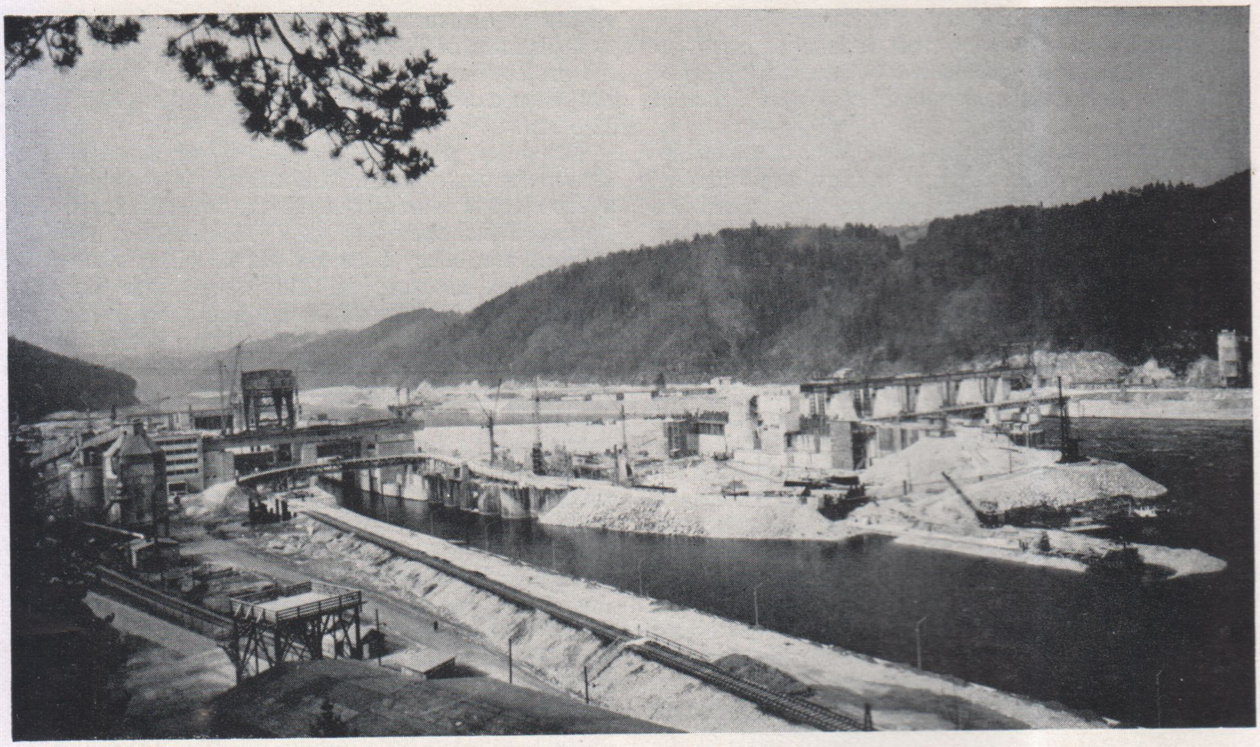

Fig. 1. Aschach site on 26 March 1962 looking upstream. The completed southern lock is on the left, the construction pit for the power station is in the centre, and the spillway structure is on the right

Aschach Station

An interim article reports progress on the construction of this important plant on the Austrian Danube

By DR. ERWIN KÖNIGSHOFER

ASCHACH station on the Austrian Danube is being built by the Österreichische Donaukraftwerke AG, who also constructed the Ybbs-Persenbeug plant which was described in WATER POWER, June 1956, pp. 207–215. As in the case of Ybbs-Persenbeug, construction work is under the charge of the directors, Dipl. Ing. Böhmer and Mosbauer, and the Baudirektor, Dr. Makovec, of the company.

A preliminary article on the Aschach power station was published in the December 1959 issue of this journal, pp. 466–471, and the following may be noted: Of the 15 power stages on the Danube (see Fig. 2, p. 468, of our December 1959 issue), Aschach will be the largest. It lies 40·66 km downstream of the Jochenstein stage and 102·25 km upstream of the Ybbs-Persenbeug, both of which have been completed. At the Aschach stage the generating capacity will be 40% greater, and the power production in the normal year 30% higher than at Ybbs-Persenbeug. This higher performance is due to the more favourable storage conditions prevailing; whereas at Ybbs-Persenbeug the net head at medium flow amounts to 11·3 m, it is 16·5 m in the case of Aschach. The water level will be raised to 280·5 m above Adriatic sea level, which will give rise to special problems to be dealt with in this article.

It may be further recalled (see Fig. 1, p. 467) that the main installations of the plant are the spillway on the left bank, the power house in the middle, and the locks with the adjoining outdoor substation on the right bank.

When visiting the power site on March 22, 1962, the author of this article noted the following progress in construction work:

The spillway, consisting of five openings, each with a free width of 24 m, and of four piers, each 9 m thick, has been completed. Two of the openings have been designed as drift-ice openings with deepened and reinforced stilling basin. The gates, which are of the hooked twin type and have a height of 15·8 m, are being mounted. In the pillar between power station and spillway two auxiliary generating units for covering the power requirements of the plant have been installed. Now that the spillway is finished it is being used for water discharge.

The southern lock too has been completed. At present the power house and the northern lock are under construction. Progress of work has thus far been very satisfactory, and it is expected that the first generating

Fig. 2. Construction Section IA, looking downstream, on 30 September 1960. On the left is the construction pit for two spillway openings, and on the right the southern lock is in course of construction. The foundation pit for the upstream training wall is in the foreground

Fig. 3. Construction Section IB, looking upstream, on 13 September 1961. Completed spillway openings 1 and 2 can be seen on the right, and the island construction pit for openings 3 to 5 is in the centre

unit can be put into operation in the summer of 1963.

The present article is to be regarded as an interim report; it is not intended to provide a description of the completed plant, which will be reserved for a future occasion, but attention will be drawn to the special problems encountered during construction as well as to the solutions found. Subsequently, mention will also be made of interesting methods of work and auxiliary practices.

The problems relating to planning and construction which are being treated herein are as follows:

(1) The use of test models in designing the plant.
(2) Investigation of the nature of the foundation soil.
(3) Arrangement of construction pits and sheet piling.
(4) Preparatory work: aggregate preparation, concrete mixing plant, railways, roads.
(5) Provision for quick filling and emptying of the locks while avoiding water-level fluctuation in the bays.
(6) Preliminary work in the storage area; its characteristics.
(7) Site equipment and transport.
(8) Provision of river craft for construction and operation, as well as of cranes.
(9) Facilities for communication.
(10) Complete construction of openings and locks.
(11) The generating units and their equipment.

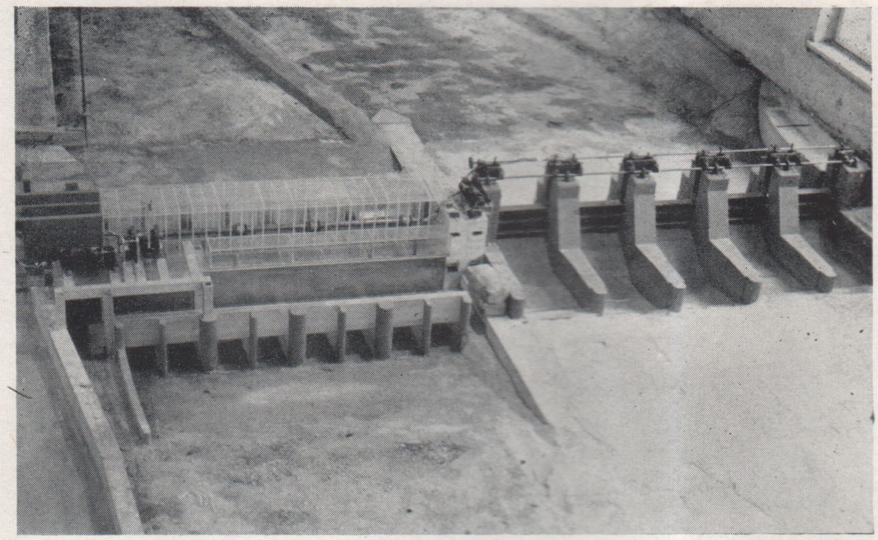

Fig. 4. The 1:80 model built at the Federal Experimental School, Vienna, seen from downstream

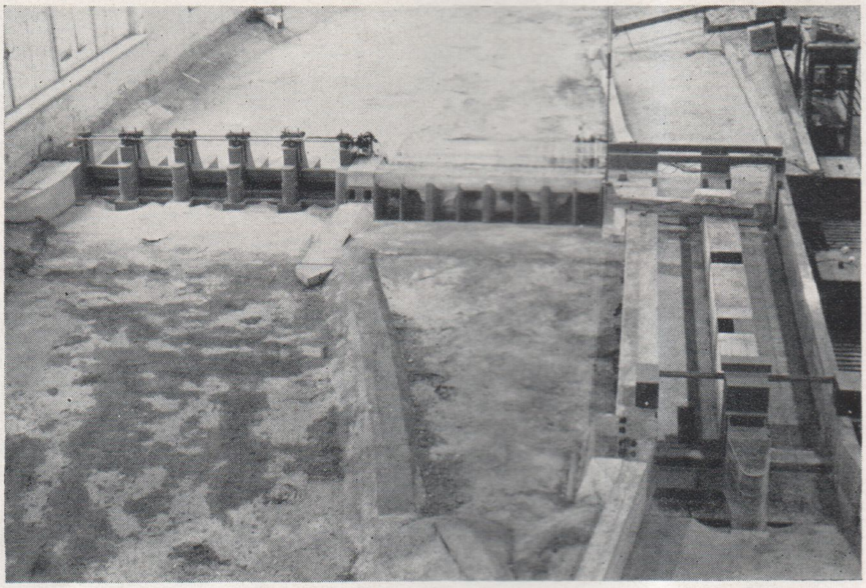

Fig. 5. Upstream view of the model shown in Fig. 4

The Use of Test Models

The experience gained and the calculation methods thus far developed in designing and constructing water-power stations do not suffice to make it possible to predict with certainty the behaviour of a run-of-river plant newly to be erected. In order to ascertain in a reliable manner the stream phenomena as well as the forces exerted by the flowing water on the plant installations and on river transport, a test model of the plant is made which is subjected to the stress of a proportionate flow, thus making it possible to determine the future operational behaviour.

Austria disposes of several suitable experimental stations, i.e., a Federal one in Vienna and one each at the two Institutes of Technology in Vienna and Graz. The hydraulic experimental station at the Institute of Technology at Graz has recently been enlarged in such a way that models of entire Danube water-power plants can be made and tested, under the direction of Professor Grengg. In designing the Aschach plant also, the laboratories of the Institutes of Technology at Karlsruhe and Stuttgart in Western Germany were consulted.

The tests were not limited to the operational behaviour of the completed installations but helped to solve problems of construction. At the Federal Experimental School in Vienna, a model to a scale of 1 : 80 was constructed, mainly of artificial stone, on which the effects of flood flows and ice were studied. It was found that flood flows of up to 11,000 m^3/sec could be controlled by the five openings and the two locks; by means of four openings and two locks, flood flows of 9,200 m^3/sec could be discharged. On this model also the water levels in the storage basin were studied, while with a second model, to a scale of 1 : 50, scouring phenomena in the headwater and tailwater of the piers and locks were examined. The tests showed that only in the tailwater would steps have to be taken

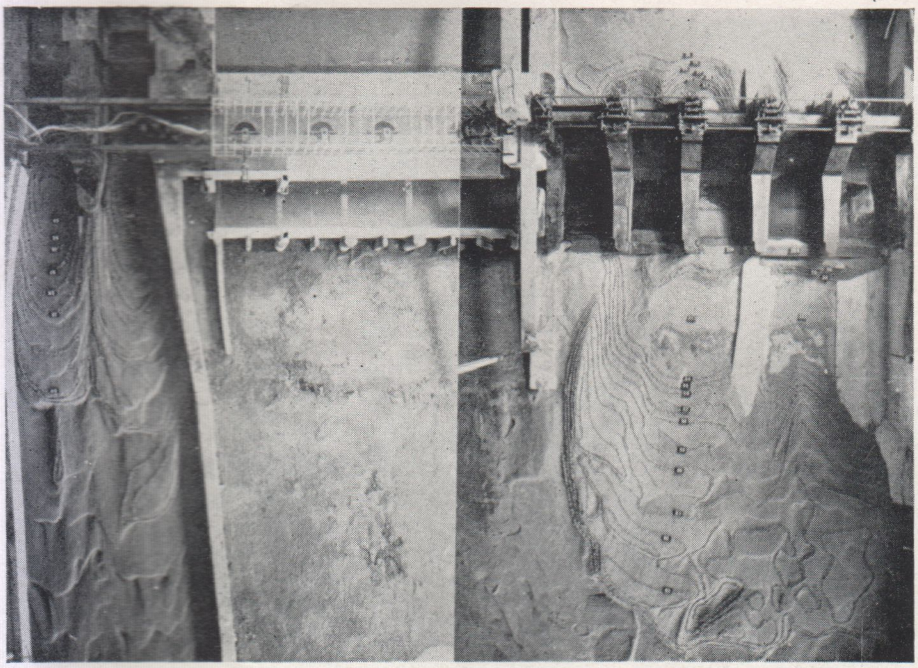

Fig. 6. Scouring effects shown on the model after a discharge corresponding to a flood of 9,200 m^3/sec through five spillway openings and two locks

pile driving was not known.

It was decided to enclose the construction pit by sealed sheet piling. In order to ensure absolute reliability, a large-scale test was made with a 650-m-long sheet pile of the type envisaged. By this test all problems in regard to the execution of pile-driving work, the choice of a suitable sheet-piling profile, the necessary grouting work, and the required pump capacity, were clarified.

The following sequence for the construction pits was established:

In construction section Ia (Fig. 2) a construction pit 1a for the building of two openings was created on the left bank of the Danube. At the same time pier caissons were sunk in the middle of the river. After completion of the first two openings on the left bank the existing pier caissons and the circular cells were connected by sheet piling, and thus a construction pit 1b (Fig. 3) for the building of the adjoining three openings and the pillar of the power house was created. Subsequent to the construction of pit 1 for the southern lock, a construction pit 1c was created for the filling structure.

In the last construction section, section II (Fig. 1), the construction pit 2 for the power house and the northern lock was created.

Water flow and weather conditions in 1960 and 1961 were favourable and advanced the progress of construction work.

against such effects. The investigations finally resulted in establishing the most suitable form of stilling basin, the flow conditions being recorded photographically. Ten plate cameras recorded the tracks of floats on which burning candles were mounted, and very valuable indications were obtained in regard to the configuration of the piers of the spillway and of the gates. Furthermore, the influence of an emergency shutdown of the turbines on the water level in the bays was investigated, and the resulting water-level variations were reduced to a tolerable size.

A lock model, to a scale of 1 : 25, assembled at the Institute of Technology in Graz, helped to solve the problem of filling and emptying the locks within an appropriate time, i.e., within 15 min. The high back-up in front of the spillway renders this problem especially difficult, and its solution will be discussed below. Detailed problems of the flow conditions were studied at the Institutes of Technology of Stuttgart and Karlsruhe, for which purpose a model was built at Ybbs by the construction company and tested.

Investigation of the Foundation Soil

The nature of the foundation soil was ascertained by way of extensive test borings, and inter alia, a horizontal borehole 300 m long was driven under the Danube from a shaft in the left bank. Altogether, 90 boreholes were driven into the soil over a distance of one kilometre (of which 750 m was in rock). The drill holes were observed with an optical probe which enabled systems of rock fracture to be measured in regard both to location and to direction. In addition, 850 tests on the permeability of the subsoil were carried out.

Arrangement of Construction Pits and Sheet Piling

The examination of the foundation soil showed that 8 m below the river bed there is an almost horizontal zone of granite of first quality. The height of the sheet piling was established at 18 m, thus including the 8-m-thick rubble layer, the suitability of which for pile driving was not known.

Preparatory Work

An indication of the size of the building project is the required amount of finished concrete, viz., 1·2 million m^3 altogether, of which 0·7 million m^3 was required for the locks and 0·25 million m^3 each for the spillway and power house. This programme called for 1·4 million m^3 of unworked gravel, of which half the quantity has already been won and processed. The gravel is won by means of draglines and transported by conveyor to the aggregate preparation plant, which is connected by a 4-km-long railway line, to the concrete mixing plant. The gravel trains are driven into the preparation plant and are loaded from the bunkers. The plant has a production capacity of 240 m^3 of gravel per hour. The concrete mixing plant has been designed for an average production of 2,000 m^3 concrete daily, the maximum being 4,000 m^3 daily.

On both river banks roads had to be laid out, whereas railways were only constructed on the right bank. Three 600-h.p. locomotives, one 200-h.p. locomotive, and ten ore cars with pneumatic bottom-discharge were obtained. A cable ferry was taken over from the Ybbs-Persenbeug plant. The living camp for the workers contains 1,400 beds.

The electric current needed for construction work,

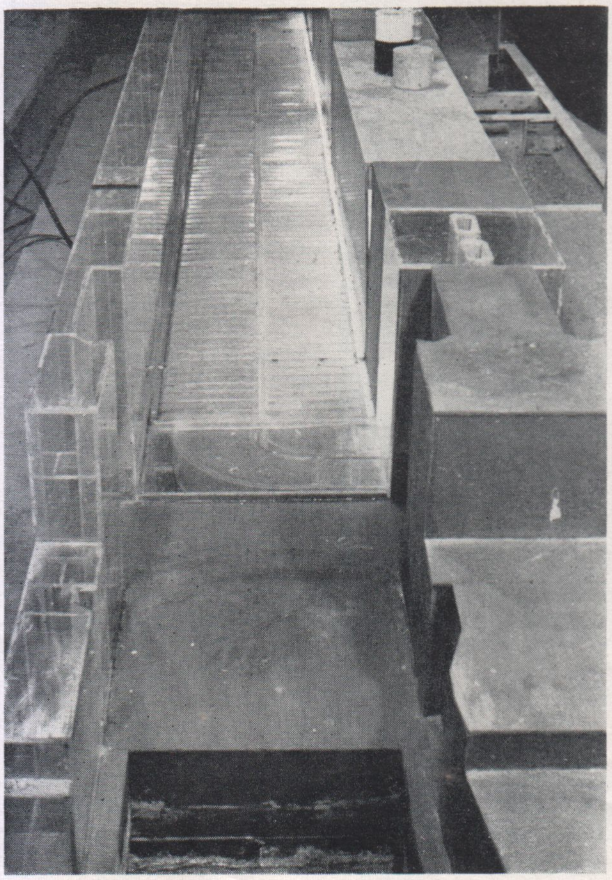

Fig. 7. Model of the lock, to a scale of 1:25, built at the Institute of Technology, Graz

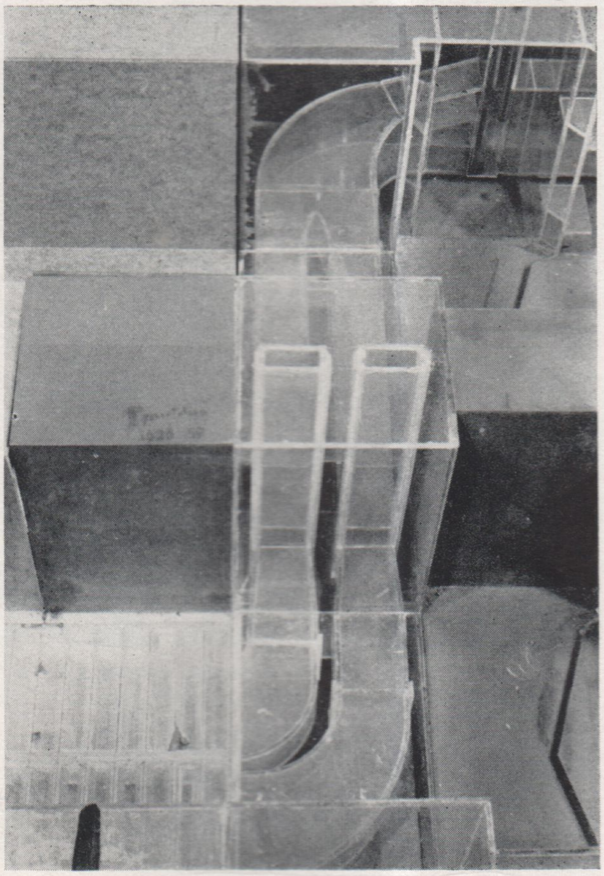

Fig. 8. View of the model emptying conduits for the southern lock, showing the emergency gate shafts

with a peak capacity of 8 MW, is supplied by a specially constructed 110-kV transmission line.

Quick Filling and Emptying of the Locks

The high lift required in the locks makes special provisions necessary for filling and emptying the locks in order to prevent inadmissible water-level fluctuations in the bays. In the interest of navigation the time for filling and emptying had to be kept as short as possible and was fixed at 15 min. In such a short time the filling and emptying cannot be affected by the lock gate, and thus the filling water has to be taken from the main river by way of a special lock-filling structure, while the locks are emptied into the tailwater of the plant by means of a narrow lock-emptying structure interposed between the power house and the lower lock gate. (The lock has a usable length of 230 m and a usable width of 24 m.) The lock-filling structure is equipped with funnel-shaped intakes leading to conduits 4 m square which can be closed by hydraulically operated rolling sluices. The conduits continue under the lock floor with a gradually increasing cross section. From these conduits the water flows through numerous 5-cm-wide slits into the lock. Emptying is also effected through these slits and thence through the lock-emptying structure. From the lock-emptying structure the water is discharged in parallel with the turbine flow directly into the tailbay of the power house. In the lock-emptying structure there is a hydraulically operated two-part roller gate for each lock chamber.

As tests with the models in the company's laboratory, as well as at the Institutes of Technology have shown, the water level in the bays rises and falls completely quietly during the filling and emptying operation. In the previous tests with the models also the problem of cleaning the filling and discharging conduits was included, and a successful operational

Fig. 9. Model lock-filling intakes

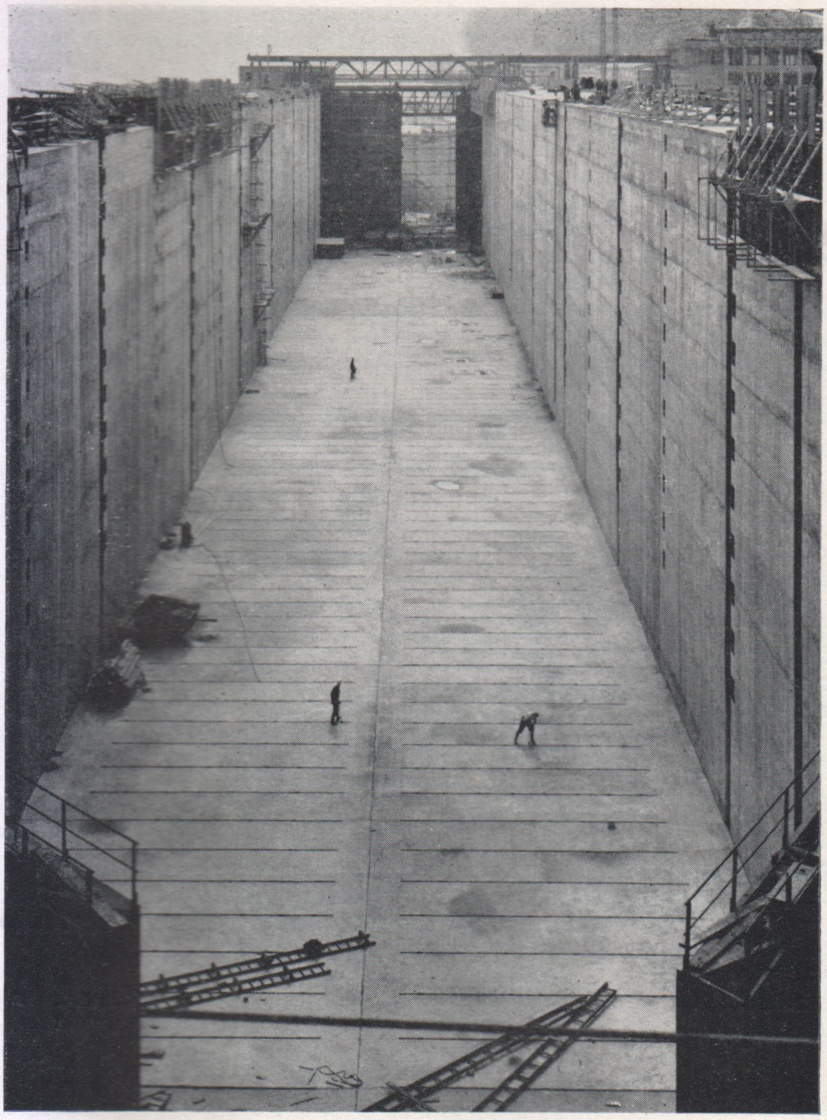

Fig. 10. The chamber of the completed southern lock

stein and the Inn power plants. Deposits of fine material such as mud appear possible in the lower part of the Aschach storage area, but their amount cannot be foreseen. If required, corresponding dredging operations will have to be carried out.

The raising of low-lying areas will be necessary only at the villages of Obermühl and Untermühl, which will have to be rebuilt. At Obermühl, the water level of the Danube will be raised by 10 m, but there is enough room for replacement buildings. At Untermühl, the water level will be raised by 14 m, and since there was no room for replacement buildings the required terrain had to be created by piling up rubble to a height of 10 m in the area between the existing houses and the slope. The material was taken from the Danube by means of wet dredging and by waste material from the adjacent quarries.

method was decided upon, but will not be dealt with here.

Preliminary Work in the Storage Area

In view of the high storage level of the Aschach plant it is not surprising that the storage area will be especially large. It extends over a distance of 40 km up to the existing Jochenstein plant. It is formed at a narrow gorge where the Danube flows mainly between steep, sparsely inhabited mountain slopes and has many sharp bends. The full storage envisaged will completely remove the numerous major obstacles to navigation and permit two-way traffic even with low water. In the storage area about 50 km of embankment and secondary roads are to be laid out, about 100 river and brook mouths with about 50 passages and bridges are to be regulated, embankments are to be raised for which more than 2 million m^3 of material will be required, and the river banks are to be reinforced by 500,000 m^3 of stone.

The storage level at Aschach will be about 10 m above the highest flood-water level ever known. Deposits of sedimentary material are hardly to be expected since the main part of the solid material will be retained in the storage areas of the Jochen-

Site Equipment and Transport

Large building sites like the one at Aschach require extensive and costly equipment for the implementation of the work, for transporting the building material and erecting the construction plant, and for transport of the personnel to and within the building site.

Although the supply of the electrical energy required for building purposes was ensured it appeared advisable to provide for an emergency supply in order to ensure operation of the water pumps, lighting, etc. On the right and the left river banks emergency generating plants were mounted consisting respectively of three and of two diesel sets designed for 1,330 and 820 kVA.

The railway feeder line for the transportation of 6,000 m^3 of crushed rock daily is equipped with ten large four-axled saddle-bottomed cars with pneumatic devices for opening and closing the discharge lids. The required driving power is provided by two diesel locomotives, each of 600 h.p.

Provision of River Craft and Cranes

The implementation of construction work in and along a river course as well as the operation of the completed power plant require river craft in sufficient quantity and size. During the time of construction wooden boats for stone transport have been used. Such craft have a very limited life, confined always to the duration of construction work. In addition, use has been made of transport barges of steel with a carrying capacity of 100 tons and lined with wood for stone and crushed-rock loads. These could be combined in a formation of two or three units, towed by a motor launch of 116–200 h.p. and a tugboat of 600 h.p. For the transport of passengers a 60-h.p. outboard motor boat and a wooden motor boat were provided.

Stagnant storage water, of course, favours the formation of ice, and freezing of the stored water often leads to inundation in the storage area. Therefore, two ice breakers of sufficient capacity are always in readiness for breaking the ice layer.

The low velocity of the backed-up water necessitated the motorisation of all cable ferries in the storage area.

For the transport of the components of the power plant to their location in the middle of the river as well as of the building materials, floating cranes of high capacity had to be made available. A 200-ton derrick crane is available and can be moved by the above-mentioned motor launch. For inspection work in respect of the weir installations and for operating the cofferdams an 80-ton floating revolving crane is used. It is equipped with cup grabs so that it may also be used for removing gravel, boulders and silt from the river.

Over the roof of the assembly shop on the right bank of the Danube and of the power house, as well as over the bridges of the spillway and the locks, extends the runway of a 220-ton gantry crane with the help of which the machines can be lowered through the hatches in the roof of the power house to their permanent locations; moreover, the gantry crane operates the stoplogs for the spillway and the turbine draft-tube. While there is no road bridge over the plant, a bridge over the Danube was erected at a distance of 2 km from the main structure. It is about 600 m long, its roadway 8·1 m wide, and two footpaths each 3 m wide and a bicycle track are planned. An 810-m-long cable crane for a cable load of 9 tons traverses the river valley.

In the machine hall two travelling cranes with a carrying capacity of 16 tons have been arranged with a wheel track of 15·8 m., the runways of these cranes being supported by concrete brackets.

Facilities for Communication

The communication facilities which have been created make it possible to telephone to any working place over the entire construction site. Existing telephone connections are used, new telephone lines have been installed, carrier-wave circuits along the high-voltage transmission lines have been created, and portable ultra-short-wave telephone sets with a transmitting power of 500 mW having a range of up to 5 km are available. Facilities for transmitting level measurements as well as a television plant for controlling the locks have been installed. Furthermore, an electro-acoustic device for call transmissions all over the plant is envisaged.

Completed Construction of Openings and Locks

Spillway openings 3 and 4 have been designed to pass drift ice; their stilling basins are deeper than those of the other openings. The piers are 9 m thick at the foot and taper to 7 m in the middle and to 5·9 m at the top. In the contact face between the rocky subsoil and the foundation there are drainages for relieving the upward pressure. The spillway crests were first erected up to 261 m above sea level, i.e., 4 m below the final level, in order to keep the back-up during the building period within acceptable limits. They remained at this height for two years before they were raised to their final height.

The lock walls were made of mass concrete, and each individual block is stable. In view of the quality of the subsoil it was not necessary to force the standard blocks into the rock by blasting. A deeper foundation was given, however, to the structures of the upper and lower gates.

Work on the power house has not proceeded far enough to warrant a report. To be complete, it may be mentioned here that the power house is subdivided into four blocks of 32 m each and that the roof will be 10 m above the storage level. The upstream-downstream length of the main block from intake to outlet is 81 m. Such a length rendered the subdivision into blocks unavoidable, and thus intake, middle and outlet blocks were formed.

Generating Units and their Equipment

In the final article the generating units and their equipment will be discussed, but it may be mentioned here that four generating units will be installed. Two turbines are being built by J. M. Voith and two by Maschinenfabrik Andritz and Escher Wyss. Their data are:

Rated head	15 m
Rated flow	500 m³/sec
Rated capacity ..	91,000 h.p.=67 MW
Speed	68·2 r.p.m.
Runaway speed ..	188 r.p.m.
Runner diameter ..	8·4 m
Thrust bearing load ..	1,600 tons
Total weight	1,300 tons

It is believed that the turbines to be mounted at Aschach will be the largest in Western Europe in physical size. The direction of rotation of adjacent sets is alternate to left and to right, so that for each two sets only one operating platform is required.

The data of the generators, which are being built by Elin-Union, are:

Rated capacity	85 MVA
Rated voltage	10·5 kV
Range of voltage	−10% to +8%
Stator weight	217 tons
Weight of rotor with poles	378 tons
Total weight	628 tons

The auxiliary units of the main generating units are fed by an auxiliary synchronous alternator rated at 250 kVA, 380/220 V, assembled with the main generator. Cooling is effected after a patent of the ELIN-UNION according to which the cooling air of the generators is cooled and purified in an air-conditioning plant. The warm air of the generator is partly mixed with fresh air and purified.

Each generator has its own transformer, stepping up to 220 kV, the transformers being mounted on a platform of the power house downstream. Two transformers are being built by Elin-Union and two by Oerlikon. They are given a very wide voltage range, which is regulated by a static magnetic amplifier. The transformers are connected to the open-air switchyard situated on the right bank by way of single-core oil-filled cables.

In concluding, it may be stated that the expected power production in a normal year will amount to 1,680 GWh.

The BICC Group. A newly published brochure received from British Insulated Callender's Cables Limited describes, with a wealth of illustrations, the activities of the 48 companies and engineering divisions which form the BICC group. Thirteen of them manufacture electric cables, wires and accessories.