Swedish industries. : Some facts and figures published in connection with t...

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SWEDISH INDUSTRIES

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SOME FACTS AND FIGURES

PUBLISHED IN CONNECTION WITH

THE EXCURSION OF THE
CORPS DIPLOMATIQUE

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IRON AND STEEL IN SWEDEN.

(JOURNEY TO AVESTA, DOMNARVET AND SANDVIKEN.)

To everybody in any way connected with the trade in or the manufacture of iron and steel the name »Swedish Iron» and »Swedish Steel» always stands as an indication of first quality. It has been so for ages, and it is so today. In order to answer why the Swedish Iron has such a fame on the world's market it is necessary to study the foundations on which this industry is based.

SOME HISTORICAL NOTES.

The great technical development in Sweden's iron industry was effected by the introduction of the blast-furnaces, which probably were developed out of the old very low furnaces on account of the rising demand for iron, which caused the building of higher furnaces and introduced more powerful blast, obtained through the use of water-power instead of muscular force.

This change was brought about in the 15th and 16th centuries and from that time the Swedish iron industry was based on manufacturing pig iron and its refining to wrought iron. The export of iron from Sweden was now very considerable and at the end of the 18th century Sweden was still the biggest producer of iron in the world. Its export amounted alone to

about the same figure as the total production of the other European countries together.

In those days charcoal was the only fuel used for blastfurnaces and refining and Sweden with its abundant forests, iron ore and water-power was consequently in a more favorable position than most other countries. The only competitor on the exportmarket of any consequense was at that time, curiously enough, Russia.

In the middle of the 18th century a great revolution occurred in the iron industry with the use of coke instead of charcoal in the blast-furnaces, followed by the invention of the puddling process, permitting use of bituminous fuel also for the refining of the pig iron. Through these inventions the advantages were passed over to the countries possessing large resources of coal and from the beginning of the 19th century we find in the first place England conquer the Swedish iron industry as regards quantity and later America and Germany. Still more marked became this change in Swedens position regarding the quantity of iron, compared with the world's output after the invention of the Bessemer and open hearth processes which made the modern steel production possible.

If however Sweden lost its position as the biggest manufacturer of the world, it has still honorably kept its position as number one regarding quality.

IRON ORE.

The resources of iron ore in Sweden are very considerable. The estimate, made in connection with the International Geological Congress at Stockholm in 1910,

showed a quantity of 1 335 000 000 tons, corresponding to about 845 000 000 tons pig iron.

The iron ore deposits are geographically divided into two groups, one situated in the middle of Sweden and the other in the northern part, Lappland. It is chiefly the first named which are used in the Swedish iron industry. Among these deposits the famous fields at Dannemora and Grängesberg are to be found. Other important deposits in this district are Bispberg, Norberg, Riddarhyttan, Stripa, Strássa, Striberg, Dalkarlsberg, Persberg and others.

The ores of middle Sweden are with exception of some parts in Grängesberg chiefly low in phosphorus and sulphur and run sometimes as low as 0·001 % P. This freedom from injurious constituents and the blend of other minerals suitable for forming a good slag are the chief characteristics of these ores.

The most famous Lappland ore-fields are Gellivaare and Kiirunavaara, situated about 60 miles north of the Polar Circle, which contain varieties of ore from very low phosphorus up to several per-cent. These ores are chiefly exported, and form a very important raw material for the Thomas-Gilchrist process.

The output from the Swedish mines in 1916 amounted in round figures to 7 million tons, the largest figure being reached in 1913 with 7·5 million tons. To these figures should be added about 1 million tons concentrate annually.

PIG IRON.

The general development of the works has gone towards the concentration of production in bigger and fewer works. 1861 there were 226 blast-furnaces run-

ning with a production of some 425 000 tons. 1916 121 blast-furnaces were in operation with a total output of 733 000 tons. The maximum of production was reached in 1915 with 760 700 tons.

As fuel for the blast-furnaces charcoal is almost exclusively used. In 1916 only 57 000 tons of pig iron were manufactured with coke as fuel, and the balance or 656 000 tons with charcoal. Products made from coke are never exported.

A fairly recent feature of the Swedish pig iron industry is the use of electric furnaces. The first experimental furnace was built by Jernkontoret at Trollhättan 1910. 1916 8 furnaces were regularly running with a production of 44 782 tons. It is to be expected that the electric pig iron production will increase on account of the abundant resources of water-power, especially in the northern parts of Sweden, and the steadily increasing prices of charcoal. The use of electrical furnaces saves about 60 % of the fuel.

IRON AND STEEL.

Wrought iron. In the times, when charcoal alone was used for the manufacture of soft iron from pig-iron Sweden had, as already pointed out, a very prominent position among the iron producing countries. The earliest so called Osmund process is already mentioned as being a direct process. It was followed by a simular process, making ductile iron from pig iron in low furnaces or forges. This process is often in literature called Osmund-process, but should be well kept apart from the old direct process.

Through the influence of foreign countries, especially Germany and Belgium, this process was perfected and

developed into the so called »German forge» and then the »Walloon forge». In the 19th century new developments were made through the introduction of the »Lancashire forge» from England. This process, Lancashire forge, is still extensively used in Sweden and through this process the Swedish bar iron is made. A smaller part of the bar iron is still made through the Walloon process, still in use in the Dannemora district.

In 1916 the manufacture of wrought iron in Sweden by means of the Lancashire and Walloon processes amounted to some 120 000 tons.

Although these processes, owing to the use of charcoal and small production necessarily are very expensive, they have held their place. The quantity of iron thus manufactured has certainly constantly diminished during the last years, but there is still a fairly steady demand for this quality of iron, which now forms the raw-material for the highest grades of crucible tool steel and above all is used in places where non corrosiveness and high ductility are required. The iron, obtained through these processes, is of superior quality of low phosphorus contents, sometimes as low as 0.007 % and practically no sulphur. Most of the bar iron is exported to England and principally to the Sheffield-district where it seems invaluable as conferring to the steel the undefined, but not less important quality known as »body».

Norway iron. It may also be remarked that Swedish bar-iron in America often is called »Norway Iron». The cause of this curious fact is to be found in the circumstance that in the times when the pioneers in America, centuries ago, received small cargoes of Swedish iron, it was generally carried by Norwegian sailing ships.

Bessemer process. When Sir Henry Bessemer in 1850 had made the invention of refining pig iron without use of fuel, the interest in this process was very lively in Sweden and it should be noted that the first successful Bessemer process in the world was carried out at the Edsken works in Sweden in 1856 by G. F. Göransson. The process made a very rapid advance but has later been outrun by the open hearth process. The Bessemer process in Sweden shows some peculiar features which have a marked influence on the quality of the steel. The pig iron, made from charcoal furnace,is taken directly from the blast-furnace to the converter and contains a fairly low percentage of silicon, only about 0·9—1 % but is higher in manganese 2·5—3 %. The process is stopped as soon as the desired percentage of carbon is reached and on account of the originally high percentage of manganese in the pig iron the product never gets oxidised or red short and no extra addition of manganese for deoxidation is necessary.

The fact that Bessemer steel, manufactured in this way, is less apt to be burnt or superheated in hardening than other kinds of steel, its hardness and toughness make the Bessemer steel valuable for certain classes of tools such as files, drills etc.

Basic Bessemer steel is only manufactured in two places for ordinary construction purposes, such as angles, rails etc.

The output of Bessemer steel in Sweden in 1916 was 23 897 tons acid and 49 134 tons basic, or totally 73 031 tons.

Open hearth steel. The open hearth process was introduced into Sweden almost as soon as the inventors had proved it a success. The regenerative Siemens

furnace being already introduced for heating purposes, the process rapidly gained ground. As fuel, wood was commonly used in the gasgenerators as giving a gas, free from sulphur, being in most places the cheapest fuel in the times when railroads were scarce and all material for the steelworks had to be transported by means of cart and horses. Later when communications become more developed, coal has taken the place of the wood as fuel to a great extent, but some works, making high quality of steel, still use exclusively wood for fuel. The tendency during the war has also naturally been to return to the wood and omit the use of coal in the iron industry as much as possible and thus avoid the difficulties to procure coal at reasonable prices which still exist on account of English labour troubles.

As raw material for the open hearth process only Swedish charcoal pig iron is used, together with own scrap, as soon as quality is aimed at. For common steel cheaper raw material is of course used. The furnaces are generally comparatively small, not often bigger than 12—15 tons and sometimes only 5 tons.

The production of open heart steel in 1916 amounted to 528 700 tons, of which 283 900 tons were made in basic furnaces.

Crucible steel. The crucible process was introduced in Sweden as early as 1816, but for several reasons many years elapsed before it became at all commonly used. As raw material serves mostly cemented Walloon bar iron. A modification of the crucible melting called the Uchatie-process is still met with in one place. The steel is in this case manufactured by melting a mixture of granulated pig iron with pure iron ore in crucibles. The quality thus obtained is excel-

lent but the process requires especially pure ore and has only been a success with the highest grade of Bispberg ore.

The production of crucible steel has in later years averaged about 3 000 tons a year.

Electric steel. In all countries the war has had the effect of raising the production of electric steel. This has also been the case in Sweden mostly on account of the high prices of fuel and the difficulty to produce crucibles, but on the other side the evolution of the electric steel smelting has been checked by the difficulty of securing good electrodes. The electric steel smelting also stands in a somewhat different position in Sweden and in other countries. While the electric process in other countries is able to produce a product which is distinctly superior to the steel manufactured in Bessemer or open hearth furnaces and consequently only has to compete with crucible steel, the electric steel has not been proved superior to the high grades of Swedish Bessemer or acid open hearth steel and is certainly more uneven as regards composition and soundness. This has been the cause of the relatively small production of electric steel in a country which on account of its abundant resources in water-power would seem to be specially adapted for this process. In 1916 6 648 tons of electric steel were produced.

EXPORT AND IMPORT.

Owing to the high quality of the iron and steel produced by most of the Swedish steel works the product is to a very great extent exported to other countries, and used for purposes where no other ma-

terial has been good enough. It has recently been estimated that during the period 1891—1895 about 83 % of the total production was exported. During the period 1911—1915 the same proportion amounted to 65 %. These two figures show that the tendency of the Swedish iron trade runs towards a more extensive use of the iron at home for manufacturing of finer tools, machinery etc. This may also be noted by comparing the figure for the export of machinery, which was practically nil during the period 1871—1875 and had a value in 1913 of something round 60 million Kr.

The import of iron and steel consists chiefly of foundry pig iron and rails, shapes for construction purposes, heavy plates for shipbuilding etc., that is iron and steel of lower quality for ordinary purposes.

OUTLOOK FOR THE SWEDISH IRON INDUSTRY.

As already pointed out, the Swedish iron and steel industry is chiefly based on the manufacture of products of high quality. Its future is therefore dependent on the demand for such products in the world. With the competition and increased use of machines instead of human labor it is certain that the demand for such steel must rise, which has indeed been the case in an enormous degree during the war, but it must also be taken into consideration to what extent high quality steel can be manufactured in other countries. It has been claimed by people connected with erecting of electric furnaces that it should be possible to make high class steel out of any raw material, and should this be the case, the Swedish steel industry would at the first glance seem endangered, but first of all that statement needs proofs not yet given, even if it

must be admitted that the electric steel for some purposes has proved itself able to take the place of Swedish, and in the second place it must be remembered, that manufacturing good steel out of common raw-material means an extra refining process, unnecessary when pure materials are used. Besides this experience has shown that if for one purpose Swedish steel is replaced by other material there arises a new demand for other purposes. This together with the growing tendency of increased manufacturing of the Swedish steel at home makes the future of the Swedish steel industry seem bright enough to warrant the belief, that this ancient industry which has more than perhaps anything else made Swedens name known and honoured will live and thrive in coming generations.

TIMBER, PULP AND PAPER.

(JOURNEY TO SKUTSKÄR AND GRYCKSBO.)

The forests of Sweden contain only a few different kinds of trees. In such an extensive country as Sweden from north to south several species of trees reach the limit of their extension and therefore the country is generally divided into many different »forest regions». In the most southernly part of the country — the beech forests district — the forests chiefly consist of foliferous trees beech and some oak. North of this district lies the so called »berry forest region», which really only consists of two kinds of trees, namely, pine and spruce. Here and there in the southern part of this district are clusters of oak or beech and in the northern part the beech occasionally appears on the banks of the streams and rivers.

More than half the area of Sweden, or a little more than 21 million hectares (52 millon acres) is covered with forests. Sweden may indeed be described as one of the European countries possessing the greatest wealth of forest-land, and Finland only can in this connection compete with her for the foremost position in Europe. On an average there are 4 hectares forest-land to each head of population. The importance of these forests, however, varies in different parts of the country. In the provinces of Västernorrland and Gävleborg about 83 % of the total area is occupied by forests. In the

south of Sweden, on the other hand, forests are of comparatively little importance. In the province of Malmöhus only about 9·5 % is wooded land.

It is not, however, merely the country's tremendous forest area, and compared with the population, her great wealth of timber that makes Sweden such a rich forest country. Owing to the excellent quality of the ground itself (principally moraine and gravel) and a climate suitable for the pine-tree, the timber produced is of the finest quality. Moreover the timber is very easily turned to account. During the winter the snow-covered forestland and frozen lakes offer excellent facilities for the transport of the logs through the wildest districts. The countless rivers and streams, of such assistance in floating the logs on account of their rapid current, supply a time-saving and inexpensive means of transport to the coasts where the saw-mills and wood-pulp factories are generally situated. Norrland (Northland) is especially well off as regards watercourses, for no district in that part of the country lacks rivers to such an extent as to prevent the timber supply of the forests being turned to account. It may, therefore, be truly said that Sweden is exceptionally favoured as far as forestry is concerned, and that as regards cheap transport facilities for the timber, Sweden is unrivalled. The majority of the floating courses have been constructed in the rivers of Norrland, Värmland and Dalecarlia and in length reach a total of 25 000 kilometres and the cost of their construction is said to have been nearly 150 million Kr. These waterways annually carry 85 million logs, representing a calculated mass of 425 million cub. feet, or nearly 12 million cub. metres.

At present the out-turn of timber from Swedish forests amounts to more than 40 million cub. m. per

year, or about 2 cub. m. per hectare of productive forest-land.

This out-turn of timber is used in the following manner:

Timber as raw material	0·4	million	cub.	m.
The manufacture of sawn wood-goods and goods otherwise prepared	8·5	»	»	»
The manufacture of wood-pulp ...	5·7	»	»	»
Charcoal for use in mines	6·0	»	»	»
Timber for domestic purposes (building and fuel)	22·0	»	»	»

The forestry and timber trades are very ancient industries in Sweden. Ever since the time when the people of this country first began to come into active commercial contact with other nations the productions of the forests have constituted a very important part of the exports. But in those days the products consisted of pitch, tar, masts and spars, and also to a certain extent of planks and boards, which, however, were at first not sawn but prepared with the axe.

Some few figures will assist in illustrating the development of the Swedish timber industry. In the year 1821 Sweden possessed 3 633 saw-mills with a manufacture of 267 000 dozen planks and boards of which about 200 000 dozen were exported. In the year 1861 Sweden had 59 greater saw-mills and 4 933 smaller saw-mills driven by wind and water, and the export of planks and boards only amounted to 1 478 000 dozen. Fifteen years later the export was three times as great and the export value of all unrefined and refined wood-goods increased to more than 100 million

Kr. a year. In 1915 the value of unrefined and hewn, sawn and other more or less refined wood-goods (consequently also including joinery etc.) exported from Sweden amounted to about 236 million Kr.

If one also takes into account the wood-pulp and paper industry which has recently come into existence and is advancing by leaps and bounds and which nowadays occupies an exceptionally prominent position in Sweden's industrial life, then the Swedish forests by their production alone would show an annual export value of about 390 million Kr. (in the year 1915), corresponding to 30 % of Sweden's total exports. In addition to this their is also the value of other forest products. The Swedish iron industry, for instance, uses charcoal to a value of about 30 million Kr. annually of which about 20 million Kr. is calculated for export purposes.

Year	Sweden's total export Kr.	Export of:			
		Wood and timber [1]	Wood-pulp	Paper and paste board	Total
		Kr.	Kr.	Kr.	Kr.
1900	391 334 000	153 030 255	26 727 787	13 862 803	193 620 845
1912	760 617 000	164 748 412	93 954 732	39 374 313	298 077 457
1915	1 316 364 399	226 049 200	111 311 600	51 408 900	388 769 700

The distribution of Sweden's timber export among the various importing countries ought to be of special interest. Of the 6 800 000 cub. m. of wood-goods, exported from Sweden in the year 1913 no less than 2 600 000 cub. m. or 38 % found its way to Great Britain and Ireland. In the same year France bought

[1] Manufactured goods of wood not included.

from Sweden about 950 000 cub. m., Denmark about 740 000 cub. m., Germany about 725 000, Norway about 375 000, the Netherlands about 360 000, Belgium about 190 000 and Spain about 170 000 cub. m. The same year Sweden exported to countries outside Europe about 645 000 cub. m. of wood-goods of which the greater part, or about 480 000 cub. m., went to Africa and about 100 000 cub m. to Australia.

*

The first wood-grinding mill in Sweden for the manufacture of wood-pulp by mechanical processes (mechanical wood-pulp) was established as early as 1857 at Trollhättan, according to Völter's improved adaptation of Keller's system, which was first made practical use of in 1846. From the beginning of the seventies, the number of wood-grinding mills in Sweden rapidly increased until about the year 1895, when the demand for chemical wood-pulp resulted in the rapid establishment of cellulose factories. The pulp is obtained by the purely mechanical defibration of the wood by grinding blocks of wood against sandstone-grindstones, the whole being kept continually supplied with water. The number of wood-pulp mills in the country is now about 100, the value of the output being some 18 million Kr.

Chemical wood-pulp is manufactured chiefly according to two methods, viz., the soda- or sulphate method, and the sulphite method. According to the soda method, which is the older, and was first employed in America during the sixties, the wood, which is first cut into short chips, is boiled under pressure in soda-lye. The first Swedish cellulose factories were

established in 1870—71 at Delary and Vermbohl, by Count Sten Lewenhaupt. Although the soda-cellulose manufacturers soon commenced to employ improved technical methods, the system began to suffer from the placing on the market of the cheaper sulphite cellulose. The discovery made by Dahl, a German engineer, that soda could be replaced by the cheaper sodium sulphate diminished, however, the cost of production of soda-cellulose, besides which, the method in question gave a larger output of pulp, and a firmer and more easily bleached mass. This method of manufacture — the sulphate method — is, at present, the alkaline boiling method most employed in Sweden. Another factor of great importance for the cellulose industry was the quality of soda-cellulose produced by A. Müntzing at Munksjö, in 1885, which forms the material for the celebrated Swedish strong brown paper (»kraftpapper»). The number of sulphate cellulose factories at the present time is 21, the value of the output being about 16 million Kr.

The sulphite-method had been suggested as early as 1866, by Tilghman, an American; but it did not become of any practical importance until 1874, when a Swede, C. D. Ekman, succeeded in producing on a large scale a satisfactory cellulose, by means of boiling spruce with magnesium bi-sulphite. Independently of the researches of Ekman, who had kept his invention a secret, Mitscherlich, a German, some time afterwards obtained good practical results with calcium bisulphite, which has since retained its position as the solvent most employed. The Swede who, next to Ekman, has done most for the technical improvement of the sulphite cellulose manufacture in the country is C. W. Flodqvist. At present, the number of sulphite

factories is about 65, with an output-value of about 85 million Kr.

The greater part of the wood-pulp produced by mechanical processes is made from spruce, though aspen is also employed, this last-mentioned wood giving a specially white and resin-free product. For browngrinding, some fir can also be employed. In the sulphate method, both spruce and fir can be used as raw material, although, in some respects, the first-named wood is considered to possess the greater advantages. Sulphite cellulose is made almost exclusively of spruce.

Sweden's production of wood-pulp was in 1917 1 023 661 tons with a value of 256 million Kr. This production is not exceeded by any European country and only inferior in quantity to the wood-pulp production of U. S. A. and Canada. About 75—80 % of the total output is exported.

The paper industry also represents a big item in Sweden's export trade, more than 60 % of the total output being shipped to all parts of the world. The greater part of the export consists of printing paper, wrapping paper and paste-board.

WATER POWER

(JOURNEY TO ÄLVKARLEÖ.)

The great wealth in waterfalls that has fallen to the lot of Sweden has for hundreds of years exercised an exceedingly beneficial influence on the development of her industry, and above all when in connection with the refinement of her principal raw materials, such as iron-ores and timber.

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The total supply of water-power in Sweden has, on one or two occasions during recent years, been the subject of calculations which it was possible to base upon very satisfactory data. These have shown that the water-power of the entire country, which is available on an average for nine months of the year, represents about 4,5 million turbine H. P. of which about $^3/_4$ lies north of the river Dal. During low water the theoretical supply of power of the rivers in their present condition is reduced to about half of the above mentioned estimate. Up to the present it has, however, been seen that the installations of power on an average exceed the nine-months-effect by 40 %, and the total installation should consequently, when used to its full extent, represent about 6.2 million H. P. The available amount of waterpower energy is estimated to 35 000 000 000 kwh.

As far as the supply of water-power is concerned Sweden is among the most fortunate countries in Europe, being about on the same level as Norway, France, Italy and Austria. Thanks to the wealth of lakes which Sweden enjoys the discharge from the different watersheds is already comparatively even and the high-water catastrophes so troublesome to alpine-countries are practically out of the question. Moreover, these natural lakes offer favourable opportunities for an effective and inexpensive regulation of the flow of the streams, which has already been done in many places and which is also being prepared in a number of large rivers. As regards the water courses, that are most important from the point of view of power, the great lakes control no less than 75 % of the total collecting areas of which the lake area itself comprises about 10 %.

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As early as the fifteenth century water-power began to be used in Sweden for industrial purposes. It was called to the aid of the manufacture of iron for which the country is celebrated, and which is nowadays chiefly concentrated in the central part of the country. The next great period of development was not commenced before the 1870 decade when the wood-pulp industry was introduced, which nowadays is very extended throughout the southern provinces and the midlands, principally in the western districts and is steadily increasing in Norrland as far as up Luleå. The development of these two branches of industry and the more important establishments in connection therewith have been described in detail elsewhere. The textile and milling industries also use a considerable amount of water-power.

Finally the progress that has been made during the last two decades in the transmission of power and in the electro-chemical and electro-metallurgical industries has provided an important step. The distribution systems which are principally in the hands of private companies, and also to a certain extent in the hands of the State and municipalities, now form a rather closely woven web, especially over the most southernly, south, westerly and central parts of the country, transmitting power from the waterfalls to industrial undertakings and for the requirements of municipalities. The largest undertakings for the distribution of power are, commencing from the south, the following: Hemsjö Kraft A.-B. (The Hemsjö Power Co. Ltd.), Sydsvenska Kraft A.-B. (The South Swedish Power Co. Ltd.), Yngeredsfors Kraft A.-B. (The Yngeredsfors Power Co. Ltd.), Statens Trollhätteverk (The State Power Station at Trollhättan), Gullspångs Kraft A.-B. (The Gullspång-Munkfors Power Co. Ltd.), and the electric power companies of Värmland, Svartälven and Örebro in the midlands, and The State Power Station at Älvkarleby, The Forsse Power Station etc. The total length of the more important power conducts (Primary) in Sweden is about 5 000 km. Electric blast furnaces on A.-B. Elektro-Metall's (The Electro-Metal Co. Ltd.) system are in use at Domnarvet, Stora Kopparbergs Bergslags A.-B. (The Great Kopparberg Bergslag Co. Ltd.), at Hagfors, Uddeholms A.-B. (The Uddeholm Co. Ltd.), and at Trollhättan, A.-B. Trollhättans elektriska smältugn (The Trollhättan Electric Blast Furnaces Co. Ltd.) and the introduction of similar blast furnaces is being planned in connection with several other iron-works. Other electro-chemical and similar kinds of works have been established for carbide and carbide-nitrogen (works at Alby and Ljunga) ferro-silicon,

manganese iron and other ferro-alloys (works at Gullspång, Vargön, Trollhättan, etc.), zinc (works at Trollhättan), chlorates (at Månsbo and Alby), etc. Finally, the electrification of railways is developing rapidly, the railway between Kiruna and Riksgränsen (in the far north of Sweden), electrified six years ago, having shown good results.

The total amount of water-power used in the year 1919 represents an installation of about 1 200 000 T. H. P. The energy consumed amounts to about 3 000 000 000 kwh, representing about 10 % of the available energy.

It is worthy of mention that during recent years the Swedish engineering industry has, with few exceptions, manufactured and delivered all the machinery and mechanical equipment for Sweden's water-power stations. For instance turbines from the Kristinehamn Works, Finshyttan Works, Nydqvist & Holm of Trollhättan, Borås Works etc., electrical machinery from Allmänna Svenska Electric Co. at Västerås, Luth & Rosén Electric Co. at Stockholm etc.

THE ELECTRIC INDUSTRY.

(JOURNEY TO ALLMÄNNA SVENSKA ELEKTRISKA AKTIEBOLAGET, A. S. E. A., VÄSTERÅS.)

The natural resources of Sweden are extremely favourable for the prosperity of an electric industry. Its water-falls are numerous and the enormous deposits of iron ore are well known; its industries in general, especially the mining industry, are extensive and growing.

The Swedish electric industry has its own history marked by a record of prominent inventions. The first inventor was Jonas Wenström who in 1881/82 constructed the first Swedish dynamo for direct current. Wenström was the first to use copper conductors sunk into slots of the armature, a method now used on every electric machine. In 1890 Wenström obtained a patent for his three-phase motor and power transmission, i. e. simultaneously with Tezla and Dobrowolsky. His patent held good until its expiration and German and American companies had to pay licence to the Swedish inventor when using the patent in his territory.

The inventions of Wenström brought into existence the »Elektriska Aktiebolaget» of Stockholm and for many years the development of the Swedish electric industry was identical with the development of this Company, which in course of time moved its shops

to Västerås and altered its name into »Allmänna Svenska Elektriska Aktiebolaget» or in English »Swedish General Electric Company».

After Wenström's death another prominent inventor, Ernst Danielsson, took charge of the technical department of the Swedish General Electric Company and the industry rapidly developed. The first power transmission was built between Hellsjön and Grängesberg in the year 1893 and was soon followed by the transmission lines at the mines of Stripa, Nora Bergslags Company, Trångfors Electric Company etc.

Danielsson took great interest in the electrification of rolling mills and the first electric rolling mill in the world at Boxholm was completed by him in the year 1894. Other works, such as Hofors, Fagersta, Surahammar, Söderfors, Domnarvet etc., followed in rapid succession.

Among inventions made by Danielsson we mention the tandem connection for three-phase motor and the autosynchronous motor. A number of other factories for electric machines and apparatus are working in different parts of the country, such as Luth & Rosén in Stockholm, Eck in Göteborg, Electromecano in Hälsingborg a. o.

Parallel with the introduction of higher voltages for the transmission, the development of the water power in Sweden has increased. Among bigger plants (10 000—40 000 H. P.) completed after the year 1900 we mention: Dejefors, Yngeredsfors, Gullspång, Finnforsen, Lagan, Mockıjärd, Forsse, Ljunga verk, Untra, Älfkarleby, Porjus, Forshult, Bullerforsen, Forshuvud etc. The largest power plant in Sweden, however, is the power station at Trollhättan. It comprises 14 generators each of 12 500 H. P., or 175 000 H. P. in

all. The current is used for the electro-chemical industry near Trollhättan and for power transmission to all the cities in the neighbourhood as well as to the city of Gothenburg. In the State-owned power-stations Trollhättan, Älvkarleby and Porjus are installed altogether 300 000 H. P.

The development of switch-gear apparatus has closely followed that of machines and motors, and the Swedish electric industry can at the present date undertake any problem in the way of power development and power transmission.

The building of electric railways has greatly interested the Swedish State which in the years 1904/05 paid large sums for investigating various matters in the way of electrification. A direct result of the work in this direction is that the electrification of the Swedish State Railways has now begun, single phase A. C. current 15 periods being used, the pressure in the working lines being 15 000 volts. The first line electrified was that between Kiruna and Riksgränsen, and the electrification of the main line Stockholm — Göteborg is now decided upon.

Among other electric developments in Sweden we may mention the electric steel furnace by Kjellin and the electric blast-furnace invented by Lindblad, Grönwall & Stålhane. The development of the nitrogen industry in Norway is also largely due to the Swedish electric industry, and the greater part of the electric installations for that industry was delivered by the Swedish General Electric Company.

The Swedish telephone industry should be mentioned. It has grown very extensive and, in fact, telephone apparatus, bearing the name of L. M. Ericsson, is now to be found in every part of the globe.

Other products of the Swedish electric industry are conductors and cables manufactured at the factory of Max Sievert, Sundbyberg, electric incandescent lamps obtained from factories in Stockholm and Nyköping, electric hoists from the factory of Graham Brothers in Stockholm, heating apparatus etc.

THE METAL AND MACHINE INDUSTRIES.

(JOURNEY TO AKTIEBOLAGET SVENSKA METALLVERKEN, VÄSTERÅS.)

This group gave employment in 1915 to the following number of factories and workmen, as shown in the table below. The productive value, together with the import and export, are also shown in the table. It should be noticed in connection with these returns that the production of raw material for this industrial group, iron, steel and other metals, is not included in the statement.

	Factories	Workmen	Productive value 1 000 Kr.	Import 1 000 Kr.	Export 1 000 Kr.
Iron and Steel Goods.....	117	22 078	171 585	49 833	136 533
Other metal work	224	14 599	132 719	69 605	53 546
Ships and boats	30	8 059	25 243	14 790	12 485
Carriages and vehicles ...	52	2 343	14 111	1 885	1 320
Machines and tools	916	57 301	289 829	25 337	85 318
Instruments	63	1 439	5 848	4 612	2 796
Watches and parts thereof				2 157	128
Total	1 402	105 819	639 335	168 219	292 126
				Deduction for import Kr.	168 219
				Surplus production Kr.	123 907

The steam engine, which was invented towards the close of the 18th century, was introduced into Sweden in the beginning of the nineteenth and here too revolutionised industrial life. Previously, however, many Swedes, such as Polhem, Rinman, Nordwall, Broling, etc. had shown the greatest interest in their technical machine branch. A particularly important invention was made in 1826 by L. Lagerhjelm, namely a machine for testing iron and steel which was the commencement of the, nowadays so indispensable, testing of materials, and without which the complete machine technique of the present day and the building art in all its branches would not have been possible.

The independent machine industry was at first coupled with the iron-works, from which the raw material was obtained. With the more general use of the steam engine and the introduction of English machine-tool for working the iron, the present machine industry began to make strides in the mechanical workshops and foundries, which were started at the coast towns and in the interior of the country at places favoured with good communications. It was, of course, an advantage to have the aid of waterfalls. This industry has been advanced and developed by such inventors as John Ericsson, Carlsund, Palmcrantz, (machine guns), L. M. Ericsson (telephone apparatus), Per Persson (knitting machines), A. Lagerman (complete machines for match factories), J. G. V. Zander (motorpathie apparatus), Gustaf De Laval (the continual separator and steam turbine), Gustaf Dalén, the Nobel prize winner (automatic lighting apparatus and light-houses etc.), Wingqvist (ball bearings) etc.

Until the seventies the mechanical workshops were erected chiefly for repair work and for coarser kinds

of castings, but in order to keep regular workmen it became necessary to specialize for the requirements of the district and sometimes for distant parts of the country. At the same time as the use of special machines has increased in the older workshops, they have also specialized their manufacture. The most modern workshops have almost exclusively been constructed for the manufacture of certain special machines and apparatus. The Swedish mechanical productions have attracted attention at most of the world exhibitions.

A special branch of industry in this group is the Eskilstuna industry, corresponding to the Sheffield industry of England. This manufacture was commenced in Eskilstuna after the town had been granted privileges of the so-called free town in 1771. Up to the nineties this trade was chiefly carried on in small smithies, but they produced excellent goods which became famous in foreign countries too. Numerous articles of iron, steel and other metals are turned out, such as knives, scissors, hinges, locks, mountings, hooks and other builders' articles, files, hammers, tongs, gimlets, sawblades, dung forks, spades, household utensils, skates, fancy articles and more recently articles of wholly pressed metal on a large scale etc. This manufacture has now developed into a great industry in connection with foundries and mechanical workshops, so that the import of such articles from Germany and England has practically ceased.

The metal industry in a more restricted sense, viz., the manufacture of copper, spelter, aluminium etc., is of minor importance in Sweden as far as mining is concerned. But there are several old-established and highly developed works for the production of tubes, plates, wire and different articles of copper; brass, alu-

minium and other metals for home consumption. The growth of the electric industry and the utilization of water power by means of hydro-electric plants have created an increasing demand for products of copper. Thus, a fresh impetus has been given to the metal industry and extensive modern plants have been erected. One of the most prominent of these are the works of Svenska Metallverken of Västerås.