REPORT ON
VISIT TO SOME
ENGINEERING WORKS

In

WEST GERMANY, HOLLAND
SWITZERLAND AND FRANCE

During 1956

Kanwar Sain

Central Water and Power Commission
Ministry of Irrigation & Power
Government of India - New Delhi

CWPC. 33
2,000

C. W. & P. C. No. 42

June 1958

Price : Rs. 2.37 nP. or sh. 4.

Foreword

In the planning and execution of our River Valley Projects we have received invaluable assistance and advice from many foreign countries. Our engineers have gone abroad to seek inspiration and learn from the experiences of others. It is only proper that those who have had such opportunities share their experiences and impressions with others who have not had the same opportunities.

The information contained in this volume will be of great interest to members of the engineering profession. Shri Kanwar Sain has vividly described some of the most modern projects of the world. I am sure that the new techniques of design and construction as illustrated in this volume will inspire and educate our engineers in executing the various River Valley and other Projects which we have undertaken. The engineering profession and for that matter all lovers of their country's effort at development will be grateful to Shri Kanwar Sain for this very useful service.

S. K. Patil
Union Minister for
Irrigation and Power

PREFACE

In our endeavour to build up various development projects in the country, it is very essential, nay, obligatory to compare and contrast the scope and techniques of engineering practices prevalent in our country with those of other countries with a view to effecting improvements in the direction of economy in design and execution. In this connection, visits to foreign countries give one an opportunity to discuss the various complicated aspects of engineering with renowned specialists of other countries. During my recent visit, I had an occasion to visit some of the important development projects in West Germany, a few reclamation projects in Holland and some of the biggest dams of the world under construction in Switzerland and France with a view to analysing and assimilating the modern trends and techniques involved in their planning, design and execution.

I felt it necessary to record my impressions in this volume as this information would be of considerable value to the members of the engineering profession, and particularly to those who have not had the opportunity to visit these projects. I hope I have collected whatever I deemed valuable during my short sojourn on the Continent, and I have tried to present the same in as simple a manner as possible.

I express my sincere thanks to the various Engineers and Administrators who spared no pains to take me round their dam projects, research laboratories and manufacturing factories.

NEW DELHI;
Dated the 28th October, 1957.

KANWAR SAIN

CONTENTS

APPENDICES

STATEMENT OF FIGURES

INTRODUCTION

The Plenary Session and the Technical Sub-committee meetings of International Standards Organisation were held at Munich in July 1956. The author was invited to preside over the Sub-committee on Fluid Flow Measurement in Open Channels. Though very much pre-occupied, it was decided to accept the invitation and a strong team of Indian engineers headed by the author attended the deliberations from the 8th to the 14th of July 1956.

Measurement of fluids in open channels, notches, weirs and flumes has been a subject on which a good deal of work has been done in our country. Irrigation engineering and particularly canal engineering has been an Indian heritage. India with its 66,400 miles of open channels naturally has maximum experience on the subject. India had contributed four technical papers in this connection, all of which were very well appreciated by the International delegates. In fact, these papers formed the basis for further work in this field. Regarding the activities of the session suffice it to say that the Indian delegation made a very favourable impression on the other delegates. It made a positive and substantial contribution to the deliberations of the conference.

During the International Standards Organisations deliberations in Munich and for a week thereafter it was arranged to visit some of the important places of engineering interest, with particular emphasis on the modern trends and techniques being used on the river valley projects. The visit covered West Germany, Holland, Switzerland and France. The author has recorded his impressions and such information collected during this visit which may be useful to our engineers in their own work.

The time available for these visits was very short since the author had necessarily to reach Colombo on the 23rd July 1956 to participate in the twenty-sixth Research Officers' Meeting of the Central Board of Irrigation and Power.

In this report an effort has been made to give a brief outline of the working of some of the factories and firms manufacturing hydroelectric machinery and equipment and certain salient features of some of the dams, power houses and navigation canals which the author saw during this short visit to the Continent.

The itinerary followed is indicated in the accompanying map — *See Fig. 1*.

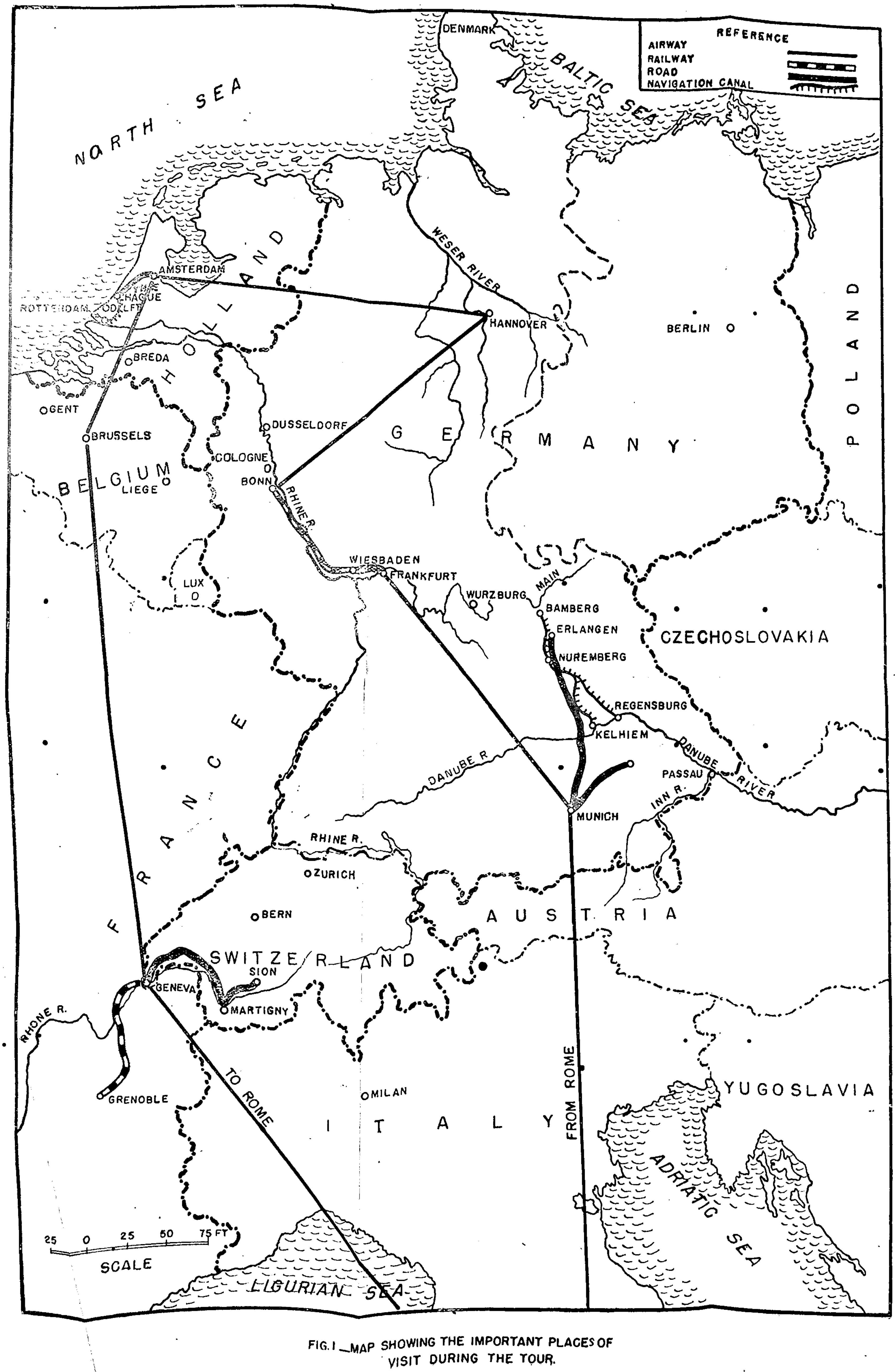
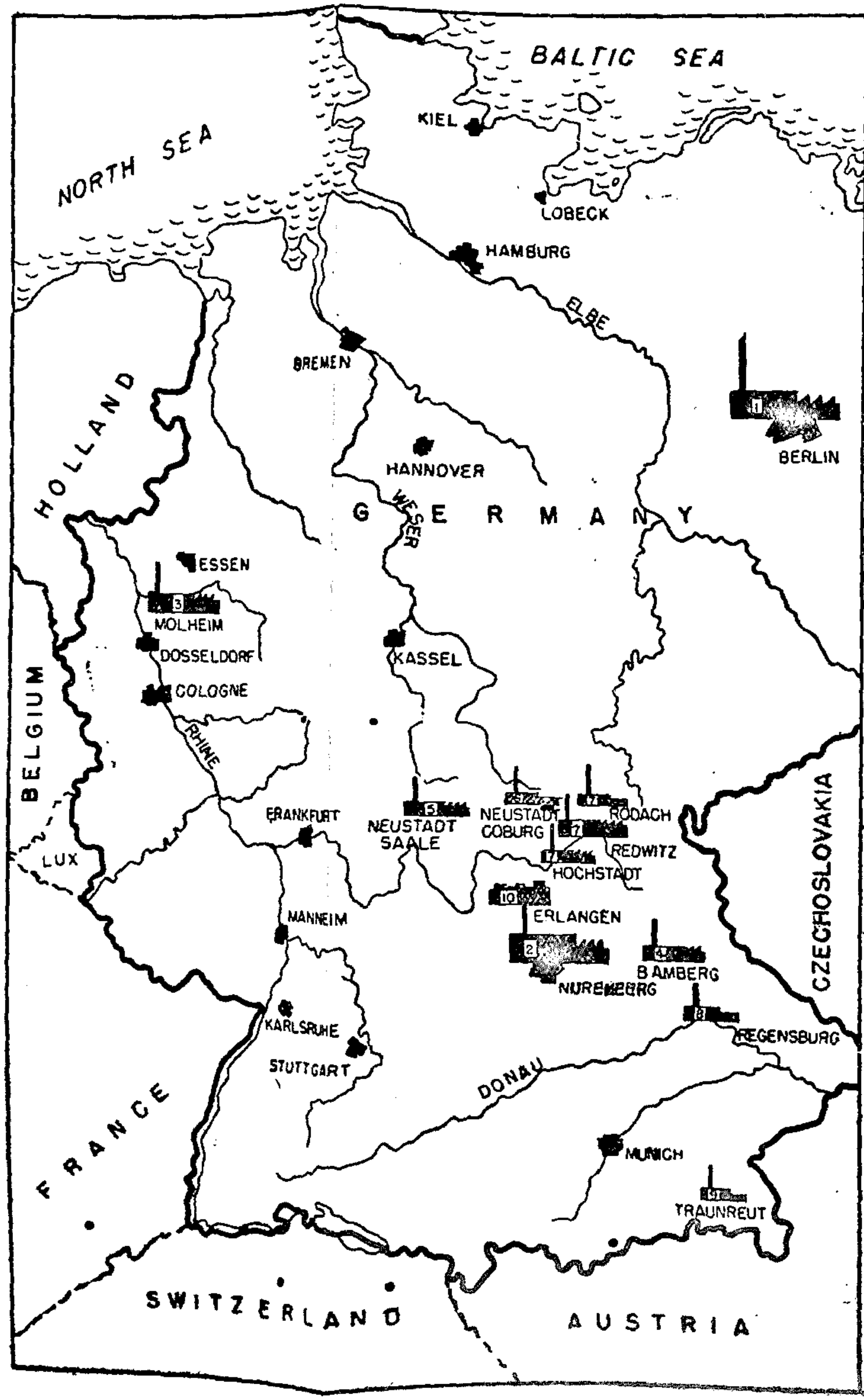


FIG. I _MAP SHOWING THE IMPORTANT PLACES OF VISIT DURING THE TOUR.



LEGEND

	BERLIN.	LARGE D.C AND A.C. MACHINES, WATERWHEEL GENERATORS, TRACTION MOTORS, CAPACITORS, REACTORS. IRON AND NON-FERROUS METAL CASTINGS HIGH AND LOW-VOLTAGE SWITCHGEAR, OVERVOLTAGE PROTECTION EQUIPMENT, RECTIFIERS AND INVERTORS, METAL-CLAD HIGH- AND LOW-VOLTAGE SWITCHBOARDS, AND SWITCHING STATIONS. REFRIGERATORS, WASHING MACHINES. CABLES AND WIRES, CABLE ACCESSORIES AND FITTINGS ENAMELLED DYNAMO WIRES BRIGHT-METAL SEMIPRODUCTS.
2.	NURNBERG.	MEDIUM-SIZED D.C. AND A.C. MACHINES SPECIAL SWITCHGEAR, ELECTRIC WELDERS, WATER HEATERS, VOLTAGE REGULATORS, FLOODLIGHTS, ELECTRICITY METERS, RELAYS, CLOCKS, INSTRUMENT TRANSFORMERS, POWER TRANSFORMERS
3.	RUHR	STEAM TURBINES, TURBO-GENERATORS, WATERWHEEL GENERATORS, CONDENSING PLANTS, GEARING
4.	BAMBERG.	LOW-VOLTAGE SWITCHGEAR, DISTRIBUTION CABINETS ETC.
5.	SAALE.	MOTORS FROM FRACTIONAL RATINGS UP TO 10 GENERATORS UP TO 10 KVA. MOTOR-DRIVER DOMESTIC APPLIANCES, PUMPS.
6.	COBURG.	CABLES AND WIRES.
7.	REDWITZ.	HIGH AND LOW-VOLTAGE PORCELAIN, LOW-VOLTAGE PORCELAIN, WELDING ELECTRODES. ISOLATING SWITCHES MOULDED PLASTICS.
8.	REGENSBURG.	WIRING MATERIAL
9	TRAUNSTEIN.	HEATING AND COOKING APPLIANCES.
10.	ERLANGEN.	DESIGN OF PLANTS AND APPLICATION ENGINE RESEARCH LABORATORY

FIG 2 _ MAP SHOWING THE VARIOUS PRODUCTION CENTRES OF SIEMENS COMPANIES IN GERMANY

VISITS IN GERMANY

SIEMENS TRANSFORMER FACTORY AT NUREMBERG AND SIEMENS HEADQUARTERS AT ERLANGEN

The Siemens companies are, as is well known, one of the reputed German firms in the field of manufacture of electrical equipment. The production works of the companies extend to practically every sphere of electrical machinery with their production centres at various towns mostly situated in Southern Germany — *indicated in Fig. 2.*

A visit was arranged, during this tour, to their Transformer Factory at Nuremberg and their Headquarters at Erlangen, on the 10th July 1956. "The Nuremberg Works" and "The Transformer Works" are the direct successors of the original Schuckert Company, which began its activity some 50 years ago, building electric meters and dynamo machines, arc lamps and search lights in a small workshop of Sigmund Schukert. These two factories alone occupy a floor area of 8 million square feet employing nearly 10,000 workers. During the last War, these factories suffered immense damage. It was said that in 1945, there was only about 5 per cent of the space that could be used with practically the whole machinery damaged. It is remarkable indeed that the Nuremberg factories have been rebuilt within these 10 years after the War. The factories are really modern and well-equipped. The production shops are well-lit and colourfully decorated. The factory buildings are very well-planned and laid. The activities of the Nuremberg factories have covered vast fields of production of almost every kind of electrical product classified under three groups : (a) machines, (b) apparatus and meters, and (c) transformers.

In the transformer works, all types of transformers are manufactured to the highest ratings including large power transformers of size 2,00,000 kVA. The annual production capacity of the transformer factory is 2 million kVA. The present day costs at the factory were said to be of the order of 30 marks per kVA. Twenty to forty per cent of the production is meant for export. Out of this it was said that about 13 per cent capacity was booked in advance.

The maximum transformer capacity under manufacture in the factory at the time of the visit was of 2,00,000 kVA unit. The gross weight of this unit was 230 metric tons. It was understood that a unit of 2,50,000 kVA capacity was being designed. Mobile transformers are distinguished from the ordinary type by their very compact structure and construction. They have gained increasing importance since the past few years in Germany and elsewhere. The Siemens Works are manufacturing these mobile transformer units of capacity 220 kVA to 200 mVA. Even transformers of capacity 300 mVA are under contemplation.

A special alloy is being used for the transformer core which is said to give a loss of 0·6 watt per kilogram. Particular care is being taken in drying out the transformer after it is manufactured. It is placed in a special drier three times for one week at a time. It is said that as much as 100 gallons of water are dried up in this process in each of the bigger units. In this factory high grade paper is used as insulating material. It is claimed that it is far superior to other media used previously. One millimetre thickness of paper is provided for every 25 kV.

About 3,000 persons are employed in this factory of which 2,300 are workmen ; 40 per cent of the workers are women. There is enough mobility in the personnel. Whenever there is slackness in any section, adjustments are done by shifting the extra men to other sections. The amenities provided for the labour and staff include kindergarten, recreation fields, modern swimming pools and baths, housing, industrial education and old-age pension besides equitable wages, profit sharing and industrial welfare for all workers. The normal wages were paid on hourly basis. An average worker earns about 50 to 60 marks a week with additional bonus of 10 to 20 per cent. An average worker works for 48 hours a week. This is being reduced to 45 hours from the 1st of October. Just after the war, the workers in the German factories put in two to three hours free labour in building up the factories. This was an ideal form of *Shramdan* which has played a very important part in building up West Germany after the War. Most of the factories had been destroyed and it was impossible to rebuild them so rapidly without the willing help of the workers in which the trade unions played a very important part. The result is that production capacity of Germany is even higher than it was in pre-war days.

SIEMENS HEADQUARTERS AND RESEARCH LABORATORY AT ERLANGEN

Erlangen is a small town and has become well-known because of the stationing of the Siemens Headquarters. The Siemens have built this headquarters which can accommodate 4,000 men, as their previous headquarters near Berlin had been destroyed. It is an imposing modern air-conditioned building. The number of their employees has since increased to 6,000, they have to build additional accommodation. The company provides built-up living accommodation for most of its employees. They have their own teleprinting units and telephone exchange.

Siemens companies attach great importance to fundamental research in the field of Natural Science, as well as its application to practical engineering. The central administrative building at Erlangen also houses a laboratory and design office to work on the basic research and practical application. The laboratory is well-equipped with all modern facilities including electron microscope, mass-spectrograph and an apparatus for spectrograph analysis. The activities of the laboratory embrace vast subjects on measuring techniques, gaseous discharges, solid state physics, organic and inorganic chemistry. Valuable results have been obtained through a systematic work in this laboratory for the last few years in the department of solid physics as a result of quantum — mechanical studies on compounds of elements of Group III and V of periodic system particularly with regard to their electrical properties.

LOW HEAD HYDRO-POWER DEVELOPMENT IN WEST GERMANY

Low head power houses are indeed an interesting feature in West Germany. Altheim Power House – *Fig.* 3 is typical of such a development and a visit was arranged to this station. The power house is situated on the river Lintera Isar. There are nine falls in a length of about 70 kilometres (43·5 miles) on this river. These drops vary from 5·7 to 8·8 metres (18·7 to 28·9 ft.). It has been planned to generate power from this river by constructing a series of nine low head power houses with distances between them ranging from 5·3 to 10 kilometres (3·3 to 6·2 miles). Two power houses out of the nine have so far been completed.

Altheim Power House working under an average head of 8 metres (26·3 ft.), is the first upstream stage development in this chain of run-of-river plants. The construction of this power house was started in 1948 and completed in 1950. The power house is built on the left flank adjoining the weir at Altheim situated at about 6 kilometres (3·7 miles) below Landshut. The maximum and the minimum discharges recorded in the river at this site are 1,600 (56,506 cusec) and 70 (2,472 cusec) cubic metres per second respectively with an average flow of 158 cubic metres per second (5,580 cusec). To permit peak load operations of the power plants, a large reservoir of storage capacity of 2 million cubic metres (70·63 m. cu. ft.) has also been built upstream of Altheim.

At the time the power house was visited the upstream water level was 384.00 metres (1,260 ft.) above mean sea level and on the downstream side the tail race water level with a discharge of 270 cubic metres (9,535 cu. ft.) per second was at

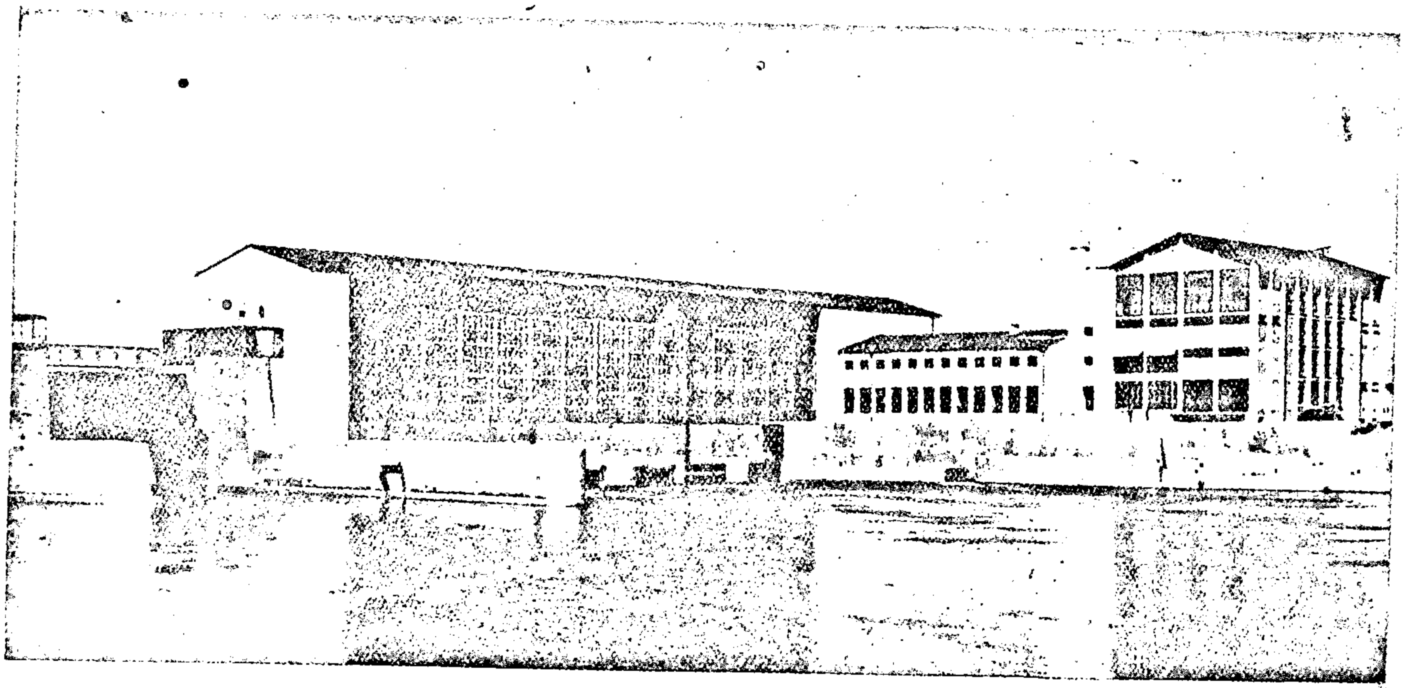


Fig. 3—Altheim Hydro-electric Power Plant

376·00 meters (1,233·7 ft.). It was said that this rose to 379·80 metres (1,246 ft.) with a discharge of 1,600 cubic metres (56,506 cu. ft.). At the time of the maximum floods the output was considerably reduced on account of reduction in head which sometimes was not more than 3 metres (9·8 ft.).

The weir itself has four sluices provided with four single sluice gates and crest gates. The gates and gate accessories have been supplied by Messrs. M. A. N. Gustavsburg Works. The gates are of 17 metres (55·8 ft.) span and the weight of three gates with all embedded parts and hoists including the electrical equipment is about 570 tons. According to M. A. N.'s, if this plant were to be manufactured and erected these days, the total price would be about DM 25 lakhs which approximates to Rs. 28·5 lakhs.

The gates are provided with fish-flaps in the upper portion which could be moved independently of the main gate. A rubber seal between the fish-flap and the main gate is provided to prevent leakage.

No fish ladder has been provided and the fish have adjusted their habits of movement.

The power house is built according to the latest practice of reduction in the overall height of the power station. It is designed on the single floor principle which has the advantage of operation and supervision of the hydraulic and electric machines from the same floor.

The erection bay is situated along the extension of the longitudinal axis of the power house. The large power crane also serves the erection bay and the railway siding is led into the erection bay for facilities of transport and loading. The arrangement of control house, office rooms and the workshop is compact and neat.

The power house machines are very modern and were supplied by Siemens Company. The salient features of the machines installed are as follows.

A. Main Generating Sets

There are three main generating sets consisting of one Kaplan turbine in each set of rated discharge 90 cubic metres per second (3178 cusec) and a synchronous generator of umbrella type with floating type terminated rim rotors. These generating sets have been designed with three bearings of usual construction for run-of-river plants. The turbine and the generator are joined by a steel pit ring. The thrust bearing is in the turbine cover, while one guide bearing is directly above the turbine runner and the other below the magnet wheel. The rated output of each generator is 8,000 kVA and the rated voltage is 6,300 volts. These are excited by means of an exciter driven by the main machine shaft. The rated speed of the machine is 107 r.p.m. and the run-away speed is 285 r.p.m. The machines are cooled by fresh air drawn through ducts under the trash-racks on the upstream side. The exhaust air is discharged into sheet steel air jackets and then into the open air by means of chimneys. The stator underside of the main generator is about 10 feet above the power house floor, from where the turbines are directly accessible.

B. The Station Service Generator Set

The Station Service set has a separate generator and a Kaplan turbine, the shafts of which are rigidly coupled. The stator of the set rests directly on the main power house floor while the turbine is accessible from a lower floor. The rated output of the machine is 750 kVA at 0·8 power factor and the rated voltage is 400 volts. The rated speed and the run-away speeds are 300 and 785 r.p.m. respectively. The cooling air in this case is drawn from the lower floor and the exhaust air is discharged into the power house through the openings in the rear of the stator frame.

C. Turbine/Pump Generating Set

The power house is also equipped with a small turbine-*cum*-pump generating set in order to utilise the contractual discharge and also to maintain the water level in a mill canal taking off from the weir, without having any connection whatsoever with the power house scheme. If the head-water level must, for any reason, be lowered below the level of the water in the canal, the turbine runner is replaced by a pump runner and the motor operation is employed to maintain the contractual discharge. Further details of the turbine-pump set are as below :—

Rated output	160 kW
Rated voltage	400 V
Rated frequency	50 C/s.
Rated speed	750 r.p.m.
Run-away speed	3000 r.p.m.

The power house has no spare unit. At the time of repairs the load is expected to get adjusted in the grid itself. Power is generated at 6·3 kV and fed on to 220 kV grid.

The cost of installation for low generation power houses was worked out to about 2,000 marks per kW at this place. This approximates to Rs. 2,275 per kW in Indian money.

The Pathri Power House, built recently in Uttar Pradesh, is more modern in various details than the one described above. It may be of interest to power engineers to go into further details to compare and contrast the two types of installations. The essential features of interest in the Altheim Power House are the low head under which the station works and the simplicity of station construction.

M. A. N. Works at Gustavsburg

A visit was arranged to M. A. N. Works at Gustavsburg on July 14, 1956. Dr. H. L. Uppal, Director, Punjab Irrigation and Power Research Station, joined the team for this visit. The M. A. N. Works entered into the field of hydraulic steel structures about 50 years ago. In 1902, the Company introduced the roller weir in the course of the construction of the Schwein Furt Section of the river Main Dam Project. In subsequent years M. A. N. played an important part in developing and manufacturing the various types of gates and weirs, docks, lock gates, fixed and moving bridges, tanks, cranes and auxiliary equipment for hydroelectric power houses and weirs. In addition they supplied complete harbour power stations and marine diesel engines.

Gustavsburg Works are well-equipped with a hydraulic laboratory which enables them to handle all complicated hydraulic problems associated with the steel structures. Consequently the M. A. N. Works are in a position to guarantee the specified requirements in respect of not only mechanical and structural constructions but in respect of hydraulic side as well.

The M. A. N. have specialised in the manufacture of various types of steel weirs and gate structures. Amongst the many sluices there are four important types of constructions — roller weirs, sluice weirs, bascule weirs and sector and segmented weirs — *Figs. 4 to 15*.

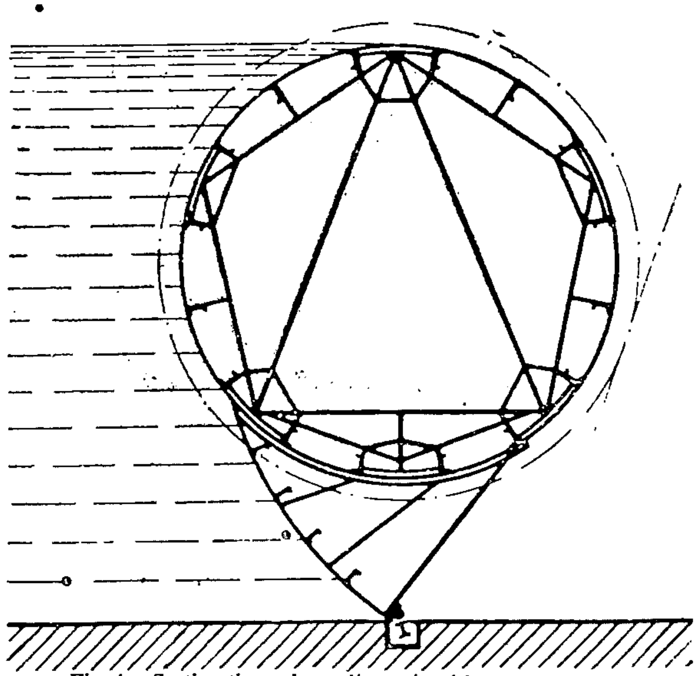


Fig. 4— Section through a roller weir with damming skirt.

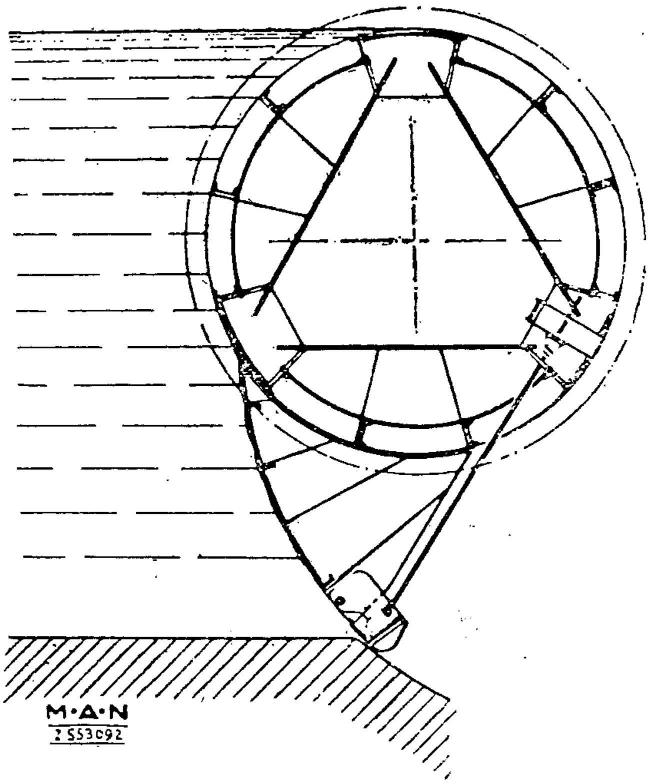


Fig. 5—M.A.N. Submersible weir roller with spring pleasure sealing.

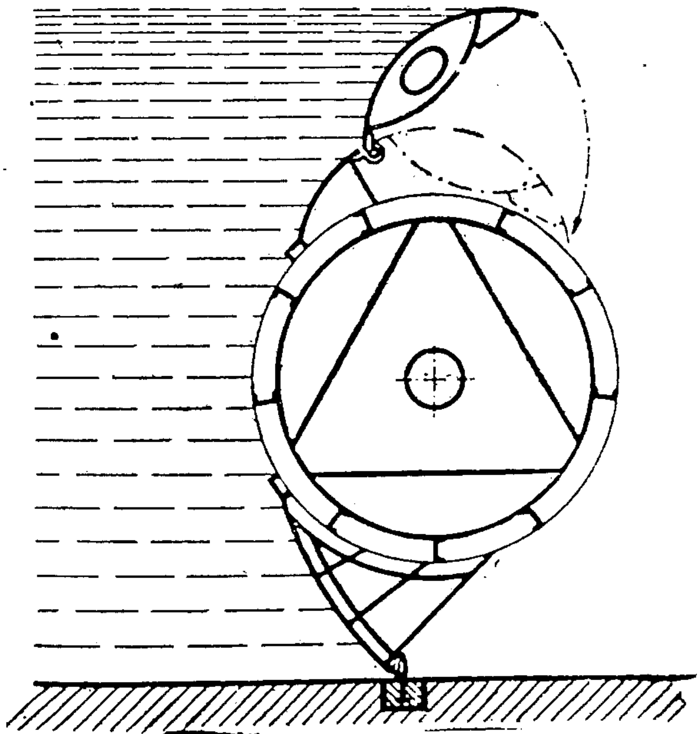


Fig. 6—M.A.N. Roller weir with Fish-belly Extension Flap.

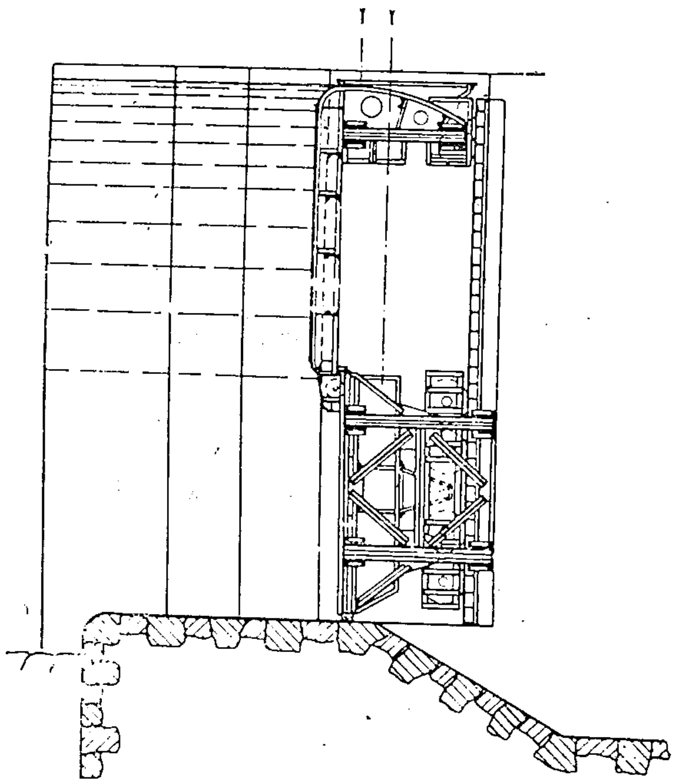


Fig. 7—Cross-section of the M.A.N. Hook-shaped Gate in closed position (Lattice Girder).

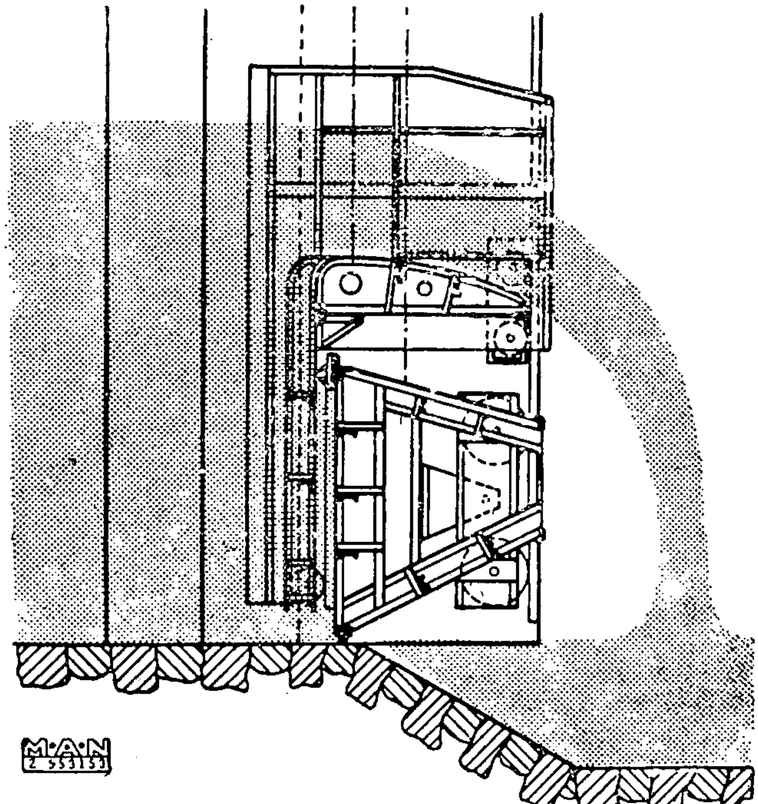


Fig. 8—Upper gate lowered. The lower gate is of a novel design in the shape of a closed casing, the lower face of which is standing upwards.

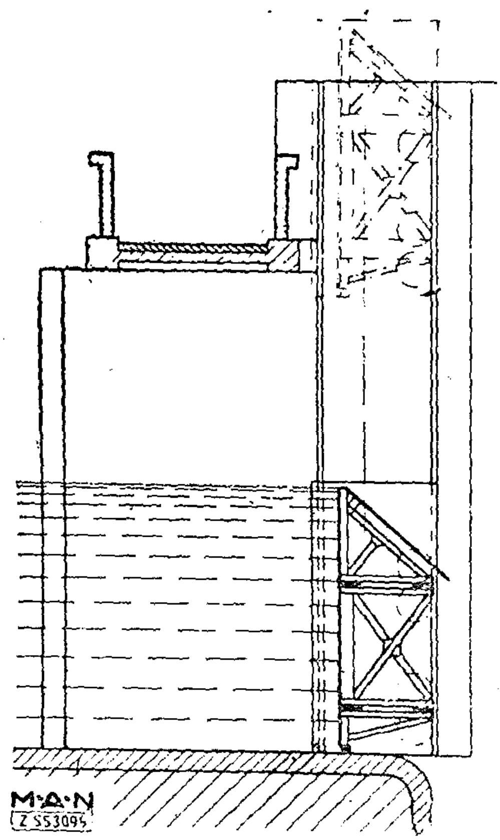


Fig. 9—Non-divided M.A.N. Roller Sluice.

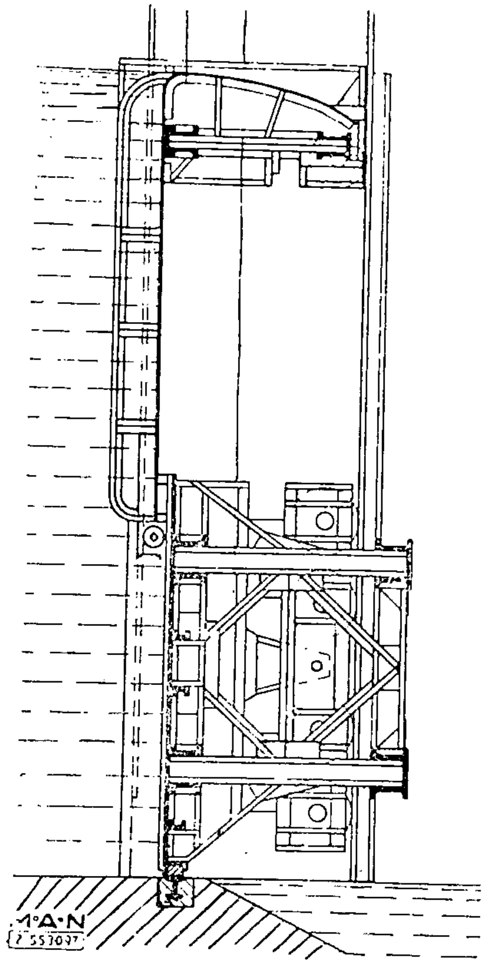


Fig. 10—M.A.N. Double Hook Sluice.

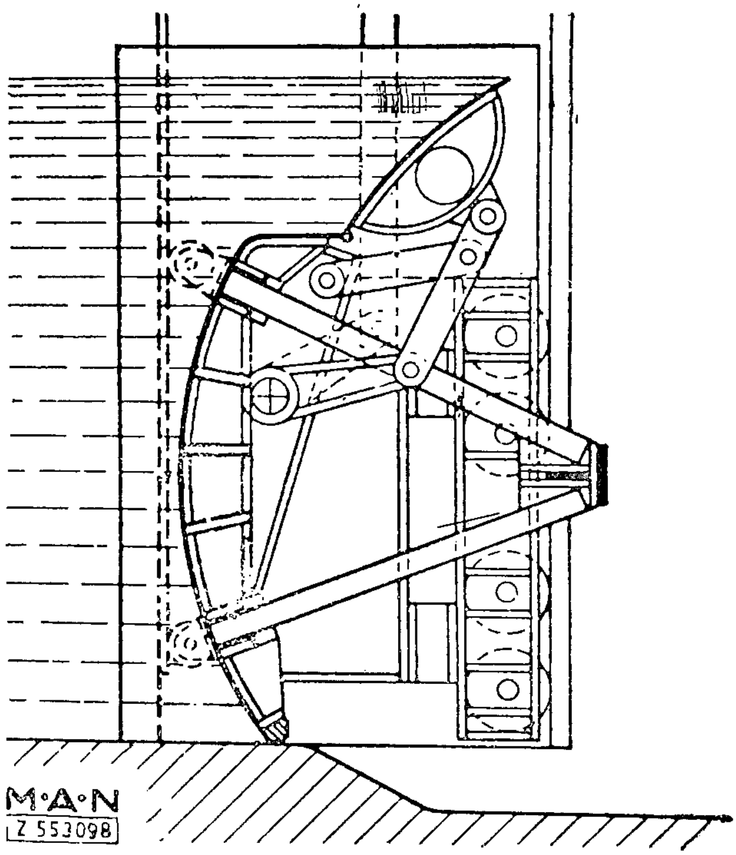


Fig. 11—M.A.N. Triangular Sluice with Extension Flap.

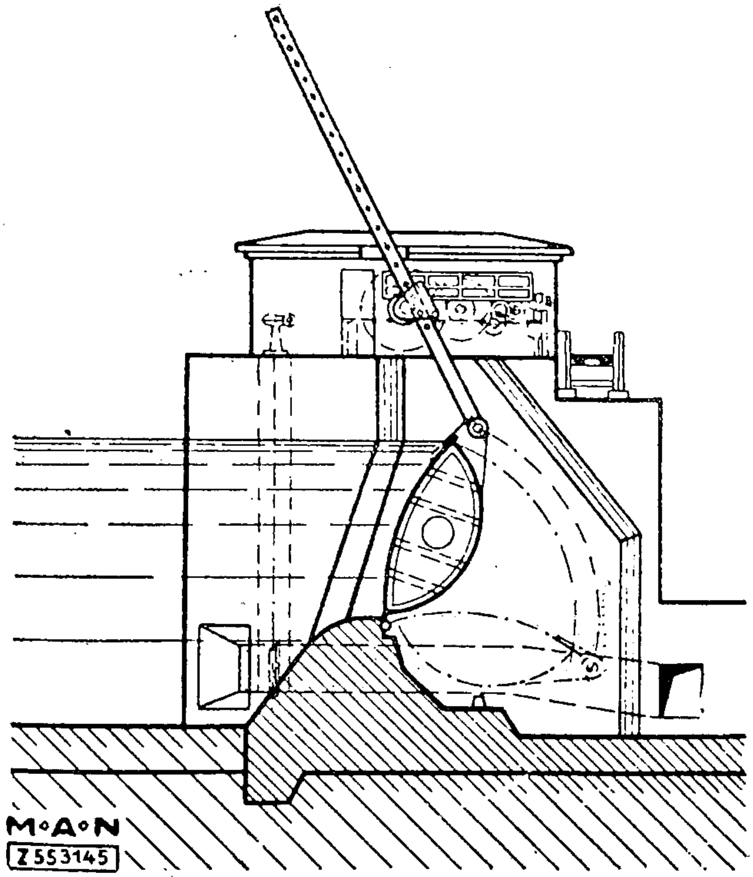


Fig. 12—M A.N Fish Belly Flaps.

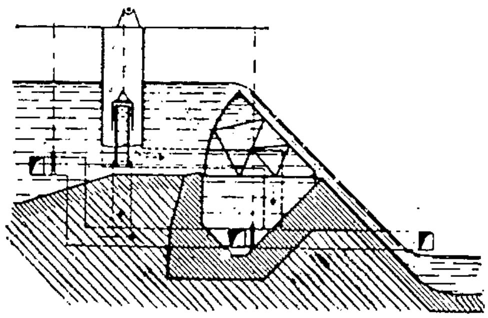


Fig. 13—Section weir with automatic precision regulation of the water level.

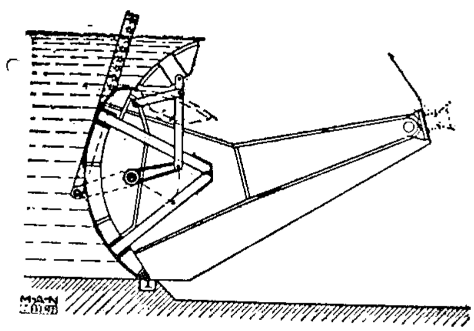


Fig. 14—M.A.N. Segment weir with Extension Flap.

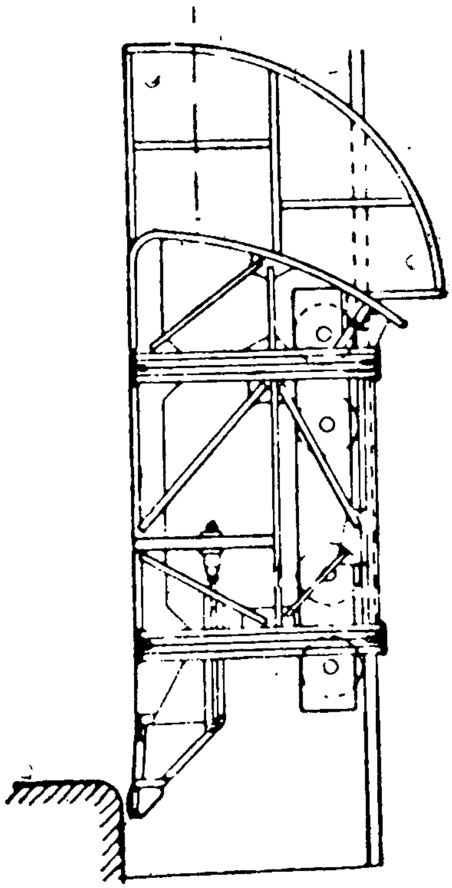


Fig. 15—Submersible Sluice Gate.

Roller Weirs

The roller weir as designed by the M. A. N. has become well-known for its excellent service since its introduction on the Main Dam Project, owing to its extremely simple design and long life.

The main element of the roller is a steel plate cylinder braced suitably by structural steel to stand the torsional and bending stresses. Usually the roller is provided with a skirt, the shape of which depends on the clearance width and depth over the sill. This also depends on as to how the shifting gravel, sand, etc., are to be cleared. The seal at the weir is generally made of timber and for the sides seals are made of timber-lined plate shields. The weir is operated by means of inclined racks installed in the recesses provided for in the pillars or piers.

Sometimes, these roller weirs are designed for overflow conditions also. In order to ensure efficient sealing on the sill or river bed, a flexible plate is usually fitted to the skirt which is pressed against the sill by the water pressure or spring force ensuring efficient sealing. It has of late become a common practice to fix movable flap to roller weirs to carry off the floating refuse and water. Both flap and the roller are controlled by a single winch gear.

The rigid roller has large clearance width to be provided and single side drive. The M. A. N's. have perfected the construction of this structure to suit varying service conditions. Upto now they have built nearly 200 roller weirs affording more than 4,09,C0C sq. ft. of weir surface to hold up water in various projects.

Sluice Weirs

These are used in large dam openings and hydro-power stations in connection with river regulation. They are also used for canal inlets, galleries and turbine locks. The M. A. N.'s double sluice gates offer the same advantages as submersible roller weirs. The top sluice gate is designed to allow waste water and floating matter to overflow. Sluice weirs can be fitted with folding flaps to allow disintegrated material and to ensure inching regulation. In this design the sluice and flaps are operated together. So far, the M. A. N. have built about 260 sluice weirs with an aggregate obstruction area of 4,30,560 sq. ft.

Bascule Weirs

Cross-section of the M. A. N.'s latest type of flap used in weirs for damming purposes is fish-bellied. This flap has most favourable hydraulic conditions and is found to withstand considerable torsional and bending stresses. The fish-belly flap is also used in other types of weirs as extension flaps.

Sector and Segment Weirs

As the name implies, the cross-section of the body of a sector weir corresponds to the sector of a circle. Raising and lowering are effected merely by the prevailing water pressure in the interior of the body, without any mechanical power being required. The design is consequently very simple. Apart from that, the weir extends across the entire opening and consequently can be dimensioned for very large clearance widths. The water inflow to the weir chamber is automatically controlled by a tubular sluice. Sector weirs are able to withstand very severe conditions.

Segment weirs also permit the passage of water, ice and refuse, provided they are fitted with extension flaps or arranged to be submersible.

Organisational Set-up of M.A.N. Works

The department is in charge of a director, assisted by two officers, one for the design and construction and the other for accounts, correspondence and general administration of the department.

There is another assistant for the project side of the work as well as two other assistants for the design and construction side.

The above staff somewhat correspond to the director, the senior deputy director and the deputy director in the C. W. & P. C. Further sub-division is in group leaders and the groups of designers.

The following work procedure is adopted in the firm. Preliminary project drawings and quotations for tenders are made by the project branch in conjunction with the costing department. Construction drawings for an order to be executed are prepared by the construction and design branch. For this purpose there is a group leader under whose guidance the complete detailed drawings are prepared. He has one, two or three assistants depending upon the volume and nature of work. The group leader is responsible for the complete handling of the order till its completion. He has to arrange procurement of the material in its proper section (Purchase Deptt.), its manufacture in the workshop, its despatch to site and its final erection, assembly and testing etc. He is in constant touch with the job in all its stages and is responsible for its completion in time. In some cases, the complete design calculations are prepared by the designer himself or by a member of his group and in others by a special design calculator who has a sound knowledge of applied mechanics.

A research laboratory is attached to the design and construction branch. It consists of a head research officer, an assistant and a draftsman, with a few fitters and mechanics. The laboratory helps the design department in all stages of project design. Drawings for the determination of calculated stresses, model analysis for the determination of the most suitable shapes and the sizes of the prototype structures and carrying out actual tests on completed jobs to compare calculations with actual results are being tackled in this laboratory. It also suggests remedies for any difficulties encountered at various stages.

The work done in the three branches — design, laboratory and the workshop — is carried out with complete co-operation and understanding. There are frequent consultations and general exchange of views between these departments. People generally do not consider themselves superior or inferior to each other, but consider everybody as a partner in a cooperative enterprise. Every one appears to be conscious of his responsibilities and limitations, freely takes advice where he needs it, gives advice wherever he can and promptly carries out the given instructions to the entire satisfaction of all.

After the main and detailed drawings are prepared, the shop drawings are made out with estimates for time and materials Specifications are explicit and dearly written out. Each and every process is shown completely laid out giving all tolerances and quality of finish. No deviations, alterations or modifications are carried out by the workshop without the prior consultation and approval of the design department. As already stated there is, however, free and frequent consultation among the workshop staff and the designer. There is, therefore, a perfect understanding and team spirit in carrying out the assigned job.

Salaries, Scales and Promotions, etc.

For purposes of scales of pay and grades, there are six groups or categories as under. An approximate grade equivalent according to our categories is given for comparison.

Grades in Germany	*Equivalent Grades in India*
Group I	Tracer.
Group II	Tracer who has learnt drawing and drafting in a recognised institute.
Group IIa	Junior Draftsman (Design Assistant).
Group III	Draftsman (Design Assistant).
Group IV	Senior Draftsman.
Group V	Head Draftsman.
Group VI	Senior Head Draftsman.

The groups, corresponding qualifications and scales of pay for these are laid down by the Federal Chamber of Commerce in consultation with the respective or concerned union.

The rates of pay for the different groups depending upon the age are shown in Appendix II and the wages are regulated only up to the age of 30 years. Above this age these are not binding. The promotions from one group to another or the increments after the age of 30 years are granted by the departmental head according to the capability of the individual. Generally after two to three years a jump of 20 to 50 D marks is given depending upon the status and the group etc. In the younger age groups it is not uncommon that people go from one firm to another, particularly from a lower group in a big firm to a higher group in a smaller one or to an equivalent group from the smaller to the bigger firm. There is quite an amount of stability, however, in the bigger firms and persons of more than 25 to 30 years service in the bigger firms are not uncommon. Graduate engineers are comparatively few. The greater number of design engineers are diploma holders from Government recognised engineering institutions. Graduate engineers start their career in group III or IV and diploma holders in group II. The duties of graduate engineers are such as requiring higher and specialised knowledge of complicated calculations.

Normal working hours are 48 per week. These are same for all categories of staff in offices or workshops. Overtime is paid for all excess hours to staff in groups I to IV. From October 1956 the number of working hours are being reduced to 45 per week.

Expenditure on Research, Design and Manufacture

A general approximate division of the production cost in the department is as under :

Design and Research	10 %
Material	40 %
Manufacture	50 %

There are, however, wide variations depending on the nature of each job, which in the case of this department almost every time presents new problems.

The costs in the design department are not calculated for each job individually. These are allotted on the estimated number of hours for the job and the estimated overall hourly cost of the department.

The research department receives an *ad hoc* grant every year depending on the nature of work expected to be carried out and if special work has to be taken in hand for a particular order, it is directly debited to that work.

A lot of useful magazines and books in German language on water economy and structural steel design are available. These magazines should be obtained for the C. B. I. & P. Library, and important articles got translated into English for the benefit of our engineers. It may be because of the language difficulty that such an important and valuable literature is shut out from the Indian engineers' purviews. This difficulty has to be overcome. A list of the magazines in German language on water economy and utilisation in Germany, Switzerland and Austria considered useful for the library is enclosed as Appendix III.

List of books in German language which were considered very useful in the field of structural steel design and a list of German standards for general and hydraulic steel structures are enclosed as Appendices IV and V. It is strongly felt and recommended that these references should be obtained for general use in the library if they do not already exist. It will indeed be a valuable collection in the field of specialised designs for steel structures and hydraulic steel structures.

OKER AND EKER DAMS

In North Germany, two dams, the Oker and Eker dams are being built by the Germans. On these dams the German engineers have adopted a special technique in dam construction, using both masonry and concrete in combination calling it as 'Plum Concrete' or 'Machine made Masonry' in order to economise on cement.

These dams are situated about 60 miles from Hanover and the salient features of the dams and the method of construction adopted are given below in brief.

Oker Dam

This is a single arch gravity dam built across a small river whose discharge fluctuates between a minimum of 1 cubic metre per second (31.3 cusec) and a maximum of 100 cubic metres per second (3131.6 cusec). The dam is 250 metres (820.3 ft.) long at the top and is 76 metres (249.4 ft.) high above foundations which has been grouted to a depth of 35 metres (114.8 ft.). The radius of the arch is 74 metres (242.8 ft.) up to the centre of the intrados. The storage capacity of the dam is 45 million cubic metres (1,589.2 mill. cu. ft.). There are eight small siphons provided to dispose of the floods. Actually the dam section has two parts. It is built as an arch dam up to a height of about 68 metres (223.1 ft.) beyond which it is purely a gravity section. This was planned to obviate the problems arising due to poor abutments as well as to minimise the thickness of the dam itself. The dam has consumed 1,45,000 cubic metres (1,89,660 cu. yds.) of plum concrete. Vertical and horizontal joints are provided at 15 metres (49.2 ft.) and 2½ metres (8.2 ft.) apart. The concrete work was commenced in 1953 and was completed in 1955.

Professor Press of Technical University, Berlin, carried out the model experiments for the dam as well as for the siphons.

Concreting Process

In this dam the German contractors, Messrs. Dycke Hoff and Widman, Hoffman and Midmana of Munich, evolved a special technique by using greater percentage of stone in order to economise on cement. The technique used was that the concrete was pumped into the dam to a thickness of 20 to 25 centimetres (7.9 inches to 9.4 inches). On top of this, 50 per cent stone varying in sizes from 30 to 60 centimetres (11.9 inches to 23.8 inches) from the quarry was laid by cranes. The stone was then vibrated by two or three internal electric vibrators. The width of the block was about 8 metres (26 ft.). It took one hour for each layer of about 40 centimetres (15.8 inches). Working 20 hours a day it was possible to lay about 2½ metres (8.2 ft.) thickness in one day. Two days rest was given for each pour of 2½ metres (8.2 ft.). No arrangement for cooling had been made. The temperature of concrete as laid was 25° centigrade, and the temperature of air was 35° centigrade.

The construction work was mostly mechanised. In general the old equipment was used with certain improvements. There were three mixers of 1½ cubic metres (5 cu. ft.) each and three pumps of a capacity of 15 cubic metres (49.2 cu. ft.) per hour. One of the pumps was kept as spare set while the remaining two worked, one each during the day and night shifts.

Tramway was freely used for carriage of materials. Stone was carried by conveyors for some distance and then lifted by cranes into position.

Composition of Concrete

The following materials were used per cubic metre of concrete :

Fine sand 0.02 to 0.1 millimetres (0.00079″ to 0.0039″)	275	Kilograms	(606 lb.)
Coarse sand 0.3 millimetres (0.0118″)	395	,,	(871 lb.)
Fine aggregate 3 to 7 millimetres (0.118″ to 0.2756″)	290	,,	(639 lb.)
Medium aggregate 7 to 15 millimetres (0.2756″ to 0.5906″)	480	,,	(1058 lb.)
Coarse aggregate 15 to 30 millimetres (0.5906″ to 1.1812″)	530	,,	(1169 lb.)
Cement	335	,,	(739 lb.)
Water	167	,,	(368 lb.)
TOTAL	2472		(5450 lb.)

To this mix, 2,900 kilos (6,395 lb.) of solid stone was added to make 2 cubic metres of mass concrete in the dam so that the average weight of the mass concrete of the dam came to 2,650 kilograms per cubic metre (165.6 lb./cu. ft.). The quality of concrete was good and the cost of concrete worked out to 50 DM per cubic metre (Rs. 161.4/100 cu. ft.).

Wooden shuttering has been used throughout.

Labour Strength

Last year when the work was in full swing the total labour strength was 150 workmen. This year at the time of visit to the works, the labour strength was 120 workmen. Out of the above 150 workmen, about 50 men were brought by the firm from their permanent organisation and were provided living huts. The remaining 100 came from the neighbouring villages by means of buses from a distance of 10 kilometres (6 miles). There were three engineers on the job last year and two engineers this year.

Designs and construction drawings were made by the firm's head office in Munich.

EKER DAM

Eker is a gravity dam constructed in 'Plum Concrete' during the war 1939 — 42. It is 58 metres (188 ft.) high and 200 metres (676 ft.) long with a storage capacity of 13 million cubic metres (17 million cu. yds.). The total quantity of concrete placed in this dam is 1,70,000 cubic metres (2,22,360 cu. yds.).

The concrete for this dam was mixed in five mixers of one cubic metre capacity each, conveyed by means of a ropeway and was then pumped into position. The maximum size of the aggregate used was 20 centimetres (7.9 inches). Cement content used at Eker Dam was 170 kilograms per cubic metre (1.60 lb./cu. ft.) of concrete.

The following is the comparison of the strength attained at Eker and Oker dams :

	Eker Dam	*Oker Dam*
Maximum strength.	400 kilos per sq. cm. (5689 lb./sq. inch)	450 kilos per sq. cm. (6400 lb./sq. inch)
Minimum strength.	300 kilos per sq. cm. (4267 lb./sq. inch)	300 kilos per sq. cm. (4267 lb./sq. inch)
Sizes of cubes tested.	20 cm. cubes. (7.9″ cubes)	1 metre cube. (3.3 ft. cubes)

VISITS IN HOLLAND

After completing the round of visits in West Germany the next country to be visited was Holland. Starting from Hanover (Germany) at 18.40 hours on the 16th July, Amsterdam (Holland) was reached at 20.50 hours the same day. The main object in visiting that country was to study on broad lines the navigational features of Lower Rhine, some of the reclamation projects such as the Zuider Zee Works as well as a few well-known engineering organisations like NEDECO.

On the morning of the 17th July 1956, it was possible to arrange a trip down the Rhine river by a launch to Rotterdam. The following gentlemen accompanied :—

(1) Prof. P. Ph. Jansen,
Director (Designate) of Delta Bureau.

(2) Mr. J. W. De Vries,
Director of Lower Rivers.

(3) Mr. E. M. H. Schaank,
Director of Upper Rivers.

(4) Mr. R. Tutein Nelthenius,
NEDECO.

THE LOWER RHINE

Immediately after its entry into Holland, the Rhine divides into two arms flowing westward. The larger of these two arms is known as the Waal. This carries nearly two-thirds of the flow of the river. The other arm still known as the Rhine again divides into two branches one of which joins the Ijssel and the other runs westward under the name Rijin. Ijssel finally flows into the Zuider Zee in the north.

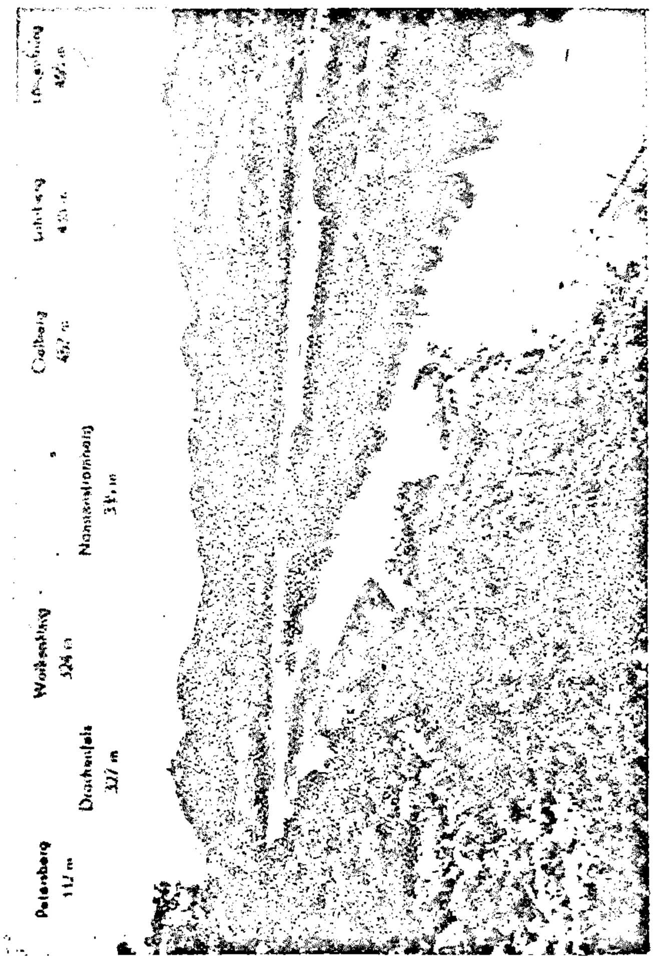


Fig. 16—Rhine River at Bonn.

Fig. 17 — Rhine River at Bonn.

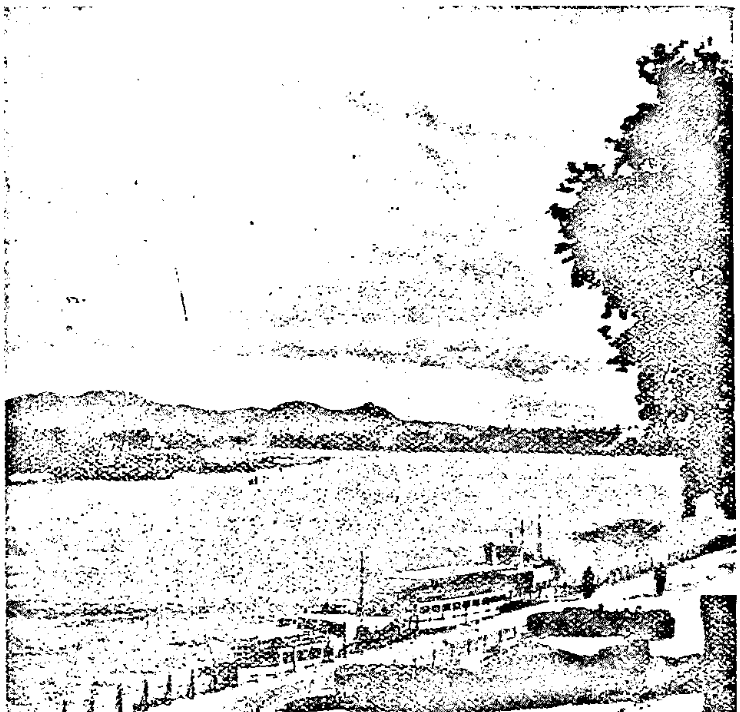


Fig. 18 — Rhine River at Bonn.

The Rhine has always been one of the chief waterways of Europe. The river is navigable practically without interruption for a distance of 550 miles from the mouth upwards. It is also open to international vessels. The maximum draft in the river is 2.5 metres (7.2025 ft.), and the minimum depth is 90 cm. (35.5 inches). It was said that the level of the water went down only once in 1955 during the last hundred years. There are no structures like bridges, locks, etc. on the river below Rotterdam to the sea. The river permits ships up to 4,600 tons capacity to ply without difficulty. Barges and tugs of capacity of 1,000 to 1,500 tons are very common. The size of the biggest boat observed was one of 4,200 tons. Some of the modern boats are sea-worthy and they are built to take up coastal traffic. A tug pulling five big boats, the entire length of the train being one kilometre was observed on the river.

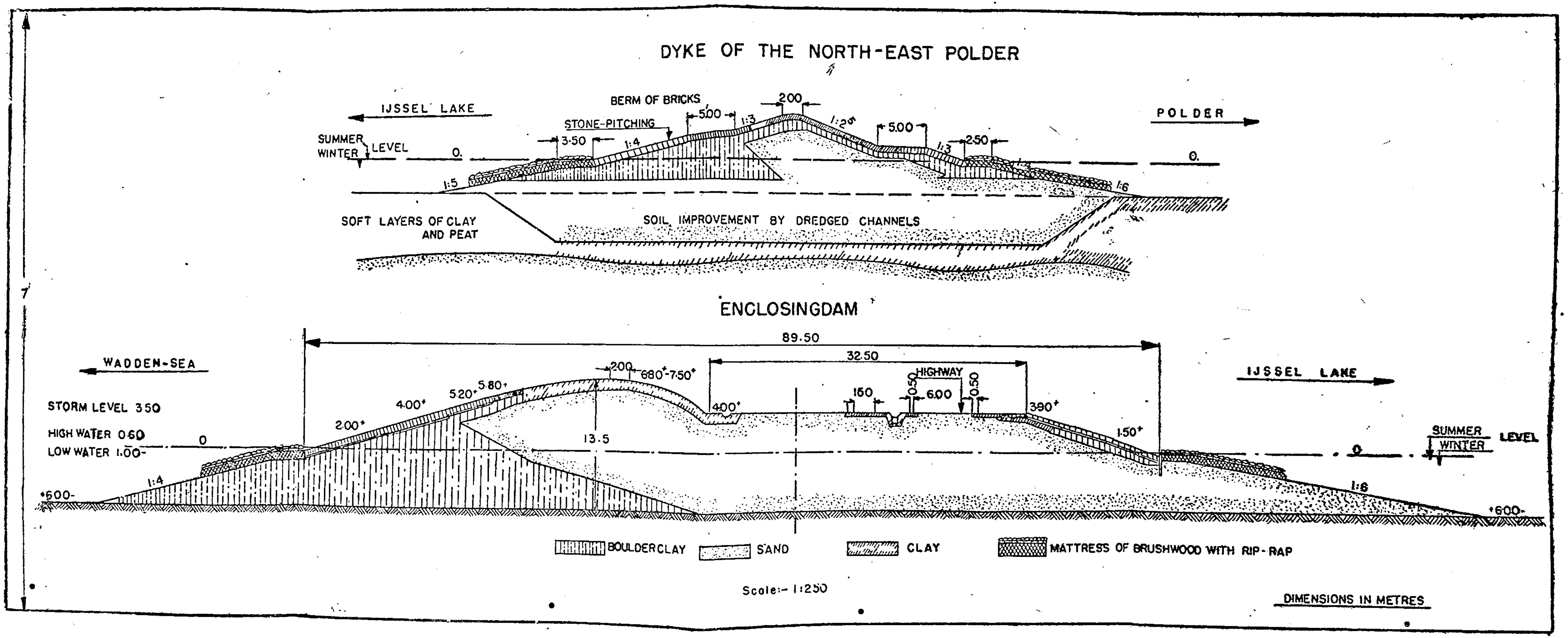
The bridges upstream have a waterway of 80 — 100 metres (262 48 to 328.1 ft.) and the bottom of the bridge has generally a clearance of 8 — 10 metres (26.25 to 32.81 ft.) above high water surface.

One interesting point is that there are no taxes or tolls on the Rhine unlike other navigable rivers.

Rotterdam is an important port in the North Sea. The length of the river from the sea to Rotterdam is 16 miles. The depth of the water at low tides on this section is about 36 feet. The facilities available at this port and some statistics regarding the reconstruction of the port and the various harbour basins at the port of Rotterdam are given in Appendix VI alongwith a map.

RECLAMATION PROJECTS IN HOLLAND

The Dutch have centuries of experience in the field of reclamation of land. As far ago as 13th century the people of Holland started to struggle against the sea to clear more land for their population. Till the beginning of 17th century, however, reclamation was mostly confined to small areas inundated by the sea, but later it became a practical proposition to reclaim large areas from a number of lakes in the northern part of the province. A remarkable example of



9—THE CONSTRUCTION OF A POLDOR-DYKE AND THE ENCLOSING DAM.

draining a lake was the Harrlemmer lake in the environs of Amsterdam city. About 45,000 acres of land subjected to the danger of inundation from the lake was reclaimed in this project by draining. The present Schiphol airport is situated in the depression of the drained lake. This is about 14 feet below the average sea level. Similarly a number of lakes such as Beemster, Schermer, Purmer and Wormer were also drained.

The Zuider Zee Works

A visit was arranged to the Zuider Zee Reclamation project which is one of the latest conquests of the sea by the people of Holland by partial reclamation of a shallow arm of North Sea, known as Zuider Zee, entering the main land with an average depth of 12 — 15 feet and the bottom of which being mostly clay. A comprehensive scheme for this partial reclamation of the sea was prepared in 1918. [Dr. C. Lely—(*Fig. 20*), an engineer of repute, was the first to conceive this project.] The project included :—

1. The construction of an enclosing dam from North Holland to the island of Wieringen (1½ miles).
2. An enclosing dam from Wieringen to the Frisian coast (20 miles).
3. The reclamation of five polders* (about 5,46,000 acres in all) behind the dam.

Construction of the Enclosing Dam and the Polder Dykes

The construction of the enclosing dam was completed in 1932 and the work on the dykes is in progress. An important factor in the building of this dam and dykes was polder clay, a glacial deposit, which offers sufficient resistance to strong currents to enable a dam to be built up to above water level, without any covering. Other materials used are sand or sand-clay stone, and brushwood.

The only material imported is stone, while others are available near the site. In general, whenever a dyke has to

*A 'polder" means any area which has to be protected by dykes against high water of the sea or of rivers.

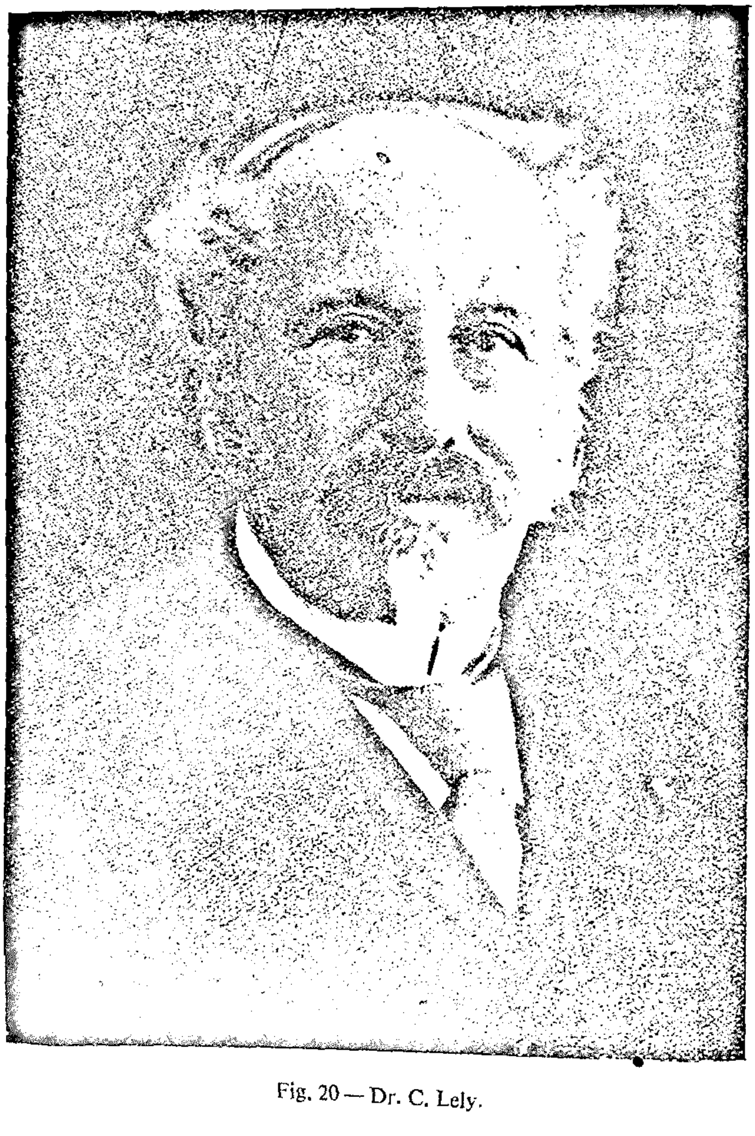


Fig. 20 — Dr. C. Lely.

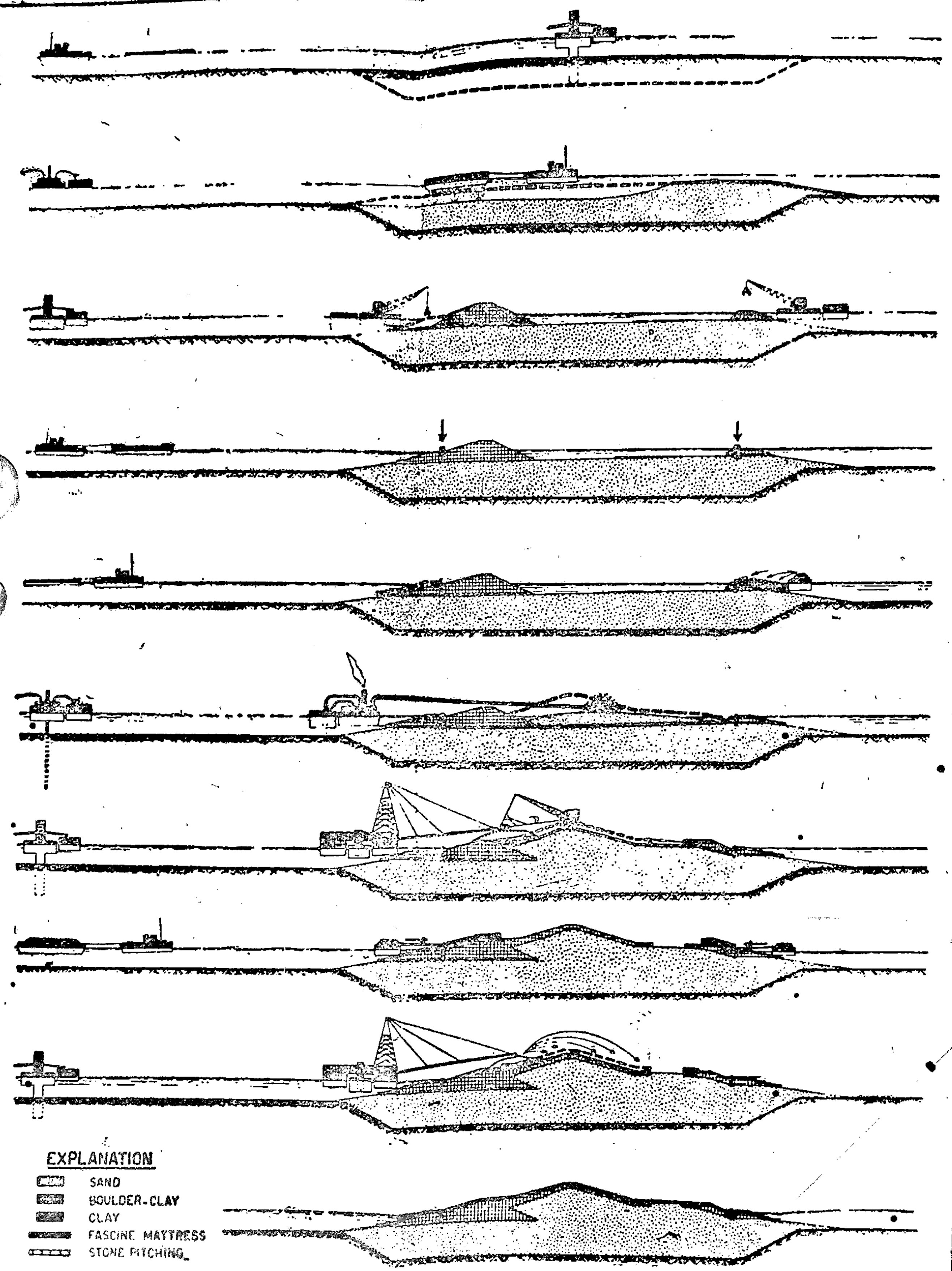


FIG.21_SCHEME OF CONSTRUCTION OF A POLDER_DYKE.

P6 80

be constructed, the soft layers at the site are dredged and are replaced by sand that forms the foundation. On this foundation, two dams of boulder clay are dumped between which a body of sand is pumped. This sand, so pumped, is covered with the protecting layers of polder clay. The slopes of the dykes so formed below the water level are protected by brushwood, sunk in position and covered with riprap. The higher slopes of the dyke are covered with stone pitching. Lighter or heavier materials, such as bricks, concrete and basalt stone are used for this pitching depending upon the situation. Before the stone is laid, the slope of the dyke is covered with mats of rice, on top of which a layer of broken brick is applied. Where the surface of the dyke is not protected by stone, it is covered with a layer of ordinary clay, upon which grass is sown. It appears, experiments were made to replace the brushwood mattresses by asphalt slabs. But it did not prove very satisfactory. The dyke above the level of water is partly protected by bituminized sand. The section employed in the construction of the enclosing dam and one of the polder dykes are furnished here for reference — (*Fig. 21*).

This enclosing dam transformed the former Zuider Zee (Sea) into fresh-water lake, which receives water from several rivers and polders. Any excess water reaching the lake is discharged in a natural way at ebb tide by means of sluices. Two sets, each having 5 sluices, are provided in the body of the dam at the eastern and western ends of the enclosing dam. The level in the lake almost corresponds to the mean level of the sea and it is kept almost constant in summer as well as in winter. By reclamation of a part of this lake 5,46,000 acres of land are proposed to be obtained as shown below :—

1.	Wieringermeer polder	50,000 acres
2.	North East polder	1,20,000 ,,
3.	Eastern Flevoland	1,35,000 ,,
4.	Markerwaard	1,35,000 ,,
5.	West Flevoland	1,12,500 ,,
	Total area to be reclaimed	5,52,500 ,,

The first two projects which were completed before the War had suffered serious damages. These have since been reconstructed and successfully rehabilitated. The latter three are in hand at present and works of huge magnitude in the nature of break-waters, harbours and dam connecting the polder with the mainland, are underway. This work also includes the construction of dams surrounding building sites of the pumping stations and the shipping locks of the future polders.

An interesting point that was observed was that in order to keep the cattle away from the dykes electric shock wires have been used. These wires give a shock to the cattle, although it is not dangerous. This method could be used with advantage to keep the cattle off the dykes in our projects also.

Another major operation of the Zuider Zee project is draining of the polders by large-scale pumping. There are a number of large pumping stations worked either by electricity or by diesel engines — *Figs. 22 & 23*. The Lely Pumping Station—*Fig. 24*, under operation draining the Eastern Flevoland was visited. There are three centrifugal pumps of one thousand H.P. each installed to pump the water in the reclamation area with the total capacity of nearly 2,60,000 gallons per minute. The capacity of each pump is about 450 cubic metres (15,892 cu. ft.) per minute and the maximum to which the pump can work, is estimated to be 600 cubic metres (21,190 cu. ft.) per minute. These are generally operated by electricity and work mostly during the night, as the tariff on electricity is cheaper at that time than during the day time. Whenever necessary diesel pumps are also worked. The pumps are directly coupled and are of low frequency working under a head of 5 to 6 metres. The cost of electricity and the maintenance of pumps, etc. are met by the reclamation authorities.

There are similar pumping stations such as "Leemans" named after the designer of the draining system of the Zuider Zee at the south-east point of the island of the Weiringen and "Buma" and "Vissoring" stations in the north-eastern polder. These pumps have a capacity of more than 1,20,000 gallons per minute. It was said that nearly 1 million gallons per minute

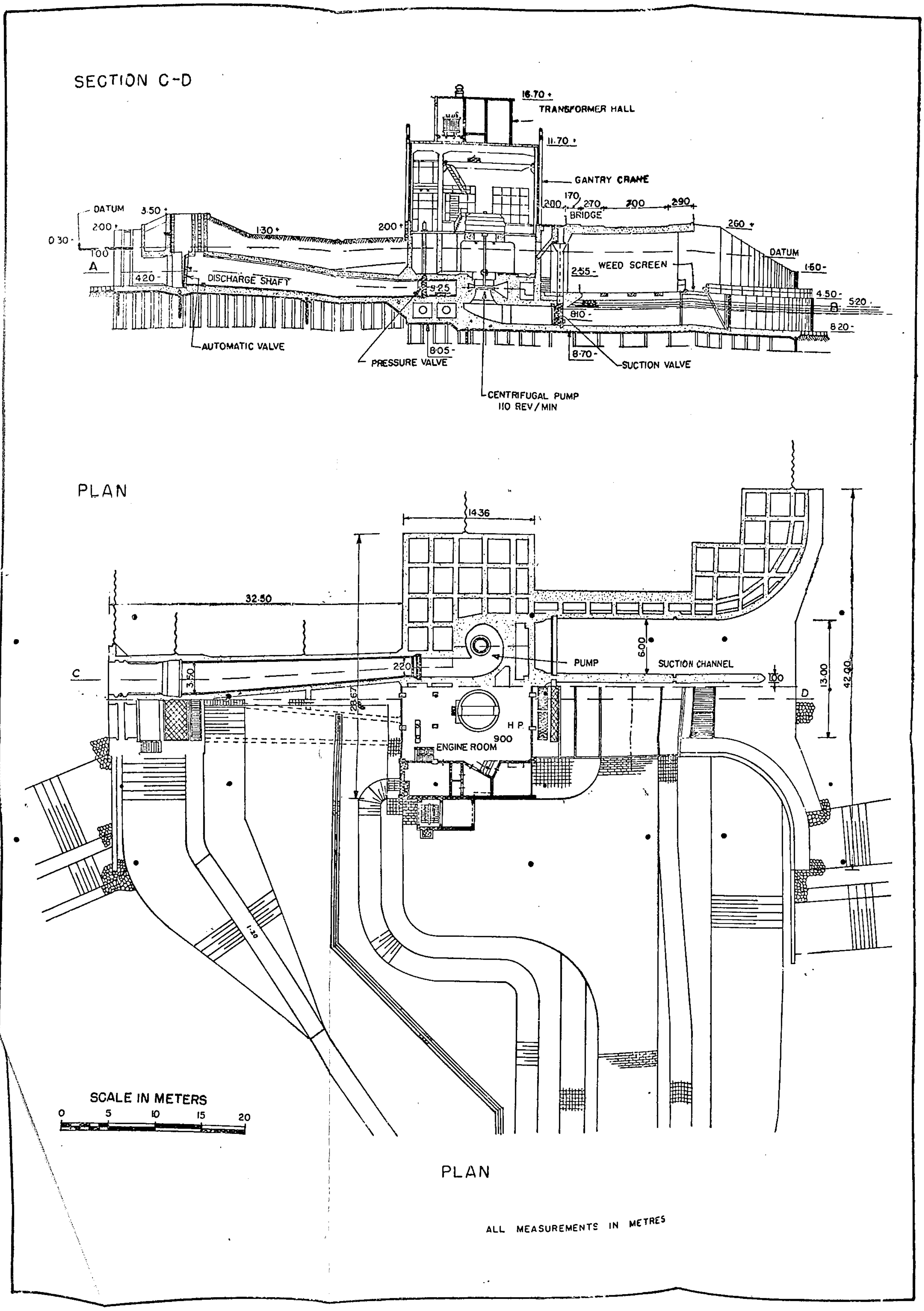


FIG.22_ELECTRIC PUMPING STATION "LOVINK" NEAR HARDEWIJK

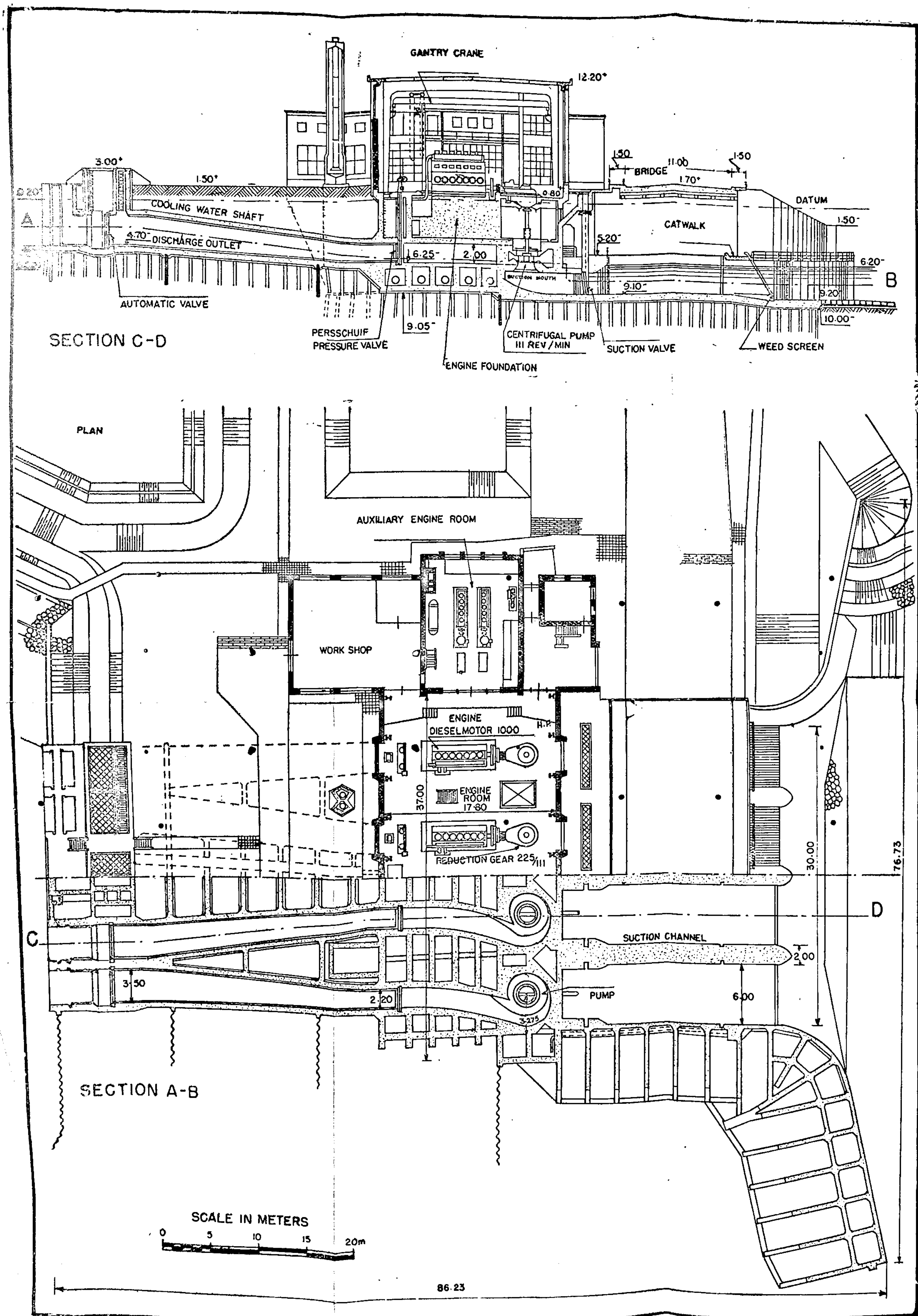


FIG.23—DIESEL PUMPING STATION "WORTMAN" AT LELYSTAD

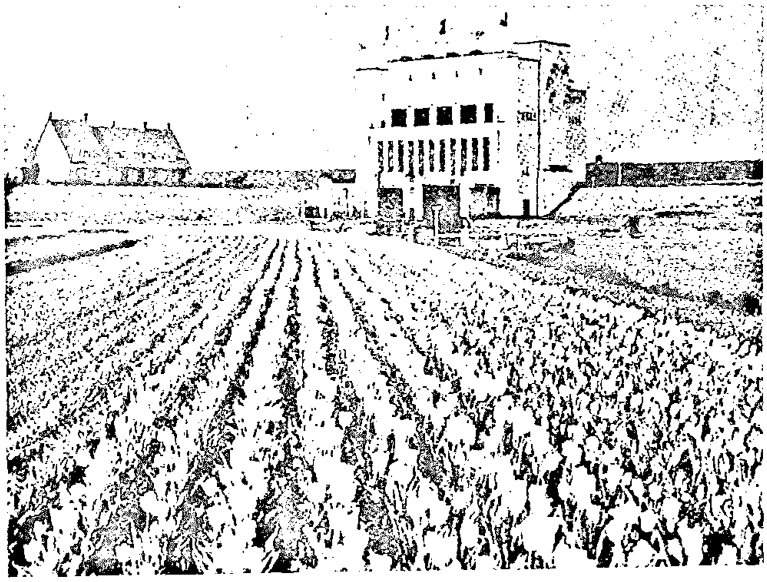


Fig. 24—Pumping Station 'Lely' seen from the Polder side.

of water was pumped out from the polder by eight pumping installations. An idea about the cost per acre can be had from the following data, relating to the reclamation of Eastern Flevoland polder :—

(1)	Area reclaimed	1,33,000 acres.
(2)	The cost of hydraulic works	290 million guilders (about Rs. 387 million).
(3)	The cost of cultivation of soil	350 million guilders (about Rs. 467 million).

The cost per acre, therefore, works out to 4,800 guilders per acre, which is equivalent to approximately 6,400 rupees per acre. The following heavy equipment were provided for construction of the eastern Flevoland :—

Bucket dredgers	19	Other barges	193
Suction dredgers	18	Tugs	79
Barge unloading dredgers	4	Flat-bottom boats	63
Floating cranes	9	Draglines	23
Cranes	21	Trucks	9
Hoppen barges	74		

Approximately 2,000 labourers are working on the project, which is expected to be completed during this year with all amenities provided for the inhabitants who will be settled there.

Netherlands Engineering Consultants — NEDECO

NEDECO is an abbreviated name for a Dutch company of engineering consultants whose object is to design and supervise public and private engineering works abroad. The Managing Director of NEDECO was met at the Delta Hotel at Rotterdam. They are advising the Bengal Government on the reclamation of the Salt Lake.

NEDECO's recommended procedure involves a reconnaissance of the scope and extent of any required engineering work, investigations to determine the physical and economic feasibility of projects, estimates of cost and a report showing the best way to accomplish the objectives, preparation of plans and specifications, supervision of construction and if needed, operational help. NEDECO do not carry out any works themselves and in accordance with their articles of association only act as consulting engineers.

The organisation consists of a small permanent staff of experienced engineers in charge of preparatory and coordinating activities. Dependent on the nature of the problems involved, the actual planning, designing and supervising work is carried out by various associated consulting offices, architects and specialized engineers, specially engaged for each specific problem in cooperation with technical, scientific and agricultural laboratories and institutions in the Netherlands.

The form of cooperation makes it possible to pool all expert knowledge and experience available in the Netherlands in the sphere of activity mentioned above and furthermore to enlist the services of experts on matters which fall outside the scope of engineering. It will frequently be necessary, for instance, to consult experts on agricultural subjects in connection with reclamation or irrigation problems. Expert advice on matters of organization may be required for works relating to transport by water, rail, road or air. Industrial objects may involve special requirements, which cannot be readily assessed by technical experts only. In such instances NEDECO cooperates with other experts or scientific organisations in the Netherlands.

The experience of Netherlands engineers includes, of course, knowledge gained by years of work and study in Indonesia and in the West Indies under tropical and sub-tropical conditions.

This cooperation on a national scale enables NEDECO to tackle extensive and complicated projects beyond the capacity and scope of ordinary consulting offices and engineering firms.

Moreover, such an association of experts is particularly valuable at the present time, seeing that the progress in science and engineering has made it possible to develop vast regions, raising problems of increasing importance and size which can only be solved by groups of specialists.

This trend of development and expansion must lead to close cooperation among nations.

A central organisation such as NEDECO is capable of handling the important problems which arise from this international cooperation, especially within the framework of the United Nations Technical Assistance Programme for economically under-developed areas. Cooperation with the countries concerned is considered essential to attain the purpose laid down in the motto : "Progress through self-help aided by intimate expert advice".

It is, of course, also essential that the economically more developed countries should cooperate with each other. These countries supplement one another in different fields of activity. A combined effort of their best experts will certainly lead to promising results, either within their own areas or for joint action elsewhere.

NEDECO have prepared the South Salt Lake Reclamation Project for the West Bengal Government. In fact the Bengal Government had appointed a technical committee which had already prepared the master plan in 1950-51. The Bengal Government had also, through their own engineers, designed and executed a drainage scheme called the Sonarpur-Arapanch Drainage Scheme which was started in 1951 and completed in 1953-54.

A statement of comparison of the estimates of South Salt Lake Project prepared by NEDECO and the Master Plan Committee showing the salient features of the Sonarpur-Arapanch Drainage Scheme Part I are given in Appendices VII and VIII.

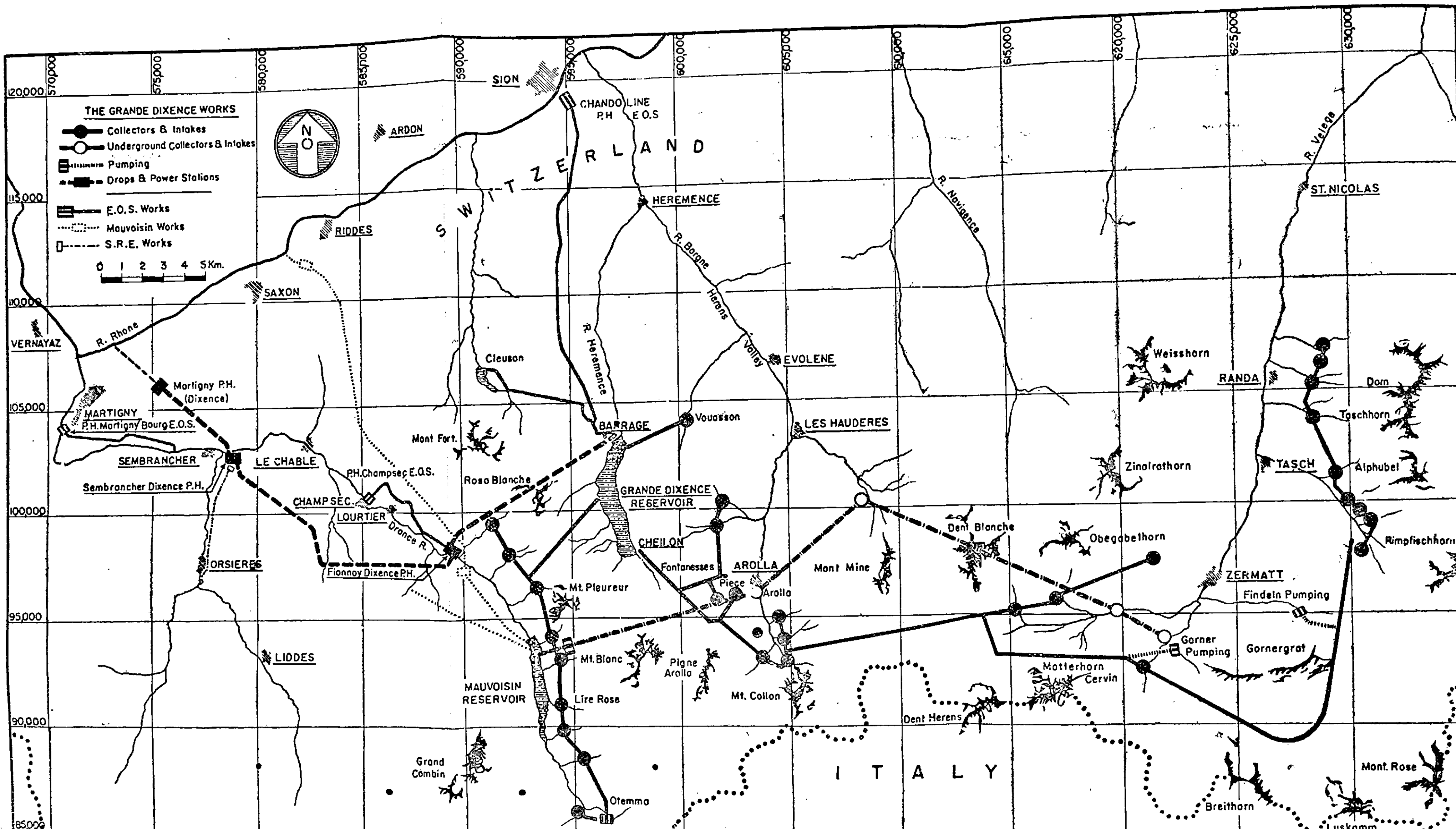
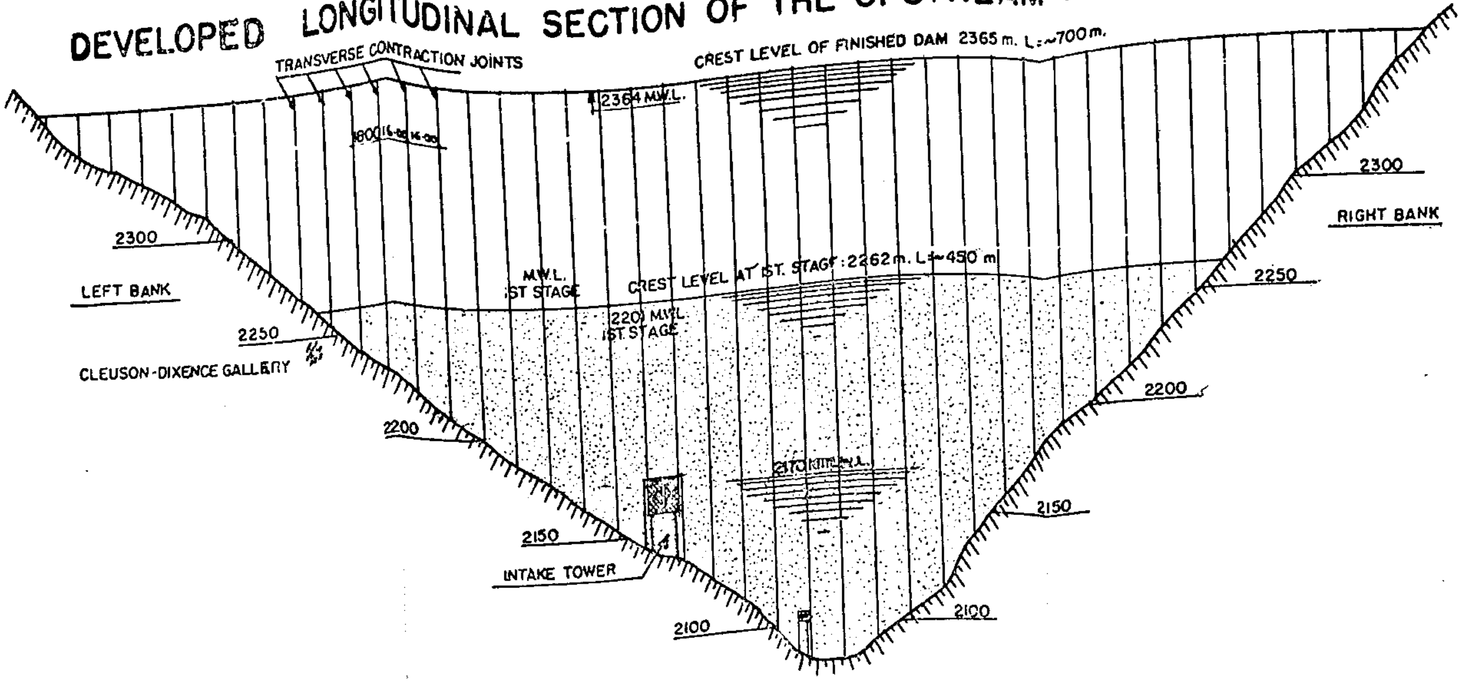
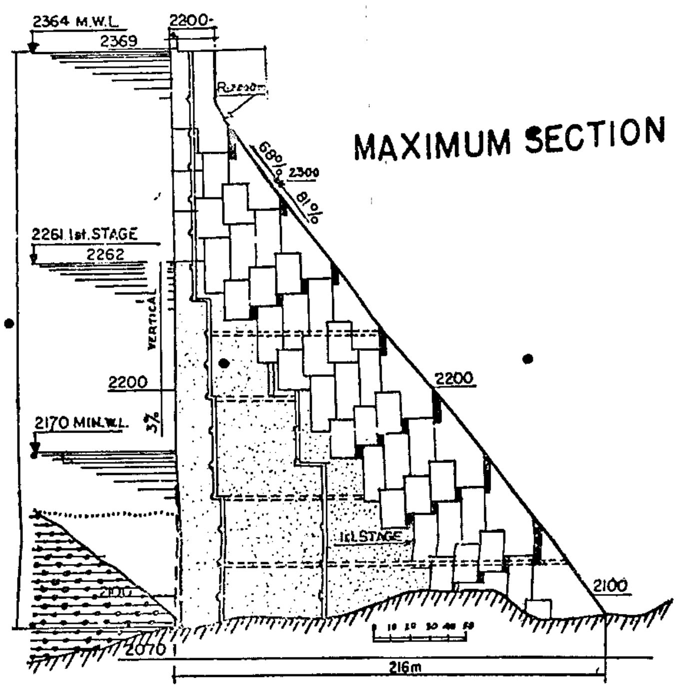


FIG.25—LOCATION MAP OF INTAKE TUNNELS AND SCHEMES.

DEVELOPED LONGITUDINAL SECTION OF THE UPSTREAM FACE OF THE DAM



MAXIMUM SECTION



STATISTICS OF THE DAM

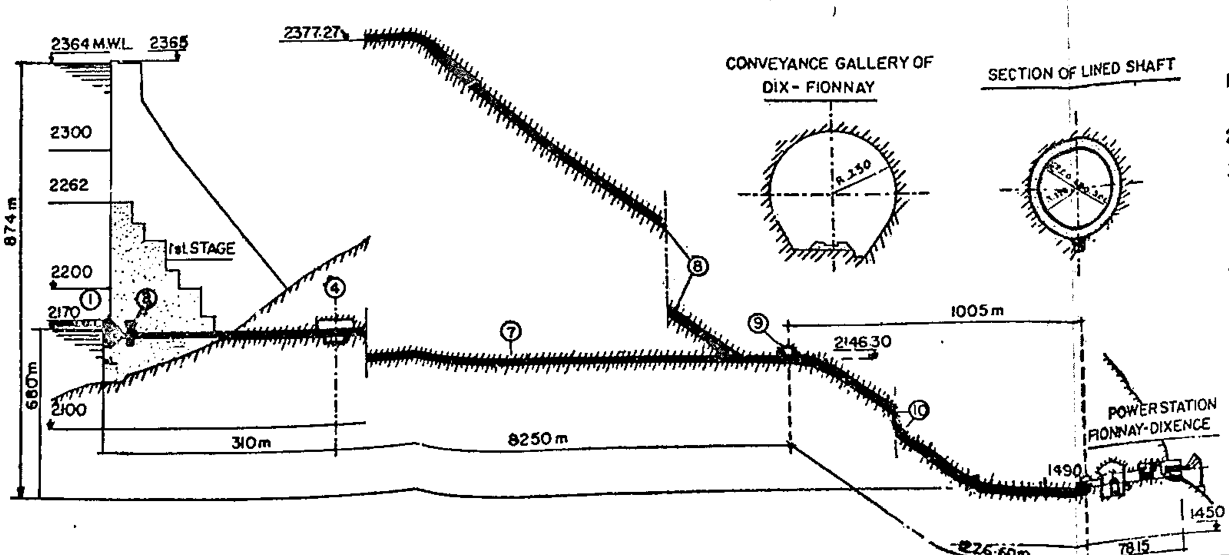
CREST OF FINISHED DAM AT ELEVATION 7750 FT

MATERIAL & TYPE: CONCRETE, GRAVITY.
MAX. HEIGHT 922 FEET.
WIDTH AT TOP: 72 FEET.
MAX. WIDTH AT BASE(APPROX):721 FEET.
LENGTH AT CREST 2300 FEET
CONCRETE: 7,540,000 CU.YD
EXCAVATION, DEBRIS 675,000 CU.YD.
EXCAVATION, ROCK: 273,000 CU.YD.
SPACING OF LONGITUDINAL JOINTS: 132 FEET.
SPACING OF TRANSVERSAL JOINTS: 52 FEET.
AGGREGATES 0-1/8", 1/8"-1/4", 1/4"-1 1/2", 1 1/2"-5"
CAPACITY OF INTAKE 1950 CU.FT/SEC (FIONNAY 1590 CFS. CHANDOLINE 360 CFS.)
DISCHARGE CAPACITY OF MAIN OUTLET: 1760 CU. FT./SEC.
DISCHARGE CAPACITY OF LOWER OUTLET: 350 CU. FT./SEC.
MAX. LEVEL OF RESERVOIR 7750 FEET.

FIRST STAGE OF DAM CONSTRUCTION (ELEVATION) 7412 FT. ABOVE SEA LEVEL.

MAX. HEIGHT OF FIRST STAGE: 584 FEET.
WIDTH AT TOP (FIRST STAGE) 50 FEET.
WIDTH AT BASE (FIRST STAGE APPROX.): 460 FEET.
LENGTH AT CREST (FIRST STAGE) 1475 FEET.
HEIGHT OF LIFTS 5 1/4'.
INTERVAL BETWEEN LIFTS 3 DAYS
ARTIFICIAL COOLING BY EMBEDDED PIPES.

LONGITUDINAL SECTION OF DIXENCE-FIONNAY SCHEME



1. TRASHRACK AND INTAKE TOWER.
2. COFFERDAM GATES
3. MAIN OUTLET GATE.
4. BUTTERFLY VALVE Ø 118" (FIONNAY)
5. PRESSURE REGULATOR AND ENERGY ABSORBER FOR CHANDOLINE.
6. BUTTERFLY VALVE (CHANDOLIN
7. TUNNEL DIXENCE FIONNAY
8. SURGE TANK.

FIG.26_ DETAILS OF GRAND DIXENCE DAM

VISITS IN SWITZERLAND

Grande Dixence Dam

Grande Dixence Dam—(*Figs. 25 & 26*) 281 metres (922 feet) high is the world's highest dam now under construction in Switzerland. The project comprises of a storage reservoir at a height of 2,365 metres (7,760 feet) above sea level in Alps, which is filled by the waters of a number of small catchments in the valleys of Arolla, Zemutt and Bagnes which have been connected by a complex system of 66 miles long tunnels and also by the water pumped from Findelen and Gorner glaciers in this region. The total capacity of the reservoir is 400 million cubic metres (3,24,320 acre ft.). The water so impounded will be utilised by three power stations at Fionnay, Sembrancher and Martigny producing 7,50,000 kW of power. The dam itself is a straight gravity dam which is 22 metres (72 ft.) wide at the top and 216 metres (721 feet) at the base involving 6 million cubic metres of concrete. The entire cost of this project including 80 kilometres (about 50 miles) of tunnels and excluding the cost of transmission lines is estimated at 1,200 million Swiss Francs (Rs. 1,350 million).

Originally there was a Low Arch Dam 285 feet high situated slightly above the present site with a storage capacity of only 50 million cubic metres (40,540 acre ft.), supplying water to Chandoline power station with a capacity of 1,50,000 kilowatts. The new dam with its 400 million cubic metres (523 mill. cu. yds.) capacity will submerge this dam. The power station at Chandoline will continue to receive its water by this new dam and this 1,50,000 kW is not included in the new scheme.

The dam is planned to be constructed successively in five stages. The first stage of the dam is expected to be over by the end of this year up to a height of 178 metres (584 feet) and the second stage will be taken up to 202 metres (667 feet) by 1959 and the final phase is expected to be completed up to 281 metres (922 feet) by the end of 1966. The growth of demand for power since the starting of the first stage has been so great that it has been decided to build the whole dam to the full height of 281 metres (922 feet). It is interesting, however, to note the method by which it was proposed to join the old and new concrete in five successive stages. The downstream face will be cut up into steps of 12 metres (40 feet) wide and 20 metres (66 feet) high. During the successive stages concrete will be laid in vertical prisms of 56 feet high. The length of each prism along the axis of the dam will be 46 feet. These blocks will be concreted at different times. In order to ensure transmission of tangential forces some tenons are provided with their faces approximately parallel to the direction of stresses. The method of construction has been very ingeneously adopted after analysing the various intricate problems relating to stresses in the dam by photo-elastic tests and practical constructional aspects. It is certain that a detailed study of this project would be quite interesting to design and construction engineers employed on dams in our country.

The principal features of the three phases of the power development are given below :—

Fionnay Dixence Stage

Maximum upstream water level :	Elevation 7,750 ft.
Minimum upstream water level :	Elevation 7,114 ft.
Length of intake tunnel :	5·28 miles.
Diameter of the drilled section :	15·09 ft.
Diameter of the lined tunnel :	13·12 ft.
Length of armoured shaft :	4,100 ft.
Inner diameter of armoured shaft :	9·84 ft. — 9·18 ft.

Underground Power Plant Fionnay Dixence

Jet valves axis :	Elevation 4,890 ft.
Maximum static fall :	2,860 ft.
Minimum static fall :	2,224 ft.
Number of generating units (Pelton) :	6
Power per unit :	75,000 H. P.
Output per unit :	267 cu. ft./sec.
Total power installed :	4,50,000 H. P.
Compensating basin downstream of the power plant Fionnay Dixence and at the heading of the tunnel Fionnay — Sembrancher :	2,60,000 cu. yds.
Compensating Reservoir :	92,00,000 cu. yds.

Sembrancher Dixence Stage

Maximum upstream water level (Compensating basin Fionnay) :	Elevation 4,877 ft.
Minimum upstream water level (Compensating basin Fionnay) :	Elevation 4,834 ft.
Length of intake tunnel :	7·89 miles
Intake tunnel diameter :	4·00 m. (13·12 ft.)
Length of penstocks, each penstock :	4,330 ft.
2 penstocks on concrete supports :	2·20 — 2·00 m. (7·22′ — 6·55′)

Power Plant Sembrancher — Dixence

Jet valves axis :	Elevation 2,390 ft.
Maximum static fall :	2,487 ft.
Minimum static fall :	2,444 ft.
Number of generating units (Pelton) :	6

Power per unit :	65,000 H. P.
Output per unit :	267 cu. ft./sec.
Total power installed :	3,90,000 H. P.
Compensating basin downstream of the Sembrancher—Dixence power plant and at the heading of the tunnel Sembrancher-Martigny :	162·16 acre ft.

Martigny–Dixence Stage

Maximum upstream water level (basin of Sembrancher) :	Elevation 2,377 ft.
Minimum upstream water level (basin of Sembrancher) :	Elevation 2,367 ft.
Length of intake tunnel :	2·76 miles
Diameter of intake tunnel :	13·8 ft.
Length of penstock :	1,360 ft.
Number of penstocks :	2
Diameter of penstocks :	8·2 — 7·55 ft.

Power Plant Martigny–Dixence

Number of generating units (Francis) :	4
Average theoretical fall :	870 ft.
Average real fall :	834 ft.
Power per unit :	26,500
Output per unit :	445 cu. ft./sec.
Total power installed :	1,46,000 H.P.
Total Output :	1,775 cu. ft./sec.
Outlet channel :	1·39 miles.

Concrete for Grande Dixence Dam

Cement for the project is brought from the railhead at Sion and is carried by two ropeways in parallel. The control tower of the ropeway is supplied by Brown Bovery of Milano. Aggregate for the concrete is arranged to be conveyed from a neighbouring valley and hill road 48 kilometres (29.8 miles) long. The aggregate is crushed at the site to the required sizes. There are two batching plants with the size of the bucket equal to 8 cubic yards. Sand is obtained by crushing stone as natural sand is not available at the site. In the original design for mass concrete, the cement content of 180 kilograms per cubic metre (11.3 lb./cu. ft.) was provided. This cement content, it was learnt, was reduced to 160 kilograms (10 lbs.), based on certain tests. When the project was visited in July, they were using only 140 kilograms per cubic metre for the body of the dam and 220 kilograms for the 10 ft. upstream face and 10 ft. downstream face respectively. The specific strength of concrete obtained in 90 days was 140 kilograms per square centimetre or 1,990 lbs. per sq. inch.

The composition of the various ingredients in the concrete per cubic metre used is given in the table below :

Sand and ballast expressed on percentage basis for various grades .

Cement kg.	(0-0·12″) 0-3 mm. %	(0·12″-0·39″) 3-10 mm. %	(0·39″-1·75″) 10-40 mm. %	(1·75″-4·72″) 40-120 mm. %
Mass 140 (309 lbs.)	21	14	25	40
Face 250 (551 lbs.)	18	13	26	43
Rear 220 (485 lbs.)	18	13	26	43

There is a field laboratory at site for testing concrete. 500-ton compressor test machine has been installed in the field laboratory. This testing machine can test up to a stress of 700 kilos per square centimetre (9,956 lbs./sq. inch). This is a very compact machine and is manufactured by M/s. Albert Teoetit, 20, Rue Marie Debog Montrouge.

With the abovementioned composition, the cost of one cubic metre of concrete with amortisation of plant including all expenses incurred by the contractor on housing facilities and miscellaneous items except the amortisation on construction plant provided by the owner worked out to 50 francs. In Indian money it costs about 165 rupees for 100 cubic feet.

Staff and Wages

The project work is purely a private enterprise and is fully mechanised. At the time of the visit Mr. Mahlen was the General Manager on behalf of the Grande Dixence Power Company. On behalf of the construction contractors, Mr. Marti was the Chief Construction Manager. It was said that there were altogether 60 to 70 engineers and technicians on the job out of which about one-third were engineers and two-thirds technicians.

The working season due to severe cold and snow is only 6 months. During these cold months only workshops carry on repairs and reconditioning of the plant. A large number of Italian workers come to the job for seasonal work. The total number of workers on the job was 1,600. The work was carried on in two shifts. In one week there were 6 night-shifts of 10 hours each and 5½ day-shifts of 11 hours each. One hour was allowed for lunch. The actual working hours come to 120 hours for two weeks.

One thousand tons of cement are used daily. Average daily outturn was 7,000 cubic metres (9,100 cu. yds.). The weekly outturn was 35,000 cubic metres (45,500 cu. yds.). Maximum outturn on any one day so far achieved was 7,500 cubic metres (9,800 cu. yds.). The concreting of the whole dam is expected to take 5 years. It is, however, gratifying to note that we in India have also achieved an outturn of 9,000 cu. yds. of concreting per day at Bhakra Dam.

The lowest wage of a worker employed on this project was 12 francs and 75 cents per day. On the average the wage came to 3 francs per hour including bonus. The minimum monthly wage was 800 francs and the maximum monthly wage

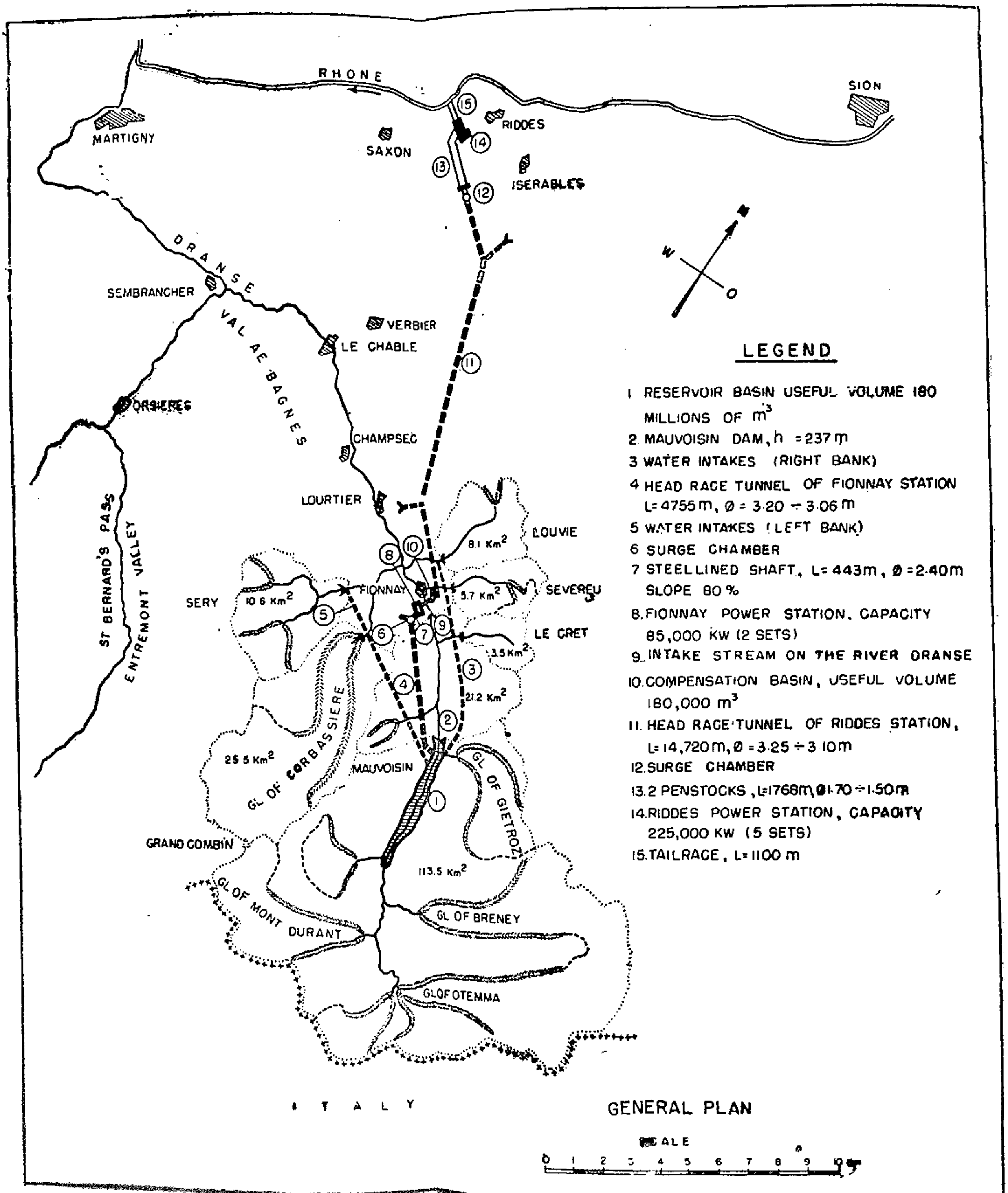


FIG 27— MAUVOISIN DAM

was 3,000 francs. The chief of construction was being paid 50,000 to 60,000 francs per year and got bonus in addition. All workers were paid for overtime work.

Mauvoisin Dam

Mauvoisin is another interesting Hydro-power Project now under construction in Switzerland (Figs. 27 to 29). It utilises the waters of the river Dranse de Bagnes at an elevation of 1,960 metres (6,430 feet) above M.S.L. in Swiss Alps, with its catchment area lying wholly in the Bagnes Valley. The dam is situated about 65 miles from Grande Dixence and Viz Sion and Martigny and has the following principal features :

1.	(*a*) Catchment area at the dam site	... 58 sq. miles (150 sq. KM)
	(*b*) Catchment area at Fionnay Power Station	... 167 sq. KM
	(*c*) Intermediate catchment situated between Mauvoisin and Fionnay	... 21 sq. KM
	(*d*) Total basin at the Riddes Power Station	... 188 sq. KM
	(*e*) Area of glaciers	... 77 sq. KM
2.	The total utilisable flow in average year	... 250 million cu. metres
3.	Average flow in the river	... 8 cu. metres per sec.
4.	Length of the dam at crest	... 520 metres (1,640 ft.)
5.	Height of the dam above foundation	... 237 metres (778 ft.)
6.	Width of the dam at the top	... 14 metres (46 ft.)
7.	The base width	... 53.5 metres (175 ft.)

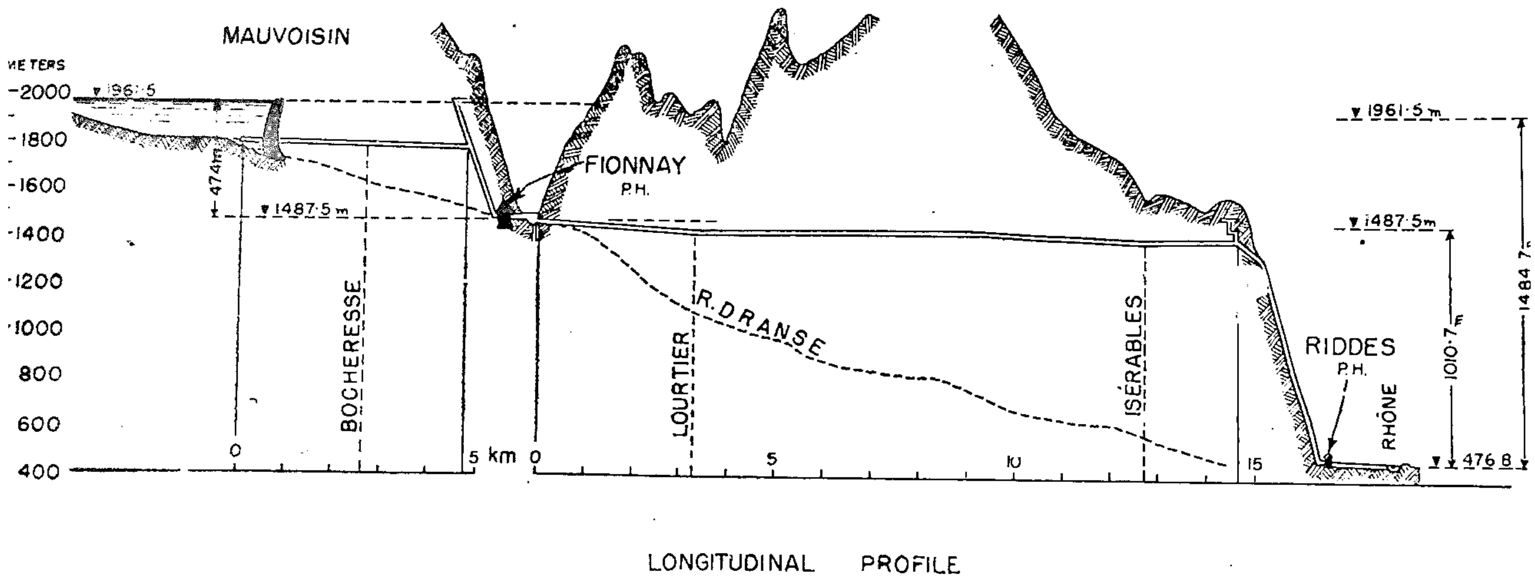


FIG. 28 — MAUVOISIN DAM — LONGITUDINAL SECTION

8.	Useful volume of the reservoir	... 180 million cu. m.
9.	Area on the reservoir at maximum water level	... 1961.5 M.S.L. (208 Ha)
10.	Volume of excavation in stone	... 450,000 cu. m.
11.	Volume of excavation in rock	... 963,000 cu. m.
12.	Total volume of concrete required for the dam	... 2,000,000 cu. m.

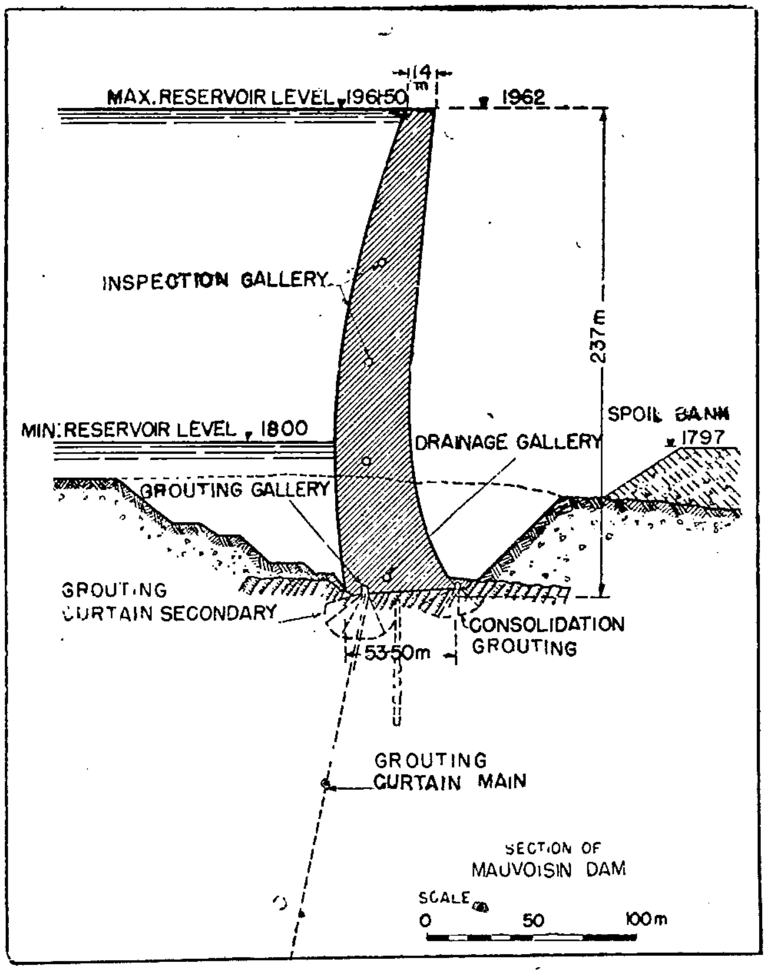


FIG 29— SECTION OF MAUVOISIN DAM

It is an arch dam in plan, having a double curvature with variable thickness at various levels designed so as to keep the stresses in the concrete more or less uniform. The distance between the radial joints is 18 metres (59 ft.).

About 1,000 cusec of water released from this dam will then feed two power houses, one at Fionnay working under a head of 474 metres (1,540 ft.) and another at Riddes with a head of 1015.7 metres (3,280 ft.) generating 85,000 kW and 225,000 kW respectively.

Materials Required for the Dam

Cement

The distance of Mauvoisin Dam from the nearest railhead is about 12½ miles (20 kilometres). Cement, steel and such other articles are carried by an 8½ miles (14 kilometres) long cable way in drums of 400 kilograms capacity and stored in Silos of capacity 5,000 tons from where it is transferred into concrete mill of capacity 3 cubic metres (4 cu. yds.) which are five in number.

Sand and Ballast

Ballast is available nearby at Torrembe situated in the upstream portion of the valley which is quarried and stocked on the downstream side near the site transporting through long and narrow winding hill road. 400 cubic metres (523 cu. yds.) per hour crushing plant equipped fully with 4 washing drums, 8 jigging sieves, 4 sorter washers for fine sand are provided at the site. There is also a secondary crushing station with 4 crushers for gravel and sand. The ballast is graded in the following sizes : 0 — 4 mm. (0 — 0.16"); 4 — 10 mm. (0.16" — 0.39"); 10 — 30 mm. (0.39" — 1.2"); 30 — 60 mm (1.2" — 2.4"); and 60 — 120 mm. (2.4" — 4.8"). The sand and ballast are conveyed to the mixers by belt conveyors in an inclined gallery.

All heavy materials are carried through special trollies by road. A pilot leads the train of these trollies in front and in the rear there is a police car. At this time all other traffic on the road is stopped. The construction plant layout is compact and the total cost of plant is estimated at 25 million Swiss francs. The total quantity of concrete to be used in the dam is 2.0 million cubic metres (70.6 m. cu. ft.). The cement content for the interior of the dam is kept at 175 kilograms per cubic metre (10.94 lbs./cu. ft.). The same for the faces being 250 kilograms per cubic metre (15.7 lbs./cu. ft). As it is an arch dam, the Consulting Engineers have not agreed to any further reduction in the cement content in this dam, as was done in the case of the Grande Dixence Dam.

The overall cost of concrete per cubic metre including all overheads and cost of the contractor comes to 60 francs per cubic metre. This is slightly higher than for the Grande Dixence Dam. Mauvoisin being an arch dam, requiring special form work and with its higher cement content than that of the Grande Dixence Dam, this higher cost may be justifiable. The daily progress in concreting is about 5,500 cubic metres (7,194 cu yds.) and the concreting of Dam is expected to be over in two years.

Labour Strength

On the day of the visit the number of workers on the project were about 700. It was said that during excavation and erection periods, there were about 1,000 workers on the job. Out of the 700 workers mentioned above, there were 50 engineers and technicians. There were about 600 workmen of all ranks. The remaining 50 were working on cafeteria, cooling, etc. The workmen have been provided with accommodation at site, in multi-storeyed wooden barracks with all facilities.

The civil and electrical equipment provided in the two Power Houses at Fionnay and Riddes are given below :

I. Fionnay Power Station

This power station utilises the water, tapped through a tunnel, from the reservoir, about 90 metres (295 ft.) upstream of the dam.

(a) Civil Works

The principal civil works involved are the construction of :

1. Sluice-gates chamber equipped with 2 butterfly gates in series of 2,700 mm. in diameter (8.9 ft.).
2. Penstock gallery of 4,755 m. in length (15,600 ft.) 3.20 — 3.06 m. in diameter and 5.5% slope (internal pressure 170 — 200 m.).
3. Equilibrium chamber with top opening under the Bec de Corbassiere. Length of the path 319 m., diameter 4.00 m., slope 80%.
4. Metal-lined shaft : length 443 m., diameter 2.40 m., slope 80%, thickness of sheets 17÷32 mm.
5. Collector : average length 69 m., diameter 2.20/1.40 m., thickness of sheets 23÷40 mm.
6. Sluice-gates chamber equipped with three double water-tight spherical sluice-gates of 1,200 mm. diameter.
7. Power station in Cauvery has for the time being two sets (maximum capacity 85,000 kW).
8. Service building in open air situated close to the out-door 225 kV station.
9. Lower equilibrium chamber of 16.1 m. in height and 9.00 m. in diameter.
10. Spillway gallery of 227 m. (745 ft.) long, 3.3 to 3.45 m. (10.8 — 11.3 ft.) in diameter and 3.08% slope up to the compensation basin.

It is at Fionnay that the exchanges of water between the Grande Dixence and the Forces Motrices de Mauvoisin can be effected by a gallery connecting the compensation basin of the Forces Motrices de Mauvoisin with the Grande Dixence Works.

(b) Fionnay Power Station Equipment

The present equipment of the Power Station consists of :

1. 3 double water-tight spherical sluice-gates of 1,200 mm. (about 4 ft.) diameter (the 3rd gate has already been

installed in anticipation of the installation of the future 3rd set).

2. 2 Francis type vertical axis turbines of 62,800 h. p. each, under a net head of 300 to 460 m. (at the present time the highest head in the world used for Francis turbines), speed 750 rev./min., maximum discharge absorbed 11.5 m^3/s (406 cusec).

3. 2 three-phase alternators of 60,000 kVA, 10.5 kV, 50 cycles/sec. (The constructional arrangement of the cavern enables the installation of a third identical set without any additional civil works.)

4. 2 three-phase transformer sets (comprising single-phase units) of 60,000 kVA, 10.5/225 kV.

5. 2 auxiliary sets of 800 kVA each, comprising a Pelton wheel turbine working a three-phase alternator.

6. The outdoor step-up station provided with two 225 kV outgoing lines towards the Riddes Station.

The 225 kV double circuit line follows the right flank of Val de Bagnes up to Chable and arrives at the Riddes Station after passing through Pierre a Voir and Croix de Coeur.

2. Riddes Power Station

This power station utilises the water released from the Fionnay Station and the contribution from the intermediate basin collected by means of separate tunnels from the Fionnay stream.

(*a*) *Civil Works*

The main items of civil works are construction of:

1. Compensation basin situated at NE of Fionnay. Useful capacity 180,000 m^3 (235,440 cu. yds.).
2. Penstock gallery on right bank of Val de Bagnes, then on left bank of the glen of Fara, length 14,720 m., diameter 3.25 ÷ 3.10 m., slope variable.
3. Double-opening equilibrium chamber situated at Villy, on the left bank of Rhone, height of the shaft 76 m., diameter of the shaft 3.10 m. Penstock first in rock, then in open air.

4. Section in rock (metal-lined gallery) : length 275 m., diameter 2.70 m. (8.8 ft).

5. Sluice gates chamber provided with 2×2 butterfly gates in series, diameter 1,750 mm.

6. Section in open air (double penstock), length 1,768 m., diameter 1.70 ÷ 1.50 m., thickness of sheets 12 ÷ 45 mm.

7. Collector : maximum length 119 m., diameter 1.50 ÷ 0.70 m., thickness of sheets 48 ÷ 23 mm., with double water-tight spherical sluice-gates of 700 mm. (27.5") diameter.

8. Power Station of a maximum capacity of 225,000 kW (5 sets).

9. Tail-race of 1,100 m. in length and 10.16 m² (109 sq. ft.) in section.

(b) *Riddes Power Station Equipment*

Riddes Power Station epuipment consists of :

1. 10 double-water-tight spherical sluice-gates of 700 mm. in diameter.

2. 5 horizontal axis double Pelton-wheel turbines, capacity 70,000 h.p. under a net head of 1,000 m., speed 500 rev./min., maximum discharge used 5.75 m³/s per set (203 cusec per set).

3. 5 three-phase alternators of 67,000 kVA, 10.5 kV, 50 cycles/sec.

4. 5 sets of three-phase transformers (consisting of single-phase units) of 67,000 kVA, 10.5/225 kV.

5. 2 auxiliary sets of 800 kVA each, consisting of a Pelton turbine running a three-phase alternator.

6. The 225 kV step-up station is at present provided for :

   2 incoming lines from Fionnay power station,

   2 outgoing lines towards the Haut Valias (Chippis),

   2 outgoing lines towards the Bas Valias (Morgins-Genissiat), and

   2 outgoing lines towards the North of Switzerland (Sanetsch-Muhleberg).

VISITS IN FRANCE

DISCUSSION WITH MR. DANEL

The journey from Geneva to Grenoble was covered by train. Grenoble was reached at 0.55 hours on the morning of the 20th July. As it was not possible to catch an earlier train, advance communication was given to the well-known Mr. Danel, Director of the Nyrpic Hydraulic Research Station, not to take the trouble of coming to the Railway Station at this odd hour. Reservations for stay in a hotel had already been made by him. In spite of all this both Mr. & Mrs. Danel were at the Grenoble Railway Station at that hour of the night.

The next morning, Mr. Danel and Ing Diaz Ambrona, Secretary of the National Committee of Spain, discussed with the author the possible changes in the constitution of the International Commission on Irrigation and Drainage.

After a very detailed discussion and reviewing the work done by other international bodies in connection with floods, it was concluded that it would be best if the author wrote a detailed note on the amendments and alterations required. This could then be sent in advance to the various national committees for discussion at the San Francisco Conference taking place in May 1957. The change in the name suggested by the author could then be discussed on the following day at San Francisco. The author in his note explained that no international body at present is dealing with the flood problems. Some aspects of the flood problems were being dealt with by the following international bodies :

1. Bureau of Flood Control and Water Resources Development of ECAFE.

2. International Association of Hydrology, Netherlands.
3. Permanent International Association of Navigation Congresses, Belgium.
4. International Commission on Large Dams, Paris.
5. International Commission on Irrigation and Drainage.
6. International Association for Hydraulics Research.
7. Union Internationale, De Sedours.

The author's viewpoint was explained and emphatically maintained that the flood problems were of great importance to India and to some other countries in the world and as these could not be separated from the drainage aspects there would be no point in creating another international body to deal with flood problems only. It were better if the flood problems could be included in the constitution of the International Commission on Irrigation and Drainage. This view was broadly accepted.

VISIT TO NYRPIC HYDRAULIC RESEARCH STATION

In the afternoon, a visit was arranged to the Library and the Hydraulic Laboratories. The most important feature of these laboratories is that there is a very large covered area for carrying out experiments at all times of the season on various problems dealing with hydraulic installation, correction and measurement of rivers and streams, utilisation of tidal power, harbour design, coastal protection, irrigation, drainage and water supply, hydro-agricultural layouts, hydraulic transport of solids in suspension and so on. In other respects it is felt that the magnitude and the nature of the problems being dealt with at Poona and Malakpur Research Stations in India were by no means lesser in importance. The construction of covered sheds both at Malakpur and Poona for eliminating some of the errors which inevitably enter into the observations in an open model, has been advocated by the author more than once. The construction of these covered sheds naturally has been somewhat delayed due to the non-availability of funds at both the stations.

The Library at Grenoble Research Station is indeed a thing which we need to copy at some of our important research stations. There are about 10,000 volumes of technical literature and 400,000 index cards. The indexing and reference to the various literature which appear in any corner of the world on hydraulic matters are so arranged both by author-wise as well as subject-wise that any information can be given at a very short notice. The classification system is slightly different from the universal method. The system of storage of books, their accession and procurement is really commendable. The Library has a staff of 25 officers and Prof. Danel, Director of Research is incharge of the Library also. Our Central Water and Power Commission's Library at New Delhi has been following this method but our research stations are not equipped with similar arrangements. It is needless to emphasize that for a really first class design and research office, a library stocking all the up-to-date technical literature from all countries in the world is absolutely imperative. It is equally important that important technical articles are translated into English for the ready use of engineers and research workers employed on these problems. We should particularly include such literature from German, French, Russian and Chinese languages. It is suggested and very much desired that a separate section for each of these languages in the CWPC Library should be created which should be properly manned by qualified technical translators.

GENISSIAT DAM ON RHONE IN FRANCE

Leaving Grenoble on the night of 20th July, Geneva was reached the same night. The programme was to leave Geneva after lunch on the next day. It was decided to pay a visit to Genissiat Dam that morning. This was possible mainly because of the courtesy of the Consulting Engineers who are advising on the design of Koyna Project, Bombay.

Construction of the Genissiat Dam in 1948 was almost a first step of unified development of the Rhone river, entrusted to Compagnie Nationale du Rhone set up in 1934, by a special

Act passed in 1921. Even though the preliminary work was started in 1936, the work of completing this project was protracted on account of intervention of the war and general set-back in the development programme. The Genissiat Dam is situated at a distance of 50 kilometres downstream of Geneva and has utilising and impounding capacity of 12 million cubic metres (15.7 million cu. yds.) for power development, out of a total volume of 53 million m^3 stored upto its maximum water level. The dam is 104 metres in height above the foundation and its width at crown and base is 9 and 100 metres respectively. The length of the dam at its crown between the cliffs is about 140 metres. In plan the dam is slightly curved with a curvature in horizontal plane having a radius of 500 metres (1,640 ft.). The dam is founded on sound limestone bed.

An interesting feature about this dam is regarding the spillway. There are two spillways : one at the surface in the right bank capable of discharging 2,700 cubic metres per second ; and another situated underground (Fig. 30) which can discharge 1,300 cubic metres (45,911 cu. ft) per second. This also acts as scouring sluice at the foot of the dam. This underground sluice with another tunnel was used as a diversion tunnel while the dam was under construction.

There are 6 main intake towers of semi-cylindrical shape provided in the dam to withdraw water from the reservoir to feed the main power units through six numbers of reinforced steel penstocks, each 57 metres (187 ft.) long and 5.75 metres (18.9 ft.) in diameter, piercing through the dam. Two other intake towers for the auxiliary groups have also been built.

The Power House is situated at the foot of the dam. It is 143 metres (469 ft.) in length and 50 metres (164 ft.) in height from the bottom of the turbine diffusers up to the ceiling. The alternator room is 23 metres (75.5 ft.) high and 23 metres (75.5 ft.) wide.

The total quantity of excavation involved for the dam and appurtenant works amount to 6,50,000 cubic metres (8,50,200 cu. yds.), the total concrete work turned out came to 6,75,000 cubic metres (8,82,900 cu. yds.) of which 35,000 cubic metres

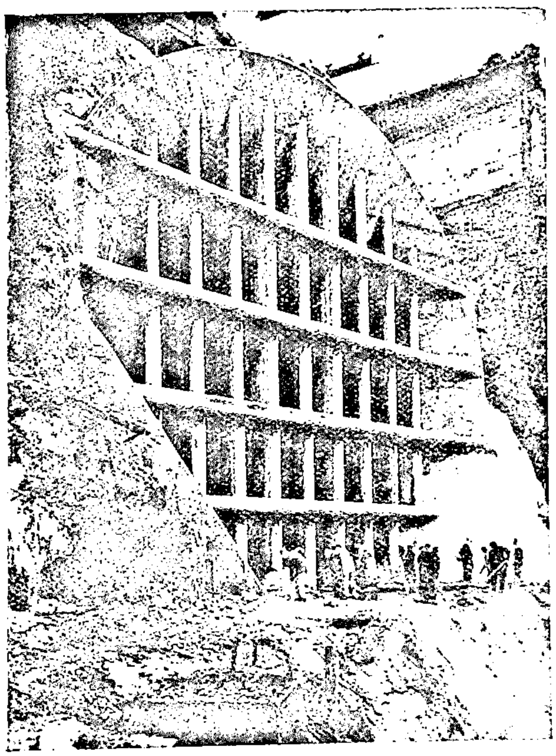


Fig. 30 — Underground sluice tunnel outlet — Genissiat Project

(45,780 cu. yds.) formed reinforced concrete work consuming 195,000 tons of cement and 9,200 tons of steel.

Power House Equipment

Provision has been made in Genissiat Power Station for 6 sets of machines of which 5 are already in service.

The characteristics of the electrical equipment are as under :

Generating Plant

(*a*) *Turbines* : There are five turbines of 1,00,000 h.p. each operating under a maximum head of 69 metres (226 feet).

Rated capacity of a turbine under a head of 64.50 metres (211 feet) and for a discharge of 120 m³/sec. (4,237 cubic feet per sec.) is 90,000 h. p.

Efficiency at that rating	...	92 per cent.
Vertical axis Francis type :		
Normal Speed	...	150 r.p.m.
Runaway speed	...	300 r.p.m.
Turbine rotor :		
Diameter	...	4.20 metres (13.78 feet).
Weight	..	35 met. tons (38.6 short tons).
Steel sheet scroll cases; Weight :	...	200 met. tons (220 short tons each).
Hollow shaft of forged carbon steel :		
Outside diameter	...	850 mm. (33.5 ins.).
Inside diameter	...	220 mm. (8.65 ins.).

The shaft is divided into two parts. Its overall length is 10.40 metres (34 feet) and its total weight 60 met. tons (66 short tons).

Hydraulic thrust	...	280 met. tons (308 short tons).
Total weight of turbine	...	600 met. tons (661 short tons).

Butterfly stop valve inside diameter 5.20 metres (17 feet) with 3 oil-operated servomotors.

Total weight of the valve	...	200 met. tons (220 short tons).

Regulators : Each turbine is governor-controlled by means of two servomotors.

Quantity of oil necessary to supply the guide-bearing, the speed regulator and the butterfly valve control	10,000 litres (2,640 U.S. Gallons).
Total weight of complete turbine in working order, with its valve and accessories	975 met. tons (1,075 short tons).

(*b*) *Generators* : Three-phase alternators — Vertical-axis — Thrust bearings at the upper part of the rotor.

Rated capacity each ...	65 mW (70 mVA at 0.93 p.f.).
Nominal voltage between phases ...	15 kV.
Voltage fluctuation ...	5 per cent.
Frequency ...	50 c/s.
(*c*) *Rotor* : Forged steel shaft ...	34 met. tons (37.5 short tons).
Spinder and cross-bar ...	27 met. tons (30 short tons).
Rotor diameter ...	7 metres (23 feet).
Total weight of rotor without exciter ...	400 met. tons (441 short tons).

(*d*) *Brakes* : 16 pads with asbestos compound faced shoes. Oil pressure operated lifting jacks.

(*e*) *Stator* : Star-connected windings with 9 terminals. Each phase divided into two parallel windings. Rolled steel frame divided into four sections. Magnetic circuit in special silicon steel laminations.

Outside diameter ...	11.50 metres (37.7 feet).
Weight of frame ...	55 met. tons (62 short tons).
Weight of copper windings ...	18 met. tons (20 short tons).
Weight of laminations ...	96 met. tons (106 short tons).
Total weight of stator ...	310 met. tons (342 short tons).

(*f*) *Main Exciter* : Continuous service : 350 kW, 250 volts, 1,380 amperes.

Maximum output	...	1,125 kW
Weight of fixed parts	...	24 met. tons (26 short tons).
Weight of moving parts	...	10 met. tons (11 short tons).

(g) *Pilot Exciter* : Continuous service : 5 kW — 250 volts.

Total weight of generator with accessories	...	750 met. tons (826 short tons).

Main Transformers

(h) *Five three-phase Transformers*

Rating	...	70 mVA, 50 c/s.
Voltage	...	15/220 kV.

Natural self-cooling up to 50 per cent load — Forced air cooling above that.

Overall dimensions : Length	...	8 metres (26.2 feet).
Breadth	...	6 metres (19.7 feet).
Height (without terminals)	...	5 metres (16.4 feet).
Height (with terminals)	...	8 metres (26.2 feet).
Weight of oil	...	50 met. tons (55 short tons).
Total weight of transformer	...	212 met. tons (234 short tons).

When this project was completed, the French regarded this as an achievement in the field of hydro-power generation.

CONCLUSION

One thing most impressive observed during this tour was the miraculous economic recovery that West Germany has achieved in such a short time after the ravages of the Second World War.

Unlike India, Germany's has been essentially an industrial economy. The last war gave a terrible blow to its industry. The productive capacity of the country immediately after the cessation of the hostilities had stood stand-still when the German currency completely disintegrated. From 1948 onwards Germany began to earn good trade and the industrial production went up as high as 30 per cent above the pre-war level with the result that the trade balance which was deficit in 1941 today shows a tangible surplus (Fig. 31). There is increased

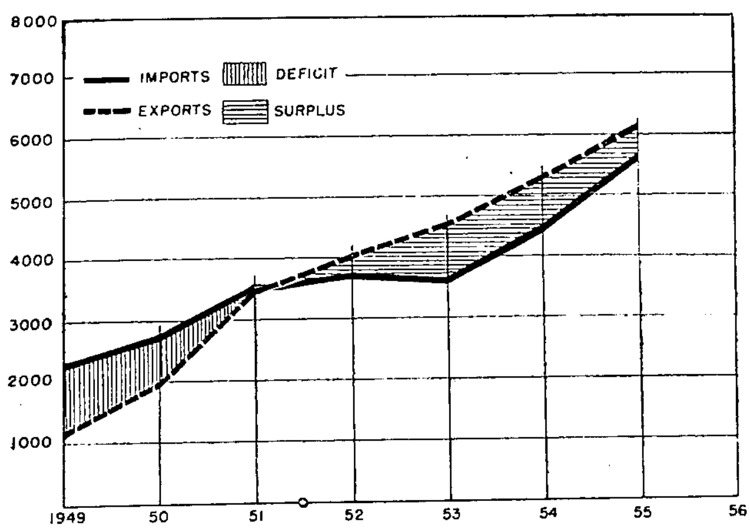


Fig. 31 — Trade Balance in Million Dollars.

employment and increased production in the country which has brought better standard of living to the people. The structure of the Supervisory Boards has changed considerably since the end of the war, and they recognise the interests of labour almost on equal footing with those of the shareholders. The workers, while they have achieved the right of co-determination equally share their responsibility that goes with it.

What is the secret of this economic miracle ? When this question was put to various people in various levels, from the highest to the lowest, the reply was surprisingly the same. It was the voluntary and willing work put in by the Germans for the nation. An incredible amount of National wealth had been destroyed by the war, and it appeared almost beyond the capacity of the man to make the recovery possible in one or two generations. Millions of hands and heads took up the work to clear huge piles of war ruins. More houses and factories were built within a few years than in any other European country, and the industrial production increased three-fold within six years. The firm resolve of the working people and the factory owners to reconstruct the war-torn economy, and the firm will of every individual to join in this remodelling of the House of the nation, is all a part of what may be considered today as the miracle.

Another important factor which may not be possible to be evaluated statistically is that the people concerned are contented and well adjusted to their environments. It was said that after working for wages in factories, the workers put in an extra two or three hours of free labour in reconstructing their broken factory and rebuilding their homes. This in fact is true *Shramdan*.

It is a genuine wish and a fond hope that the same dynamic spirit would actuate the millions of our countrymen for the successful accomplishment of the country's second and subsequent Plans.

APPENDIX I

Itinerary of Shri Kanwar Sain, ISE, Chairman, Central Water & Power Commission during his recent trip to Europe [redacted]

July 1956

7 Leave Delhi — 19 30 hrs. by Air India International.

8 Arrive Munich — 16.35 ,,

9 to 14 — Attended the Technical Committee meetings of the International Standards Organisation at Munich. Visited Headquarters of Siemens Factories at Erlangon and the Transformer Factory at Nurnburg.

14 Leave Munich — 8.00 hrs. by Hansa Airways.

Arrive Frankfurt — 10.00 ,,

Visited the M.A.N. Laboratory at Gustavsburg.

Leave Weis-Baden — 15.30 hrs. by Train.

Arrive Bonn — 18.00 ,,

15 Attended Reception at Petersburg at 9.00 a.m.

10.30 to 1.00 p.m. Discussions with Mr. B.D.A. Birkendahl and Mr. Twiehaies, Ministerial in the Federal Ministry of Transport, Bonn.

Leave Bonn — 17.30 hrs. by S.K. 622

Arrive Hanover — 18.55 ,,

July 1956

16 Contacted Mr. F. Widmann and Pfisterer and visited Oker and Eker dams (by auto).

Leave Hanover	18.40 hrs. by K.L. 210
Arrive Amsterdam	20.50 ,,
Drive Amsterdam to Hague	By auto.

17 Visited Rotterdam by Launch on the Rhine.

Returned to Rotterdam by auto and contacted the following :

Professor P. Ph. Jansen, Director (Designate) of Delta Bureau ;

Mr. J. W. De Vries, Director of Lower Rivers ;

Mr. E. M. H. Schaank, Director of Upper Rivers ; and

Mr. R. Tutein Nelthenius, NEDECO.

18 Visited the Zuider Zee Dykes by auto.

Leave Amsterdam	14.10 hrs. by K.L. 385
Arrive Geneva	17.30 ,,

Proceeded to Sion by auto, stopped for the night.

19 Accompanied by Mr. Bolens, Director, Society General for Industry, visited Grand Dixence and Mauvoisin Dams and returned to Geneva by 20.20 hrs. by auto.

Leave Geneva	21.00 hrs. by train.
Arrive Grenoble	Midnight.

July 1956

20	Attended meeting of the International Congress on Irrigation & Drainage in Mr. Danel's room and visited the Hydraulic Laboratory.	
	Leave Grenoble	18.39 hrs.
	Arrive Geneva	20.51 ,,
21	Leave Geneva	09.00 hrs. by auto.
	Visited Genissiat Dam and Power House in France.	
	Arrive Geneva	13.00 hrs.
	Leave Geneva	16.20 hrs. by A.I.I.—110
22	Arrive Bombay	16.20 ,,

APPENDIX II

Pay Scales — Key Chart

Group		*Age*		*Per cent of Basic Pay*
1	Till	15	years.	25
	After	15	,,	30
	,,	17	,,	45
	,,	18	,,	55
	,,	19	,,	60
	,,	20	,,	75
	,,	23	,,	80
	,,	26	,,	90
	,,	30	,,	100
2a	Till	17	,,	45
	After	17	,,	50
	,,	18	,,	65
	,,	19	,,	70
2	Till	18	,,	60
	After	18	,,	70
	,,	19	,,	80
	,,	20	,,	90
	,,	23	,,	100 (Basic wage)
	,,	26	,,	110
	,,	30	,,	120
3	Till	23	,,	110
	After	23	,,	120
	,,	26	,,	135
	,,	30	,,	150
4	After	23	,,	130
	,,	26	,,	150
	,,	30	,,	175
5	After	26	,,	175
	,,	30	,,	200
6	After	30	,,	230

The basic wage is dependent upon the cost of living index and the locality (At Gustavsburg the present basic wage is DM 329).

APPENDIX III

Technical Magazines in German

(Technical Zeitschriften)

	Title	Publisher	Published	Price
1.	The Structural Engineer (Der Bauingenieur).	Springer-Verlag/Berlin.	Monthly (monatlich)	DM 3,——
2.	The Structural Technique (Die Bautechnik).	Wilhelm Ernst & Sohn Berlin-Wilmersdorf.	,,	DM 4,——
3.	Austrian Structural Journal (Osterr. Bauzeitschrift).	Springer-Verlag/Wien.	,,	DM 2,33
4.	Austrian Water Management Regulation (Osterr. Wasserwirtschaft).	Springer-Verlag/Wien.	,,	DM 2,33
5.	Swiss Structural Journal (Schweizer. Bauzeitung).	S. Jegher & A. Ostertag Zurich, Dianastr.	Weekly (wochentlich) je	DM 1,64
6.	The Steel Construction Structure (Der Stahlbau).	Wilhelm Ernst & Sohn.	Monthly (monatlich)	DM 2,50
7.	Water & Power Management/Regulation (Wasser-und Energiewirtschaft).	Elektrowirtschaft Zurich I, Postfach.	,, je	DM 1,67
8.	Water Management Regulation (Wasserwirtschaft).	Frank'sche Verlagsbuchhandlung-stuttgart.	,,	DM 2,——
9	VDI (German Engineering Publications) News (VDI Nachrichten).	Deutscher Ingenieur-Verlag, Dusseldorf.	Bi-weekly (14 Tagig)	DM 3,10 (Quarterly Subscription).
10.	Conveying & Elevating (Fordern U. Heben).	Verlag fur wirtschaftschrifflum Otto K. Kransskopt Wiesbaden Balmhofstr 61.	Monthly Ea.	DM 2,——

Note :– Magazines Nos. 1, 2, 7, 10, 13 and 14 are published in West Germany Nos. 4 & 5 in Austria and Nos. 6 & 9 in Switzerland. All are, however, in German language and are the official organs of the various expert bodies of the countries concerned. These deal with the latest construction techniques and methods and developments, and are mainly concerned with water rights, water power, water utilization, hydraulic steel structures, inland navigation and general engineering development.

APPENDIX IV

List of Reference Books in German Language on Structural and Mechanical Engineering

1.	Stabl in Hocbbau (Steel structures) 12th Edition (1953)	Apringer Verlag Berlin.	DM 40
2.	Taschenbuch fur Maschinenbau. (Mech. Engg. Handbook)	Do.	DM 37,50
	Band I & II by Prof. Dubbel	11th Edition (1953)	
3.	Hebezeuge Band I, II, III by Prof. Dr. Ernst (Lifting & Handling Dbics).	Do.	DM 113,35

APPENDIX V

List of Various German Standards for Steel Structures and Hydraulic Steel Structures

1. DIN 1050 — Basis of calculation for Steel in Superstructure.

2. Publication No. 3006 — 1933 or its equivalent (Latest Edition) — German Standards for Materials — Steel and Iron.

3. DIN 4100 — Specifications for welded steel structures.

4. DIN 1000 — General conditions of contract for the supply of steel structures.

5. DIN 120 — Basis of calculations of hydraulic steel construction of cranes and crane track.

6. Draft rules for the calculations of hydraulic steel structures.

7. Specifications of hydraulic steel structures for design, fabrication and supply — compiled by Rhem Main Donar A.G.

APPENDIX V — *Contd.*

Harbour Basins	Length		Width		Depth at M.L.T.		Water Area		
	m.	ft.	m.	ft.	m.	ft.	ha.	acres	Square yards
Parkhaven	525	1720	125	410	6.00	20	6.50	16	240
St. Jobshaven	350	1150	115	380	8.00	26	3.50	8	2900
Schiehaven	550	1800	120	395	9.00	30	6.50	16	240
IJselhaven	525	1720	120	395	10.00	33	6.00	14	3870
Lekhaven	785	2585	120	395	10.00	33	9.00	22	970
Keilehaven	900	2950	70	230	4.0	13	7.50	18	2420
Merwehaven I	1250	4100	135	440	10.00	33*			
Merweh ven II	750	2460	120	395	10.00	33	37.00	91	1935
Merwehaven III	450	1375	115	380	8.00	26			
Binnenhaven	1000	3280	70	230	6.00	20	7.00	17	1450
Entrepothaven	220	720	60	195	6.00	20	1.50	3	3390
Spoorweghaven	1200	3935	105	345	7.00	23	13.00	32	485
Rijnhaven	1100	3600	140	460	8.00	26	28.00	69	970
			400	1300	9.00	30			

1e Katendrhaven	200	660	105	345	7.35	24	2.00	4	4550
2e Katendrhaven	250	820	120	395	7.35	24	3.00	7	1935
Maashaven	1900	6230	325	1070	9.00	30	60.00	148	970
Waalhaven	2460	8070			10.00	33	300.00	741	—
Eemhaven	1500	4920	100	330	3.35 5.35	11 17	15.00	37	240
2e Petroleumahaven	2600	8530	200 240	600 790	11.00	36	55.00	135	4115
1e Petroleumahaven	2350	7700	200 240	660 790	11.00	36	55.00	123	2420

* The depth can be brought up to 40 ft.

APPENDIX VI

Facilities of the Port of Rotterdam

Harbour Conditions

Entrance.

Nieuwe Waterweg ("New Waterway"), length 16 miles, depth 36 ft. at low tide.

Connection with the Hinterland

The natural estuary of Rhine and Meuse, in open communication with the Rhine and its connecting waterway system.

Harbour Basins

For sea-going vessels: area 1200 acres, general depth of water 26 — 33 ft. at low tide; in the first basin of the Merwehaven the depth can be brought up to 40 ft. at low tide. The depth in the Petroleum harbour basins is 36 ft.

Tide

Ordinary tide 5½ ft., spring tide 6 ft.

Weather

Annual rainfall 27 inches. No special rainy season. Harbour is ice-free.

Berthing Accommodation

Ship size.

No length limitations to anchorage at berths.

Loading and Discharging Berths

167 sea-going vessels alongside quays, total length of quays for sea-going vessels 21.350 yards. 85 sea-going vessels on buoys and dolphins.

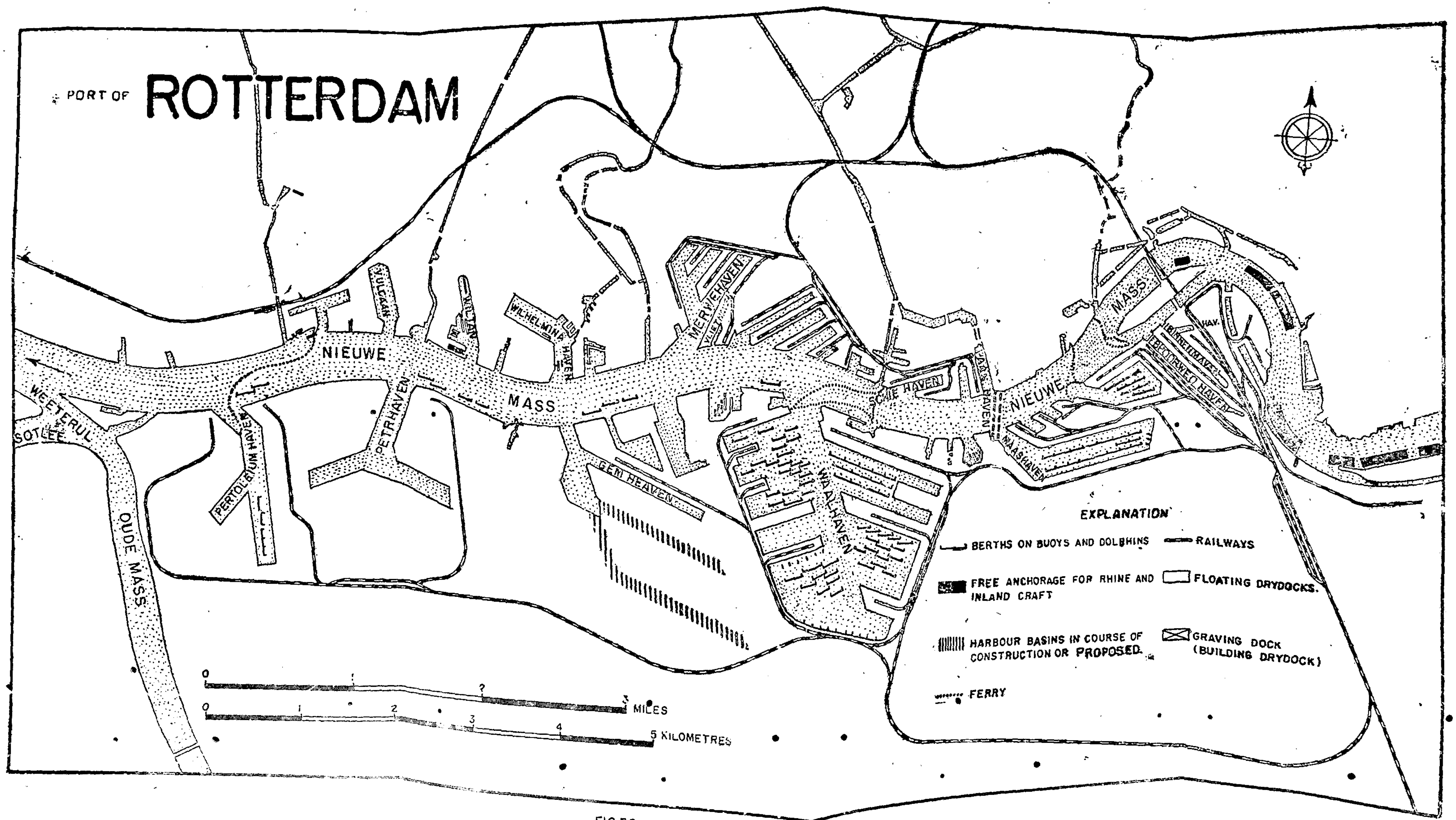


FIG.32 — PORT OF ROTTER-DAM.

P680

Specified as follows :

	Petroleum berths	Berths alongside quays (mainly general cargo)	Berths on buoys and dolphins (mainly bulk cargo)
Ship's length over 460 ft.			
Depth of water over 30 ft.	23	94	40
Depth of water from 24 — 30 ft.	—	18	24
Ship's length under 460 ft.			
Depth of water over 30 ft.	—	12	7
Depth of water from 24 — 30 ft.	—	9	5
Depth of water under 24 ft.	—	11	—

Loading Bridges

2, lifting capacity 8 tons.
3, ,, ,, 10 tons.
4, ,, ,, 12½ tons.
6, ,, ,, 15 tons.
2, ,, ,, 16 tons.

17

Floating Cranes

14, lifting capacity 3 tons, radius 100 — 115 ft.
18, ,, ,, 3 tons.
8, ,, ,, 5 tons.
18, ,, ,, 8 tons.
8, ,, ,, 10 tons, radius 10S — 121 ft.
15, ,, ,, 10 tons.
3, ,, ,, 12½ tons.
2, ,, ,, 17½ tons.

86, of which 62 floating grab cranes for bulk cargo (coal, ore phosphate, etc.)

Floating Cranes for Heavy Loads

18,	lifting	capacity	10 — 40 tons.
5,	,,	,,	55 — 70 tons.
7,	,,	,,	80 — 140 tons.
4,	,,	,,	200 — 250 tons.
34			

Cranes on Quays

55,	lifting	capacity	up	to	3 tons.
209,	,,	,,	,,	,,	5 tons.
14,	,,	,,	,,	,,	8 tons.
5,	,,	,,	,,	,,	10 tons.
4,	,,	,,	,,	,,	15 tons.
3,	,,	,,	,,	,,	20 tons.
290.					

167 of which (level luffing cranes) with a radius of 100 to 125 ft.

Discharging and Loading Capacity for Bulk Cargo

100,000 tons/24 hours.

Other Port Equipment

Grain elevators.

24 floating grain elevators with a capacity of 125 — 250 tons/hour.

9 elevators on quays.

Mobile Equipment

270 platform-trucks, 20 tractors, 160 fork-lift trucks, 60 mobile cranes, 20 remaining mobile equipment.

Bunkering

2 floating transporters with a capacity of 350 tons/hour.

Tugs

160 tugs of 75 — 600 I.H.P.

18 sea-going tugs up to 4200 I.H.P. for the towage of dry-docks, dredging plants, floating cranes and for salvage of ships.

Petroleum Harbour Basins

Location.

12 miles from North Sea.

Connecting industrial area.

1250 acres.

Berthing Accommodation

23 berths connected with tankpark by pipe lines.

Refinery Installations

The refineries are equipped with cracking plants in addition to installations for the manufacture of synthetic soap and raw materials for the "plastics" industries.

Storage

Sheds and warehouses

Floor space	...	53,83,000 sq. ft.
Fruit storages	...	2,97,000 sq. ft.
Three cold storages	...	1,86,000 sq. ft.
		58,65,000 sq. ft.

Capacity fruit storages 35,30,000 cu. ft., capacity of the three cold storages 17,65,000 cu. ft.

Granaries

6 granaries, capacity 1,80,000 tons.

Open Area

39,00,000.

Tanks

Mineral oils : storage capacity 39,50,000 tons.

Edible oils : storage capacity 4,13,000 tons.

Ship-building and Marine Repair

8 shipyards with several foundries and machine shops.

Floating Drydocks

10,	lifting	power	up	to	6,000	tons
2,	,,	,,	,,	,,	8,000	,,
1,	,,	,,	,,	,,	10,500	,,
3,	,,	,,	,,	,,	15,000	,,
2,	,,	,,	,,	,,	20,000	,,
1,	,,	,,	,,	,,	32,000	,,
1,	,,	,,	,,	,,	46,000	,,
20						

Graving Dock

1 graving dock 'building drydock' with 2 berths of 650 ft. length each.

1 graving dock with 2 berths long 690 ft.

Slipways

32 patent slipways and 5 side slipways with travelling cranes.

Ship Supplies

Dock and engine.

Any quantity.

Provisions

Meat, fresh fruits, vegetables and cold storage provisions available.

Water

Drinking water and boiler water available, supplied by waterboats and pipe lines on wharf.

Fuel

Normally available :

Coal	...	...	1,00,000 tons.
Oil	...	...	1,00,000 tons.

Ballast

Gravel and sand available.

Rhine and Inland Transport

Harbour basins

Area for inland craft 320 acres ; general depth of water 13 ft. at low tide.

Loading and Discharging Berths

Total length of quays for inland craft : 13,775 yards.

Hinterland

The Rhine and connecting waterway-system :

		for Rhine barges to
Navigable to Duisburg	...	3000 tons loading cap.
Navigable to Strassburg	...	2000 tons loading cap.
Navigable to Basle	...	1200 tons loading cap.
Main to Frankfurt	...	3000 tons loading cap.
Navigable to Wurzhurg	...	1500 tons loading cap.
Neckar to Stuttgart	...	1200 tons loading cap.
Neckar to Mittelland canal	...	1000 tons loading cap.

Inland Craft

Annually Rotterdam was visited by more than 2,00,000 Rhine and inland crafts, total tonnage 4,00,00,000.

Largest barge has a loading capacity of 4200 tons.

Railroad and Motor Transport

Railroad

All quays and wharves on both banks of the river are connected with the national and international railroad system.

Total track-mileage in the port : 160.

Handling capacity : 1000 vans/day.

Road Transport

Road motor transport services to all principal centres of Central and Western Europe.

Custom House

A special system of custom house facilities renders Rotterdam "freer than a free port".

General Data of the Town

Population

Rotterdam, in the metropolitan area of the Western Netherlands, has 7,20,000 inhabitants and within 30 miles' radius a population of 30,00,000 (nearly 1/3 of the total population of the Netherlands).

Industry

Metal industry :

Shipyards,
engineering works,
boiler works,
the making of railway material,
motorcar-assembling plant.

Chemical industry :

Rock-oil refineries,
manufacture of artificial manures,
manufacture of plastics,
manufacture of soap.

Feeding and luxury industry :

Grain production industry,
coffee, tea, cocoa, tobacco factories,
brewery industry,
distilleries.

Electrotechnical industry.

Clothing industry.

Packing industry :

Paper and cardboard works,
box-making.

Figures of the Reconstruction of the Port of Rotterdam

	10-5-40	5-5-45	31-12-46	31-12-47	31-12-48	31-12-49	15-12-52	31-8-54	1-4-56
Quays for sea-going vessels (Total length in kilometres, 1 kilometre = 1093.6 yards)	18.6	11.3	12.1	13.5	16.86	18.5	18.75	19.3	19.54
Quays for inland craft (Total length in kilometres, 1 kilometre = 1093.6 yards)	16.7	10.8	10.8	10.8	12.5	12.5	13.35	13.35	13.35
Cranes on quays	254	157	170	174	187	205	260	270	290
Loading bridges	28	2	2	2	10	11	13	15	17
Floating cranes	80	45	65	70	75	76	85	86	86
Floating grain elevators	26	28	27	26	26	26	26	24	24
Sheds and warehouses alongside the port basins (floor-space in square metres, 1 sq. metre = 1,196 square yards).	550,000	350,000	365,000	370,000	390,000	450,000	500,000	503,000	545,200*
Granaries (Storage capacity in metric tons)	125,000	125,000	125,000	125,000	125,000	125,000	150,000	180,000	180,000
Tanks for mineral oils (Storage capacity in metric tons) †	900,000		730,000	900,000	1,000,000	1,000,000	2,000,000	3,000,000	3,950,000
Tanks for edible oils (Storage capacity in metric tons) †	270,000	30,000	220,000	250,000	260,000	270,000	280,000	300,000	413,000
Floating dry docks †	16	3	15	16	17	20	20	20	20

† In/at/a/in Rotterdam, Schiedam, Vlaardingen.

* Included cold and fruit storages.

APPENDIX VII

Comparative Cost Estimates of Reclamation of South Salt Lake Area

(Prepared by NEDECO and the Master Plan Committee)

	Particulars	South Salt Lake	
		As prepared by NEDECO (1953 — 54)	As prepared by Master Plan Technical Committee (1950 — 51)
1.	Area pumped	13 sq. miles	15 sq. miles
2.	Area benefited	13 sq. miles	15 sq. miles
3.	Discharge (pumping capacity)	450 cu./secs.	304 cu./secs.
4.	Length of canals :		
	(a) Main	4 miles	4½ miles
	(b) Branch	19 miles	5 miles
5.	Ground levels	+2.00 to +10.00 (P.W.D.)	+2.00 to +10.00 (P.W.D.)
6.	Number of pumps	3 Nos. @ 150 cu./secs. each.	2 nos. @ 125 cu./secs. each. 2 nos. @ 75 cu./secs. each.
7.	Pump head (Maximum)	15 ft.	15 ft.
8.	Cost	Rs. 73 lakhs	Rs. 37.73 lakhs
9.	Reclamation cost per acre	Rs. 877	Rs. 393
10.	Cost of maintenance per acre	Rs. 9.7	Rs. 9
11.	Embankments	All round	Nil

Note — Rupees 6 lakhs have been paid to NEDECO as consultation fee for preparing this scheme for the Government of Bengal.

APPENDIX VIII

Salient Features of the

Sonarpur-Arapanch-Drainage Scheme (Part I)

Extended by the Government of West Bengal (1954)

Location and Area

Drainage area	...	Sonarpur-Arapanch area in Sonarpur and Baruipur Police Station, District 24 Parganas.
Pumping station	...	At Uttarbhag on the right bank of the river Peali in P. S. Baruipur, District 24 Parganas, about 25 miles away from Government House, Calcutta.
Basin area	...	57 sq. miles — This was under 6-7 feet of water permanently (Additional area benefited is about 8 sq. miles south of Canning road).
Area benefited	...	36½ sq. miles

Drainage Channel System

Main channel	...	Length nearly 9 miles. Designed capacity at the tail-end — 1,258 cusec.
Branch channels	...	Length nearly 16 miles. Designed capacities varying from 24 cusec to 409 cusec.

Electric Pumping Sets

Number of pumping sets	...	4 Nos., 250 each.
Total pumping capacity	...	1000 cusec or 3,75,000 gallons per minute.
Pump	...	Vertical M. A. N. Propeller Pumps with impeller shaft and distributor withdrawable from the top.

Output per pump	...	250 cusec or 93,750 gallons per minute.
Net pressure head	...	15 ft.
Total pressure head	...	17 ft.
Manometric efficiency	...	88%
Speed of pump shaft	...	295 R.P.M.
Size of delivery pipe	...	5′-3″ to 8′-0″ dia.
Power required at motor shaft	...	570 (B.H.P.)
Motor output provided	...	630 (B.H.P.)
Actual working speed of motor shaft	...	985 R.P.M.
Motor	...	Siemens slip ring, three-phase induction ventilated type, vertical, coupled to the pump-shaft through oil-cooled reduction gear.
Motor voltage	...	6,000
Switchgear	...	A.E.C. High Tension, metal clad dust-tight operated on 6 kV 3 phase cycles per second.
Reflux valve	...	Butterfly, self-closing, 63″ dia.

Transmission Line

Underground	...	One mile at 6 kV, from Calcutta Electric Supply Corporation, Tollygunge Sub-station to State Sub-station at Bansdhani.
Overhead	...	19 miles at 33 kV, from Bansdhani to Uttarbhag *via* Garia, Sonarpur and Baruipur.
Sub-station		Parson's make transformed oil immersed naturally cooled step-up transformer 6/33 kV., 30C0 kVA complete with off-load tap changing switch.

Parson's make transformer oil immersed naturally cooled step-down transformer 33/6 kVA complete with automatic on-load tap changing switch.

Inlet and Delivery Channels

Bed level of inlet channel at the Pump House ...	R.L. 6.00 P.W.D.
Bed level of delivery channel at the Pump House ...	R.L. 6.00 P.W.D.
Sump level of Pump Chamber ...	R.L. 8.00 P.W.D.

Pump House

Foundation bed level ...	R.L. 12.17 P.W.D.
Foundation details ...	R.C. raft supported on 20 ft. (av.) Sal piles with a grillage consisting of two tiers of 90 lbs. rails embedded in concrete as an additional precaution.
Capital cost of the scheme ...	55.0 lakhs.
Cost of the pumps ...	14.0 lakhs.
Maintenance cost (annual) including cost of electricity ...	1.50 lakhs excluding interest.
Maintenance cost per acre ...	Rs. 6/4/- (approx.) per acre per year.
Capital cost of reclamation per acre ...	Rs. 235 per acre } Against Rs. 2000 per acre in Holland.

CONVERSION TABLE
for
METRIC - BRITISH - UNITS

1 million cu. m.	= 810 acre ft.
1 kg./sq. cm.	= 14.223 lbs./sq. in.
1 kg./cu. m.	= 1.69 lbs./cu. yd.
	=0.0625 lbs./cu. ft.
1 cu. m.	=1.308 cu. yds.
	=35.316 cu. ft.
1 cm.	=0.393 in.
1 metre	=3.281 ft.
	=1.094 yds.
1 mm.	=0.039372 in.
1 kilometre	=0.622 mile.
1 sq. cm.	=0.155 sq. in.
1 sq. metre	=10.764 sq. ft.
	=1.196 sq. yds.
1 cu. cm.	=0.061 cu. in.
1 litre	=0.035 cu. ft.
	=0.22 imp. gallon.
1 kg.	=2.205 lbs.

ERRATA

Page	*Line*	*For*	*Read*
25	10	dearly	clearly
26	23	are such as requiring	require
27	17	such an important	such important
	18	purviews	purview
42	8	Hoppen	Hopper
69	8	Erlangon	Erlangen
	8	Nurnburg	Nuremberg
72	Heading Line	Pay Scales	Pay Scales in Germany
	under 'group'	1, 2a, 2, 3 4, 5, 6	I, II, IIa, III, IV, V, VI
78	Heading Line	Facilities of the Port	Facilities at the Port
86	Footnote	In/at/a/in	In/at/&/in