# Engelsberg's Oil Factory
# An Early Petroleum Refinery

By PER ÅGREN

In the following article Mr. Per Ågren, previously Technical Director of the Nynäs Petroleum Refineries of the Axel Johnson Group, gives an account of a plant for refining crude oil, started in the 1860's at Engelsberg in Central Sweden and still existing, excellently preserved. It must be considered very remarkable that a refinery – of a type very common in the USA in the initial stage of the petroleum industry – has been preserved until our time, and strange that this survival is to be found in Sweden, far from the cradle of the petroleum industry.

**Beginning Petroleum Industry**

The petroleum industry can be considered as having been born on the 27th August 1859, when Edwin L. Drake succeeded in finding oil by drilling a well at Oil Creek near Titusville in Pennsylvania thus making it evident that oil could be extracted from deep layers of the earth, in large quantities and at low cost. Drake's discovery started a revolutionary development. In the USA the production of crude oil rose, in round numbers, from only 2,000 barrels in 1859 to 500,000 barrels in 1860, 5,260,000 barrels in 1870, and 26,286,000 barrels in 1880. The rapidly growing production was followed by an equally rapid decrease in the price. The first lot of crude oil was sold at $ 20 a barrel. (A petroleum barrel is equivalent to 0.159 cub.m.) At the beginning of 1860 the price was still $ 10 a barrel, but a few months later crude oil could be had at $ 2 a barrel. Within the course of three years the price went down to only 10 cents a barrel, but it soon rose again to above $ 2 a barrel.

When Drake made his discovery there were in the USA some fifty plants where coal-oil was distilled from bituminous coal and afterwards treated with chemicals in order to make the oil fit for lighting purposes. As soon as it was established that the same methods were applicable to crude oil, petroleum refineries of the same type as the coal-oil refineries sprang up like mushrooms and petroleum lighting oil (kerosene) soon became the petroleum product most in demand. To begin with, the petroleum refineries were rather primitive; the first is said to have been erected at Titusville by William Barnsdall and William H. Abbott at a cost of some $ 15,000.

As the petroleum industry advanced new and more specialized plants became necessary for the manufacture of kerosene, lubricants and many new petroleum products. The old refineries, no longer justifying their existence, were pulled down to make room for new plants. If anything of the plants could have been expected to survive it might at the utmost be some odd part of the equipment preserved as a museum specimen. It must, therefore, be regarded as very remarkable that a petroleum refinery of the type used in the USA in the 1860's still exists, complete and intact, in Sweden far from the birthplace of the petroleum industry. The refinery is situated at Engelsberg in Central Sweden, the site of an old ironworks that got its first privileges in 1597 and closed down in 1919. It now belongs to the Axel Johnson Group.

**The Engelsberg Refinery**

The Engelsberg refinery was not the first of its kind in Sweden. In the year 1859 Henry Orland Jones — born in New York in 1830 — purchased two and a half acres of land on the island Reimersholme in Lake Mälaren in the outskirts of Stockholm where he and his partner, Charles G. Lundborg, presumably of Swedish extraction, intended to build a factory for the manufacture of "American Photogene Oil". Their original intention seems to have been to make coal-oil, because shortly afterwards they were granted a Swedish patent for using a type of iron retort for manufacturing kerosene, other oils and solid paraffin from pit coal and other bituminous substances. The plant was erected during the years 1862—63 and, as far as known, only used for refining imported crude oil. The economic returns were poor, the plant closed down, and Jones, who had separated from Lundborg, returned to America. Lundborg, on his side, started a factory at Södertälje, not far from Stockholm, where he produced coal oil and refined it into lighting oil. The competition from imported American kerosene, however, became so intense that Lundborg was forced after a few years to close down his business. Afterwards he occupied himself with oil-drilling at several places in Sweden, obviously with no success. His factory was taken over by a company which refined imported American crude oil, but after some years broke down owing to a sharp fall in the price of imported American kerosene. A new company was formed which continued to refine imported oil. It succeeded in keeping the business going until the outbreak of the first World War.

Of Lundborg's plant at Södertälje not a trace is to be seen today. Of Jones' factory at Reimersholme, which after his return to America was rebuilt into an alcohol distillery and later taken over by the State monopoly, some factory buildings and a big built-in tank remain.

In the year 1871 August Ålund, born at Örebro in 1826, commenced erecting an oil factory at Annelund, a small farm on the shore of a lake called Snyten in the neighbourhood of Engelsberg. It was a strange site for an industrial undertaking: on one side a fairly large lake, on the other a vast and practically uninhabited wooden area. There was no water power available, and the communications were miserable. Engelsberg is situated on the shore of Lake Åmänningen, one of the many lakes in the Strömsholm channel system. In Ålund's time this channel was still an important means of communication for the many mines and iron works in this part of Sweden, connecting

them with Lake Mälaren and thereby with the Baltic Sea. The crude oil that was to be refined at Annelund could be conveyed in barrels on barges as far as Engelsberg. There the barrels had to be unloaded from the barges and transported on carts either on bad roads some six English miles to Annelund, or over the neck separating the Lakes Åmänningen and Snyten from each other, and further to the factory by boat. Annelund was certainly not the kind of place where lucrative business could be carried on, but a man engaged in dangerous experiments with inflammable matters and wishing to keep his doings secret might have found the place ideal.

Two documents dated in January 1874 throw some light on Ålund's situation. In one of these documents he points out that, after seven years of experiments, he had succeeded in finding a new and better way of distilling oil. In the other he presented a cost estimate of the method, based on results arrived at during the course of three years. Counting backwards from 1874 this seems to imply that Ålund commenced his experiments in 1867, and that in 1871, precisely the year when he commenced building the factory at Annelund, he had considered his method ripe for exploitation. So far it is not known where he — formerly a farm superintendent — had acquired the necessary know-how to start his experiments in 1867. Ålund's factory was ravaged by fire twice and the second time it burned down entirely after being struck by lightning. With his clothes aflame Ålund escaped from the fire by jumping into the lake. The foundation walls of the factory, covering an area of about 32×16 feet, can still be seen.

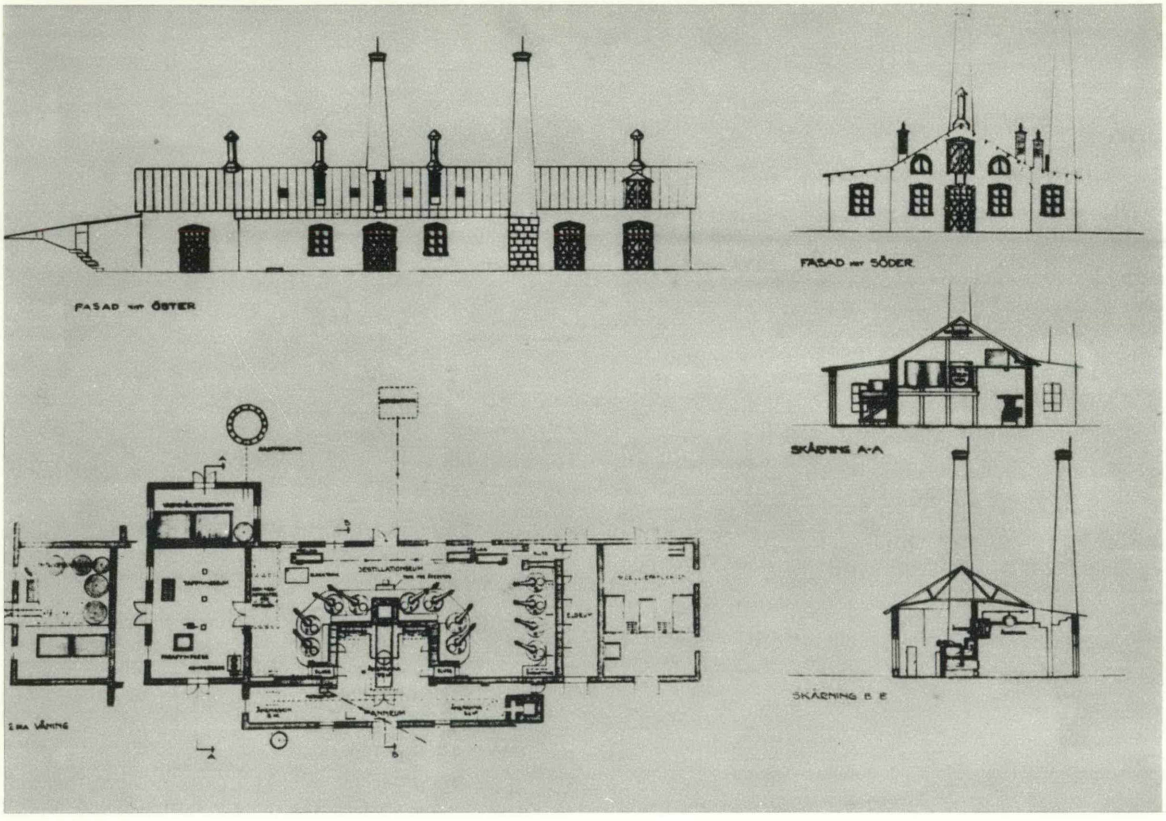
After this misfortune Ålund purchased from Carl Erik Westling and Johannes Mattsson (both part-owners of the Engelsberg iron works) for the sum of 500 Swedish crowns and an annual rent of 2 Sw.cr. a roughly nine acres big island in Lake Åmänningen. In 1873 Ålund commenced building an oil factory on the purchased island, then known as Barrön, now Oljeön (Oil Island). In January 1874 he invited subscriptions for shares in a company that was to carry on the business. He pointed out that he "after seven years of experiments" had succeeded in finding a method to distil heavy oils by means of steam which made it possible to separate what he called the "lean" (sträva) and the "fat" (feta) oils and from the latter produce valuable lubricants and machine grease which could be sold at a higher price than the lighting oils. He also presented a costs estimate for the manufacture of lamp-oils and lubricants "based on results from distillation



*General View of the Petroleum Refinery at Ängelsberg, built in 1876 on the Oljeön Island (Oil Island) in the Lake Åmänningen.*

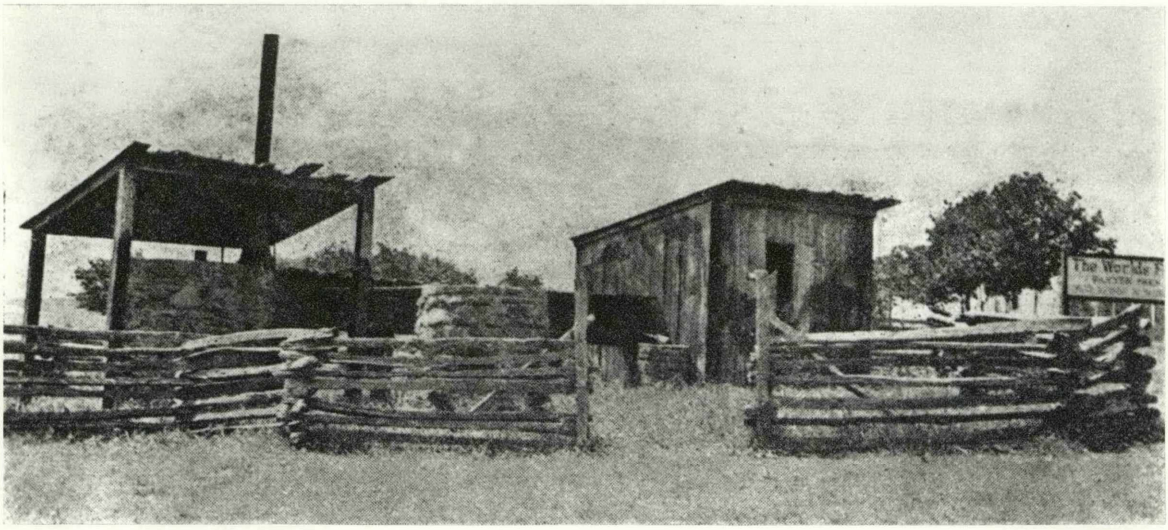
*The main building of the Refinery.*





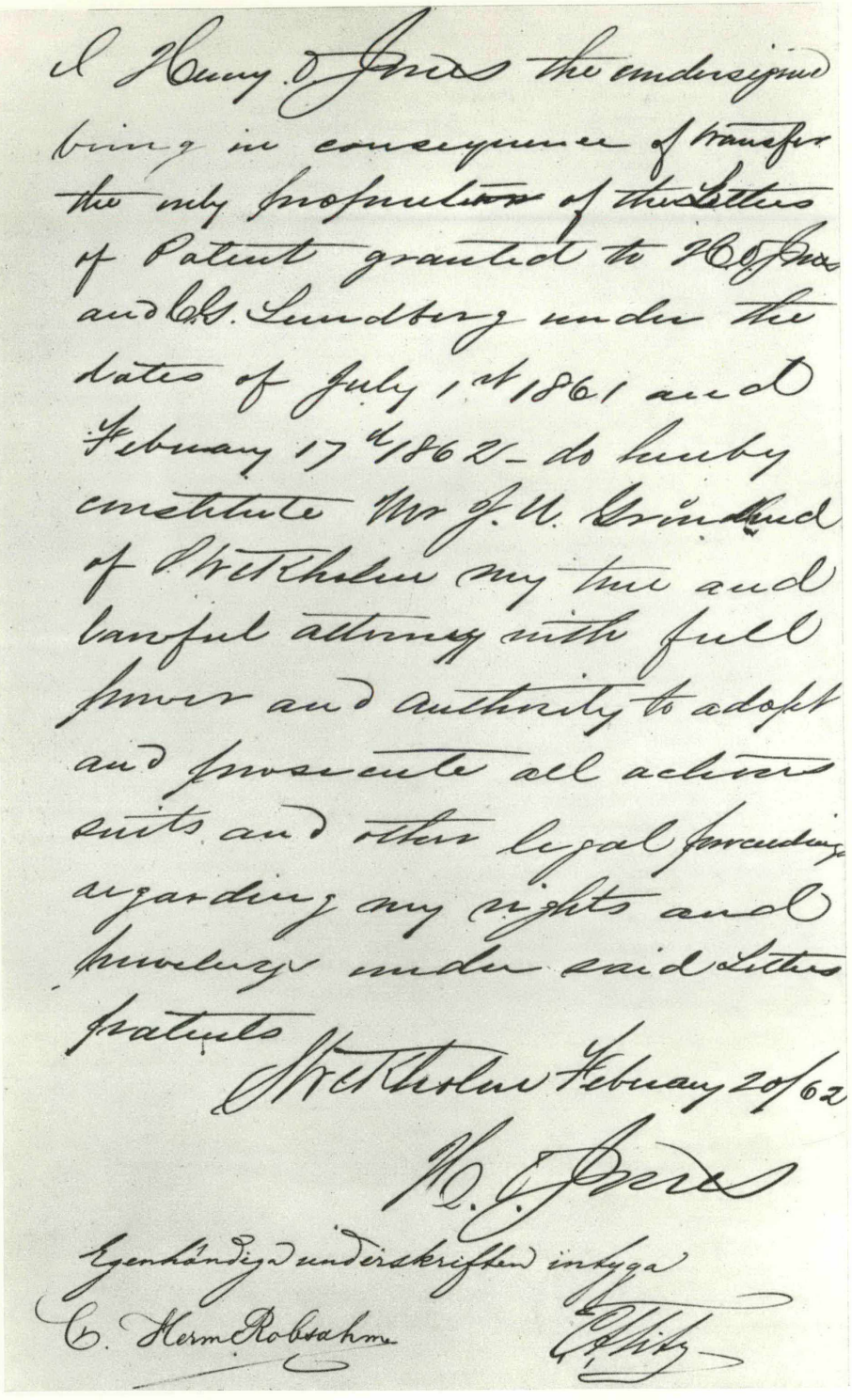

*Measured drawing of the main building.*

*The world's first oil refinery, built by William Barnsdall June 1860 at Parker Farm near Oil Creek, Pennsylvania, USA.*





*Refinery building, viewed from the Island.*



I Henry O. Jones the undersigned
being in consequence of transfer
the only proprietor of the Letters
of Patent granted to H.O. Jones
and C.G. Lundborg under the
dates of July 1st 1861 and
February 17th 1862 - do hereby
constitute Mr J.U. Grönlund
of Stockholm my true and
lawful attorney with full
power and authority to adopt
and prosecute all actions
suits and other legal proceedings
regarding any rights and
privileges under said Letters
Patents

Stockholm February 20/62

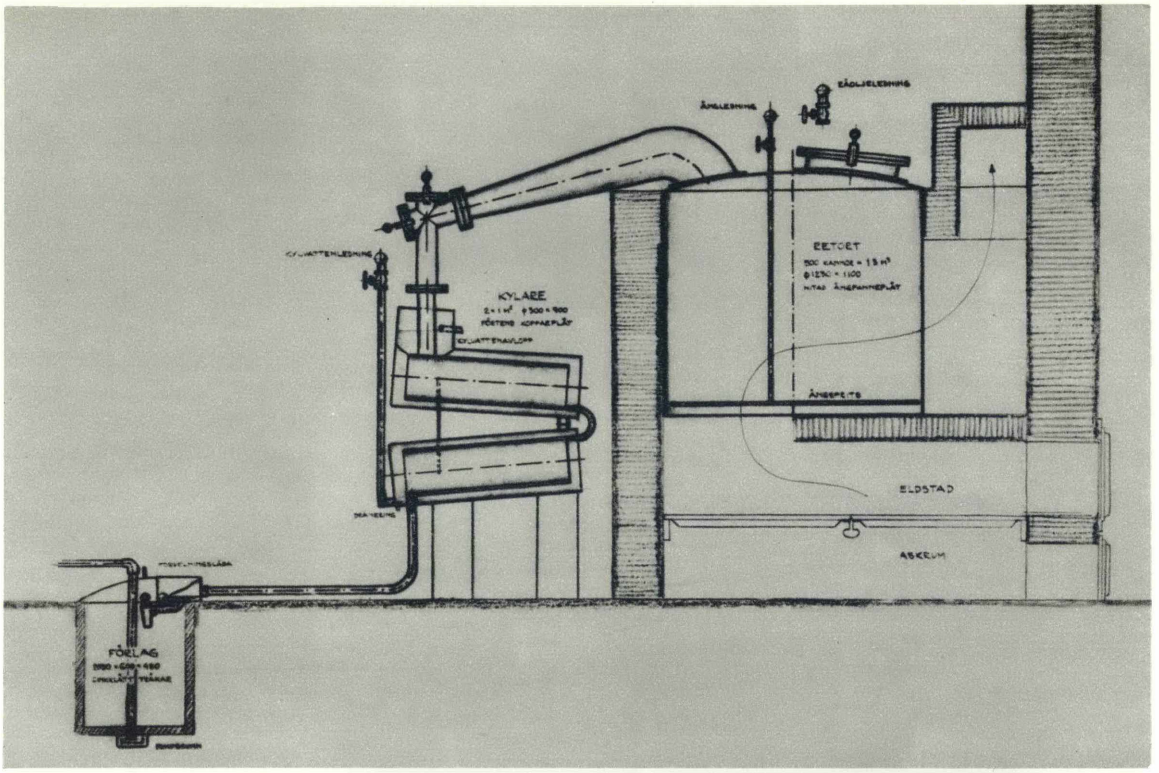
H.O. Jones

Egenhändigt undertecknad intygas

C. Herm. Robsahm

C. Whitby

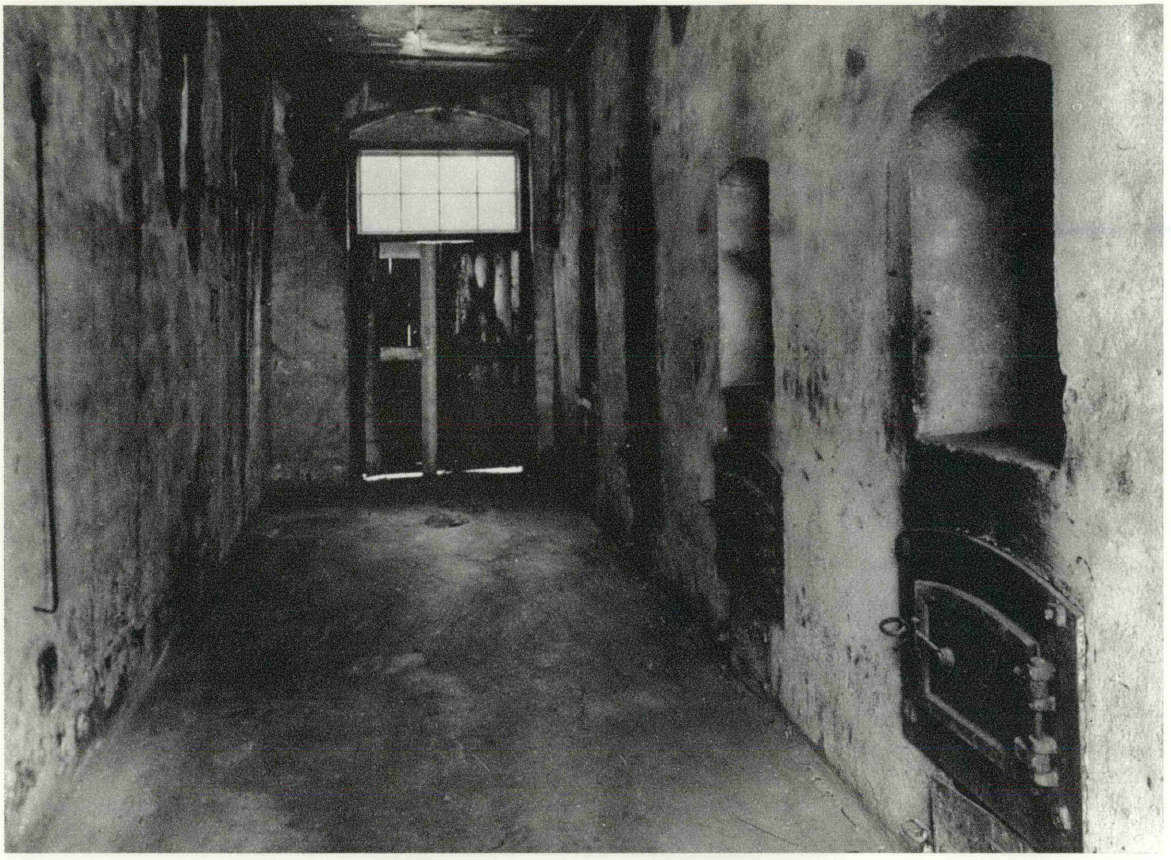
*Mr. H. O. Jones's proxy, in his own handwriting, for Mr. J. U. Grönlund to act as patent agent on Mr. Jones's and Mr. Lundborg's patents of July 1st, 1861, and February 17th, 1862.*



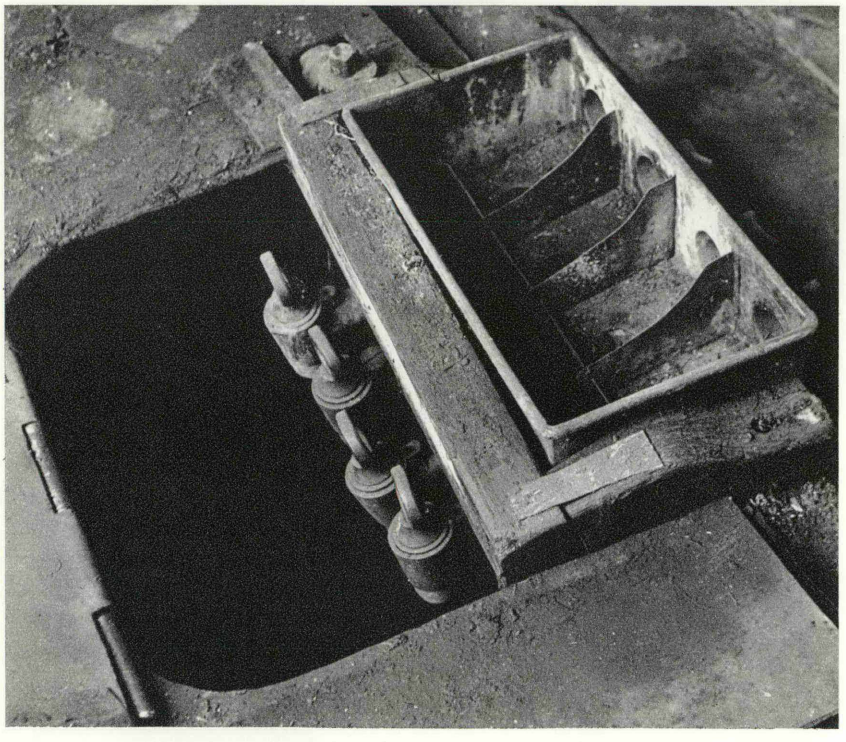

*Distillation equipment in the Ängelsberg Refinery. Measured drawing.*



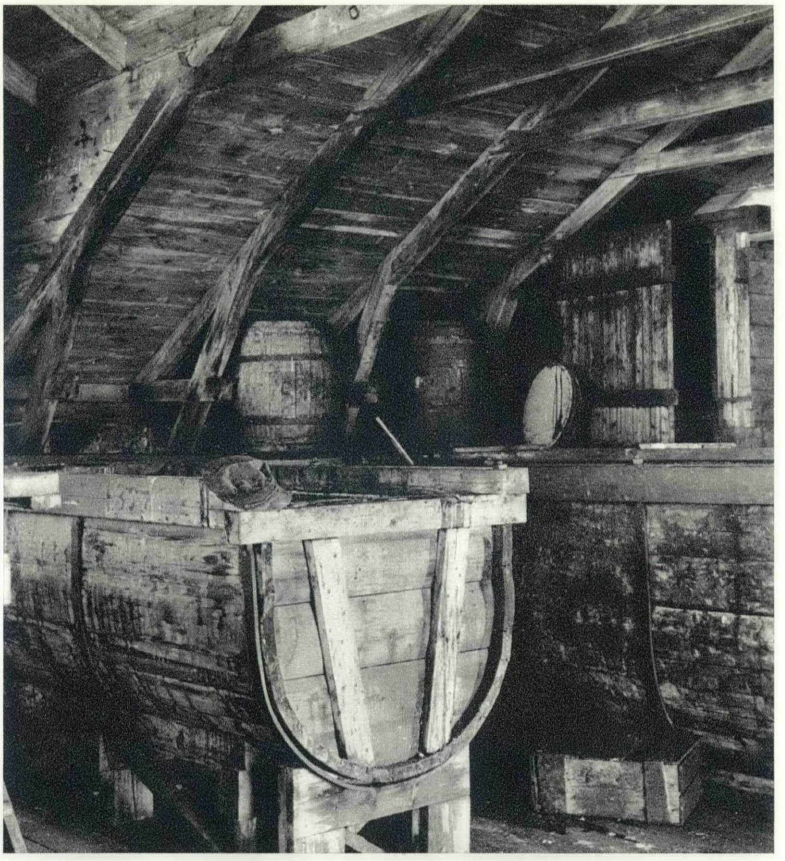
*Detail of cooler.*



*Stoves for heating with wood. The stove doors were accessible from a closed area, separated from the distillery room with air locks.*

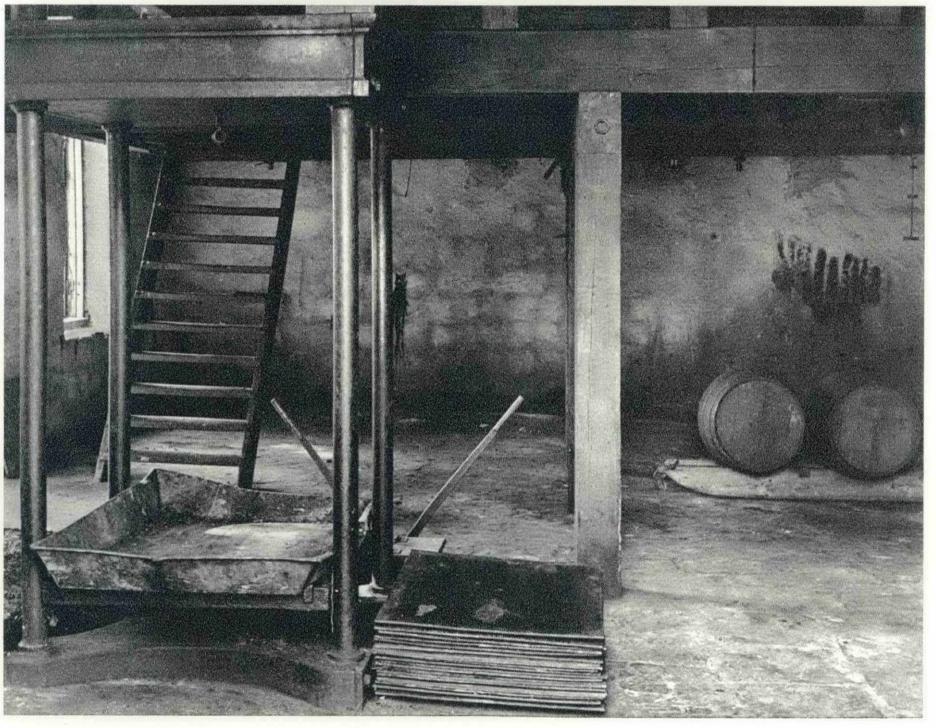


*Detail of vessel for distribution of the distillation products to the storage tanks.*



*Vat for mixing lubricating oil.*

*Filterpress for paraffine.*





*Original tools, most of them used in the early days of the Refinery, now exhibited on the premises.*

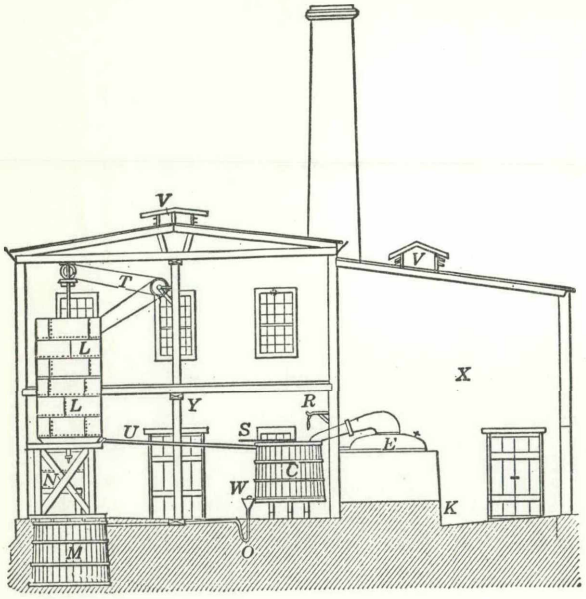
with steam during the course of three years". The articles of association of the company, named Engelsbergs Oljefabriks AB, were sanctioned by the Government in May 1875. The paid up share capital was 85,000 Sw.cr. I August 1876 the company was granted permission to refine inflammable oil, until further notice limited to maximum 1,000 barrels a year.

From 1877 to 1902 the company operated successfully with an annual turnover during the best years of between 100,000 and 150,000 Sw.cr., and an annual net profit of between 20,000 and 25,000 Sw.cr. Dividends of between 10 and 20 per cent could be paid. The manager of the company was Bengt Fredrik Zetterström, a general-store dealer from Engelsberg, with Ålund acting as head of the factory. Ålund remained the factory head until 1883 when illness forced him to retire. He died on the 18th August 1883. Zetterström remained head of the company until his death in May 1905.

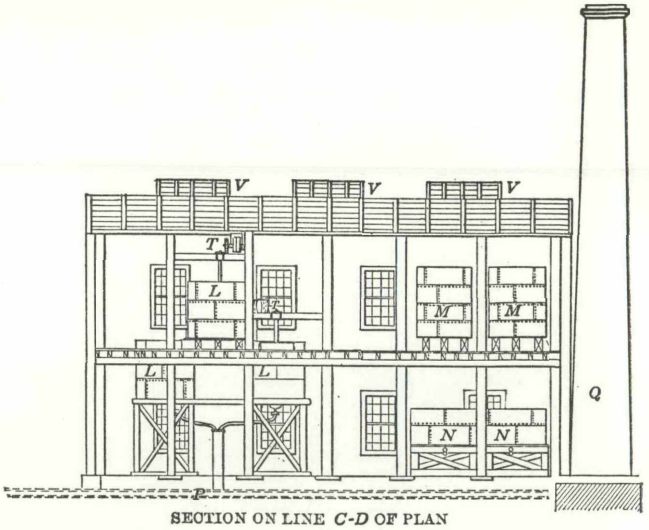
**Buildings and Equipment**

The main factory building was situated on the narrower (northern) part of the island of Barrön, at a distance of 45 feet from the water on the one side and 100 feet on the other. It was built of blast-furnace bricks under a roof of boards covered with asphalt felt. The house was 60 feet long and 30 feet broad and the walls 12 feet high. At the southern short side there was an extension of 200 feet length and of the same breadth as the main building. The eastern side also had an extension, 43 feet long and 11 feet wide. The extensions were built of the same materials as the main building. The whole main building and a part of the extension on the long side formed the factory proper. It was ventilated by two sheet-iron tubes of 16 inches diameter straight through the roof.

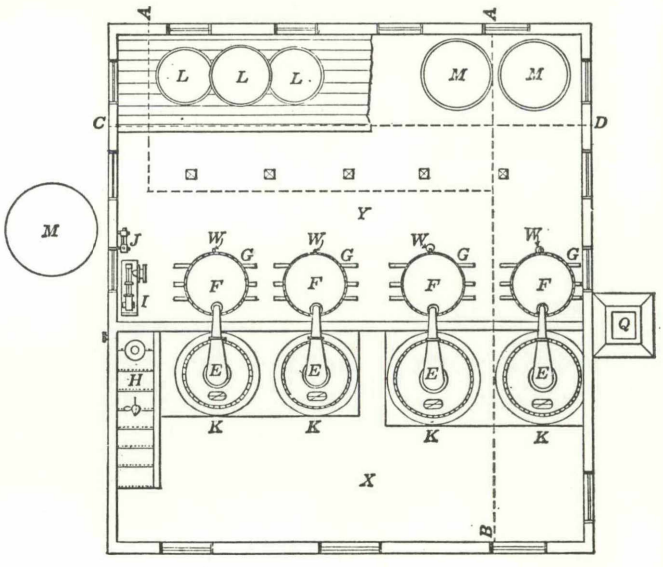
At first the building contained eight retorts set in brickwork, but the number increased so that the equipment now existing consists of twelve retorts. They are made of riveted boiler plate and each holds 300 gallons. Each retort has its own furnace for woodburning, a cast-iron "neck" with pipe connected to a tin-coated copper cooler for condensing. There is also a walled-in steam-boiler of 3 feet diameter and 11.5 feet length with two walled-in superheaters. Four tanks of iron plate, each holding about 500 gallons, a filter-press for solid paraffin, water pumps and various containers and valves and piping complete the equipment.




SECTION OF BROKEN LINE *A-B* OF PLAN



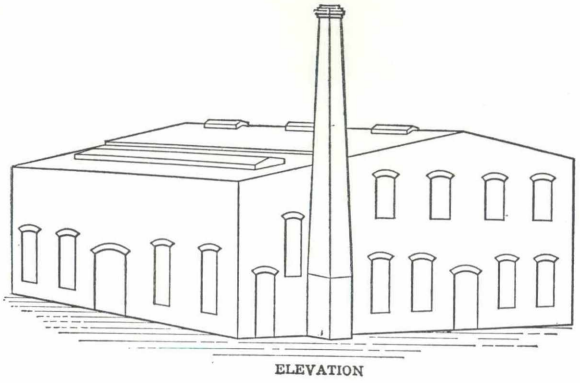

SECTION ON LINE *C-D* OF PLAN



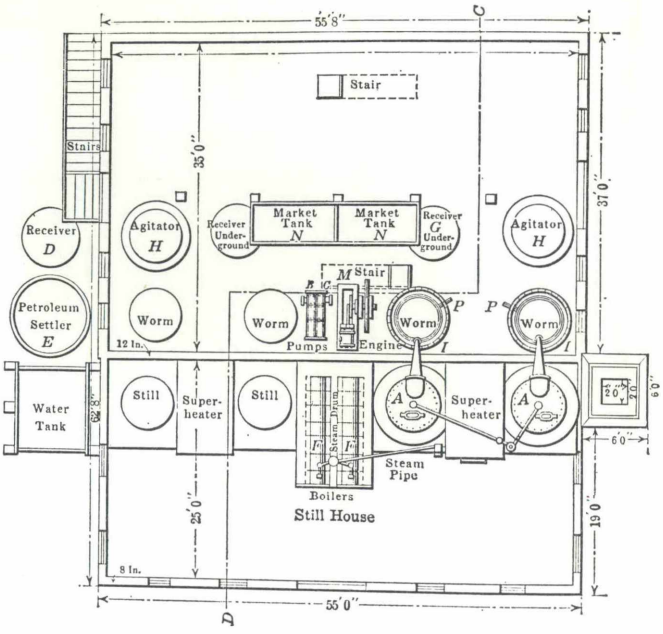

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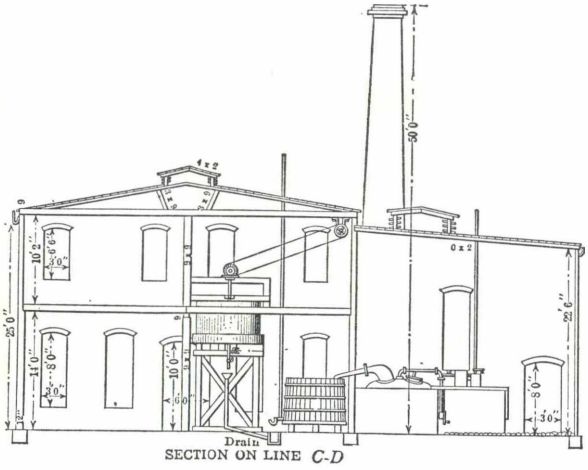
*E* - Stills
*F* - Worms
*G* - Worm Tanks
*H* - Boiler
*I* - Engine
*J* - Steam Pump
*K* - Still Furnace
*L* - Washers, or Agitators
*M* - Receivers
*N* - Market Tank
*O* - Syphon of Still Pipe
*P* - Drain
*Q* - Chimney
*R* - Water Pipe
*S* - Steam Pipe
*T* - Washer Gearing
*U* - Pipe from Agitators to Stills
*V* - Ventilators
*W* - Tail Pipes
*X* - Still House
*Y* - Refinery

*A plan of an 1860 coal oil refinery, having a daily capacity of 600 gallons. — From The American Petroleum Industry by Raymond Foss Bacon and William Allen Hamor, McGraw-Hill Book Company Inc., New York 1916.*



ELEVATION




SECTION ON LINE *C-D*

*A plan of the type of petroleum refinery erected in the early sixties. — From The American Petroleum Industry by Raymond Foss Bacon and William Allen Hamor, McGraw-Hill Book Company Inc., New York 1916.*

Following an inspection in August 1876 the authorities concerned raised objections against the lay-out of the factory. They found it unacceptable that the fire-boxes of the retorts and that of the steam-boiler had been placed in the same room as the refining equipment and the tanks for the distilled products. They therefore prescribed that all furnace openings and all smoke-channels should be separated from the equipment in the hall by fire-proof ceilings and brick-walls. An earthen dike was to be erected between the workshop and the lake, long enough and high enough to take up all the oil that was being treated at one time, thus in case of emergency preventing leaking oil from reaching the lake.

Furthermore, air-locks were installed to separate the still room from the fire room.

**Manufacturing Process**

Through fractional distillation the crude oil was divided into a series of distillates, each fraction with its particular properties as to boiling range, flash point, gravity etc. The distillation was carried out intermittently in batches of 210—260 gallons per retort. The crude oil was let down into the retorts by pipes from tanks on an upper floor and heated by wood-burning in furnaces under the retorts. The oil began to boil at 105—140° F (40—60°C), and the gases and vapours driven off from the oil were led from the neck of the retort into two coolers coupled in series. During the beginning of the process the cooling water was kept as cold as possible. At first gases and vapours that did not condense at atmospheric pressure were driven off. When the vapours began to condense in the coolers the liquid was led through pipes into a look-box on the floor. As the firing increased and the temperature of the oil rose, heavier distillates with higher boilingpoints were obtained. Samples were taken regularly in the look-box. According to the result of the samples as to gravity, flash-point etc. the condensate was divided in different fractions (cuts). By means of a system of pipes and valves (manifold) the cuts were led to receiving tanks, with separate tanks being kept for each fraction. The light product obtained during the first part of the process, before the temperature rose to 100° F (40° C) was called in Swedish "gas-olja" ("gas-oil"). It had a gravity of 0.70—0.75 and an end boiling point of about 390° F (200° C). The gas-oil was followed by kerosene ("photogene") with a gravity of 0.79—0.82 and a boiling point between 390° F (200° C) and 480° F (250° C). After the




*Etikett använd vid förpackningar för läder- och skosmörja tillverkad av Oljefabriken i Engelsberg under 1910-talet.*

"photogene" a mixture of heavier oils was obtained with a gravity of 0.83—0.90 and a boiling range between 480° F (250° C) and 750° F (400° C). This crude distillate was redistilled, resulting in the final products: heavy "photogene", lubricating oil and paraffin wax. As the paraffin began to vaporize, the temperature of the cooling water had to be raised to about 85° F (30° C) in order to prevent the pipes from being choked by the solidifying paraffin.

After the distillation the kerosene was subjected to a chemical treating process for improving colour and odour. The kerosene was blown with air for removing water. It was extremely important that the "photogene" should be quite free from water as even small amounts of water made the oil cloudy.

The oil to be sold as machine or cylinder oil was refined in bleaching vessels set out into the lake on the eastern side of the island. The vats were made of iron plate and bottomless with 30 inch high sides. They were arranged in two rows and suspended in chains so that they could be raised or lowered as required. The oil was poured into the vats directly on the water surface. Bleaching was undertaken twice a year during the summer. Depending on the weather conditions the operation lasted three to four weeks. It resulted in improvement of colour and removal of aciduous components of the oil. It was particularly important that sewing-machine and gun oils did not corrode steel. After bleaching the oil was pumped into barrels by hand. When the plant was working at capacity, twenty bleaching vessels were in use with each vat holding eighteen barrels.

The crude oil used as raw material was a paraffin base oil holding a great quantity of paraffin. In order to allow the wax to crystallize and to make it possible to remove it before further distillation the crude distillate was stored for a considerable time. As can be seen from the proceedings of the Board the storage was a heavy cost, but one that had to be met as this product was considered the most valuable. The solid paraffin with adhering oil was separated and put into sacks and stacked between sheets in a hydraulic filter press. The oil that was pressed out was collected in a tank and could be used as a lubricant.

When in January 1874 the shares of the company were issued, Ålund pointed out that only one refinery had been built in Sweden so far. This was because the distillation method used up to then, while giving the desired product (lighting oil) also gave a mixture

of lubricant and non-lubricant oils difficult to separate and not much in demand. His method to distil by means of superheated steam was to prevent the decomposition of the oil. The following table gives an idea of the quantities of finished products actually obtained in volume per cent of the treated crude oil:

| | |
|---|---|
| "Gas-oil" | 12.5 % |
| "Photogene" | 31.0 % |
| Lighting Oil | 12.5 % |
| Light machine oil | 1.1 % |
| "Oil for machine lubrication" | 17.5 % |
| Cart grease | 6.0 % |
| Pressed solid paraffin | 6.0 % |
| Losses | 13.4 % |

**Market Conditions**

Kerosene, called "fotogen" in Sweden, and "gas-oil" were the main products from a quantitative point of view. The company also made a good income from lubricating oils (genuine as well as compounded oils) and from solid paraffin. The raw material, namely crude oil from the USA, "goudron" (coal-tar) from Galizia, and fats and tallow from Russia and other countries were imported in barrels, either directly or through agents. The finished products were distributed in barrels made at the factory.

The customers were to be found mostly among the mines and iron- and steel-works using the Strömsholm Channel as their natural way of communication. Outside the channel district deliveries were made by rail.

During the first years the company was able to profit by a rather high tariff protection. In 1874, crude oil could be imported dutyfree, but the finished products were liable to an import duty of 20 per cent of the sales price, or more. At the beginning of the 1880's the import duty was reduced by one half.

At the close of the century market conditions for the company's products deteriorated and the refining of crude oil became less and less profitable. In 1901 the annual profit fell to only 9,742 Sw.cr. owing to a rise in the price of crude oil from 21.41 Sw.cr. a barrel in the previous year to 25.07 Sw.cr. and to falling selling prices. In the following year growing competition with imported refined oils made it necessary to reduce the prices even further and at the

same time the production had to be decreased as a ship-load of 1500 barrels crude oil, bound for the company, was destroyed by fire in a Baltic harbour. The Board now deemed it no longer profitable to refine imported petroleum and found it better to sell imported lighting oils and lubricants, made of mixed imported oils. Refining of crude oil at the factory accordingly ceased in 1902. The sales of imported products, however, did not turn out well.

Zetterström, who had been manager of the company since the start, died in May 1905. At a meeting in July of the same year it was agreed that the company should be dissolved. The liquidation was completed in April 1907.

**A New Company takes over**

In January 1906 the plant on Barrön was sold to a new company called AB Oljefabriken for a sum of 40,787 Sw.cr. The new company had a share capital of 50,000 Sw.cr., later increased to 100,000 Sw.cr. The manager was Wilhelm Lagergren, born in 1850. He came from a well-known family of iron-masters; three generations of his ancestors had been owners of the Kloster iron-works. Wilhelm Lagergren graduated in 1873 from the Royal Institute of Technology in Stockholm and afterwards entered the family works. During the years 1897—1905 he rented the forges of the Engelsberg iron-works.

AB Oljefabriken carried on business in the oil trade until 1927 when it went into liquidation. Lagergren had retired some years earlier and died in 1925.

**Epilogue**

After the liquidation of the AB Oljefabriken the properties of the company on Barrön were bought by the well-known Swedish industrialist Consul General Axel Ax:son Johnson, since 1916 owner of the old iron-works at Engelsberg. He was a man with a living interest in the history of culture and technology. Evidence of this interest can be found in many places where the Axel Johnson Group is active: in Avesta, Nynäshamn and — not least — at Engelsberg, where the manor and an old blast-furnace have been carefully preserved as monuments to culture and technology in times long past. As such a monument the oil factory at Engelsberg, unique not only in Sweden but very probably throughout the world, commemorates the rise of a technology that created a new era: the era of oil.