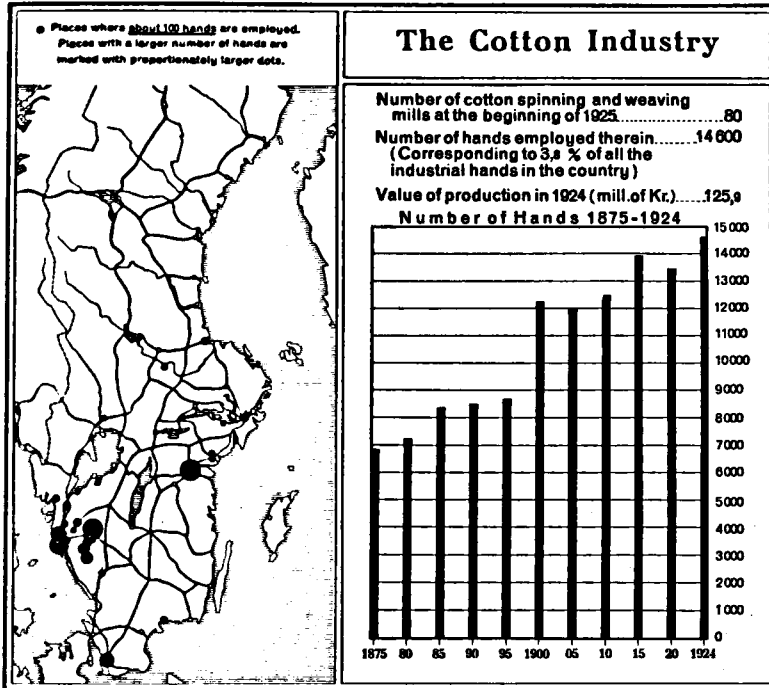
Among the various branches of textile industry the cotton industry occupies the first place both as regards scope and also the number of hands engaged. That is true both of Sweden and of the world as a whole, the explanation of the fact being the relative cheapness of the raw material, cotton, and the number of uses to which it can be put. The important rôle that the cotton industry plays in world manufacture may be proved for one by its having been chiefly in this branch, that those wonderful mechanical inventions were made in England that inaugurated the so-called Industrial Revolution towards the close of the eighteenth century and which had such far-reaching results, extending to the most widely different spheres of human life and industry.



Sven Erikson.
b. 1801 d. 1866.

It is not known when the cotton industry was actually started in Sweden. Shortly after 1730 the manufacture of cotton seems to have been carried on to some extent at the Alingsås Manufacturing Works, which had been established by Jonas Alströmer, but cotton goods do not appear to have been manufactured on any considerable scale before the beginning of last century. Up to 1812 only small quantities of cotton had found their way to Sweden and the importers handed over the greater part of it to the peasants to be spun. The earliest successful cotton spinning-mill in Sweden was built in 1805; the second at Sjuntorp, south of Trollhättan (founded 1813), is still running.

During the first half of the 19th century several other spinning



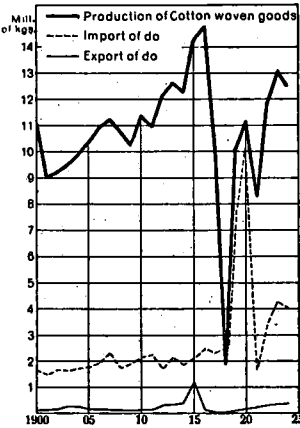
A.-B. KARTOGRAFISKA INSTITUTET

mills were started, leading in time to the establishment of weaving-mills. The manufacture of cotton fabrics had been previously carried on chiefly as a domestic industry, especially in the so-called "pedlars' district", i. e. the seven southern hundreds of the province of Älvsborg in the west of Sweden. In 1834 the first Swedish cotton weaving-mill was established at Rydboholm in that district by Sven Erikson, who is the most prominent figure in the history of the Swedish cotton industry. Erikson began his career by going about as a pedlar, selling the cloth made by his mother, and before he died he had created a home-weaving industry which gave occupation to more than 1,500 women and girls and had also established important cotton factories at Rydboholm, Rydal and Viskafors. Even to-day — as will be seen from the accompanying sketch-map — the cotton industry is still concentrated within that same district: Viskadalen, its metropolis being the town of Borås. The diagram shows how greatly the number

— THE TEXTILE AND TAILORING INDUSTRIES —

of hands employed in this industry has increased during the past few decades. The number of spindles in the cotton industry amounts at present to no less than 550,000 and the number of looms to 14,500.

Although the Swedish cotton industry — like the woollen industry — stands on a very high technical level, there is nevertheless a not inconsiderable import of manufactured cotton goods. The chief cause of that is that certain of the finer special counts cannot be produced in this country at a profit. That notwithstanding, it is estimated that the share taken by the Swedish cotton industry in supplying the home demand for cotton yarn amounts to more than 90%. As regards fabrics it is true the above figure is not attained, but the accompanying diagram shows that — apart from the catastrophic fluctuations during 1918 to 1920 — Swedish-made cotton goods occupy a predominant place in the home market. The diagram also bears witness to the vigour and future possibilities of this branch of industry, for although production almost ceased during the last years of the Great War, when quantities of foreign-made



goods were dumped upon the country to compete with the Swedish article, it was able in a very short time to regain its former predominant position.

As a rule the larger mills are of the combined type, i. e. they embrace both spinning and weaving; besides these there exist both independent spinning-mills and independent weaving-mills. A number of factories also do piece-dyeing and printing both of their own and of imported fabrics. In addition to their principal manufactures in the cotton branch some mills also make woollen or halfwoollen goods. Finally it may be pointed out that the cotton industry also embraces a number of mills which manufacture only cotton-wool and cotton-waste.

The organs of the Swedish cotton industry are the Swedish Cotton Manufacturers' Association (Svenska Bomullsfabrikantföreningen) and the Swedish Cotton Spinning Mills Association (Svenska Bomullsspinneriföreningen), both in Göteborg, and the Association of Manufacturers of Coloured Cottons (Förenin-



Weaving-room (Stockholms Bomullsspinneri och Väveri A.-B.).

gen av fabrikanter av kulörta bomullsvävnader), in Borås. In this connection there should also be mentioned the Weaving School at Borås. It was opened in 1866 and was enlarged in 1884 to embrace hosiery and knitted goods. One department, for male pupils, is engaged in training the future foremen and manufacturers; in the department for girls the pupils are instructed in artweaving and domestic textile industries.

Of the combined cotton mills the following are the principal: *Bords Väveri A.-B.*, Borås, employing about 2,000 hands; other large enterprises are *Gamlestadens Fabrikers A. B.* and *Claes Johansson & C:os Väveri A.-B.*, both at Göteborg; *Norrköpings Bomullsväveri A.-B.* ("Tuppen") and *Holmens Bruks & Fabriks A.-B.*, both at Norrköping, each employing close upon, or more than, 1,000 men. The following are not much inferior as regards size: *Stockholms Bomullsspinneri & Väveri A.-B.*, Stockholm, *Manufaktur A.-B. i Malmö*, Malmö, and *Rydboholms A.-B.* with mills both at Rydboholm and Viskafors. The following may also be noted — in approximate order of size: *L. J. Wingqvist, Fritsla, A.-B. Sjuntorp*, Upphäråd, both with more than 500 hands, *Gävle Manufaktur A.-B.*, Strömsbro, *Strömma Bomullsspinneri A.-B.*, Karlshamn, *Ahlafors Nya Spinneri A.-B.*, Göteborg, *Kampenhofs A.-B.*, Uddevalla, *Hargs Fabrikers A.-B.*, Nyköping, and *Dala Väveri A.-B.*, Molkom.

— THE TEXTILE AND TAILORING INDUSTRIES —

Among the independent cotton-spinning mills the following may be mentioned: *Nääs Fabriks A.-B.*, Floda station, *Rydals Manufaktur A.-B.*, Kinna, *Åkerlunds Bomullsspinneri A.-B.*, Borås, *A. B. Perioden*, Norrköping, and *Aug. Werner & Cos Fabriks- o. Handels A.-B.*, Göteborg.

The following are some of the independent cotton textile manufacturers: *Alingsås Bomullsväveri A.-B.*, Alingsås, *Mölnlycke Väveri A.-B.*, Mölnlycke, *Drufvefors Väveri A.-B.*, *Wiskabergs Fabrikers A.-B.*, *Katrinédals Väveri A.-B.*, *Österdalens A.-B.* and *A.-B. Dalhems Väveri*, the last five at Borås, and *Kinnaströms Väveri A.-B.*, *A.-B. Claes Häkansson*, *Ludvig Svensson (Kinnamarks Mekaniska Väveri)* and *Marks Textilfabrik*, all four at Kinna, *A.-B. Brännö*, Kinnared, *A. J. Borgs Väveri A.-B.*, Kinnahult, *Carlsbergs Väveri A.-B.*, Mölndal, *Säters Väveri A.-B.*, Säter, and *L. P. Kruse & Son*, Malmö.

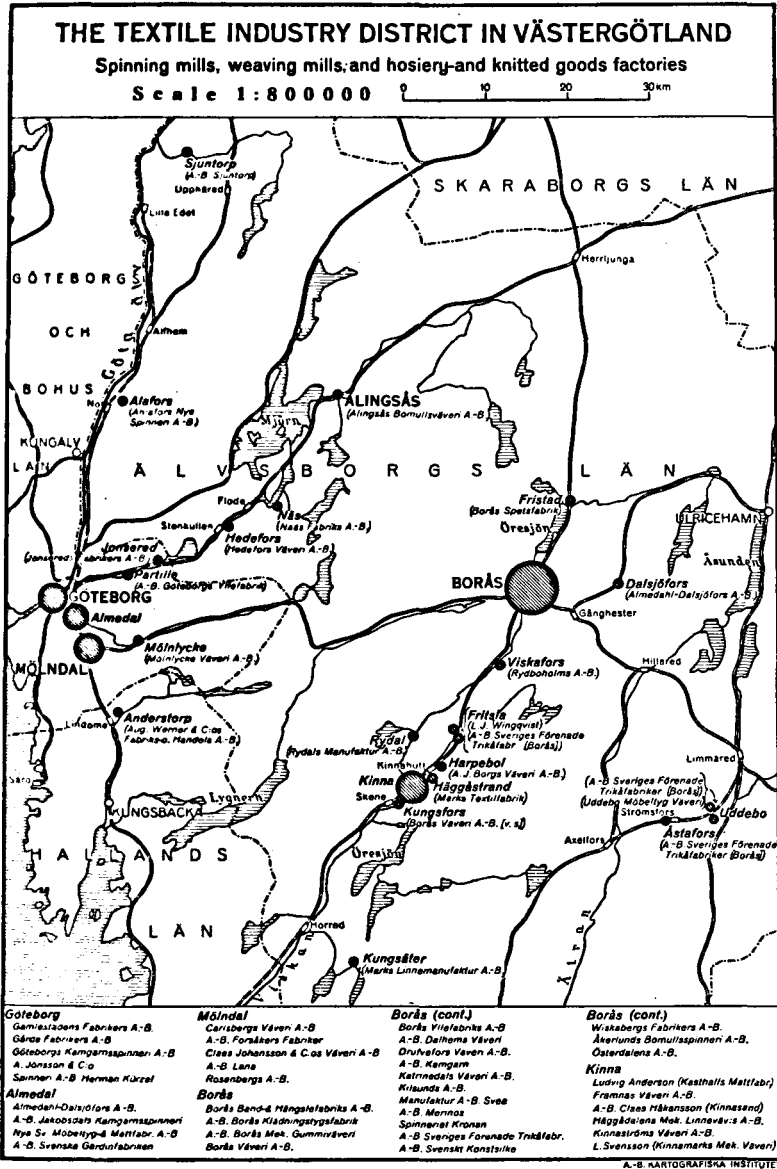
Among the cotton-wool factories the following may be noted: *A.-B. Stockholms vaddfabrik*, Stockholm, *A.-B. Axel K. Bergvall & Söner*, Norrköping, and *Mosås Vaddfabrik*, belonging to the firm of *Johnson & Hill*, Örebro.

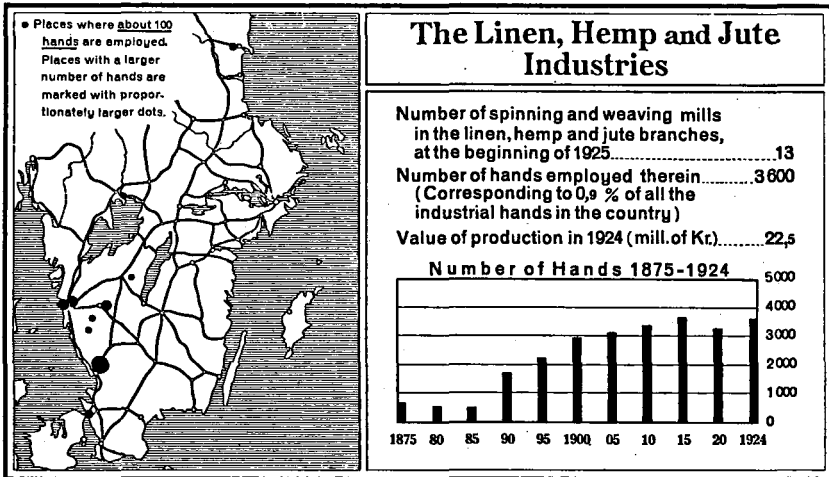
In this connection it may be mentioned that cotton driving-belts are made by *Jonsered's Fabrikers A.-B.*, Jonsered, *Göteborgs Remfabriks A.-B.*, Göteborg, and *Fredfors Fabriks A.-B.*, Sundbyberg.

THE LINEN AND JUTE INDUSTRIES.

The manufacture of linen goods out of a raw material of native origin has been carried on as a domestic industry in Sweden from time immemorial. The linen-industry on factory lines, which may be considered to have originated with the establishment in 1846 of the Almedahl linen-spinning mills near Göteborg, also started with Swedish raw material. During the latter part of last century the cultivation of flax in Sweden declined very greatly and the consequence was that the linen industry was obliged to satisfy its demands for raw material chiefly from abroad. It is true that during the Great War attempts were made, fostered by the State, to put fresh life into the cultivation and preparation of flax in the country, but this movement has died out and at the present time the native cultivation of flax is of little importance as a source of raw material for the linen industry.

During the last few decades the Swedish linen industry has made steady progress. The production of linen and also of hemp yarn has in an increasing degree managed to satisfy the home demand and during the last few years there has even been a slight balance for export. As regards linen fabrics it may be said that at present the Swedish production supplies about three-quarters of the home demand. The goods consist not only of coarse fabrics, such as sail cloth and tarpaulins, canvas, drill, saddle-girth fabrics, driving-belts, hoses etc., but





also of medium fine and fine cloths such as sheetings, towellings and table-cloths etc. Swedish linen cloths have long been renowned for their excellent quality.

The largest undertakings in the linen branch are *Almedahl-Dalsjöfors A.-B.*, Almedal, employing a total of 900 hands, *Holma-Helsinglands Linspinneri & Väveri A.-B.*, Forsa and Madängsholm, *Häggedalens Mek. Linneväveriers A.-B.*, Kinna. *Jonsereds Fabrikers A.-B.*, Jonsered, are engaged in the manufacture of coarse products of flax, hemp, jute, and cotton. The following may also be noted: *Marks Linnemanufaktur A.-B.*, Kungsäter, and *Skandinaviska Jute-Spinneri & Väveri A.-B.* with a linen factory at Oskarström.

The jute industry is of considerably more recent date than the other branches of textile industry already mentioned. It commenced in Sweden at the close of the eighties of last century, and was based on jute imported chiefly from the East Indies which, owing to its cheapness and strength, is specially suitable for the manufacture of packing and carpet fabrics. Before the imposition of a duty in 1888 the whole demand of the country for jute goods was supplied by imported goods. But two factories were established the very next year and ever since then the Swedish jute industry has supplied the main part of the jute yarn, the packing canvas, sackings and baggings and the other jute goods that are required.

The principal undertaking is *Skandinaviska Jute-Spinneri & Väveri A.-B.*, Oskarström, which includes jute-spinning mills, jute cloth factories, ropeyards and sack

— THE TEXTILE AND TAILORING INDUSTRIES —

manufactories and also linen mills at the above-mentioned place; this undertaking employs more than 1,000 hands. *Skånska Jutfabriks A.-B.*, Hälsingborg, also owns spinning and weaving mills and employs 300 hands. The output of both of these firms is disposed of to customers by *Svenska Jutfabrikernas Centralkontor*, Halmstad. The firm of *Jonscreds Fabrikers A.-B.* mentioned above under the linen-industry, also owns spinning and weaving mills in the jute branch.

In close connection with the jute industry are the plants for the manufacture of *carpets and upholstery fabrics*, for some of which jute forms the main raw material; others again make use of linen, cotton or wool on a larger scale than jute.

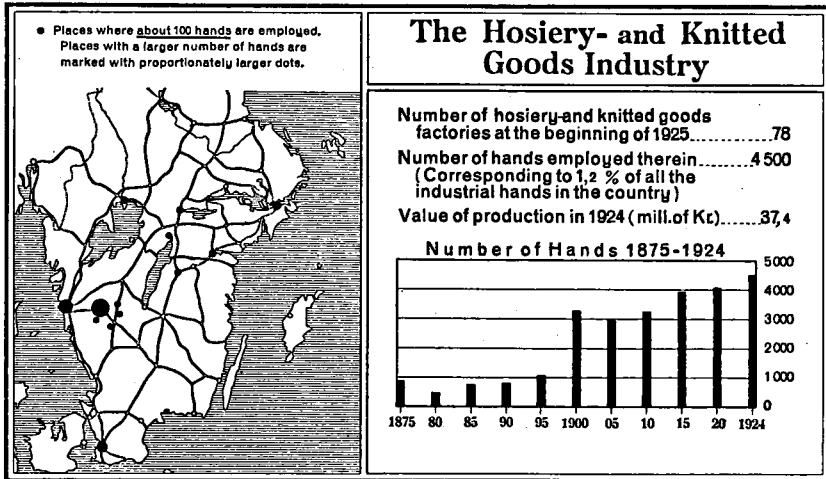
Among undertakings belonging to this category may be noted the following: *Nya Svenska Möbeltygs- & Mattfabriks A.-B.*, Göteborg, *Ludvig Anderson (Kasthalls Mattfabrik)*, Kinna, *Karlstads Spinneri & Väveri A.-B.*, Karlstad, and *Uddebo Möbeltyg Väveri*, Uddebo.

THE HOSIERY AND KNITTING INDUSTRIES.

The manufacture of hosiery and knitted goods as a factory industry has the character of a combined weaving and clothing industry in which the raw material, the yarn, is turned direct into the finished articles, such as stockings, vests etc. In addition to such goods turned out by the piece, there are of course also fabrics made in long-lengths, but the sewing work for the manufacture of articles of clothing out of such fabrics also takes place at the hosiery and knitted goods factories.

The man who first introduced knitting-machines into Sweden was Kristofer Polhem. He also had some stocking-looms constructed at Stjernerund at the beginning of the 18th century, much of the mechanism of which was his own invention. An important innovation in this branch was made in Sweden in the eighties of last century: PER PERSSON invented the counting-apparatus for pattern-knitting, which relieves the worker from troublesome and tedious counting. A variety of ingenious machines, both circular looms and knitting-machines, worked by hand or by motor-power, are nowadays employed in the industry to the great increase of its output. With a so-called "Lamb's machine" a workman can make from 8 to 10 pairs of stockings every day or double that number of socks.

The Swedish hosiery and knitted goods industry, which had its origin in domestic hand-knitting, dates from the first half of the 19th century. It developed rather slowly however until the close of the



A.-B. KARTOGRAFISKA INSTITUTET

'nineties, when a flourishing period began which was partly the result of the increase of import duties on certain of the articles. The last few decades present a comparatively uniform and satisfactory development.

The consumption is almost entirely domestic and the industry satisfies about three-quarters of the home demand. This branch of industry, especially during the last few years characterized by the great variety of novelties in the hosiery and knitted goods department, has proved to possess an astonishing power of adaptability and great initiative in seizing on new ideas to suit the demands of the day.

Female labour is employed to a far greater degree in the hosiery and knitted goods industry than in any other branch of manufacture, no less than about 90 % of the total number of hands being women and girls.

In this branch a prominent position is taken by *A. B. Sveriges Förenade Trikkfabriker*, Borås, which was formed in 1913 by an amalgamation of 17 separate factories, representing about one-third of the stockinet products of the whole country and employing altogether 1,400 hands. The next largest enterprise is *Gårda Fabrikers A. B.*, Göteborg, with about 500 hands. The following may also be mentioned: *Malmö Mek. Tricotfabriks A. B.* and *Svenska Tricotfabriks A. B.*, both at Malmö, *A. B. Värmlands Trikkfabrik*, Karlstad, *A. B. Strömna Tricotfabrik*, Karlshamn, *A. Jönsson & Co. Trikk A. B.*, Göteborg, *A. B. Norrköpings Tricotfabrik* and *A. B. Axel K. Bergvall & Söner*, both at Norrköping, *Emil Petterssons Trikkfabrik* and *Albert Terberger, A. B.*, both in Stockholm, *Sem L. Stawe*, Karlstad, and *A. B. Askersunds Trikk-*

— THE TEXTILE AND TAILORING INDUSTRIES —

fabrik, Askersund. Mention may be made here of the fact that, of the above cloth mills in the woolen and cotton industries, which are also engaged in the making of stockinet, the following are the principal: *Stockholms Bomullsspinneri & Våveri A.-B.*, Stockholm, *Manufaktur A.-B. i Malmö*, Malmö, and *Wallbergs Fabriks A.-B.*, Halmstad.

THE SILK AND ARTIFICIAL SILK INDUSTRY. Side by side with the other branches of textile industry there was carried on in Sweden during the 18th and 19th centuries a not unimportant manufacture of silk goods, which was encouraged by the passing of special commercial measures through Parliament. When about the middle of the 19th century those measures were allowed to lapse the industry gradually declined. At the present time there is only one firm that carries on the manufacture of woven silk goods, although only on a very small scale.

So-called artificial silk, which is made from woodpulp, has during the last few years attracted very great attention and, as far as one can judge, bids fair to become a textile manufacture of great importance. Owing to its quality the Swedish sulphite pulp is very suitable for manufacturing of artificial silk. The production of same has assumed very large proportions especially in America, England, Germany and Italy. In Sweden too the manufacture of artificial silk has begun and at present about 120,000 kilograms of artificial silk-yarn are produced yearly. The artificial silk produced in Sweden has for the most part been absorbed by the hosiery and knitted goods industries.

The only enterprise which has specialized in the manufacture of artificial silk from sulphite pulp is *A.-B. Svenskt Konstsilke*, Borås, with about 200 hands.

THE TAPE AND PACKTHREAD INDUSTRIES.

In consequence of the manifold uses to which *the manufacture of tape, braid etc.* can be put, chiefly as accessories in clothing and in shoe-making, those articles have gradually become of greater importance and scope. It is true that the industries connected with these branches are influenced to no small degree by variations of fashion, it being only in certain cases that the demand may be considered constant. The more important products in this connection are white cotton tape, trimmings, boot and shoe laces, garters, braces and furniture-cord.

Among the undertakings belonging to this category the following may be mentioned: *Fabriks A.-B. Skandinavien*, Malmö, which besides tapes also makes lace,

— THE TEXTILE AND TAILORING INDUSTRIES —

buttons etc., *A.-B. Borås Mek. Gummiväveri* and *Borås Band- och Hängslefabriks A.-B.*, both at Borås, *Svenska Band- och Snörmakerifabriks A.-B.*, Hälsingborg, *A. Svensson & Co.*, *Snörmakerifabrik*, Malmö, and *Gust. Barthels*, Göteborg, and also the above mentioned firm of *Gårda Fabrikers A.-B.*, Göteborg, which makes tapes.

The manufacture of packthread and cordage in Sweden dates back to the close of last century when it gradually began to develop out of the old handicraft of rope-making. Hackling and yarn-spinning machines showed themselves to be not only labour-saving but also to produce a better article, and so hand-spinning could no longer compete with machine-work. The most important raw material is hemp, of which considerable quantities are imported every year. Other materials are also employed, such as flax, cotton, jute, manilla and sisal hemp etc. The production covers about 90 % of the demand of the home market.

The principal enterprise is *Svenska Bindgarnsfabriken A.-B.*, Malmö. The following may also be mentioned in this connection: *International Harvester Co.*, Norrköping, *A.-B. Nykvarns Bindgarnsfabrik* and *Wahlbecks Fabriker*, both at Linköping, and *A.-B. Herman Gotthardt*, Malmö.

THE CLOTHING AND OTHER TAILORING INDUSTRIES.

The clothing industry in the real sense of the word — i. e. the factory-production of ready-made clothing — is one of the most recently established of the industrial branches in Sweden. It was not until the nineties of last century that it had any scope worth mentioning, but since then it has developed into an industry of considerable dimensions. It is divided into three main branches, which are fairly distinct from each other and differ with respect to the conditions both of production and competition.

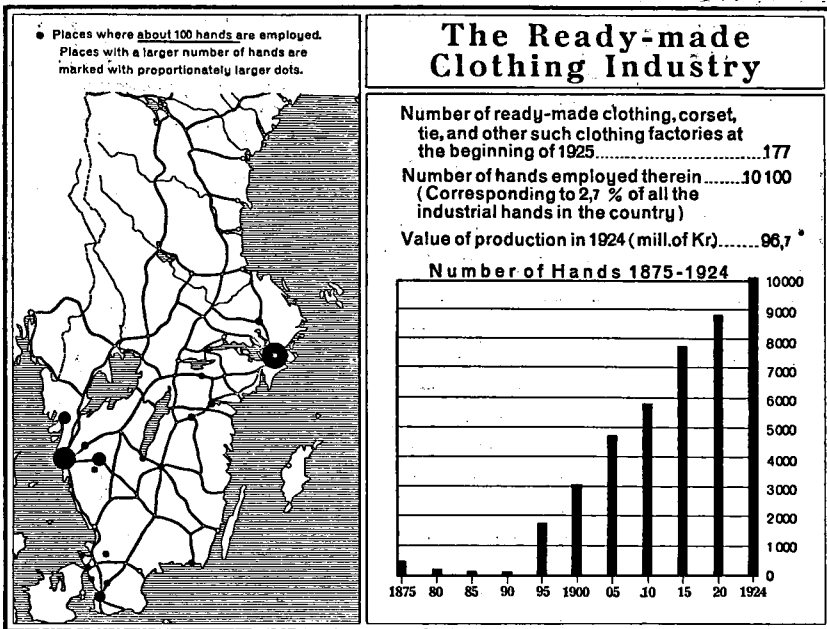
(1) *Men's Ready-made Clothing Industry.* This embraces the factory production of men's suits, overcoats, ulsters etc., and also a special branch of manufacture, the so-called "Borås ready-made clothing trade" in which the sewing and knitting are carried on as a domestic industry and which chiefly embraces working-men's clothes such as blouses, shirts, overalls etc. There does not exist however any sharp distinction between the two branches. Generally speaking this industry obtain 90 % of its raw material from Swedish textile factories. The production satisfies on the whole the demands of the Swedish market.



Work at a ready-made clothing factory (A.-B. J. A. Wettergren & Co.).

(2) Ladies' Ready-made Clothing (cloaks, costumes and skirts). This is a branch that in the 'eighties had already begun to be carried on on factory lines. Here too it is chiefly Swedish material that is made use of. The production in this branch is dependent on changes in fashion to a far greater degree than is the case in men's clothing; and here too foreign competition is rather severe.

(3) The lighter articles of ladies' clothing embraces the blouses, dresses, dressing-gowns, collars etc., of thin, airy materials, mostly of foreign origin. As far as the number of hands employed is concerned, this branch is considerably smaller than the two preceding ones. It arose as a result of the blouse-fashion which flourished at the beginning of the nineties of last century and which gave rise to an extremely large demand for the articles in question. The greater number of the Swedish concerns in the branch however started after the beginning of the present century. As new shapes and cuts come into fashion twice every year, production has to be organized with an eye to these rapid and incessant changes. The repeated selling off in Sweden of foreign goods, which have been left over as bad stock owing to the constant changes in the fashions, causes this branch great difficulties.



A.-B. KARTOGRAFISKA INSTITUTET

The largest ready-made clothing factory in Sweden is *A.-B. J. A. Wettergren & Co.*, Göteborg, which employs over 800 hands in the making of ladies' cloaks, costumes, and skirts. This firm also owns *Nya A.-B. Herr- och Gosskläderfabriken*, Göteborg, which makes men's clothes. There are four other large undertakings which are engaged in the manufacture of men's outfits and ladies' cloaks and similar garments, viz. *A.-B. Gunnar Collijn*, Stockholm, *A.-B. Hj. Söderberg*, Uppsala, and also two large stores in Stockholm, namely *A.-B. Nordiska Kompaniet* and *Paul U. Bergströms A.-B.* Among men's outfitters the following may be mentioned: *A.-B. Schwartzman & Nordström*, Uddevalla, *Henning Schlasberg & Co.*, Landskrona, *A.-B. L. & P. Widengren*, Vingåker, *A.-B. Kläderfabriken*, Nässjö, *Konfektions A.-B. Oscar Molander*, Alingsås, *A.-B. Erikson & Larson*, Borås, *A.-B. Fritsla Syfabrik*, Fritsla, *Carl Holten A.-B.*, Malmö, and *A.-B. Svensk-Engelska Herrkonfektionen Hjelm*, Örkel-ljunga. The following firms are engaged in the making of ladies' cloaks, costumes, and skirts: *A.-B. Béve & C:nis Kappfabrik* and *A.-B. Elis Fischer*, both in Stockholm, *A.-B. Moresco*, Malmö, *Konfektions A.-B. Leslie*, Göteborg, and *Sahlins Konfektions A.-B.*, Eslöv etc. The following names are those of makers of lighter articles: *Konfektions A.-B. H. Bengtson*, *Konfektions A.-B. Salén* and *Otto Halldéns Fabriks- & Handels A.-B.*, all three in Stockholm, and *A.-B. Gust. Uddenberg* and *August Erasmis Eftr.*, both at Göteborg,

The manufacture of *linen-drapery*, *corsets* and *neckwear* is closely allied to that of ready-made clothing and has been carried on on a

— THE TEXTILE AND TAILORING INDUSTRIES —

factory scale in Sweden since the nineties of last century. It is principally in consequence of the production of good-quality and good-wearing articles that these industries have succeeded in gaining a market for their products in spite of competition from countries which set the fashions. In all three branches the greater part of the home demand is nowadays supplied by Swedish makes.

Linen-drapery consists of shirts and collars, ladies' and children's underclothing, corset-protectors, aprons etc. For the most part the Swedish linen-drapery industry uses for its products raw materials turned out by the Swedish textile factories. The Swedish neckwear industry embraces the production of gentlemen's ties of silk and cotton. The raw materials in this branch are almost exclusively of foreign origin.

In the linen-drapery business the following firms may be noted: *Sveriges Förenade Linnfabrikers A.-B.*, *A.-B. Linnfabriken Merkur* and *A.-B. F. W. Hasselblad & Co.*, all at Göteborg, also *A.-B. Stenströms Skjortfabrik*, Hälsingborg, *Alingsås Linnfabriks A.-B.*, Alingsås, *Linköpings Linnfabriks A.-B.*, Linköping, and *Jönköpings Linnfabrik (Rudolf Herzog)*, Jönköping. The principal corsetmakers are *Konfektions A.-B. Karlsson & Starck*, Göteborg, *Arnbergs Corsettfabrik*, Höganäs, *Korsettfabriken Spirella A.-B.*, Malmö, and *A.-B. Svenska Korsettfabriken (Jansson & Co.)*, Stockholm. The leading tie-makers are *Amanda Christensen A.-B.*, Stockholm, and the firm of *I. Hedström*, Göteborg.

The manufacture of awnings, sun-blinds and tarpaulins constitutes a special group of industries. The yearly output corresponds approximately to the home demand for such goods.

Of enterprises belonging to this category the following may be noted: *A.-B. P. Ericsson & Co.* and *J. Dahlander & Cos Tapetfabriks A.-B.*, both at Göteborg, and *Norrköpings Regnkläders- & Presenningsfabriks A.-B.*, Norrköping. In this connection it may be mentioned that blinds are manufactured by *Haglund & Söners Handels & Fabriks A.-B.*, Falköping.

THE MANUFACTURE OF HATS AND CAPS. The Swedish *hat-factories*, a number of which were established some twenty-five or thirty years ago, embrace the manufacture of men's felt-hats and what are called "felt-stumps" (semi-manufactured felt-hats), and also the manufacture of ladies' hats and straw-hats. During the last few years the value of the home manufacture has been about equal to that of the imported articles.

Among hat-factories the following are the principal: *Karlskrona Hattfabriks A.-B.*, Karlskrona, makers of men's felt hats and hair-felt hats, and *J. A. Fors's A.-B.*, Fal-

— THE TEXTILE AND TAILORING INDUSTRIES —

köping, principally makers of men's felt hats. *A.-B. Sveriges Förenade Hattfabriker*, Malmö, is a financial amalgamation of four enterprises, chiefly engaged in the manufacture of women's hats, viz. *Nya A.-B. Levin Strå- och Filthattfabrik* and *A.-B. Rügheimer & Westrell*, both in Stockholm, *A.-B. Malmö Stråhattfabrik* and *Nya A.-B. Svenska Strå- och Filthattfabriken*, Malmö. Women's straw and felt hats are also made by *A.-B. Wilhelm Carlsson & Co.*, Stockholm, and *A.-B. Norrköpings Strå- & Filthattfabrik*, Norrköping.

The cap-industry in Sweden may be dated back to the seventies of last century. Even as late as the close of the century the greater part of the production was carried on as a pure handicraft, often in connection with some retail business. At present the manufacture is carried on as a rule at special cap-factories, although caps are also made at a number of factories in the ready-made clothing and fur-goods industries.

Of undertakings belonging to this category the following may be noted: *Aug. Holts Pels- & Mössfabriks A.-B.*, Stockholm, *L. Haglund & Co.*, Gävle, *Göteborgs Mössfabriks A.-B.* and *Alb. Bohlin & Co:s Nya A.-B.*, both at Göteborg, and *A.-B. Oscar Wigén*, Tranås.

THE DYEING, BLEACHING AND IMPREGNATING INDUSTRIES. Included among the textile and ready-made clothing industries are those concerned in the dyeing, bleaching and impregnating of textile goods, although in their nature they are chemical processes. The work in question is carried out either as an integral part of the process of manufacture at the mills, where the goods are produced, or else at the independent dye-works, bleaching-establishments and impregnating factories.

Among these undertakings the following may be mentioned: *Färgeri A.-B. Levanten*, Almedal, *A.-B. Nordens Textilfabrik*, Borås, *A.-B. Lundby Skönfärgeri & Kem Tvättanstalt* and *Eriksbergs Färgeri A.-B.*, both in Göteborg.





THE LEATHER, HAIR, AND RUBBER-GOODS INDUSTRIES.

THE TANNING INDUSTRY.

The existing Swedish tanning industry has developed in part from the ancient tanning handicraft, which was carried on as a guild-craft, and in part from certain privileged tanning enterprises, which arose in the 17th century, the so-called "English tanneries". These latter, in the course of time, encountered many changes of fortune, while by degrees the tanning handicraft on the basis of the guild-craft system grew stronger and stronger. The rivalry which existed from the very first between the two branches of the tanning business above mentioned continued until, with the disappearance of the guild-system in 1846, the difference also vanished between an "English tannery" and a "guild tannery".

At the close of the nineteenth century the tanning industry began to develop rapidly in the direction of large-scale manufacture. This was especially the case as regards the manufacture of sole-leather, which at the time mentioned, thanks to the increased duty put on it by Parliament in 1897, was enabled to enter energetically into competition with the imported sole-leather coming especially from America. One contributory cause of the rapid development of tanning was the flourishing state at that time of the boot and shoe industry, for that meant that the home consumption of factory-made leather greatly increased. At about the same period new and more rapid methods of tanning came into use.

As will be seen from the appended table, the larger concerns in the branch are nowadays chiefly concentrated in the southern part of the country, while in olden times the tanning industry was chiefly carried on in central Sweden, especially Stockholm.



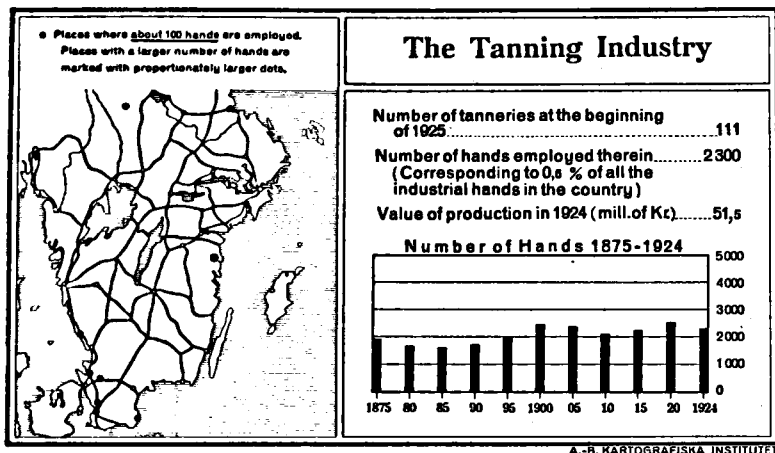
Interior of a Swedish Tannery (L. A. Matton, Gävle)

The Swedish tanneries employ considerable quantities of home-produced raw hides and skins, but there are extensive imports of foreign hides for their account, especially for the manufacture of heavy sole-leather, dubbed-leather etc.

The tanning-agents used in the process are chiefly obtained from abroad. It has been estimated that only about 17% of the demand for vegetable tanning-materials is covered by home-grown spruce-bark and oak-bark or oak-wood. Among imported tanning-materials the principal ones are quebracho extract, mimosa-bark extract and myrobalan, vellonea and chrome salts.

The manufacture of leather, if a good result is to be obtained, demands technical experience and judgment. Thanks to skilful management however the Swedish tanning industry has attained a position in which its products are acknowledged as first-class goods, whilst at the same time the manufacture has been developed in such a way as to satisfy in an ever-increasing degree the home demand for leather, although that too has rapidly increased.

The greatest consumer of leather is the boot and shoe trade. Less important are the manufacturers of travelling-bags etc., leather-

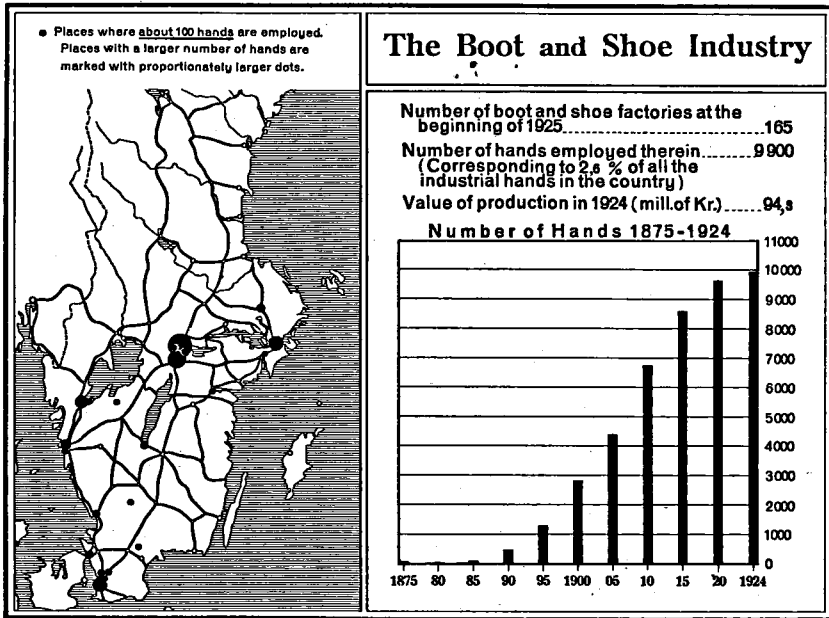


belt factories, glove-factories, saddlers etc. While the production of sole and insole leather is practically sufficient for the home demand, some 15 % of the demand for other kinds of leather and skin, on the basis of value, is satisfied by imported goods.

The largest tanning enterprises are *L. A. Matton*, Gävle, a firm which makes exclusively sole-leather, *C. J. Lundbergs Läderfabriks A.-B.*, Valdemarsvik, which concentrates especially on the making of upper leather, and *A.-B. Ehrnberg & Sons Läderfabrik*, Simrishamn, who manufacture practically all kinds of leather (specially dyed leather and skins). The following are also important firms: *A.-B. Wilh. Grönwalls Läderfabrik*, Ängelholm, *Chromgarveriet Klippan A.-B.*, Klippan, and *A.-B. Dan Lundgrens Läderfabrik*, Falkenberg, *Malmö Läderfabriks A.-B.*, which, besides leather, also make shoes, and *Malmö Handsk- och Glacéläderfabriks A.-B.*, Kävlinge. The following may also be mentioned here: *A.-B. Läderfabriken Öresund*, Malmö, *A.-B. Alfr. Lindgrens Läderfabrik*, Karlstad, *Carl Gillberg*, Örebro, *Martin Levissons Söners Läderfabriks A.-B.*, Göteborg, *Läderfabriks A.-B. Göta*, Alingsås, *A.-B. Lilljedahlska Läderfabriken*, Sölvesborg, and *A.-B. Norrvikens Läderfabrik*, Borås. Finally reference may be made here to *And. Eliassons Läderindustri A.-B.*, which is the largest of several tanning enterprises of no inconsiderable size in the parish of Malung in Dalarna.

THE BOOT AND SHOE INDUSTRY.

The factory-production of boots and shoes in Sweden as well as abroad is a comparatively recent industry. The mechanical devices



A.-B. KARTOGRAFISKA INSTITUTET

which have brought about a transition from handicraft to large-scale production in this branch were invented and first utilized in U. S. A. It was the pegging-machine and the sewing-machine that in the middle of the nineteenth century there made a complete revolution in the making of boots and shoes; a couple of decades later that was consolidated by the so-called Goodyear welting machines, for thereby an entire system of most ingenious labour-saving machinery had been provided for the various details of this branch of industry.

This new method of manufacture reached Sweden at the beginning of the seventies of last century. In 1873 A. F. CARLSSON started the first Swedish boot and shoe factory at Vänersborg. Even as late as 1890 however the Swedish boot industry was still in its infancy though later it experienced a period of great prosperity. Not the least among the contributory factors were the protective duties, which were imposed in 1897 to foster this industry because it had suffered severely from foreign competition. The diagram on this page shows the extremely vigorous development that has characterized the Swedish boot and shoe industry since the nineties of last century. As will



Sewing-work at a boot and shoe factory.
(Nya Skofabriks A.-B. Örnén, Örebro).

— THE LEATHER, HAIR AND RUBBER-GOODS INDUSTRIES —

be seen, the number of hands employed has become many times greater during the period.

Almost half of the shoe factories are concentrated in the central parts of the province of Närke, especially in and about Örebro and Kumla, where shoemaking had long been carried on as a domestic industry on a large scale before it became a factory one.

The manufacture of boots and shoes is far from simple in character. In few industries are the details of the work distributed amongst so many special machines as in shoemaking. For the production of one shoe in an up-to-date factory there is required the co-operation of about 100 different machines. Selling conditions in the shoe-trade in Sweden are such that the larger boot and shoe factories in general are obliged to make all varieties of boots and shoes, whereby an otherwise much to be desired specialization in the branch is precluded. The American boot industry, on the other hand, has as a rule one speciality for each factory. Hence at a Swedish boot factory with the constant change there is in fashion the number of different models is very large, amounting in some cases to as many as 20,000.

The work in boot and shoe factories is to a great extent done by women and young people under twenty-one years of age, about 40 % of the total number of hands belonging to these categories. Of the raw material consumed at the factories the sole-leather comes almost exclusively from Swedish tanneries, while on the other hand, as regards the uppers, the largest item of a boot and shoe factory, about one half is imported. The output of the Swedish factories in this branch is known for excellent quality, good fit and very often really elegant finish.

There exist no statistics relating to the number of boots and shoes manufactured earlier than 1913; since that date, however, the annual production has been between 6 and 8 million pairs. Even in 1910 the production sufficed for 99 % of the home demand. After the war there was a temporary import of American goods in consequence of the high prices and the scarcity of material then prevailing in Sweden, but nowadays the production is greater than the demand in the home market. As a result a certain interest is directed towards export.

Of the shoe factories in the country the following are the principal: *A.-B. A. F. Carlssons Skofabrik*, Vänersborg, the oldest and at the same time the largest enterprise in this branch in Sweden, with factories at Vänersborg and Göteborg,

— THE LEATHER, HAIR AND RUBBER-GOODS INDUSTRIES —

employing altogether 800 men. After this firm come *A.-B. Stockholms Skofabrik*, Stockholm, *Malmö Skofabriks A.-B.* and the shoe-factory of *Malmö Läderfabriks A.-B.*, both at Malmö, and *A.-B. L. E. Larsson & Co.*, Uppsala, each of the three employing about 300 workmen. The following enterprises may be noted in Örebro: *Nya Skofabriks A.-B. Örnén*, *Skofabriks A.-B. Oscaria*, *A.-B. J. Pehrson & Comp.*, *Svenska Skoindustri A.-B.*, *Örebro Skofabrik*, *A.-B. Skofabriken Victoria*, *A.-B. Skofabriken Rex*, *A.-B. Skofabriken Svea*, *A.-B. Skofabriken Skandia*, *A.-B. Almquist & Johansson*, *Skofabriks A.-B. Kronan*, *A.-B. Marks Skofabrik* and *A.-B. Emil Edling*, and the following enterprises at Kumla: *A. G. Anderssons Skofabrik*, *C. G. Ström*, *C. A. Jonsson*, *A.-B. Skofabriken Sture*, *Kumla Skofabrik (Carl Nilsson)* and *A.-B. Lundholms Skomanufaktur*. At Göteborg the following factories may be noted: *A.-B. Carl Alms Skomanufaktur* and *Gårda Skofabriks A.-B.*; and in Skåne the following companies: *A.-B. Kjöfvinge Läder- & Skofabrik*, *Kävlinge*, *Eslöfs Skofabriks A.-B.*, *Eslöt*, *Malmgrens Skofabriks A.-B.*, *Hälsingborg*, *A.-B. Ramlösa Skofabrik*, *Ramlösa*, *Knislinge Skofabriks A.-B.*, *Vanås*, and *A.-B. L. O. Wallenbergs Skofabrik*, Malmö. Finally, reference may also be made here to several well-known enterprises in other districts, namely: *A.-B. John Löfquists Skomanufaktur*, Jönköping, *Kembels Skofabriks A.-B.* and *A.-B. Nordisk Skoindustri*, both in Stockholm, *A.-B. J. Bryntesson & Co.*, Skara, and the firm of *Carl Francke* (felt-shoe factory) and *A.-B. Janne Richardson*, both the last-mentioned at Halmstad.

THE FUR AND SKIN INDUSTRY AND THE BRUSH- MAKING INDUSTRY.

The making of fur-goods has been carried on in Sweden from olden times, but the factory-production of such goods can hardly be said to have existed before 1889.

Strictly speaking the greater part of the Swedish fur-goods factories should really be regarded as ready-made clothing factories, for the industrial treatment does not consist, in most cases, in the preparation or dyeing of the furs, these being imported ready prepared, but only in the work of sewing and trimming. Swedish fur-goods consist of better-quality men's and ladies' fur coats and cloaks, boas, muffs etc., and also sheepskin coats, rugs, etc., for which latter articles Swedish raw material is employed on a large scale. The manufacture of the former class of goods is carried on in the larger towns of Sweden while that of the latter kind is to a very great extent concentrated around Tranås and in the parish of Malung in Dalarna; at both those places there are a large number of firms working in this branch. The output is sold chiefly in Sweden, for exports are insignificant. On the

— THE LEATHER, HAIR AND RUBBER-GOODS INDUSTRIES —

other hand ready-made fur goods have been imported on a large scale during the last few years.

The principal furriers are *A.-B. Skandinaviska Pelsvarufabriken, Stockholms Pelsvarufabriks A.-B.* and *A.-B. C. J. Lindners Pelsvaruindustri*, all in Stockholm; *A.-B. Svenska Pelsvarufabriken* at Göteborg, *A.-B. C. & M. Fougstedt, Pelsvarufabrik, Eftr. and Hj. Drucker & Son*, both at Malmö. The following may also be noted: *A.-B. Oscar Wigén* and *A.-B. Fritz Lundberg*, both at Tranås, and *A.-B. S. P. Persson*, Malung. Among the smaller enterprises the following may be mentioned: *A.-B. Trands Skinnberederi*, Tranås, and *Johan Jonsson*, Överhörnäs.

The manufacture of gloves in Sweden was classed as a factory industry as early as in the 18th century. The modern glove-manufacture however has no direct connection with that earlier production of French and reindeer or doeskin gloves, which was introduced into Sweden during the so-called "Period of Liberty" (the middle of the 18th century) and which gradually died out. The existing Swedish glove manufacture does not date farther back than the middle of last century. The production covers about two-thirds of the home demand and is mostly localised to Skåne.

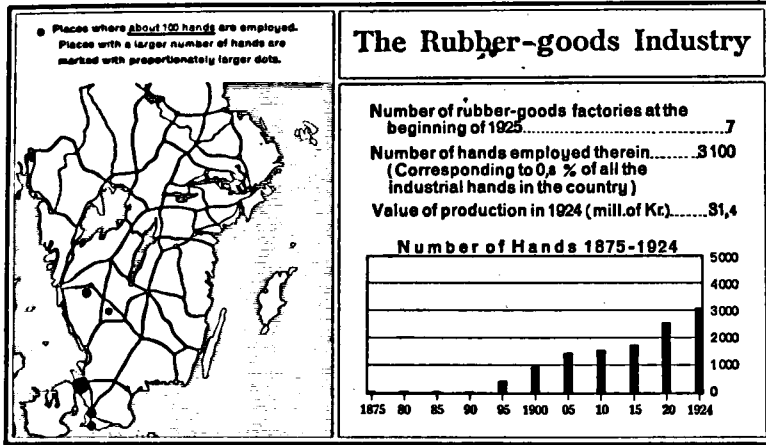
Of enterprises belonging to this category may be noted *Hugo Nordströms Handsk-fabrik*, Lund.

Travelling-trunk factories, portfolio factories, leather-belt factories and saddlery-shops carried on as factories, did not become of any great importance in Sweden until the nineties of last century. During the past quarter of a century however these branches have shown a not unimportant development and have become a "quality" industry, which has increased the reputation of the goods. The production of these articles satisfies quite two-thirds of the home demand.

Among trunk-makers the following are the largest: *A.-B. John A. Gahm* and the firm of *Fiedler & Lundgren*, both at Göteborg. Of saddlery-shops the principal are: *A.-B. Bröderna Claesson*, Kungälv, and *Militär Ekiperings A.-B.*, Stockholm. Of the machine-belt factories the following may be mentioned: *Svenska Remfabriks A.-B.*, Gislaved, *Sydsvenska Läder- & Remfabriks A.-B.*, Ängelholm, also *Fredfors Fabriks A.-B.* and *Kautschuks & Guttaperkavaru A.-B. Kuntze & Co.*, both in Stockholm.

Brush-making is carried on in Sweden both as a handicraft and — since the beginning of the seventies of last century — as a factory-industry. The output of brushes and paint-brushes supplies about two-thirds of the home demand.

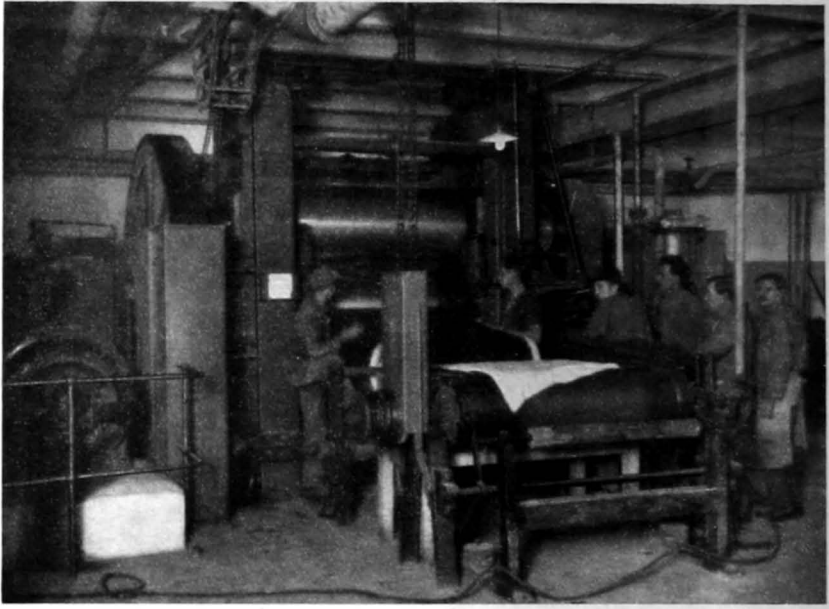
The largest and most noted brush and paint-brush factories are: *Stockholms Borstbinderi A.-B.*, *A.-B. F. Stocklassas Borst- och Penselfabrik*, Stockholm, and *A.-B. Husqvarna Borstfabrik*, Huskvarna. The following may also be mentioned in this connection: *A.-B. Joh. Ulrik Johansson*, Göteborg, and *A.-B. Borst & Penselfabriken*, Kristinehamn.



THE RUBBER-GOODS INDUSTRY.

It was not until the middle of last century that cautchouc or rubber — produced from the milky sap of certain tropical plants — began to be utilized to any greater extent. As the result of a series of scientific inventions and experiments concerning the chemical composition and qualities of the material, there were then created new and wider possibilities for the treatment of the article. Most revolutionary among the inventions was that of the so-called “vulcanization” method of eliminating the sensitiveness of rubber to changes of temperature and of giving rubber goods a solid lasting form by means of heating the material together with sulphur. Not until this discovery was made, was it possible to employ rubber freely for different purposes and for the factory-production of rubber goods. In the sixties of last century the rubber-goods industry began to develop — especially in Russia and U. S. A. — into a large-scale business. Since then this branch of manufacture has gone ahead vigorously and, especially during the last few decades, has won an ever-increasing range.

The industry was set on foot in Sweden in the 'seventies, though on a very humble scale, the manufacture embracing only certain kinds of packings and other simple articles. It was not until the 'nineties that



Up-to-date galosh-factory machine, a calander. (Hälsingborgs Gummifabriks A.-B.)
The web is here coated with rubber, and from this the galosh material is afterwards cut out.

the industry began to flourish as a result of the generally favourable economic conditions then existing in Sweden. This development is to some extent illustrated by the diagram showing the number of hands employed during the period.

The Swedish rubber-goods industry embraces, in the first place, the manufacture of galoshes, which has had a very vigorous development since the close of the nineteenth century. Even before the Great War it was found possible to almost entirely capture the home market in spite of a stubborn competition on the part of Russian factories. Now, when the competition of the great Russian enterprises no longer exists, Swedish galosh-factories have attained such success that they not only supply the country with the whole of its demand but are also able to export considerable quantities of galoshes and other rubber shoes. The foundation of this success is in no small degree due to the skilful commercial direction, to careful workmanship and to the great adaptability shown in supplying types of galoshes to suit all classes

— THE LEATHER, HAIR, AND RUBBER-GOODS INDUSTRIES —

of shoes and to meet the special wishes of customers. In consequence of the high quality of Swedish galoshes it has been found necessary to employ a relatively large amount of manual labour, more than half of which is female.

In addition to the manufacture of galoshes the Swedish rubber-goods industry has also taken up the manufacture of motor-car, bicycle and other tyres, tubes and pipings, mats, balls, rubber-stamps and technical rubber-goods. The production of many of these articles satisfies only a small part of the home demand. The manufacture of motor-car tyres especially is subject to extremely severe competition from abroad, where, in consequence of the more favourable conditions existing there, it is possible to take better advantage of specialization and standardization. The manufacture of balls and hard rubber articles has developed to such an extent that a considerable export of such goods has arisen.

Of the Swedish rubber-goods factories *Hälsingborgs Gummifabriks A.-B.*, Hälsingborg, is the largest enterprise with about 2,100 hands; next comes *Ryska Gummifabriks A.-B.*, Malmö (with 600 hands), then *Skandinaviska Gummi A.-B.*, Viskafors, and *Svenska Gummifabriks A.-B.*, Gislaved; galoshes are the principal product of these factories. *Trelleborgs Gummifabriks A.-B.*, Trelleborg, which is under the same management as the Hälsingborg factory, makes motor-car and bicycle tyres, technical rubber-goods, rubber-cloth, etc. *Uppsala Gummifabriks A.-B.*, Stockholm, (with factory at Ulvsunda) also make bicycle tyres, technical rubber-goods, etc.





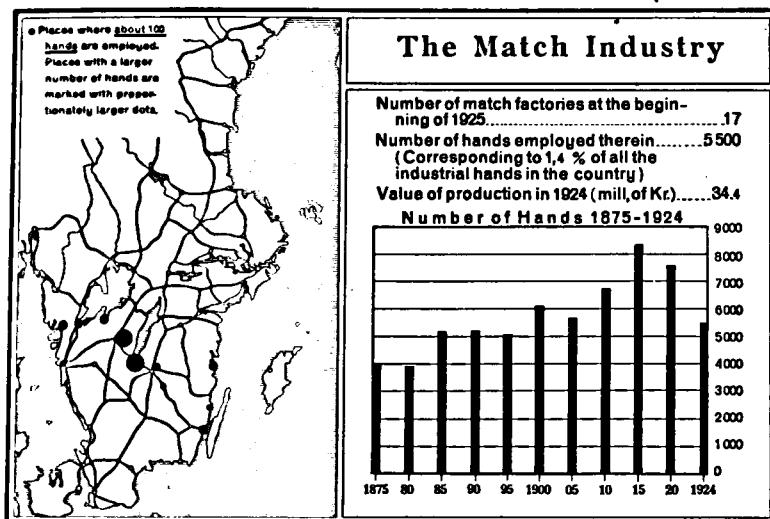
THE MATCH, OIL, FERTILIZER, EXPLOSIVES AND OTHER CHEMICAL INDUSTRIES.

Chemical industry in its widest sense may be considered as embracing all the productive activities in which chemical processes form an essential part. Such, for instance, are the metallurgical, the china and glass and the woodpulp industries, sugar-refining, brewing and spirit distillation, tanning, etc., which have been already dealt with in the foregoing pages. In the grouping of the industries, that is adopted in the official statistics and followed here, *chemical industry* represents a more restricted range of production, including the following groups: matches, oils and fats, fertilizers, explosives, colours and varnishes, destructive distillation and electro-chemical products, etc.

Since the eighties of last century the chemical industries in Sweden have developed immensely, a fact which is fairly accurately illustrated by the diagram on p. 250 showing the number of workers employed during the period 1875—1924. This diagram, however, does not include the match industry, for which a separate diagram will be found on the following page. The remarkable increase in the number of employees after 1910 is principally due to the great expansion of the electro-chemical and the explosives industries. The chemical industries are not homogenous: their raw materials and products and also their manufacturing processes are all of the most varied kinds.

From the appended map (p. 250) it will be seen that these industries are largely concentrated in the capital and in Göteborg and Malmö.

The safeguarding of the interests of the chemical industries is in the hands of an association, formed in 1917, the Federation of Swedish Chemical Industries (Sveriges Kemiska Industrikonator), Stockholm.



EDVARD LUNDSTRÖM, "the Father of the Swedish Match Industry", based his production of "safety matches" on this invention when he and his brother, Carl Frans Lundström, a couple of years later opened his new match factory at Jönköping. The name "safety matches" has its origin in the fact that these matches, unlike phosphorus matches, "ignite only on the striking-surfaces of the box", thereby removing the danger of fire present in the easily ignited phosphorus matches.



Johan Edvard Lundström.
b. 1815 d. 1888.

With an unerring eye to the future the brothers Lundström continued to develop the Pasch invention, both technically and commercially. The production of matches in Jönköping increased with extraordinary rapidity. During the following decades, the output was doubled many times over, thanks to the skilful leadership of the manager, Mr. BERNHARD HAY, and to the exceptionally able technical intelligence-work directed towards improving methods of production, which resulted in a number of valuable patents. The phenomenal success naturally led to the rise of a considerable number of rival concerns.

From the very outset the production of the Jönköping factory was organized to a great extent for export. Swedish matches rapidly gained international renown in consequence of their superior quality. At the present time by far the greater part of the output goes abroad, Swedish matches being shipped to practically every country in the world, among which the British Empire, Holland and its colonies, and U. S. A. are the chief customers. For a long time the most dangerous competitor was Japan, which owing to its plentiful supply of cheap labour and its close proximity to some of the largest match markets, worked up a considerable export to China and to the Dutch and British Indies. The Japanese matches, however, have never come up to the high standard of the Swedish product, and in the last few years they have been largely ousted from several markets, especially the Indian. Probably no country can boast of an industry which has maintained its superiority against all foreign competitors for such a long period and so completely as the Swedish match industry.

The most important raw material of the match industry is the wood for the matches and the boxes. For the matches themselves

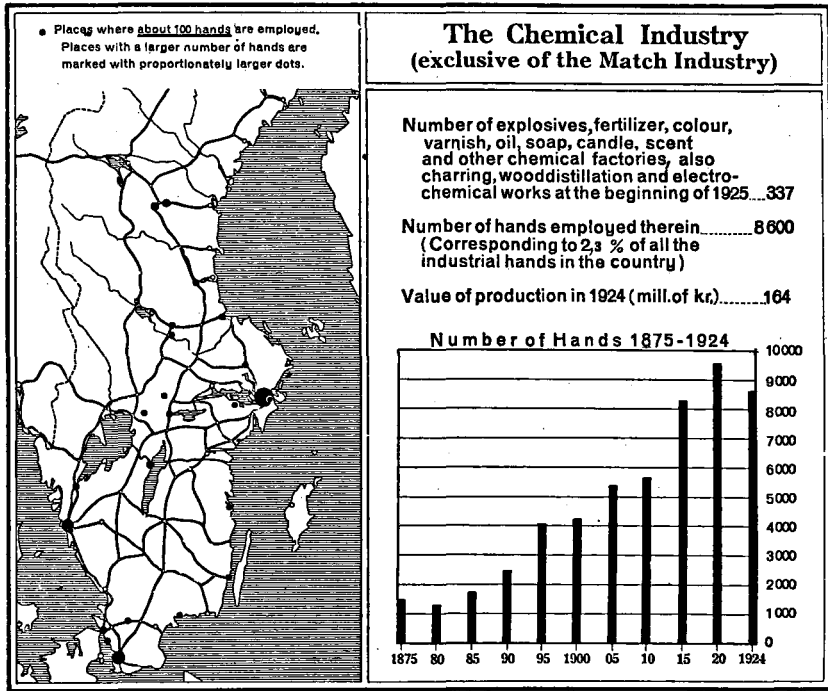
— THE MATCH, EXPLOSIVES AND OTHER CHEMICAL INDUSTRIES —

Swedish and foreign aspen-wood is employed; but, owing to technical improvements, the match industry will be able, if necessary, to make use of Swedish alder, birch or fir. The supply of foreign aspen-wood is, consequently, not now a primary factor, although the match factories continue to import rather large quantities of that timber from the other side of the Baltic. Of the other important raw materials used in the match-manufacture, all the chlorate of potash, and the bulk of the paper are made at subsidiary works. This is also the case with the match-making machines.

Probably no other industry employs such complicated and ingenious machinery as the match-industry. Multi-process machines are used to a great extent, and of these one invented in the 'seventies by ALEX. LAGERMAN is the best known. This machine, which both "dips" the matches and fills the boxes is, after fifty years of use, still running, a splendid example of the incomparable value of the invention. The largest multi-process machines turn out up to 40,000 boxes of matches per hour.

In 1917, the Swedish match industry came under one direction, all the factories being absorbed by the newly-formed Swedish Match Co., Ltd., the share capital of which is at present 270,000,000 kronor. This Company is by far the largest in the world in its branch. During the last few years the Company has, partly with the aid of foreign capital, secured powerful interests in the match industries of various countries, so that at the present moment more than one-third of the world's total match production is under the ultimate control of the Swedish Match Co. The Company produces at its Swedish and foreign factories 10 milliard boxes of matches annually, or 30,000 matches per second. The ability with which this comprehensive international enterprise has been built up by Mr. IVAR KREUGER and his fellow-workers has assured the Company an absolute control of all the more important markets, thereby further improving the future prospects of the Swedish match industry.

Svenska Tändsticks A.-B., Stockholm, are owners of *Jönköpings och Vulcans Tändsticks A.-B.*, Jönköping, with factories at Jönköping, Smålands Anneberg, Tidaholm, Uddevalla, Vänersborg and Västervik, employing altogether 4,300 hands, and also of *A.-B. Förenade Svenska Tändsticksfabriker*, Stockholm, with factories at Göteborg, Kalmar, Lidköping, Mönsterås and Vetlanda, employing together 1,200 hands.

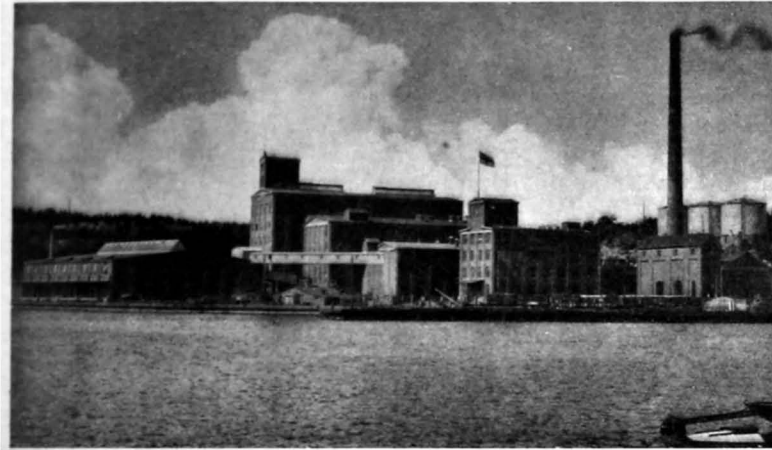


THE OIL AND FAT INDUSTRY.

In the old days the inhabitants of the northern countries were obliged to supply their requirements of oils and fats from the animal kingdom; but with the development of the means of transport and the great increase in the consumption of fats, the vegetable world of Southern climes, and of the tropics in particular, has been utilized on a steadily increasing scale to supply these needs.

In addition to animal fat, chiefly obtained from tallow and other slaughter-house products, however, vegetable fats have long been produced in Sweden in small primitive oil-mills in the districts where flax and rape were cultivated. In the latter part of the 19th century, however, the cultivation of flax was largely discontinued; and this led to a complete reorganization of the whole industry.

The Oil Industry at the present time comprises a small number of large factories, situated in the neighbourhood of seaports, and is based



Oil and Cattle-food factory, Karlshamn (Reymersholms Gamla Industri A.-B.).
In the background, the silos; in the foreground the press- and extraction works
and the refinery.

exclusively on the use of imported raw materials, not only linseed and rape-seed, but also copra (from which cocoanut-oil is obtained), soya beans, palm-kernels and ground nuts. From linseed, rape-seed, copra and ground nuts the oil is obtained by means of pressure, the residue being made into cattle food. The soya bean is treated either by pressure or extraction, usually by the aid of petrol: in the former process oil and oil-cakes are obtained, in the latter, oil, with cattle meal as a bye-product. The oil of palm-kernel is obtained by extraction. The oils for foodstuffs are refined before use; the oils for technical purposes can in most cases be used direct.

The oil products are employed in a variety of ways. Linseed oil is used in the manufacture of soft soap, the preparation of paints, the impregnation of textile fabrics, the manufacture of putty, printing-inks, enamels, lacquers and linoleum, etc. Rape oil is used mostly as a lubricant. The raw soya bean oil is employed in the manufacture of soft soap; when refined, it makes a good cooking oil. From the ordinary cocoa-nut and palm-kernel oils soap is manufactured; from refined oils, margarine. The ground-nut oil is used in making margarine, and as a cooking oil. The oil cakes and meal form excellent

— THE MATCH, EXPLOSIVES AND OTHER CHEMICAL INDUSTRIES —

cattle-food, which during the last few years has come to be extensively used in Sweden.

The total production of vegetable oils, which is now more than five times greater than in 1900, supplies over 70 per cent. of the home consumption. The manufacture of oil cakes and meal in the same period has become more than six times greater, but even so it does not cover more than about 40 per cent. of the home requirements.

By treatment with hydrogen, oils and other fats can be transformed chemically, i. e. hydrogenated, thereby producing fats with a higher melting-point. Whale-oil, for instance, which is otherwise almost inedible owing to its rancid smell, can by hydrogenation and subsequent refining, be rendered perfectly odourless and tasteless, and useful for many purposes.

The making of oils and feeding stuffs is carried on by *Svenska Oljeslageri A.-B.* with mills in Stockholm and Göteborg, *Malmö Oljeslageri & Hoppachs Söpfungfabriks A.-B.* and *A.-B. Oljeraffinaderiet Ceres*, both at Malmö, *Reymersholms Gamla Industri A.-B.*, with oil-mill at Karlshamn, *Nya Margarin A.-B. Svea*, with oil-mill at Kalmar, and *Thorburns Söners A.-B.*, Uddevalla. *Extraktionsverken A.-B.*, Agnesberg, are makers of fish-oils etc. The only hydrogenating factory in the country is *A.-B. Henriksborgs Fabriker*, Henriksdal.

The manufacture of soap, washing-powders, cosmetics and antiseptics. The manufacture of these commodities on an industrial scale in Sweden may be said to have begun at the commencement of the 19th century, home-made soap having up to that time been extensively used. The most important products of this industry are soft soap, tablet soap and washing-powder, frequently combined with the manufacture of scents, eau de Cologne, toilet articles, dentifrices, pomades, etc.

In this industry there are a comparatively large number of undertakings, of which some cater only for local requirements, while others, by means of extensive publicity, have gained a market for their products all over the country. Both the leading firms and some of the smaller ones, have attained a high level, both technically and commercially.

The larger and best known enterprises in this branch in Stockholm are as follows: *Barnängens Tekniska Fabrikers A.-B.*, *Hyllin & Co:s Fabriks A.-B.*, *A.-B. Grumme & Son*, *Parfymeri F. Pauli A.-B.*, *A.-B. Wilh. Becker* and the firm of *Lars Montén*; also *Tekniska Fabriken Helios* and *Lazarol-fabriken (A. Lindahl)* and *A.-B. Oxygenol*; at Göteborg: *Fabriken Tomten*, *A.-B. Eneroth & Co.*, *Tvål- & Parfympabriken Viola A.-B.* and *Schéels Fabriker, A.-B.*; at Malmö: *A.-B. Fabriken Carl*, *Malmö Gamla Tvålfabriks A.-B.*, *A.-B. A. P. Sjöbergs Fabriker*, the firm



Moulding machines for stearine candles (Liljeholmens Stearinfabriks A.-B.).

of *M. Zadig, Malmö Oljeslageri & Hoppachs Såpfabriks A.-B.*, and the firm of *Joh. D. Andersson*. The following may also be mentioned: *Nya A. B. Triton, Sundbyberg, Tekn. A.-B. Flora, Gävle, Henrik Gahns A.-B., Uppsala, Fabriks A.-B. Victoria, Hälsingborg, A.-B. Tekniska Fabriken Gripen, Linköping, Henrikssons Tekniska Fabriks A.-B., Örebro, and Industri A.-B. Sylva, Landskrona*. Antiseptic preparations are also made by *A.-B. P. Håkansson, Estöv*.

The manufacture of stearine candles in Sweden began in 1838, when the Liljeholmen stearine factory in Stockholm was established. The raw materials principally employed are tallow, bone fat and palm oil. Another type of candle is made from a mixture of stearine and imported paraffin. The production of candles has declined during the last twenty years in consequence of the growing use of electricity for lighting purposes.

There are two Swedish factories which make stearine candles, viz.: *Liljeholmens Stearinfabriks A.-B.* and the firm of *Lars Montén*, both in Stockholm.

THE FERTILIZER INDUSTRY.

Modern agriculture cannot content itself with merely natural manure, and for intensive cultivation artificial fertilizers must also be employed. The substances most beneficial to active plant life, which

— THE MATCH, EXPLOSIVES AND OTHER CHEMICAL INDUSTRIES —

must be supplied to the soil, are phosphoric acid, nitrogen and potash. The phosphatic fertilizers are superphosphates, Thomas phosphate and bone-meal; the nitrogenous are calcium cyanamide and ammonium sulphate, also Chile and Norwegian saltpetre. As potash fertilizers the potash salts are used. The production of phosphorus and nitrogenous fertilizers has developed vigorously in Sweden, especially during the last quarter of a century, but potash fertilizers are not made in the country.

The oldest and most important of the fertilizers is *superphosphate*, factories for its production having been erected in Stockholm and Hälsingborg as long ago as the early 'seventies. The production — which chiefly consists in treating imported mineral raw phosphate with sulphuric acid — has since that time made vigorous progress. An important part of the manufacture of superphosphate is the production of the necessary sulphuric acid, which is nowadays made by the superphosphate factories themselves. Technically this industry has been vastly improved during the last two or three decades, especially as regards mechanical devices; and Swedish engineers have been foremost in this development.

Thomas phosphate is obtained as a by-product in the manufacture of steel from pig-iron made of iron-ore containing apatite, and, before being used, it must be carefully ground.

Bone-meal is made by the pulverization of bone after its glutinous elements have been extracted. It is used both as a fertilizer and as cattle-food.

Superphosphate is produced by *Reymersholms Gamla Industri A.-B.*, with factories for this product at Hälsingborg and Limhamn, *Stockholms Superfosfat Fabriks A.-B.*, with factories for this product in Stockholm and Göteborg, *Konstgödnings Fabriks A.-B. i Landskrona*, Landskröna, and *A.-B. Svenska Konstgödnings- & Svavelsyrefabriker*na, Malmö. — Thomas phosphate is produced by *Stora Kopparbergs Bergslags A.-B.*, Falun. — Bone-meal is made by *Stockholms Benmjölsfabriks A.-B.*, Stockholm.

A considerable Swedish industry has also grown up for the production of nitrogenous fertilizers. The nitrogenous fertilizer industry is one of those which have undergone quite a revolutionising development as the result of a series of inventions during the last twenty years. This primarily holds good with regard to the utilization of atmospheric nitrogen; in Sweden the most extensive production is that of *calcium cyanamide*. This fertilizer is obtained electro-chemically by

— THE MATCH, EXPLOSIVES AND OTHER CHEMICAL INDUSTRIES —

the action of nitrogen gas on calcium carbide. After some years of experimental work, commercial-scale production was started in 1907 and further extended in 1912.

Ammonium sulphate is manufactured in Sweden from calcium cyanamide and also as a by-product in gasworks.

Among producers of nitrogenous fertilizers the following may be noted: *Stockholms Superfosfat Fabriks A.-B.* (calcium cyanamide and ammonium sulphate), *Alby Carbidsfabriks A.-B.*, *Alby* (calcium cyanamide), and *Oxelösunds Järnverks A.-B.*, *Oxelösund* (ammonium sulphate). Ammonium sulphate is also produced at the gasworks in the various towns.

THE PRODUCTION OF EXPLOSIVES.

The manufacture of gunpowder in Sweden dates a long time back. Already at the beginning of the 15th century black powder was made in the country, chiefly for military purposes. It was not until the middle of the 17th century that powder was first employed for blasting in mining operations. All the raw materials necessary for the manufacture of black powder — charcoal, sulphur and potassium nitrate — were formerly produced within the country; but nowadays it is practically only the charcoal that is obtained here. Since the invention of new explosives, black powder has lost its earlier importance.

The modern explosives industry dates back to the invention of *nitro-cellulose* and *nitro-glycerine*. In 1846, Schönbein, a Swiss, produced nitro-cellulose by the nitration of cotton, i. e., the treatment of cotton with a mixture of concentrated nitric and sulphuric acids. Nitro-cellulose explodes with considerably greater effect than black powder and is smokeless. Nitro-glycerine was invented in the same year by Sobrero, an Italian, but this dangerous "explosive oil" only acquired technical importance after ALFRED NOBEL had discovered practical methods for its production and use. An important step in the development of the explosives industry was Nobel's great invention of *dynamite* (nitro-glycerine absorbed in infusorial earth). In 1865, Nobel established the first nitro-glycerine factory at Vinterviken, near Stockholm. Blasting gelatine is a compound of nitro-glycerine and nitro-cellulose; together with ammonium nitrate, etc., it constitutes the chief component in several kinds of modern Swedish dynamite (extra dynamite; express dynamite, etc.). Certain ammonium nitrate and perchlorate explosives belong to the

— THE MATCH, EXPLOSIVES AND OTHER CHEMICAL INDUSTRIES —

class called "safety explosives" and, like dynamite, are chiefly used for blasting rocks and uprooting tree-stumps. The *smokeless powder* which is employed for military purposes and has superseded black powder, consists either of nitro-cellulose or of a compound of nitro-glycerine and nitro-cellulose, the latter being mainly used for heavy guns. Numerous other organic substances are nitrated in Sweden into powerful explosives, one of the most important of these being *trinitrotoluene (trotyl)*, which, in consequence of its high degree of insensitiveness, is used for charging shells, mines, etc.



Alfred Nobel.
b. 1833 d. 1896.

The demand in Sweden for explosives is fully covered by the home production. During the last few years the exportation of explosives has also assumed substantial proportions. The raw materials, however — nitric acid, potassium

nitrate, glycerine, cotton, etc. — are mainly imported.

The largest enterprises in this branch are: *Nitroglycerin A.-B.*, Stockholm, and *A.-B. Bofors Nobelkrut*, Bofors, *Skånska Bomullskrutfabriks A.-B.* and *A.-B. Svenska Krutfaktorierna*, both at Landskrona, *Stockholms Superfosfat Fabriks A.-B.*, Stockholm, *A.-B. Expressdynamit*, and *A.-B. Nora Tändrövsfabrik*, both at Grängesberg.

COLOUR AND VARNISH, DESTRUCTIVE DISTILLATION, ELECTRO-CHEMICAL AND OTHER INDUSTRIES.

The manufacture of colours and varnishes. With regard to colours, a distinction is drawn between coal-tar dyes on the one hand, which are chiefly employed for dyeing textile fabrics, leather, paper, etc., and, on the other hand, painters' colours, which are mixed in oil, water or limewater, and which are applied to the object by a brush or by printing. Coal-tar dyes are not made in Sweden; and of the many varieties of painter's and printers colours, only red-ochre (Falun red), whiting and charcoal black are produced on an industrial scale in Sweden. Falun red is obtained out of weathered iron-pyrites from the copper-mine at Falun, by means of washing, burning and grinding. Charcoal black is usually obtained by the pulverization and washing of charcoal.

Side by side with the production of colours in the proper sense of the term there is a manufacture of paints, colour-mixtures and

— THE MATCH, EXPLOSIVES AND OTHER CHEMICAL INDUSTRIES —

liquid colours out of imported raw materials which is carried on in Sweden on a large scale for various purposes.

In this category may also be placed the manufacture of varnish, embracing the production of oil, spirit and lacquer varnishes. Oil varnish is obtained by boiling linseed oil; lacquer and spirit varnish by dissolving resins in oil varnish and turpentine or alcohol.

Red-ochre is made principally by *Stora Kopparbergs Bergslags A.-B.*, Falun, and charcoal-black by *Osby Kimröks Fabriks A.-B.*, Osby etc. — About forty different factories in the country specialize in the preparation of paints and varnishes for various purposes, among which the following may be noted: *A.-B. Alfort & Cronholm, A.-B. Wilh. Becker, A.-B. M. Hansen*, and *Klint, Bernhardt & Co.*, all in Stockholm, *Oscar Bäckens A.-B.*, *Dorch, Bäcksin & Co:s A.-B.*, *Färg A.-B. International, A.-B. Göteborgs Hartzoljefärgfabrik* and *Göteborgs Kemiska Fabriks A.-B.*, all five in Göteborg, also *Färg- & Ferniss Fabriks A.-B. Standard*, and *A.-B. Phylatterion*, both in Trälleborg, *C. Ijungdahls Handels & Fabriks A.-B.*, Lerum, and *Skånska Färgfabriks A.-B.*, Malmö. Printing ink and colours are made by *Fabriken Typochroma* and *A. B. Lagerholms Färgfabrik*, both in Stockholm, etc.

The manufacture of polishing materials, ink, glue, medical preparations, etc. A large number of factories in Sweden are mainly occupied in the making of a variety of chemical compounds for household and other purposes. Among these are leather and metal polish, ink, sealing-wax, glue and gelatine paste, size, etc. and of these boot-polish have become a comparatively important article. In this group may also be included medical preparations.

Manufacturers of boot-polish and leather dubbing are *Industri A.-B. Viking*, Örebro, and *F. Ahlgrens Tekn. Fabrik*, Gävle; as well as several of the soap factories mentioned on pp. 252—253. Metal polishes etc. are made by the majority of the soap and varnish factories as well as by *A.-B. Axel Christiernsson*, Stockholm. Ink is made by *Barnängens Tekn. Fabriks A.-B.*, *A.-B. Grumme & Son* and *A.-B. Linds Tekn. Fabrik*, all in Stockholm, etc. *Stockholms Gelatinfabrik* specializes in the manufacture of gelatine. Finishing and other preparations for the textile and shoe-industries are made by *A.-B. Kemiska Fabriken Monopol*, Borås, etc. Medical preparations are produced by *A.-B. Wilh. Becker* and *A.-B. Pharmacia*, both in Stockholm, and *A.-B. Astra*, Södertälje.

Destructive distillation. The manufacture of charcoal products formerly took place only in charring kilns; but kiln-charring in Sweden has during the last twenty-five years been largely superseded by charring in specially constructed charcoal retorts. In kiln-charring there is obtained, in addition to charcoal, wood-tar; retort charring also yields a number of other valuable by-products, such as tar-oil, pitch, wood-spirit, turpentine-oil, acetic acid, etc. During the Great War, the in-

creased demand for destructive distillation products caused the retort-charring industry to develop very rapidly. Apart from these sources for charcoal there are also a number of sawmills which turn their waste-wood to account by charring it in kilns.

The destructive distillation of mineral coal takes place in coke ovens either in special coking plants, where the coal is turned into coke to supply the needs of the iron industry, or in gasworks. In the coking process a great number of important by-products are obtained, such as coal-tar, benzole products, ammonia, etc.

Destructive distillation is carried on by *Ljusne-Wozna A.-B.*, Ljusne, *Skogens Kol A.-B.*, Bollnäs, *A.-B. Träkol*, Vansbro, *Stora Kopparbergs Bergslags A.-B.*, Falun, *Trävaru A.-B. Dalarne*, Vansbro, *Skånska Åttikfabriken*, Perstorp, etc. Destructive distillation of coal is carried on by *Oxelösunds Järnverks A.-B.*, Oxelösund, as well as by the gasworks in the various towns.

The Electro-chemical Industry. In recent years increasing attention has been paid to electro-chemical manufacturing processes, based either on heating in electric furnaces or on electrolysis by the wet process. As the electro-chemical industries consume large amounts of electrical energy, industrial production can only take place where electric power is cheap. In Sweden calcium carbide is manufactured by the electric heating process, whilst chlorates and perchlorates, caustic soda, caustic potash and chlorine are obtained by electrolysis.

The most important of these processes is the production of calcium carbide by melting together lime and carbon. Calcium carbide is used for lighting and welding purposes, but above all as a raw material for the manufacture of calcium cyanamide, referred to in the foregoing pages (254—255). Close on half the output is exported. Chlorates and perchlorates find extensive use in the match and explosives industries. By the electrolytic disintegration of common salt (sodium chloride) or of potassium chloride are obtained, on the one hand, caustic soda and caustic potash and, on the other, chlorine, which in the form of "chloride of lime" is largely used in the woodpulp, paper and textile industries.

Calcium carbide is made by *Stockholms Superfosfat Fabriks A.-B.*, Stockholm, *Wargöns A.-B.*, Vargön, and *Gullspångs Elektrokemiska A.-B.*, Gullspång; chlorates and perchlorates by the former, and potassium-chlorate also by *Alby Nya Kloratfabriks A.-B.*, Alby, and *Elektrolytiska A.-B. Trollhättan*, Trollhättan. Caustic natron (caustic soda) and chloride of lime are produced by *Uddeholms A.-B.* (Skoghallsverken), Skoghall, and *Elektrokemiska A.-B.*, Bohus. The last-mentioned firm also makes caustic potash.

— THE MATCH, EXPLOSIVES AND OTHER CHEMICAL INDUSTRIES —

The production of acids and salts. Among the many branches of production in the chemical industry a prominent place is taken by the manufacture of salts and acids, inasmuch as these are necessary for a large number of chemical processes of production. The first place should here be given to the manufacture of sulphuric acid. As has already been mentioned, sulphuric acid is an important material in the manufacture of superphosphate; and all superphosphate factories now make their own sulphuric acid. This acid is further used in the making of nitric acid, hydrochloric acid and sulphate of alumina, as well as for various purposes in stearine, explosives and yeast factories, ironworks, etc. Iron pyrites are now the only raw material used for the production of sulphuric acid, and these are almost entirely imported from Norway and Spain. Swedish pyrites are only used by the *Stora Kopparbergs Bergslags A.-B.* — Of no less importance for the chemical industry is nitric acid, especially in a highly concentrated form. In Sweden, nitric acid has been manufactured only on a very small scale since the cheaper product obtained from atmospheric nitrogen began to be imported. The manufacture of hydrochloric acid, which is used in many processes in the chemical industry, has during the last few years shown a steadily rising tendency. Phosphoric acid is also produced in Sweden and is mainly employed in the match industry.

Mention should also be made of sodium sulphate (Glauber's salt) and sodium bisulphate.

The manufacture of salts of alumina (aluminium sulphate, aluminium hydrate, alum, etc.) is a by no means unimportant industry. The products are employed in the paper industries, in dye-works and tanneries, etc.

Finally, there is the manufacture of crystallized soda, from imported soda ash, which is dissolved in water and crystallized.

The manufacture of sulphuric acid is both carried on by the superphosphate firms enumerated on p. 254 and also by *Stora Kopparbergs Bergslags A.-B.*, Falun. Nitric acid is made by *Stockholms Superfosfat Fabriks A.-B.*, and hydrochloric acid and phosphoric acid by *Reymersholms Gamla Industri A.-B.*, Hälsingborg. Sodium sulphate is produced by that firm and also by *A.-B. Oskarhamns Kopparverk*, Oskarshamn. The following are manufacturers of salts of alumina: *Reymersholms Gamla Industri A.-B.* (aluminium sulphate and alum) and *A.-B. Grden*, Landskrona (aluminium sulphate). — Crystallized soda is produced by a number of small enterprises, most of which affiliated to *Sodafabrikernas Försäljnings A.-B.*, Göteborg.

The production of compressed gases. A special branch of the chemical industry is the production of compressed gases, such as carbon

— THE MATCH, EXPLOSIVES AND OTHER CHEMICAL INDUSTRIES —

dioxide, acetylene, oxygen, hydrogen, etc.; which are kept and sold in steel cylinders. The carbon dioxide is chiefly used in the manufacture of mineral waters, while acetylene and oxygen are employed for lighting purposes, and for the welding and cutting of metals.

Liquid carbon dioxide is produced by *De Förenade Kolsyrefabrikernas A.-B.*, Stockholm; acetylene and oxygen gas by *Svenska A.-B. Gasaccumulator* and *Nordiska Syrgasverken A.-B.*, both in Stockholm, *Strömsnäs Järnverks A.-B.*, Degertors, *Stora Kopparbergs Bergslags A.-B.*, Falun, and *A.-B. Sollefteå Syrgasverk*, Sollefteå, etc.

Finally, among other branches coming within the chemical group of industries there may be mentioned the manufacture of *vegetable tanning materials, films, copying paper, copying carbon paper, tar paste-board and incandescent gas-mantles.*

Vegetable tanning-materials are made by *Garvämnes A.-B. Weibull*, Landskrona, and *A.-B. Tannin*, Västervik. Films are produced by *A.-B. Svensk Filmindustri* and *A.-B. Tullberg-Film*, both in Stockholm; blue, sepia and white copying papers by *Stockholms Tekn. Pappersfabrik*, Stockholm; copying carbon-paper and typewriter ribbons by *A.-B. Linds Tekn. Fabrik*, Stockholm; and tar paste-board by several of the paste board factories mentioned on p. 191 and also by *A.-B. Malmö Takpappfabrik* and *A.-B. Svenska Icopal och Takpappfabriken*, both at Malmö, *A.-B. Phylatterion*, Trälleborg, and *A.-B. Tölö Fabriker*, Kungsbacka. Incandescent gas-mantles are manufactured by *A.-B. Keros*, Södertälje.

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