THE GERMAN INDUSTRIAL EXPOSITION AT DUESSELDORF.

By FRANK C. PERKINS.

In passing through the main gate of the Düsseldorf Exposition one enters the Machinery Hall of the Gutehoffnungshütte Building which has large adjoining halls on the right and left-hand sides. On the side walls are hung photographs and plans of various works situated in Oberhausen and Sterkrade, as well as a large bird's-eye view of the district and other pictures and plans showing the development of the Gutehoffnungshütte during its existence. On the right hand side of the hall are exhibited, with the exception of a Riedler express pump, only the produce of the mines, the blast furnaces as well as the steel works and rolling mills with accompanying plans and drawings, while the produce of the iron and steel foundries, of the forge and boiler works as well as of the engineering department are placed in the left-hand side halls; three of the machines at work belong to the last category, viz., the blast engine in the left-hand side hall, the hauling engine in the middle hall, and the Riedler express pump in the right-hand hall.

The double-tandem hauling engine mentioned above has a stroke of 80 inches with high and low pressure cylinders 34 and 48 inches respectively. There are

ute. It has an auxiliary lifting gear for loads up to 8 tons at a speed of 32 feet per minute. The motors are of the direct-current type, built by the Helios Company of Cologne-Ehrenfeld. Among the other important exhibits in this building are plans and illustrations of underground pumping engines, vertical and horizontal tandem rolling-mill engines, as well as reversing rolling-mill engines and a blowing engine for Bessemer plants.

A most excellent exhibit may be noted showing axle and wheel-tire manufacture, the group including among many other articles, the rough ingots, a pressed ingot for wheel tires, a pressed and punched ingot for wheel tires, a forged tire finished and seven cooled wheeled tires of an internal diameter of 1400 to 2000 millimeters. Another group represents a construction of wheel centers and wheel disks, which another shows sets of wheels and axles for tramway use, while a third group shows the products from the plate mills.

There are also in this building excellent exhibits of bridge-building material as well as products from the steel foundry, iron foundry, boiler works and forges of this great industry.

During the present summer the German National Art Exhibition is being held at Düsseldorf on the Rhine, and in conjunction with it an industry and trade exhibition for Rheinland and Westphalia. Many of the

to a height of 1968 feet. It is driven by a three-phase motor of 450 horse power, operating at a potential of 2000 volts and a speed of 200 revolutions per minute.

The engine and generator exhibits of the Düsseldorf Exhibition, while not as extensive as at the Paris Exposition, are of great interest and well worthy of careful study and consideration. The 2000 horse power twin tandem engine built by the Maschinenfabrik Grevenbroich, driving the Helios polyphase alternator, is used largely for lighting the exposition.

The four engines in the foreground of our general view are used for driving direct-current generators by belt transmission. They are of 37, 47, 60 and 76 horse power capacity and the Lahmeyer dynamos, so driven, are used for supplying exciting current for the large alternators located in that section of the exhibition building.

These engines, as well as the 600 horse power vertical compound engine seen in the background at the right, are supplied with superheated steam at 350 deg. by a special direct-fired superheater in the boiler room. This superheater was constructed by the Dinglerische Maschinenfabrik Actien-Gesellschaft of Zweibrücken, and has a heating surface of 150 square meters, supplying per hour 6000 kilogrammes of superheated steam at 350 deg. and at from 10 to 12 atmospheres pressure.

The large vertical engine seen in the background of

GENERAL VIEW OF THE MACHINERY HALL AT THE DUESSELDORF EXPOSITION.

two enormous cylindrical drums on this engine which are 70 inches in width, with a diameter of $26\frac{3}{4}$ feet, each with valve link motion and a special steam reversing gear. A net weight of nearly 5 tons may be hauled at an average speed of 69.36 feet per second from a depth of 2460 feet. It is fitted with a steam brake, a falling weight brake, also the necessary safety apparatus, tachometer and depth indicator.

On the left-hand side of the hall there is a large blowing engine for blast furnace having a stroke of 30 inches and two air cylinders 34 inches in diameter. This is coupled to a 1000 horse power blast furnace gas engine, built by the Deutz Gas Motor Company. It takes 1000 cubic feet of air per minute at 135 revolutions and compresses the same to .5 atmosphere. It is fitted with regulating gear whereby it is possible, with the same motor power, but with altered aspiration, to compress the air to .75 atmosphere. The discharge of the air is effected by return valves (Stumpf's patent), the admission by means of cylindrical valve motion.

In the left-hand side of the hall, showing this enormous 1000 horse power gas engine and blowing engine for blast furnaces, there is an electric overhead traveling crane having a span of $54\frac{1}{2}$ feet. Its capacity is 40 tons and it is equipped with a continuous current motor of 25 horse power for lifting and one of 6 horse power for traveling with a speed of 100 feet per min-

buildings of this exposition are of most excellent architectural design and the grounds and decorations are arranged in the most pleasing manner, the electrical effects being particularly fine. Among the interesting exhibits should be mentioned those of the Gutehoffnungshütte, Actienverein für Bergbau und Hüttenbetrieb of Oberhausen II., Rheinland. In the main machinery hall of the Gutehoffnungshütte Building, this firm exhibits an enormous vertical triple-expansion steam engine of 3000 horse power, directly connected to an alternating-current generator and a direct-current exciter, the latter dynamo being mounted at the end of the engine shaft, outside of the main alternator bearings. This high-power engine was constructed for the electric central station at Essen. The diameter of the high-pressure cylinder is 33 inches and the low-pressure cylinder 82 inches, while the intermediate cylinder measures 56 inches in diameter and the length of stroke 48 inches. The speed of the engine is 94 revolutions per minute and the low-pressure cylinder is constructed with cylindrical valve gear, while the high and medium-pressure cylinders are built with Gutermuth's distributing valve motion.

At the right-hand side of the hall an electric Riedler express pump is shown, with two simple-acting plungers, each 7.4 inches diameter, with a stroke of 10 inches in length. At a speed of 300 revolutions per minute, this pump raises 8.2 feet of water per minute

the illustration of interior of Machinery Hall, was constructed by this firm and when supplied with superheated steam and operating at a speed of 120 revolutions per minute, develops 600 horse power. The cylinders of the engine are 600 millimeters and 950 millimeters in diameter and the stroke is 700 millimeters in length.

In the Machinery Hall at the Industrial and Trades Exhibition, there are a number of high-power engines in operation, both vertical and horizontal types, directly connected to electrical generators and it may be of interest to note some of the details of construction of these machines and their accessories.

Among the larger engines shown is one of 2000 horse power, constructed by the Maschinenfabrik Grevenbroich of Grevenbroich (Rheinland), located under group IV. This engine is of the twin compound-horizontal type and has on each side a high-pressure cylinder ($8\frac{1}{2}$ inches), 725 millimeters in diameter, and a low-pressure cylinder ($43\frac{1}{4}$ inches) 1100 millimeters in diameter, and a piston stroke common to both of ($51\frac{1}{8}$ inches) 1300 millimeters.

This horizontal engine has a speed of 72 revolutions per minute and is directly coupled to a three-phase alternating-current generator built by the Helios Electricitäts Actiengesellschaft, of Ehrenfeld, Cologne, Germany, which supplies a large proportion of the necessary electric current for the exhibition.

The engine develops 2000 effective horse power when worked condensing with the cut-off at 25 per cent stroke and a working pressure of 10 atmospheres in the high-pressure cylinders. Siemens-Martin steel is used in the construction of the crankshaft, and it is bored throughout its entire length, and the wrought-iron cranks are shrunk on warm and counterbalance weights are provided in order to partially compensate the disturbing influence of the inertia of the rods. The large main pedestals which carry the crankshaft are cast in one piece with the Corliss frames, and the frames have tubular guides carried by the foundation throughout their length. There are four parts to the steps of the main bearing, and the crank and cross-head pins are in two parts, and all the bearings are adjustable, while the main and crankpin bearings are lined with white metal. The crosshead pin bearings are of bronze, and the crankpins are of nickel steel. The crosshead pins are of crucible steel and the cross-heads are of cast steel polished and provided with long cast-iron guide shoes.

The piston rods of this 2000 horse power German engine are of Siemens-Martin steel, and are all of the same diameter ($6\frac{1}{2}$ inches) 160 millimeters, and are not carried through the rear cylinder covers.

The oil distribution and devices for catching the

The steam is lubricated before it enters the valves to the steam cylinders, and the surface over which the piston runs is directly lubricated by means of oil distributors and a Mollerup pump. To catch the oil which runs off there are provided guards of cast-iron or planished sheet metal, and they are so arranged that the waste oil splashed about is securely caught, and they permit the moving parts to be observed.

Each side of the engine may be worked independently, and the cock levers and stop valve are all accessible from one position. By means of an oblique-lying spindle the main stop valves are operated, this spindle being brought into connection with the screw spindle of the valve by bevel gear.

The lubrication of the crankpins is accomplished by means of a tube fitted into the head of the crankpin and provided with an oil cup which revolves concentric and coincident with the axis of the shaft, from which cup the oil passes out by centrifugal force to the crankpin.

In the four cylinders the steam distribution is effected by means of balanced double-headed valves, four being used on each cylinder. The admission and exhaust valves on the high-pressure cylinders are worked by positively closing valve gear designed by Maschinenfabrik Grevenbroich, while the valves of the

voir from which the oil passes into the bearing proper by means of tubes with an adjustable visible drop feed. The steps of bearing, as well as the shaft journal, have appropriate oil paths formed in them to insure a proper circulation of the oil, while the oil which flows away from the pedestal is caught in receptacles which are provided with fine sieves in order to keep out the dust. The oil is pumped back into the oil reservoirs from these receptacles by small oil pumps driven by chain wheels from the valve motion shafts. The reservoirs are each furnished with a fine sieve and diaphragms of felt to catch the impurities, and in order that the thick deposits on the bottom may not be allowed to enter the pedestal the outflow is not taken from the deepest point. This arrangement of oil circulation provides a very lavish lubrication, and as the oil is used over and over again it requires renewal only at long intervals.

Another large engine on exhibit is a tandem compound rolling-mill horizontal engine constructed by the Duisburger Maschinenbau-Aktiengesellschaft, vormals Bechem & Keetman, of Duisburg a. Rh. Germany. This engine has a capacity of 1100 horse power, under a normal speed of 100 revolutions per minute, and with a working steam pressure of 10 atmospheres. The high-pressure cylinder is $28\frac{1}{2}$ inches in diameter, and the low-pressure cylinder has a diameter of 42 inches. The flywheel of the engine weighs 53 tons and is 25.584 feet in diameter.

The Maschinenfabrik Grevenbroich, of the Rhine Province, exhibits in the main steam generating station of the Exposition an interesting design of water-purifying apparatus. It has a duty of 4444 imperial gallons (20 cubic meters) per hour which supplies purified water for half of the boilers exhibited. The water used for purification is that coming from the condensing plant (hot well water from injection condensers).

The apparatus is constructed in the form of a press, and is horizontal, containing in itself the heater, filter and precipitating apparatus, the three parts being mounted together in one frame in such a manner that adjoining the fixed head a number of heater elements in the form of plates, each having a special inlet for steam and for water, are arranged in sequence.

The precipitation tank then comes, which forms a chamber for the calcareous sediment, and the filter elements join directly onto this. These contain a channel which takes up the filtered water and conducts it back through the precipitation chamber and the heater elements to the fixed head again.

In the operation of this water-purifying apparatus an independent vertical compound steam pump takes the water to be purified from a collecting tank and forces it through the water purifier, and it flows first into the heater and then passes into the precipitation tank above where the lye is added to it in a definite proportion, according to the quantity and quality of the water. The water along with the precipitated matter then passes out from the precipitation chamber direct into the adjoining filter chamber, whence, after being purified, it is led into a reservoir for pure water, from which the feed pumps draw the water directly into the boilers. The apparatus is also constructed in vertical form with heater, lye vessel and gravel filter. The water to be purified is heated by either exhaust steam or live steam, and the details of construction may be noted in the accompanying drawings.

THE CAPE TO CAIRO RAILWAY.

WHEN the Duke and Duchess of Cornwall and York visited South Africa, they found a "train de luxe" in use on the Cape government line. According to the last annual report of the directors of the British South Africa Company, the train de luxe will soon be running between Cape Town and Bulawayo (1500 miles).

In Rhodesia, railroad building is progressing rapidly, although the Boer war interfered with the transportation of construction and equipment material from the south. Meanwhile, the Beira-Salisbury line has been extended southward and a junction formed with the main line at Bulawayo. It was originally intended that the line from Bulawayo via Gwelo to Salisbury should constitute the first section of the main line northward, toward Lake Tanganyika, and that the Zambesi should be crossed in the vicinity of Kariba Gorge. Later explorations, and particularly the discovery of the Wankie coal beds, have led to the adoption of a route farther to the west, including the crossing of the Zambesi at Victoria Falls. The railway is due to reach the coal fields during the coming autumn and Victoria Falls before the end of 1903.

On April 14, 1902, an agreement was signed in Brussels which would seem to constitute an important step toward the realization of the late Cecil Rhodes' "dream." Under the Belgian contract, the German route is abandoned, and the Cape to Cairo Railway will be carried through the Kongo Free State to the upper waters of the Nile. Instead of heading for Lake Tanganyika and German East Africa, the line will continue due north of Victoria Falls to the Kongo border, and thence via Katanga to Lake Kasali, which is the most southerly navigable point on the Lualaba (one of the principal reaches of the Kongo). Approximately, the distances to be covered are: Bulawayo to Victoria Falls, 300 miles; Victoria Falls to Lake Kasali, 700 miles. From Stanley Falls on the Upper Kongo, a railroad will be built to Mahagi on Albert Nyanza (480 miles), thus supplying the missing link between the Cape and the Egyptian railway nets. Such is the scope of the concession which Mr. Robert Williams obtained last month from the King of the Belgians. This project does not, however, necessarily replace the original central line through German territory, as planned by Mr. Rhodes and the German government. In fact, it is quite likely, if the proposed railroad be built from the coast of Dar-es-Salaam, the capital of German East Africa (either through subsidy granted by the Reichstag or by private capital under State guaranty), that the original Cape to Cairo scheme via Tabora will be realized. Both lines may astonish the world before many years as full-fledged realities. All maps of Africa more than six months old are obsolete, because history is being made so rapidly in those regions.

DIRECT-FIRED STEAM SUPERHEATER AT THE DUESSELDORF EXPOSITION.

waste oil are so arranged that all the lubricating apparatus for moving parts are fixed and may be attended to and replenished at any time while the engine is in motion. Sight-feed drop lubrication is used for all parts not subjected to steam pressure, while Mollerup's oil pumps are used for lubricating the parts under pressure.

The steam pistons are hollow and are formed so as to support their own weight. They are secured to the rods by means of cones and nuts, and are made of cast-iron. Metallic packing is employed for making the piston rods steam-tight, and in order to avoid canting the gland when tightening the packing the glands are formed with teeth engaging into a toothed annulus whereby all are turned simultaneously.

Distance pieces are used to connect the high-pressure cylinders to the low-pressure cylinders, and the latter are directly connected to the Corliss frames, and the steam cylinders have steam jackets, the whole being cast in one piece.

Direct live steam is used for heating the high-pressure cylinders and receivers, and working steam through the main stop valves of the engine is used for heating the low-pressure cylinders, and each cylinder is provided with escape valves combined with drain cocks.

low-pressure cylinders are worked by cams which are adjustable.

Bevel gear is used for driving the valve-motion shafts, and the shafts are provided with expansion couplings in order to compensate the longitudinal expansion of the steam cylinders. For the lubrication of the crossheads each pin is provided with an oil cup having a metal wiper. The fixed drop-feed lubricator is provided with a socket furnished with a fine brush, on which the oil from the drop-feed lubricator flows, and then as the wiper on the crosshead pin lubricator comes opposite the oil is wiped off the brush and carried with the crosshead. The guide shoes are provided with oil paths and equipped with scrapers of copper below, and of felt above, by means of which the oil is very efficiently distributed over the curved surface of their path.

A device is arranged with the spring-loaded governor for varying the number of revolutions, being mounted on distance pieces between the low and high-pressure cylinders, and is driven by helical gear from the valve shafts. A hand lever is mounted between the valve gear and the governor, and the former may be thrown out of action and further admission of steam cut off instantaneously in case of any accident.

Above the main pedestal cover there is an oil reser-