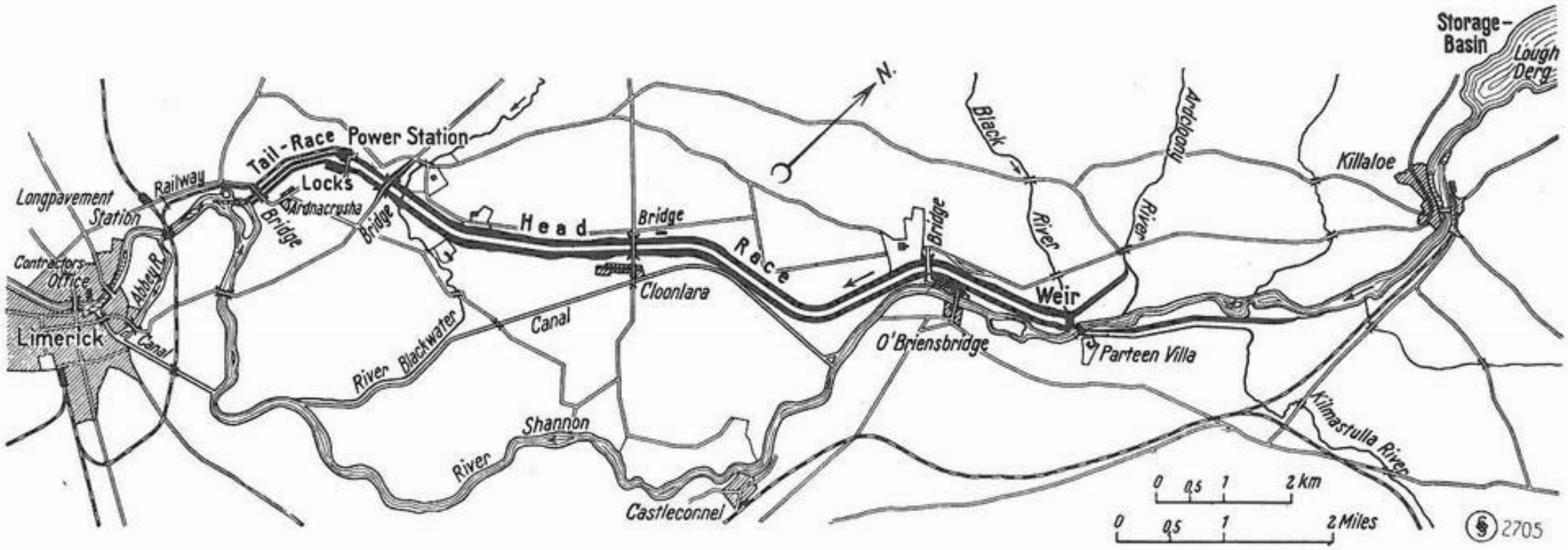


Plan of the Shannon Scheme, 1925-1929.

Ardnacrusha—Birthplace of the E.S.B.

PAUL DUFFY*

The first part of this article deals very briefly with the background to the decision to build the Shannon Power Scheme and the creation of the E.S.B. The second part deals, at some length, with the actual construction work undertaken on the scheme. Footnotes have been avoided, for the sake of simplicity, in this latter section but all references consulted in its preparation are listed in the Bibliography at the end of the article.

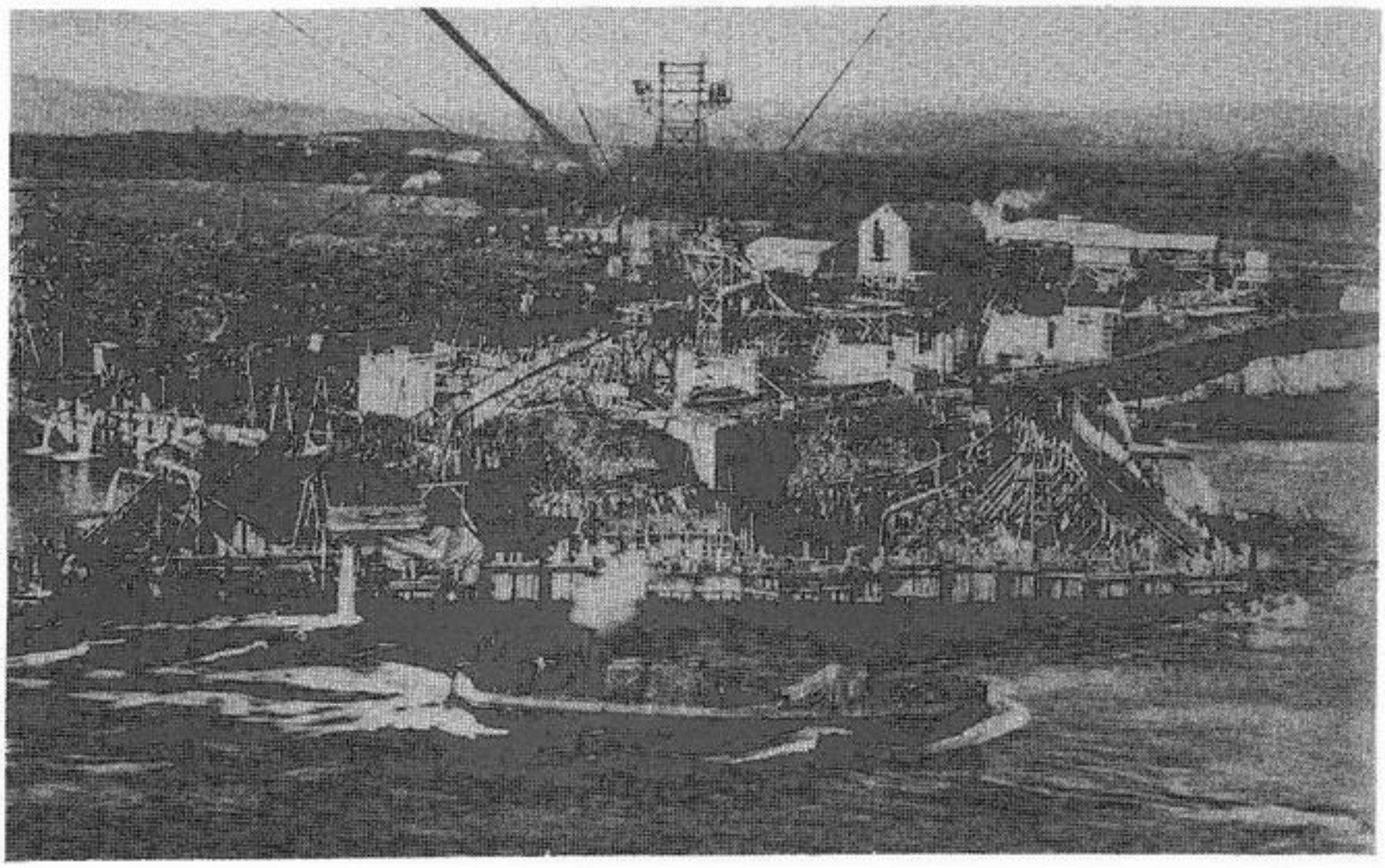
* * * *

In 1844, Robert, later Sir Robert Kane,[1] published his monumental work entitled *The Industrial Resources of Ireland.*[2] In this work Kane assessed the available water power of the Shannon between Killaloe and Limerick at 350 horse power per foot of fall. Based on a 97 feet fall in the river between these two locations, the available power was 33,950 horse-power.[3] It must be borne in mind that the science of hydrology was in its infancy and that these figures were based on only three years' observations of the flow of the Shannon at Killaloe. The catastrophe of the potato blight (1845-1847) pushed Kane's work into the background and, indeed, it was not until 1875 and the 'coal famine' in England that serious technical consideration seems to have been given to Kane's observations on the water power resources of Ireland. In that year an anonymous article was published in *The Engineer*[4] which postulated that, using less than half the available fall in the Shannon between Killaloe and Limerick, it was possible to create a water power source generating 14,000 horse power. By the end of the century, the Frazer scheme to build a hydro-electric scheme on the lower Shannon was being mooted. Essentially, Frazer's proposals consisted of a plan to direct the waters of the Shannon into a head-race canal to a location near Doonass where a single fall would be created and a power station built; a tail-race canal would then convey the water back to the Shannon. Parliamentary powers to carry this scheme into effect were granted with the passing of the Shannon Water and Electric Power Act (1901), a private Act passed by the Imperial Parliament in London. To protect fishery interests, this Act imposed certian restrictions with regard to the amount of water which would be permitted to flow down the old river channel; the quantity of water was to vary in accordance with the seasons and the restrictions meant that, in effect, there would be no water available at certain times of the year to run the power station. Accordingly, an auxilliary steam-powered generating station would have to be installed to maintain the level of electricity to be generated. This, in effect, killed the scheme.[5]

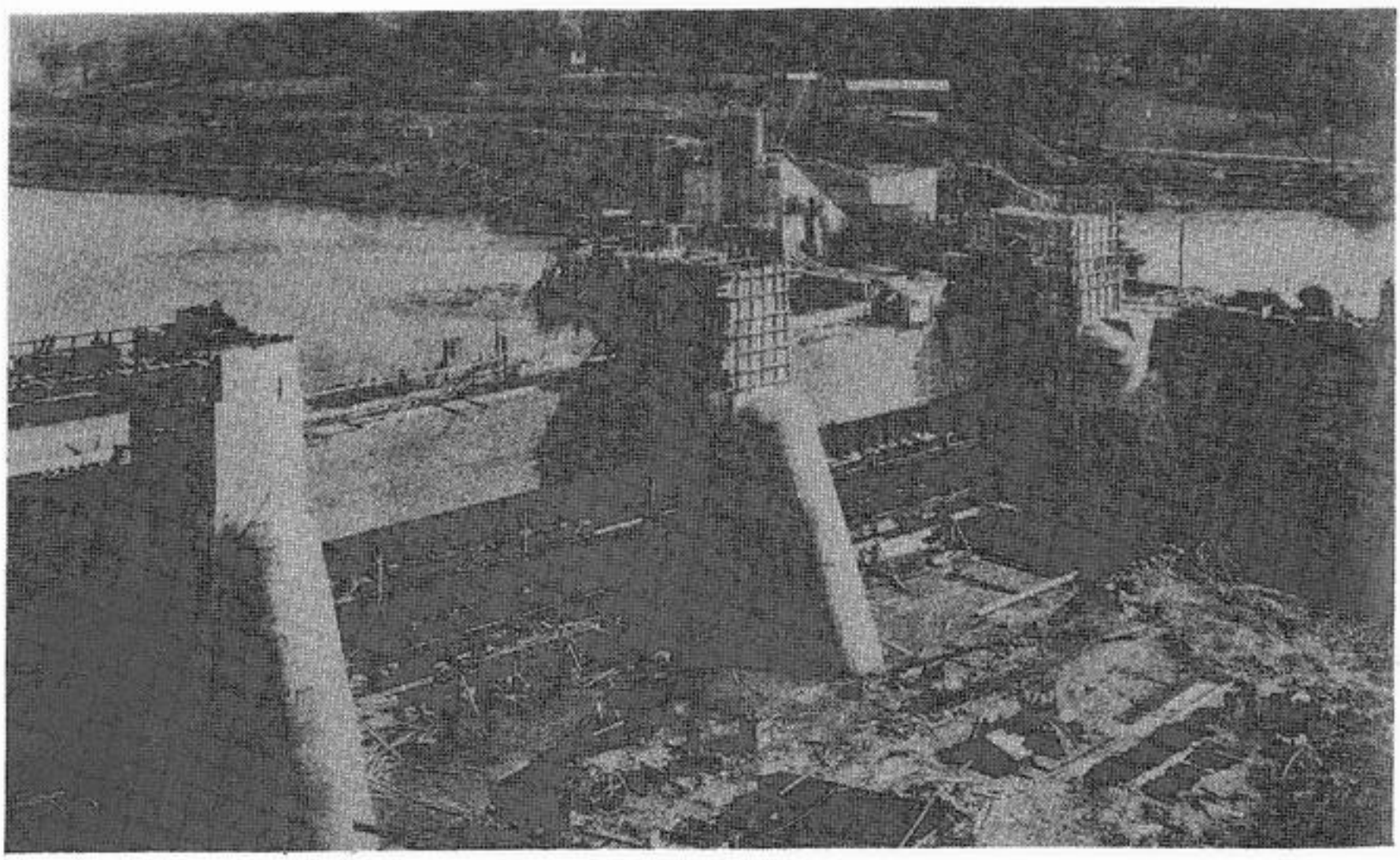
In 1902 a Mr. S. F. Dick proposed that the abrupt fall of seventeen feet at Doonass be harnessed to generate electricity.[6] Other proposals came on-stream but never advanced beyond the proposal stage. One scheme was to utilise Lough Derg as a storage reservoir for the proposed generating station. This was to be achieved by raising the weir at Killaloe

*"Cascia", Rockbarton North, Salthill, Galway.

[1]For a short but readable account of his life see D. Ó Raghallaigh, *Sir Robert Kane,* Cork 1942.
[2]Kane, Robert, M.D., *The industrial Resources of Ireland,* Dublin 1844 (2nd Edition 1845).
[3]*Ibid.,* p. 83 both editions. See also Ó Raghallaigh, *op. cit.,* p. 21.
[4]Anon., "Water in Aid of Steam Power", *The Engineer,* October 15th 1875, pp. 261-262.
[5]Griffith, Sir John Pursar, *Notes on the Siemens-Schuckert Shannon Power Scheme,* Dublin Jan. 1925, p. 11.
[6]W. Tatlow, *Trans. Inst. Civil Engineers of Ireland,* Vol. 45, p. 81.



Illus. 1. Bird's-eye view of the weir and intake under construction at Parteen Villa.



Illus. 2. The intake at Parteen Villa under construction.

by between four to five feet. The problems of consequential flooding did not seem to have been adequately thought out and the proposal came to naught.[7] The local authorities, even, got involved. Sean Wall, Commander of the East Limerick Brigade, I.R.A. was elected Chairman of Limerick County council in 1920. He insisted that the Council carry out a survey of the Shannon to see if its water power could be harnessed, but he was killed in an action with enemy forces at Annacarty, Co. Tipperary, in May, 1921, and the survey was never carried out.[8] One major problem that faced all power-scheme proposals was the lack of concrete data on water flow levels in the Shannon. This defect was rectified by T. Chaloner Smith who published the results of twenty-five years of measurements of the daily flow of water over the weir at Killaloe.[9] Because of the huge variation in flow, Smith reckoned that the 'Great Shannon Myth' (*i.e.* the large scale harnessing of the Shannon) could not, economically, become a reality, and he concluded that the storage of water in the lakes above Killaloe was impossible.[10]

In 1918 the British Board of Trade appointed a committee to enquire into the water power resources of the United Kingdom. A special Sub-Committee under the chairmanship of Sir John Pursar Griffith was set up to deal with the Irish water power resources. The report of the sub-committee entitled "The Water Power Resources of Ireland" was published in Dublin in May, 1921. Basically it came down in favour of a proposal by Theodore Stevens, to develop the Shannon in four steps between Killaloe and Limerick. Four hydro-electric stations were to be built in the river, with an installed electrical horse power of 69,500 units. The water level of Lough Derg was to be lowered by at least two feet below the navigation level; Lough Ree and the other smaller lakes were also to have their water levels lowered whilst Lough Allen was to be raised five feet. The combined effect of these alterations in lake level was to raise the storage of water in the Shannon by 10,000 million cubic feet. The cost of Stevens' proposals was put at £2,634,000. The First Dáil also set up a committee to enquire into the water power resources of the country. This report, published in 1922, summarised Stevens' proposals for the Shannon but did not endorse them.[11] The conclusion the committee came to was that "any scheme for the development of the Shannon will depend mainly on the storage which can be got, and consequently on the cost of that storage".[12] The cost of the storage would include not only the cost of any dams or weirs built to increase the water levels in the lakes but also compensation for flooded lands.

At about this point in time Dr. Thomas A. MacLoughlin enters the scene. MacLoughlin graduated with a B.Sc. Degree from U.C.D. in 1916 and was awarded an M.Sc. Degree in 1918. He was appointed an Assistant Lecturer in Physics in University College, Galway. Whilst there he obtained a B.E. Degree (First Class) in 1922 and was awarded a Ph.D. Degree by that college in 1923. Tradition has it that, whilst at Galway, MacLoughlin was greatly influenced by Professor J. F. Rishworth who held the chair of Civil Engineering there. It is generally accepted, in Galway, that Rishworth instilled in MacLoughlin the idea

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[7]J. O. Moynan, *ibid.*, p. 85.

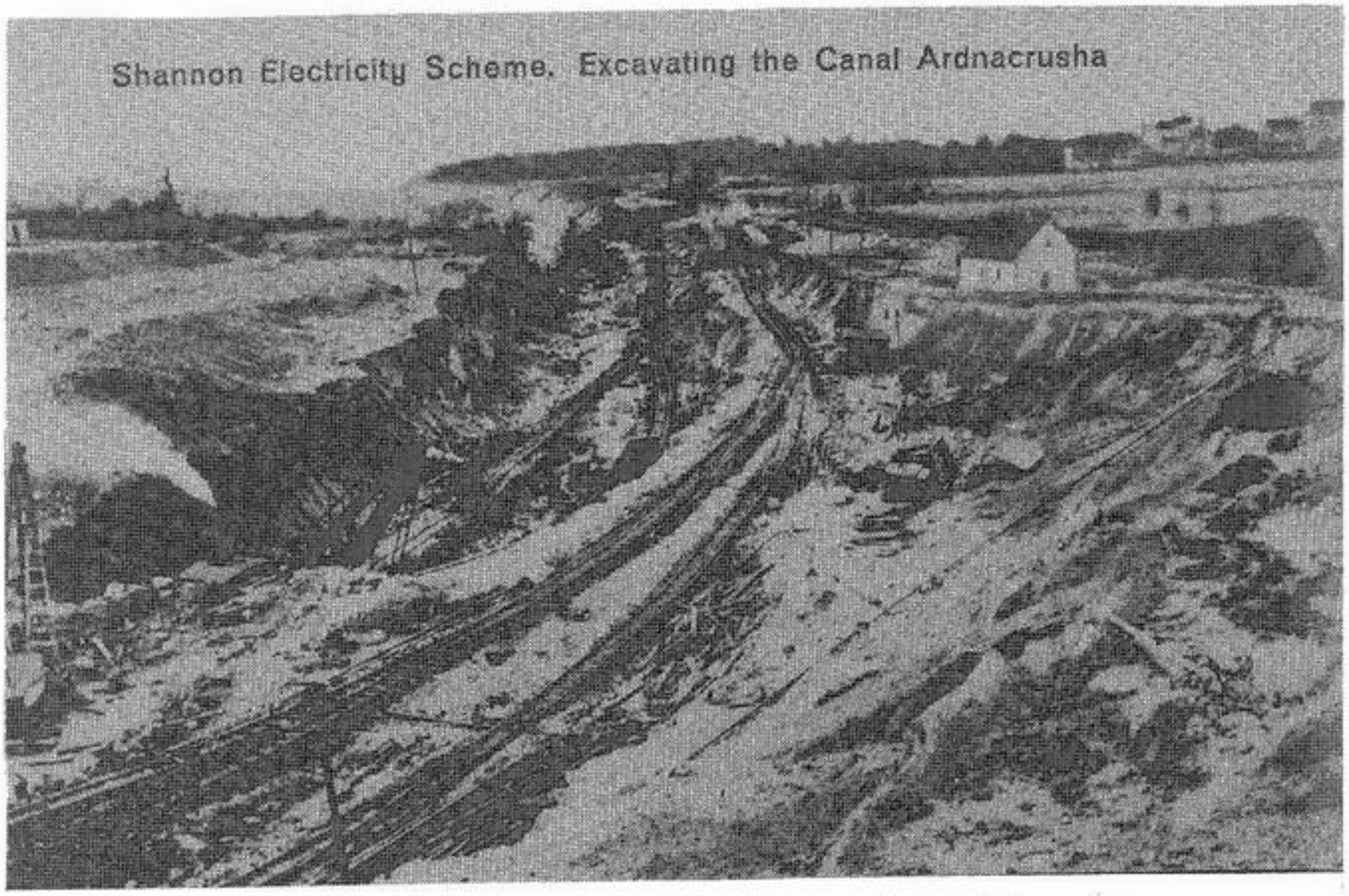
[8]P. Duffy, "The Shannon Hydro-Electric Scheme: The Workers", *The Engineer's Journal,* Vol. 38, Nos. 9 and 10, pp. 59-61.

[9]C. J. Smith, "Notes Upon the Average Volume of flow from Large Catchment Areas in Ireland: the probable duration of stated rates of flow etc., deduced from gaugings on the River Shannon at Killaloe", *Trans. Inst. Civil Engineers of Ireland,* Vol. 45, pp. 41-118. Tatlow's and Moynan's comments can be found in the published discussions on Smith's paper.

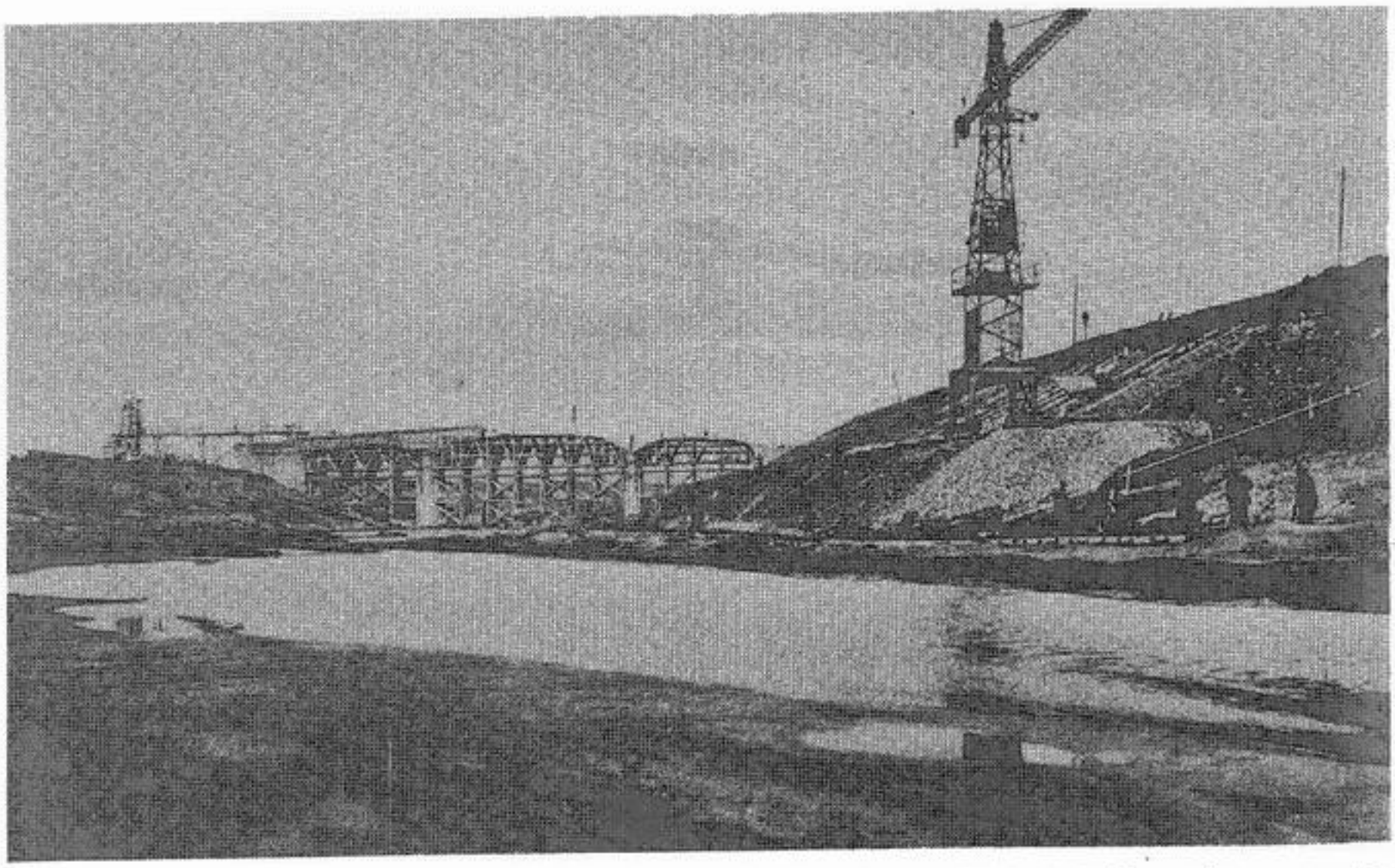
[10]*Ibid.*, pp. 64 and 65.

[11]*Commission of Inquiry into the Resources and Industries of Ireland: Report on Water Power,* Dublin 1922.

[12]*Ibid.*, p. 7.



Illus. 3. Excavation work on the head-race canal near Ardnacrusha.



Illus. 4. Finishing work on inner face of the head-race embankments and O'Brien's Bridge under construction.

of harnessing the Shannon.[13] In December, 1922, MacLoughlin took up a position with the firm of Siemens-Schuckert in Berlin.[14] Siemens had some practical knowledge and experience of Irish water power being used to generate electricity. Their London subsidiary was appointed as Electrical Engineers to the Giants Causeway Tramway—the pioneer hydro-electric railway in these islands, which opened to the public in 1883.[15] The power station for this railway was at Walkmills on the River Bush, in Co. Antrim. It is quite possible that Siemens-Schuckert were considering another venture into Ireland for they apparently gave MacLoughlin carte blanche to do as he wished.[16] As well as developing his idea for a Shannon scheme he studied the problems encountered during the electrification of Pomerania, in Germany. His preliminary calculations for the Shannon convinced him that he could obtain much greater power from the river than anyone else had anticipated. His outline costings also appeared economical. Fired with enthusiasm, he interested Siemens in the proposal. Through Patrick McGilligan, a contemporary from his days in University College, Dublin, MacLoughlin also interested the Government in his ideas. Siemens-Schuckert were asked to submit detailed proposals for the electrification of the Irish Free State. A commission of independent experts appointed by the Government vetted and approved the proposals, subject to certain modifications.[17]

The proposals caused a storm of protest, not least because of the cost involved, £5.2 million; the total budget for 1925 was only £25 million. Sir John Pursar Griffith published a pamphlet attacking the proposals and advocated that the Stevens plan be adopted.[18] Opposition based on the cost-effectiveness of the scheme came from so many quarters that MacLoughlin published a pamphlet[19] defending the scheme. In this publication he drew heavily on his studies of the electrification of Pomerania. Despite the campaign of opposition, the Shannon Electricity Act, enabling the Shannon Hydro-Electric Scheme to be undertaken, was passed by both houses of the Oireachtas in June 1925. The contract for the electrification of the Irish Free State was signed between the Government and Siemens-Schuckert on August the 13th, 1925. Work began almost immediately as there was only three and a half years allowed for completion of the work.

When the Shannon Electricity Act was passed the question of who was to run the power scheme had not yet been decided. McGilligan had studied the arrangements made in various countries in relation to electricity undertakings.[20] He finally came down in favour of establishing a semi-state body, Ireland's first, to manage and carry out the programme for national electrification. This form of "creeping socialism being introduced by the back door" generated an even greater storm of protest than the power scheme proposals.[21] Eventually McGilligan had his way and the E.S.B. was established on 11th August, 1927. Had the process of legislation been reversed and the Act to establish the E.S.B. been introduced first it is doubtful if either the E.S.B. or the Shannon Scheme would have seen the light of day. As it was with work on the Shannon Scheme well under way and the

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[13]Anon., Commemoration Leaflet to mark the naming of Áras T. A. Mhic Lochlainn, Galway, March 3rd 1987.

[14]M. Manning and M. McDowell, *Electricity Supply in Ireland. The History of the E.S.B.*, Dublin 1985, p. 20.

[15]T. H. McGuigan, *The Giant's Causeway Tramway,* The Oakwood Press 1964, p. 7.

[16]Manning and McDowell, *op. cit.*, p. 20.

[17]*The Shannon Scheme, Report of the experts appointed by the Government,* The Stationery Office, Dublin, n.d. but 1925.

[18]Griffith, *op. cit.*

[19]T. A. MacLoughlin, *The Shannon Scheme considered in its National Economic Aspect,* Dublin n.d.

[20]Manning and McDowell, *op. cit.*, pp. 54 et. seq.

[21]*Ibid.*, pp. 61 et. seq.

Government committed to its completion, some body or institution was going to have to take it over and run it on completion.

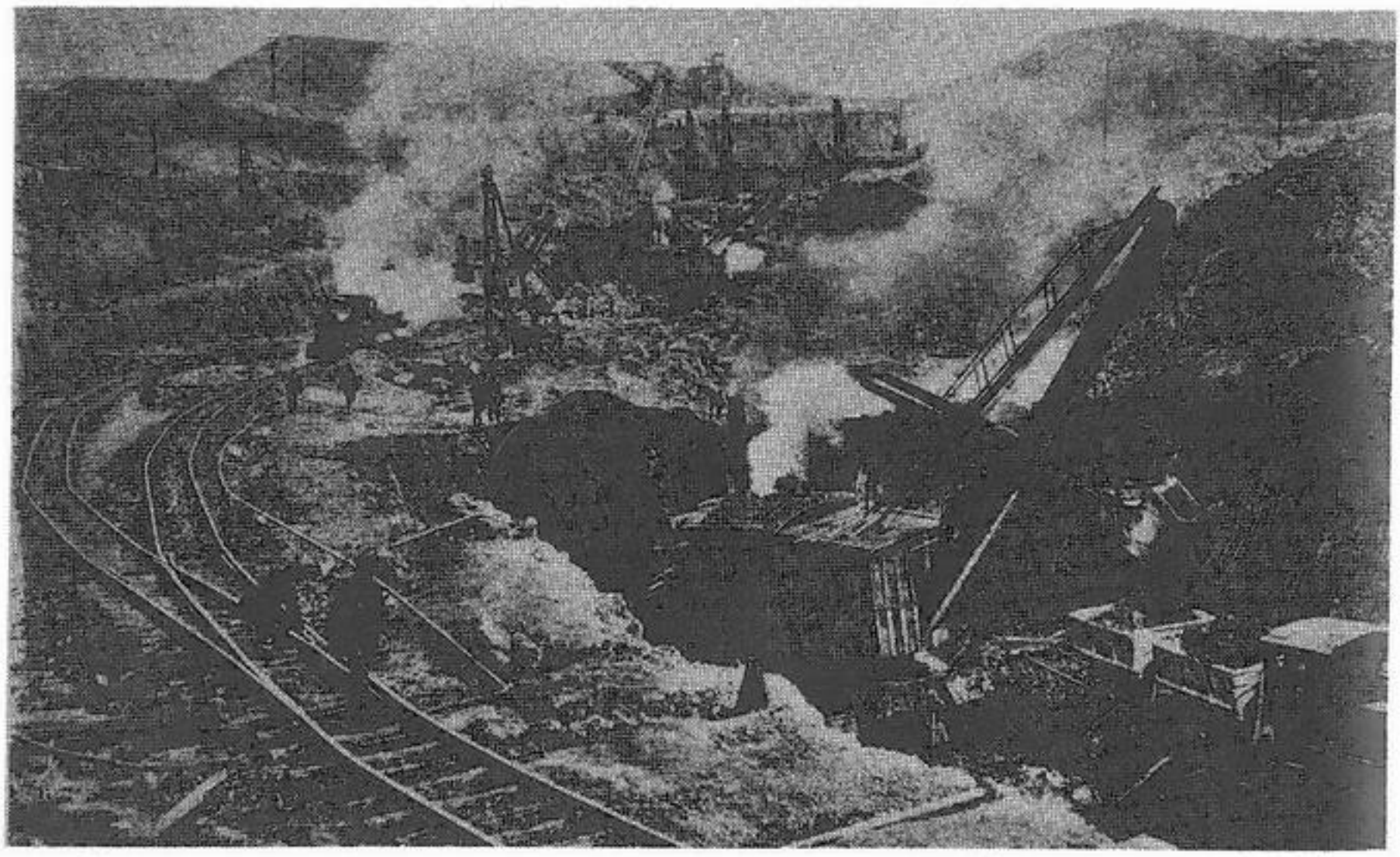
The completion of the Shannon Scheme on time and at, virtually, the contract price was a triumph. It was a triumph for MacLoughlin's vision; McGilligan's and the Free State Government's determination; Siemens-Schuckert's expertise, and Irish skills and labour. But it was much more than that. It was a statement of Ireland's independence and nationhood. To quote W. M. Harland of the *Financial Times,* "For half a century the country under the British regime toyed with the suggestion of harnessing the Shannon. The British are a hardheaded and practical folk, but they jibbed at such a venture. Then the Free State came into being, and ardent untired administrators, remembering that they had always been accused of being dreamers, seized on this chance of showing what they can do.

. . . . they have had thrown on their shoulders the not easy task of breaking what is in reality an enormous inferiority complex and the Shannon Scheme is one—and probably the most vital—of their methods of doing it. . . . "[22]

DESCRIPTION OF THE WORKS

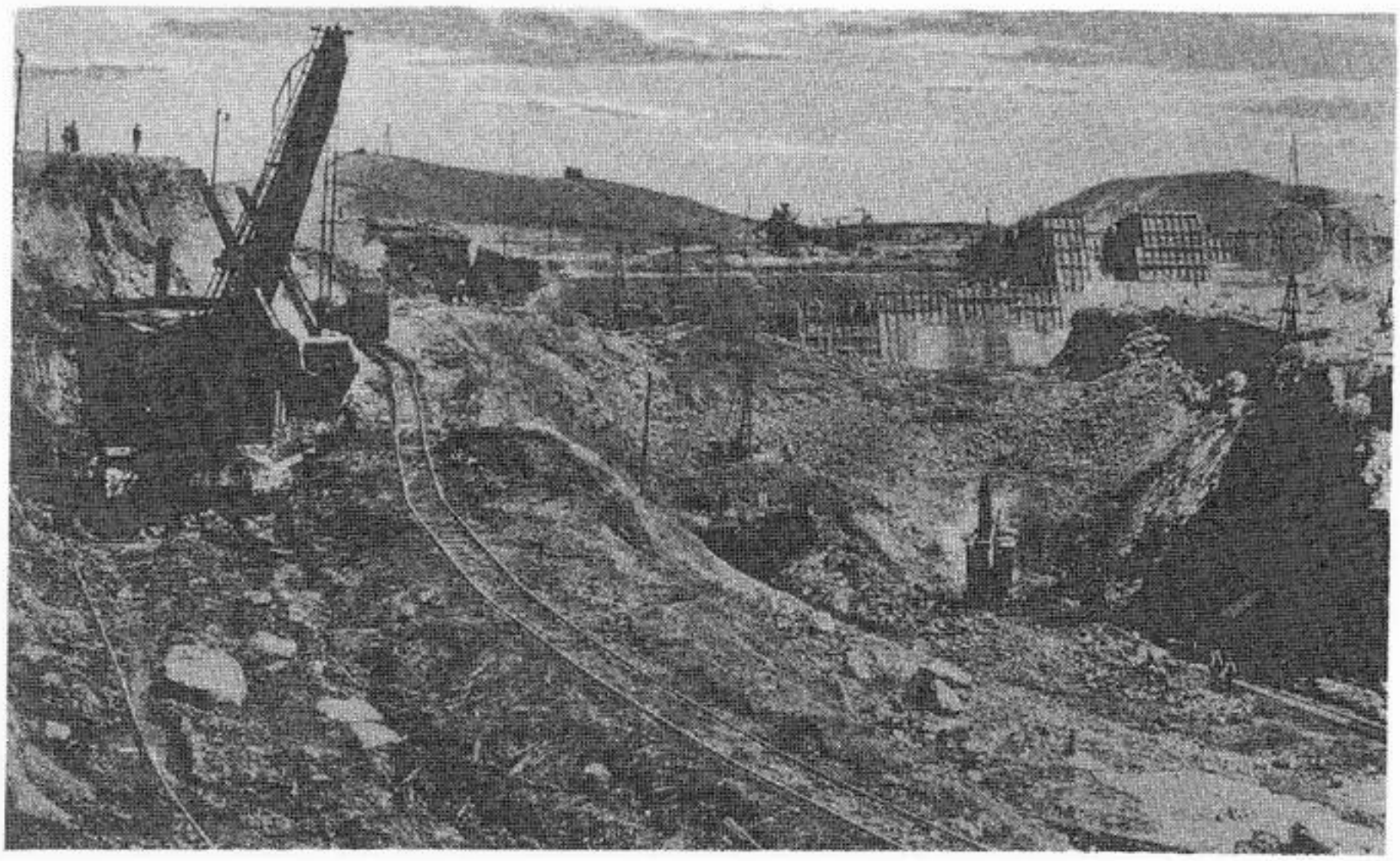
The Principle of the Scheme

When a flow of water comes into contact with turbines the latter are set in motion, and where these turbines are connected to generators the energy of this motion is transformed into electricity. The chief considerations for a water-powered generating station are the quantity of water available and the head or height of water above the turbines. This latter can be referred to as the fall. Where there is sufficient fall at a particular location then a dam can be built across the river at this point to control the flow of water to the turbines. Where the fall is spread out along a long stretch of river and at no one location is sufficient,



Illus. 5. Excavation work for the foundations of the intake sluice house at the power station.

[22]*Ibid.*, p. 53.



Illus. 6. Excavation work for the foundations of the power house.

then two alternatives present themselves. The first is to build a dam at the most suitable location to create the necessary fall. In the case of the Shannon Scheme this would have resulted in wholesale flooding of the lower reaches of the river and was, accordingly, unacceptable. The second alternative is to divert the river, via a head-race canal, to a suitable location where the necessary fall can be created. This method, whilst necessitating a large amount of extra work, greatly reduces, or eliminates, the need to flood large areas of land, and was the preferred option for the Shannon Scheme.

A glance at the map (p. 68) showing the layout of the scheme will give some idea of the scope of the works undertaken. Briefly these consisted of the construction of a weir and intake near Parteen Villa, head- and tail-race canals with four bridges spanning them, and the power station complex itself. Such a simplistic summary does not, however, convey the magnitude of the work involved in building what many Irish people regarded as the "Eighth Wonder of the World". Several rivers had to be diverted or conveyed under the head-race by syphons; vast quantities of earth and rock had to be excavated and special provisions had to be made to facilitate fishery and navigation interests. Accordingly, it is proposed to give a brief account of the principal features of the scheme with some outline of their construction.

The Weir and Intake at Parteen Villa

Both the weir and intake are interlinked and were built at the same time, the weir across the Shannon, the intake across the entrance to the head-race. The weir regulates the flow of the Shannon and diverts water into the head-race canal; the flow into the canal is controlled by the intake.

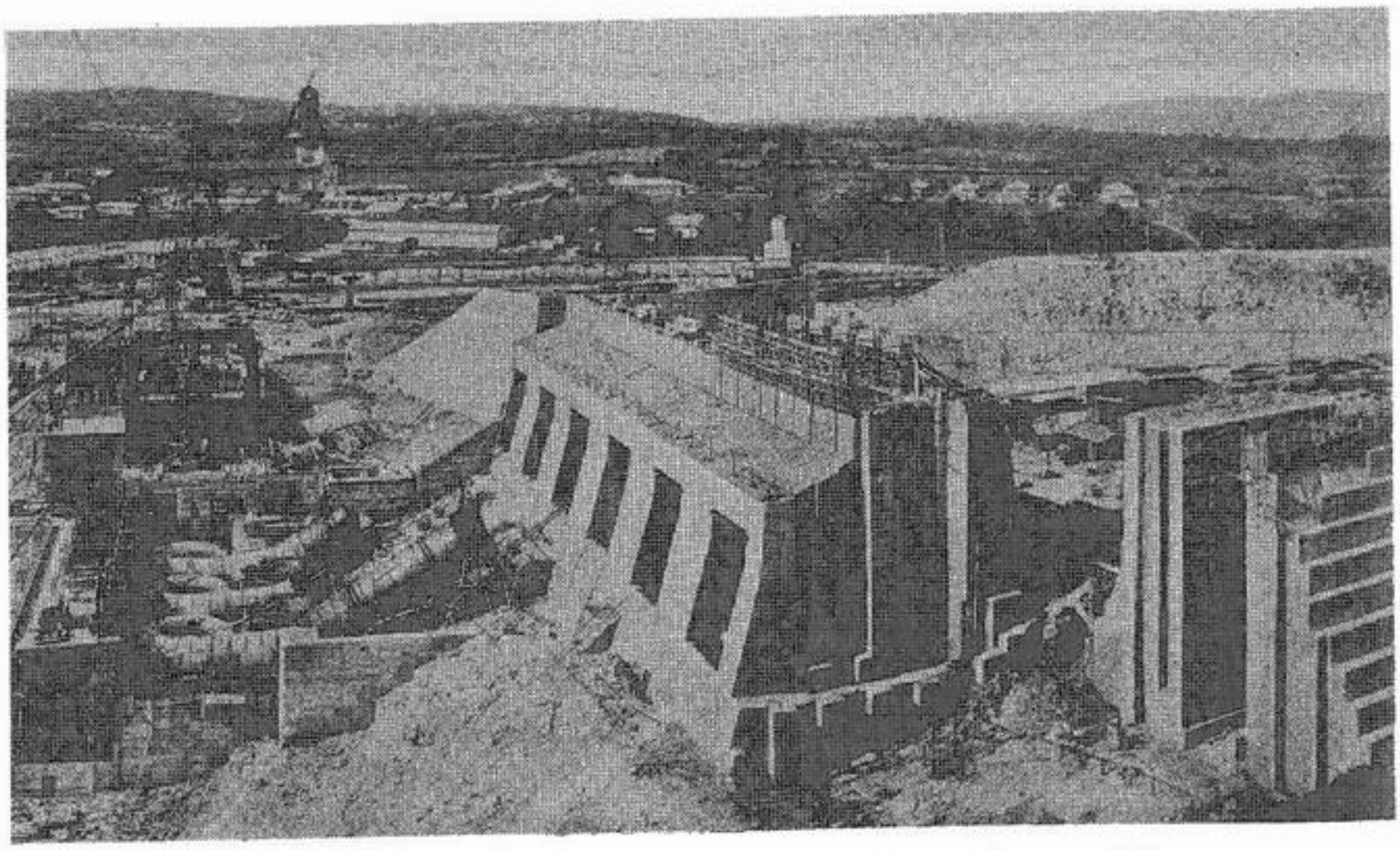
The weir was designed to raise the water level at Parteen Villa by 7.55 m., to the level of Lough Derg. Hence, the entire benefits accruing from the fall between Killaloe and

Limerick are conserved for the power scheme. However, this has also resulted in the formation of a new lake south of Killaloe created by the flooding of low-lying land. The landowners, of course, were compensated. One of the islands in the old river that was submerged was Inis Lua or Friar's Island, on which were the remains of St. Lua's Oratory. This building was removed stone by stone and re-erected near the Catholic Church in Killaloe.

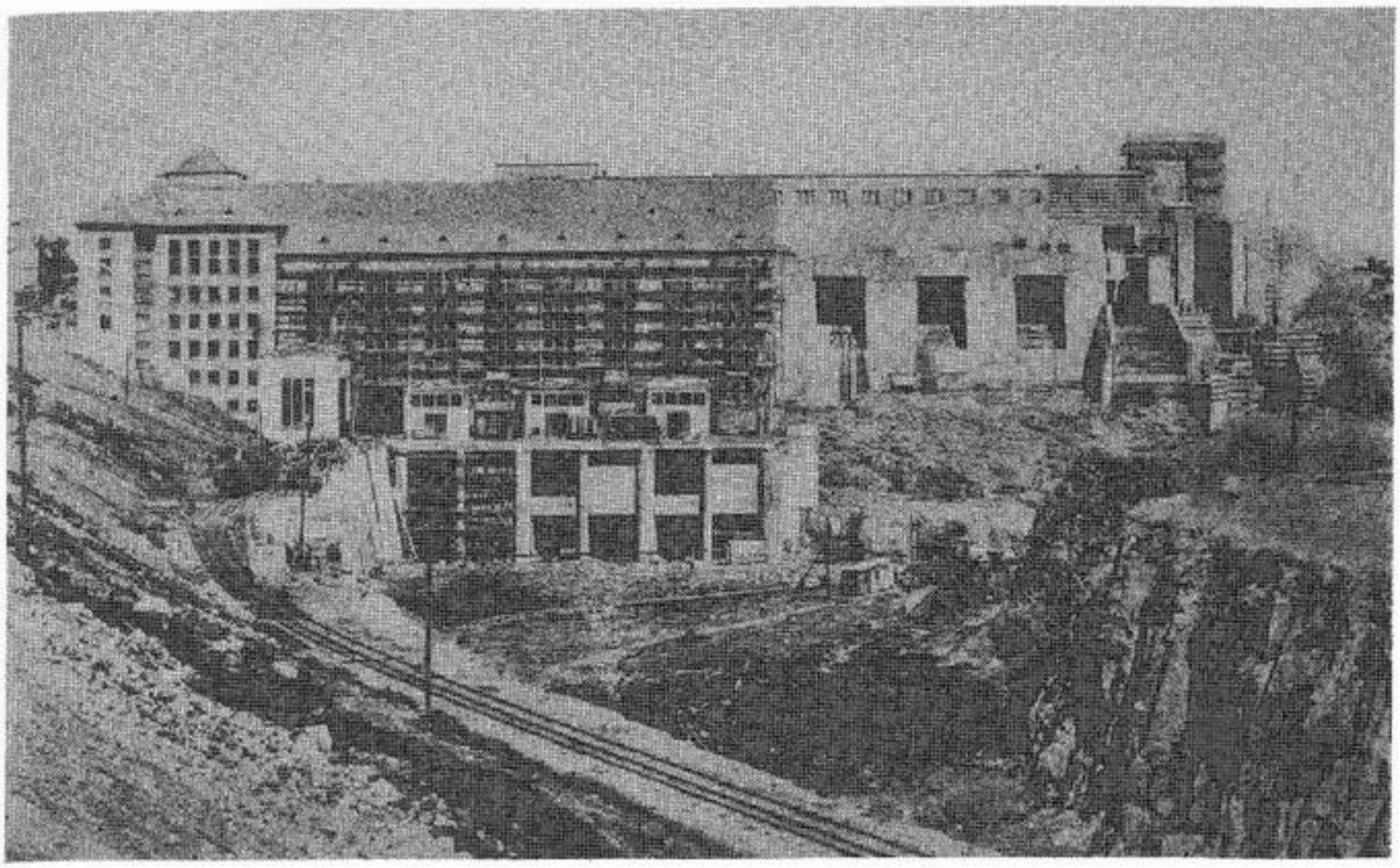
The weir was constructed in stages across the Shannon, the site for each stage being enclosed within a coffer-dam (Illus. 1). Once the water within the dam was pumped out work could commence. Even during the height of the floods in the winter of 1927-1928 the dam held back the flood waters although the dam height had to be raised with sand-bags. The weir has six sluce gates incorporated in it and is designed so that all flows, from the minimum of 10 tonnes per second to extreme floods of over 900 tonnes per second, can be discharged; a minimum flow of 10 tonnes per second must be allowed down the old river bed to protect fishery interests. Incorporated into the weir is a fish pass some 190 m. long, one of the longest fish passes in the world when constructed.

As mentioned previously, the intake (Illus. 2) controls the flow of water to the head-race canal. It has three openings 25 m. wide and 7.6 m. deep, and one opening 10 m. wide by 3.7 m. deep. This latter opening is designed to act as a ship's pass, allowing barges of up to 150 tons to use the navigation, and has a maximum clearance of 3.5 m. over water level. The sluice gates in both the intake and weir can be controlled either electrically or mechanically.

During the construction of the weir and intake two rivers had to be diverted. The Black River, in East Clare, is now conveyed under the intake building by means of a syphon to discharge into the Shannon below the weir. On the opposite bank of the river the Kilmastulla River has also been diverted to discharge into the Shannon below the weir.



Illus. 7. The intake sluice house at the power station nearing completion. The upper navigation lock is to the right of the picture.



Illus. 8. The power station under construction.

Head-race Canal

This conveys the water from the Shannon to the power station at Ardnacrusha, a distance of 12.6 km. The canal had to be designed not alone to deliver 500 cu.m. (cubic metres) of water per second to the power station but also to facilitate navigation. This latter provision meant that the cross-section of the canal had to be designed to limit the maximum velocity of the water to 1.5 m. per second. At water level the width of the canal is 90 m. whilst its bed is only 31.5 m. wide. The depth of water is just over 11 m. Only a short section of the head-race is constructed in cutting only; for most of its length it had to be constructed partly in cutting, partly in embankment. Along one section the embankments reach a height of 18 m. During the construction of the head-race canal 4.5 million cu.m. of earth and 300,000 cu.m. of rock had to be excavated (Illus. 3).

As the head-race cuts through several roads it was found necessary to build three reinforced concrete bridges across it. O'Brien's Bridge is the first bridge to be encountered downstream of the weir and intake. This, like the bridge at Blackwater (Illus. 19), is a three-span reinforced cantilever structure.

The construction work on O'Brien's Bridge is shown in Illus. 4 where the timber centering for the bridge can clearly be seen. Also shown is the finishing work on the inner face of the embankments. Essentially, this consisted of placing and rolling a 60 cm. thick layer of clay where the canal bed and the embankments were not considered sufficiently water-tight. To protect the slopes from the erosive effect of the water, a layer 40 cm. thick of broken stone was spread across the clay. The portion of stone most susceptible to wave action had a protective layer of concrete 12 cm. thick laid over it. This layer extended from 1 m. below water level to 1 m. above it. Electric swivel cranes with a reach of 15 m. and a load capacity of 2 tons were used to place both the stones and concrete. The finished face of a section of the embankment can be clearly seen in the foreground of Illus. 17.

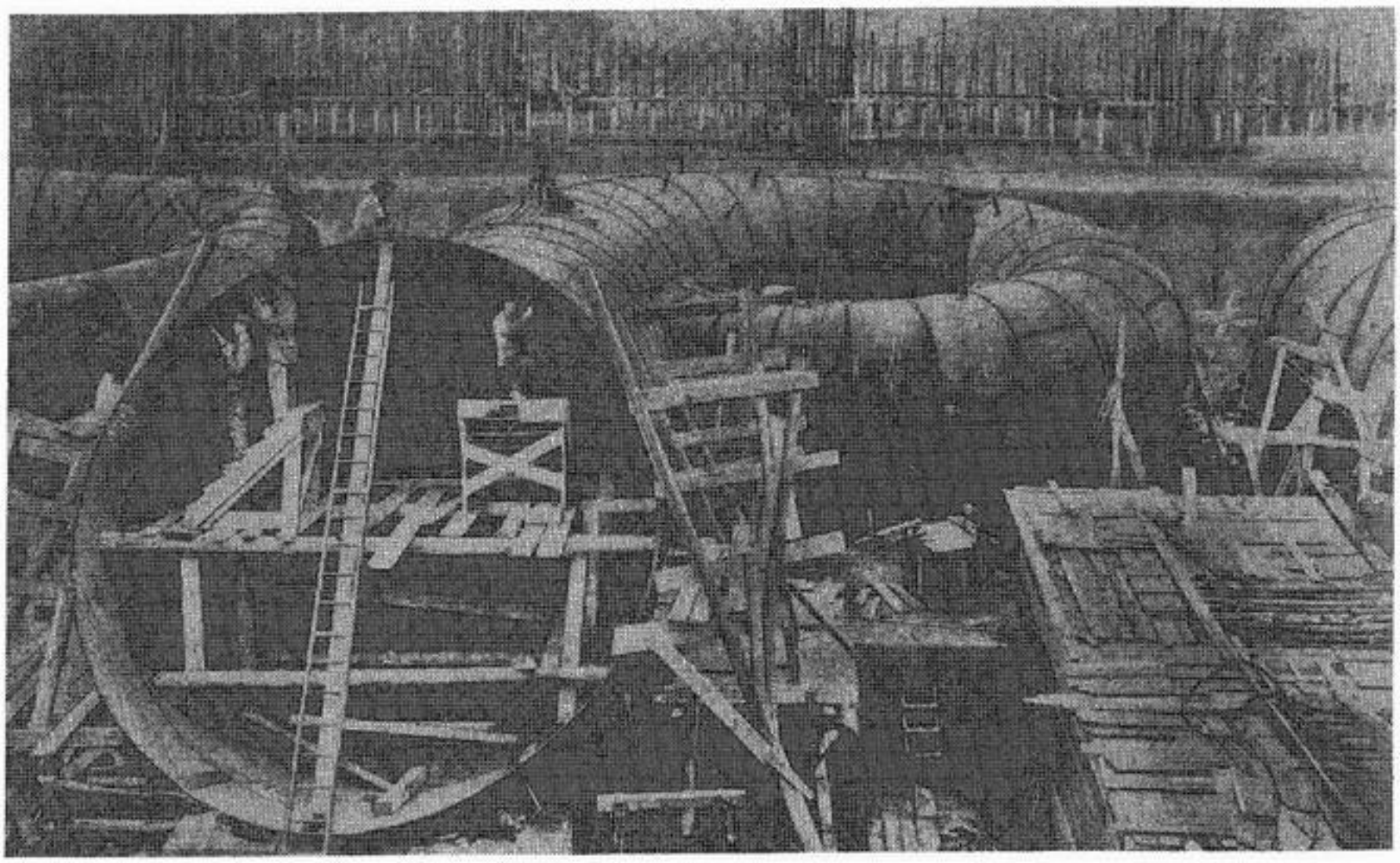
The Intake Building and Power Station

The *raison d'être* of the Shannon Scheme is the Power Station. This is located near Ardnacrusha at the end of the head-race canal. Essentially it consists of an intake sluice house, penstocks, generating building, waste channel and navigation locks. Immediately above the power station complex the head-race canal is widened out into a forebay to reduce the velocity of the water.

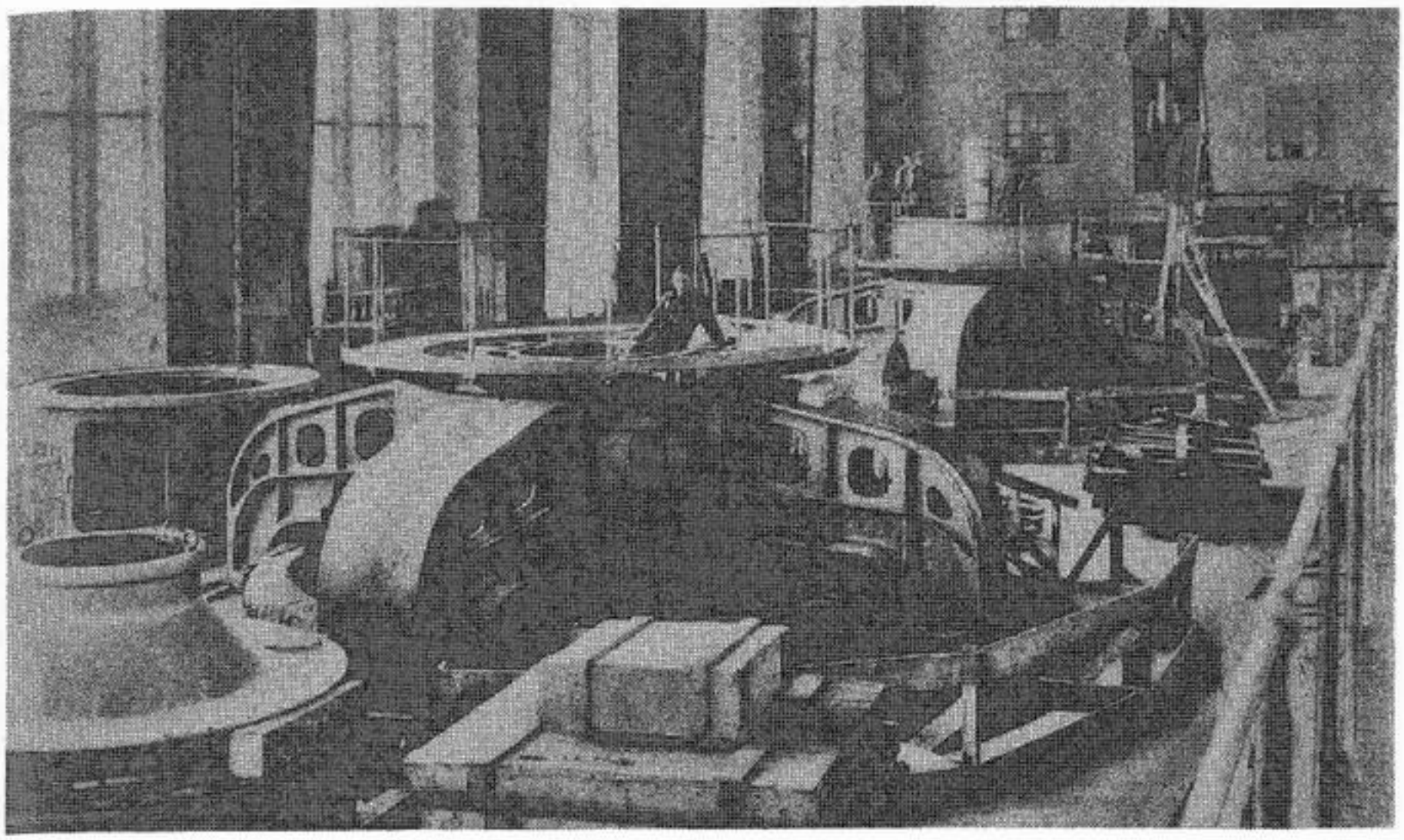
The intake sluice house, a massive structure containing some 600,000 cu.m. of concrete, forms a barrage across the head-race (Illus. 7). This regulates the flow of water through the penstocks (Illus. 12) to the turbines. The intakes to the penstocks are controlled electrically operated sluice gates which can be closed in thirty seconds if necessary. Screens are placed in front of the sluice gates to prevent the entry of debris into the penstocks. These are cleaned using a track-mounted, motorised, rake which can travel the entire length of the building. If, for any reason, the head-race has to be run dry a specially constructed waste channel is utilised. Once the sluices in both intake buildings (at Parteen Villa and the Power Station) are closed, the head-race waters are let run off through this channel.

The penstocks are used to convey water to the turbines. They are 41 m. long, 6 m. in diameter, and have a slope of 31 degrees. Each penstock delivers approximately 100 tonnes of water per second. At their bottom the penstocks are bent horizontally and then tapered gradually from a diameter of 6 m. to 4.8 m. (Illus. 9). At this point they connect to the spiral casings which are designed to supply water to the turbine rotor with maximum efficiency. A West Galway tradition has it that some of the Connemara men who worked on the scheme were employed in the construction of the penstocks because of their skills as hooker builders. Initially three penstocks were installed, the fourth was added in 1933 when an extra turbine, a Kaplan type, was commissioned.

The power house, "a splendid example of Teutonic architecture", was constructed using a steel girder framework (Illus. 8). The steel girder uprights are 18 m. high and weigh 11



Illus. 9. Assembly work on the spiral casings.



Illus. 10. Interior of power house during installation of generators.
Note the positioning of the workman for scale purposes.

tons each, whilst the cross-beams each have a weight of 5 tons. To allow for movement, due to temperature variations, the uprights rest on steel hinged bearings fixed to the concrete foundations. Due to the enormous weight of the machinery installed in the power house particular care had to be taken in its design and construction. The revolving parts of each turbine alone weigh 227 tons. The power house is equipped with two overhead travelling cranes, each capable of lifting 100 tons. The cranes can be operated individually or in tandem for large loads.

During the excavation work on the site of the intake and power house some 200,000 cu.m. of earth and 150,000 cu.m. of rock had to be removed (Illus. 5 and 6). The foundations for the power house are some 30 m. below those of the intake house (Illus. 6). As there was a risk of damage to the foundations from underground water movement through the underlying limestone rock the area was pressure grouted with cement to a depth of 15 m.; a pressure of 6 atmospheres was used.

Initially three Francis type turbines were installed, a fourth, Kaplan type, was added in 1933. They are each rated at about 30,000 horse power output, even though the Francis turbines have a maximum output of 38,600 horse power. This is because of the changes in level of the fall available. The fall depends on the level of water in both the head- and tail-races. The tail-race is subject to tidal variations. The turbines are connected to generators. Generators 1, 2 and 3 are rated at 30,000 k.v.a. (kilovolt-amperes) and run at a speed of 150 r.p.m. (revolutions per minute). The fourth generator is rated at 25,000 k.v.a. and runs at 167 r.p.m. They produce electricity at 10.5 k.v. (kilovolts) which is stepped up to 40 k.v. and 110 k.v., via transformer stations, for transmission through the National Grid. The entire power station is controlled by a centralised control room which is manned 24 hours a day throughout the year. Water from the turbines is discharged via draft tubes 18 m. long to the tail-race to be conveyed back to the Shannon at Parteen-a-Lax.

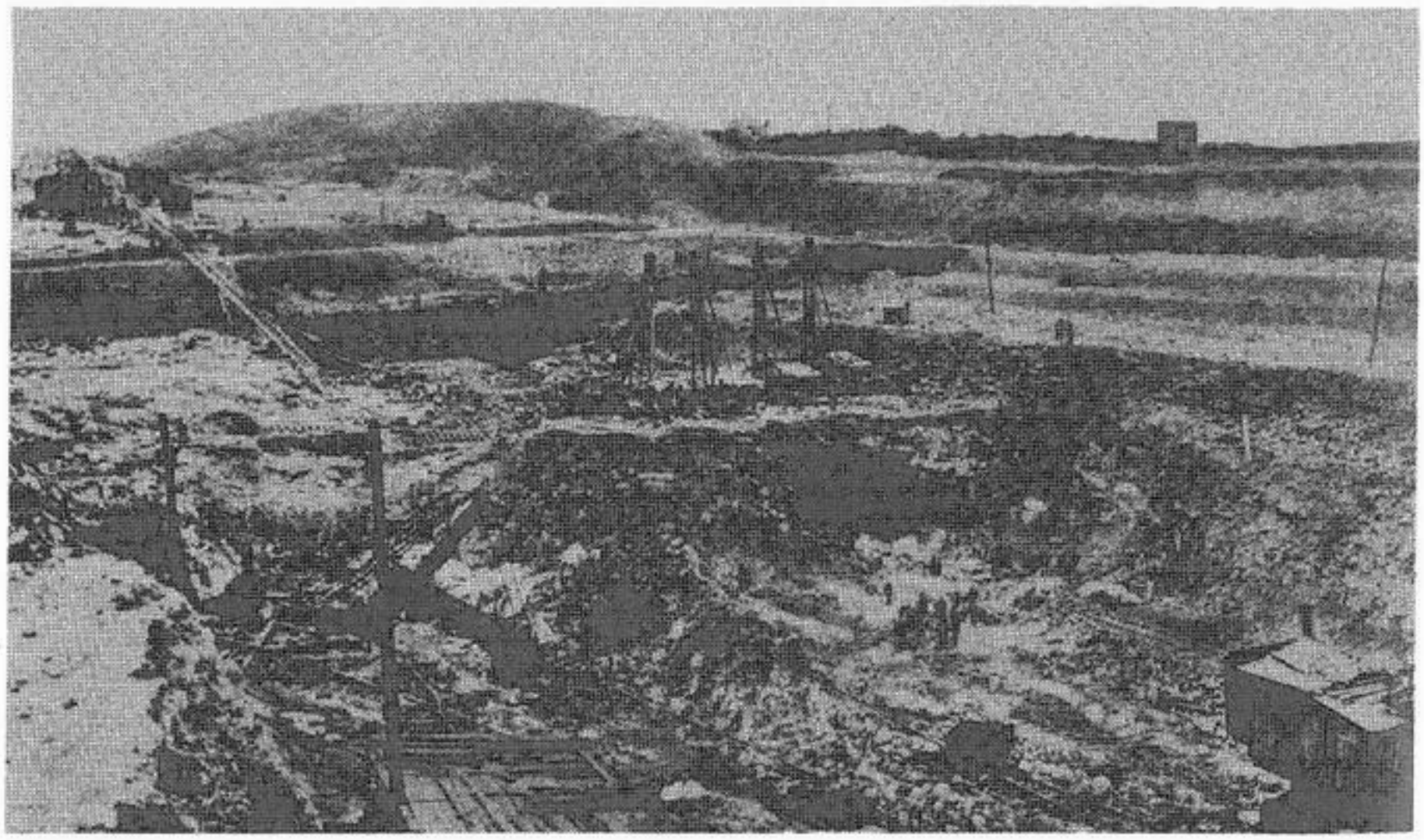
Navigation Locks

As the head- and tail-races also had to cater for navigation interests some form of lock had to be provided at the power station. The original proposal was for a ship's lift which could accommodate barges of up to 150 tons. As the utilisation of the navigation was not sufficient to warrant the expense of this twin navigation, locks with a combined drop of 34 m. were provided. Each lock has a drop of 17 m. and is 32.2 m. long by 6.1 m. wide. The upper lock is shown under construction on the right hand side of Illus 7.

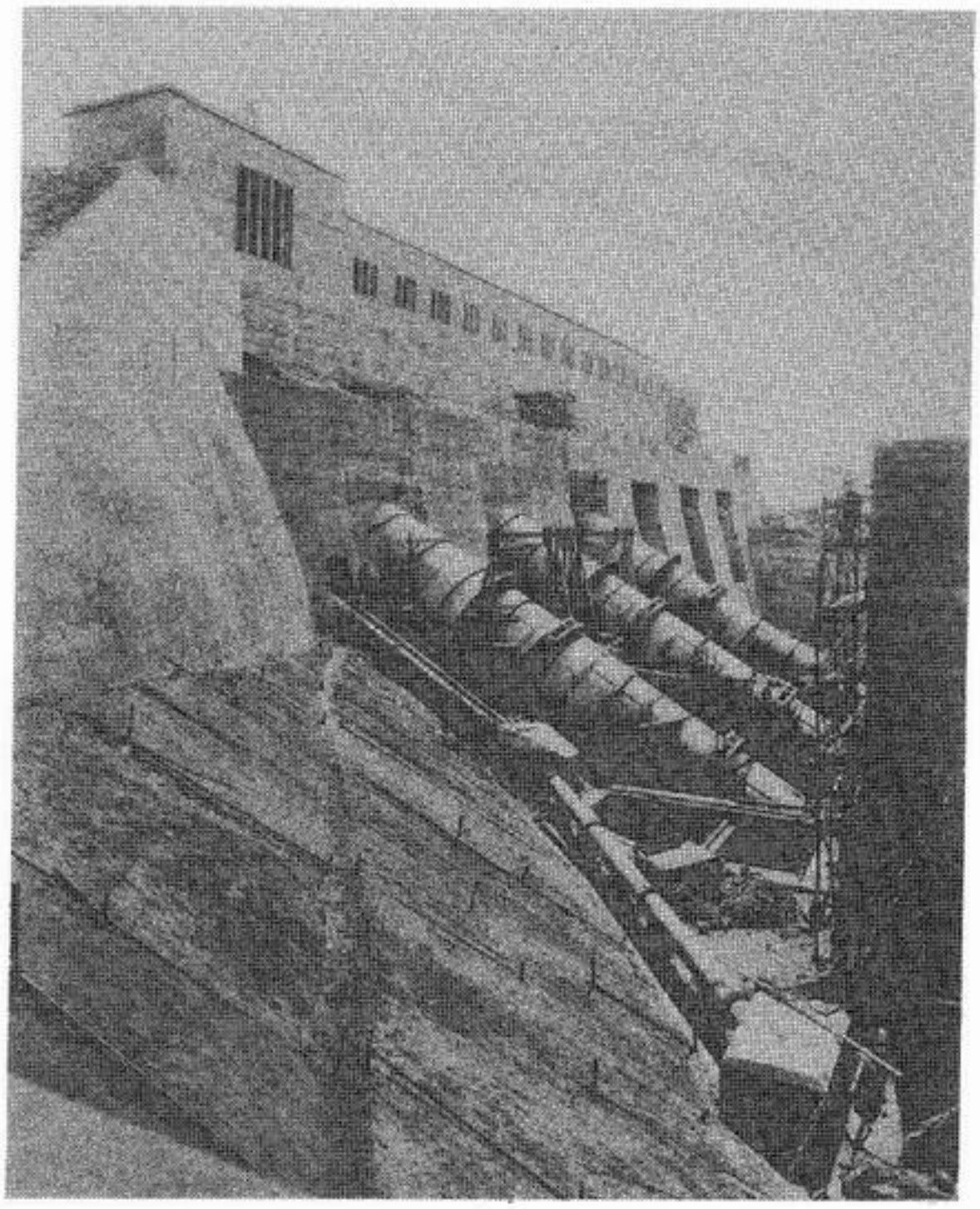
In the 1960s it was traditionally believed, in Galway, that the late Professor Rishworth, of the Engineering School there, designed these locks and that the Great Lakes Navigation Company of North America were so impressed with his work that they commissioned him to design improvements to their own navigation system. This has still to be verified.

Tail-race

The tail-race is a channel 2.4 km. long constructed to carry the water from the power station back to the Shannon (Illus. 11). For the greater part of its length it is a cutting through solid rock. The rock is 19 m. deep at its deepest and the bottom of the tail-race is 22 m. wide. Through the rock the sides are cut at a slope of 6 to 1. Particular care had to be taken during construction to remove irregular or protruding pieces of rock in order to eliminate any danger to vessels using the navigation. The cross-section of the tail-race, like that of the head-race, had to be designed to prevent the current from exceeding 1.5 m. per second, for navigation purposes. As the tail-race is subject to tidal variation, this problem had to be overcome in the design. The tail-race is spanned by one bridge, near Parteen Village. Some idea of the rock excavation necessary for the construction of the tail-race can be gathered from Illus. 13 and 16.



Illus. 11. Excavation work on the tail-race at Ardnacrusha.



Illus. 12. The penstocks in position.

Rock Excavation

During the excavation of the head- and tail-races, approximately one million cu.m. of rock had to be removed; some two-thirds of this was in the tail-race section.

Because of the time limits imposed for the completion of the work, special attention had to be given to blasting operations. It soon became evident that satisfactory progress could not be made using compressed air rock-boring methods, because the drills regularly became locked in rock crevices. Also, before new bore-holes could be drilled, the rock surface had to be cleared of loose material. Accordingly, it was decided to use drop hammer boring machines (Illus. 13 and 22). Using these machines any number of bore-holes could be made to the desired depth without interfering with the steam shovel excavators (Illus. 13). The boring chisels at the end of the hammers varied in diameter from 100 mm. to 200 mm. (millimetres). Using these machines bores up to 14.5 m. deep were obtained; on average it took five hours work to sink the bore 1 m.

After boring, the holes were charged with explosives and primed. Amonite and amonite-gelatine were the explosives used, as they were comparatively safe in the event of fire or frost and could not be exploded by blows or ordinary concussion. Electric detonators were used, thereby enabling several blasts to be set off together, thus reducing the quantity of explosives used. Upwards of 1,000 cu.m. of rock were blasted at the one time. After blasting, the compressed air drills were used to finish off the bed or side faces of the races or to

split large boulders. During blasting operations the backs of the track-mounted steam shovels were covered with bundles of brushwood to protect them from damage caused by flying stones. These machines were very slow-moving and cumbersome, and had they to be constantly moved work would have been slowed considerably.

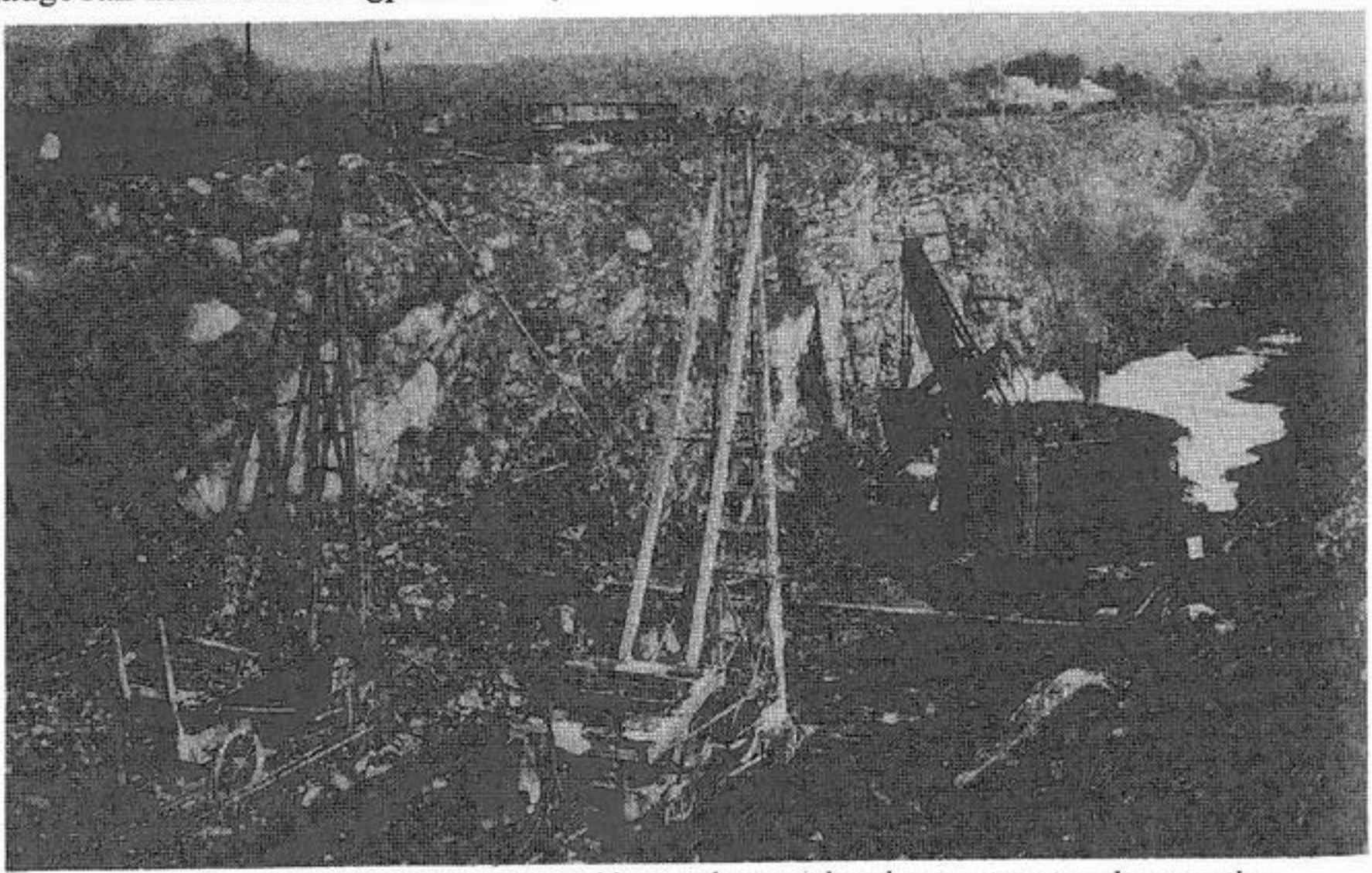
Bridges

As already mentioned four bridges had to be built, three over the head-race canal at O'Brien's Bridge, Blackwater and Clonlara, and one over the tail-race at Parteen Village. The bridges at O'Brien's Bridge and Blackwater are triple-arched cantilever types whilst those at Clonlara and Parteen Village are triple-hinged single arch structures. Ample clearance had to be provided for navigation purposes. Some 4,000 cu.m. of concrete was used in the construction of the Blackwater Bridge alone (Illus. 19).

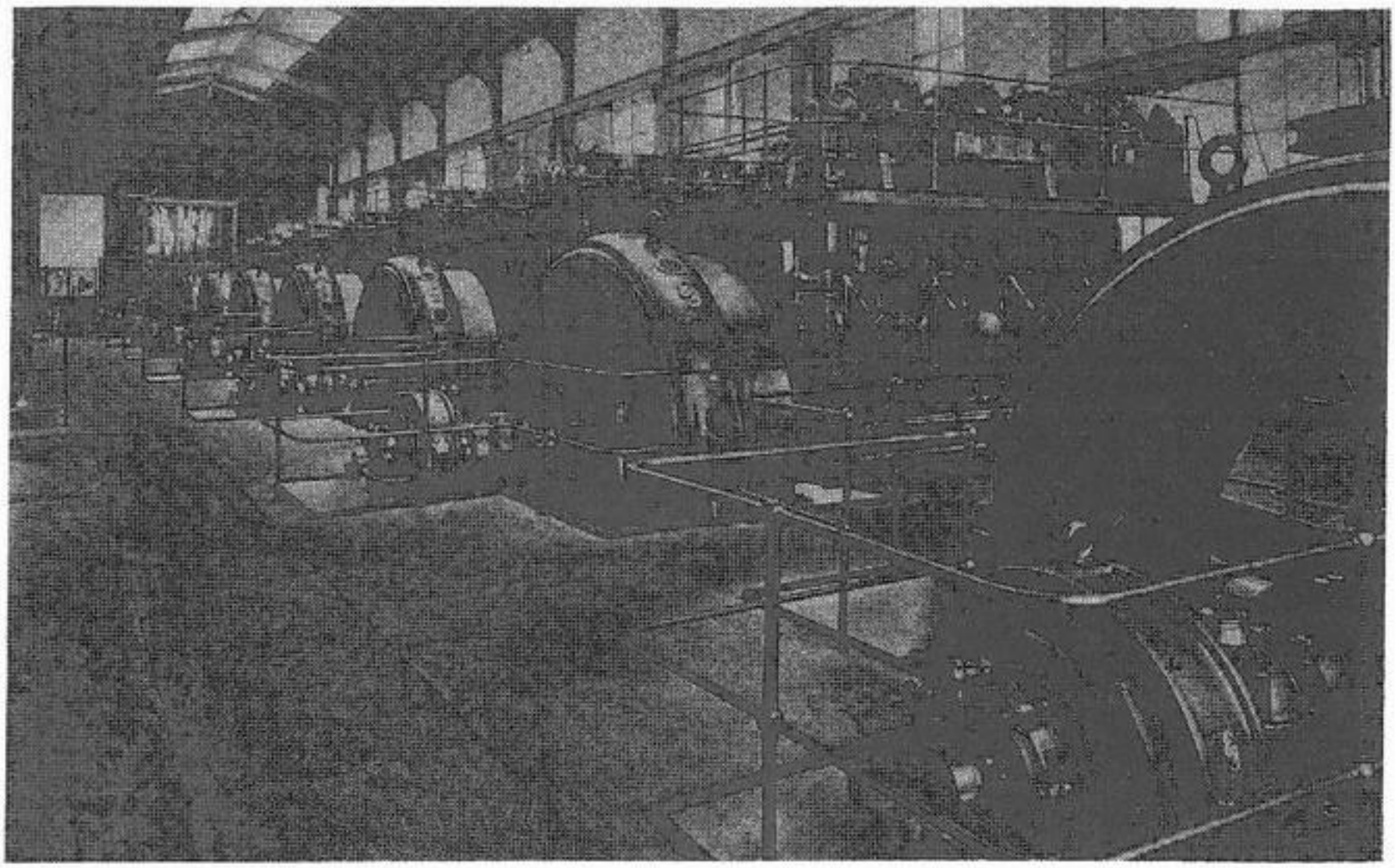
As well as the four bridges some nine rivers or streams had to be conveyed under the head-race by means of culverts or syphons. The largest of these was for the Blackwater River. As this river is liable to flash flooding, particular care had to be taken to make the culvert large enough to cope with the flood waters. The culvert is 206 m. long, 4.5 m. wide and 3.5 m. high. In all some 3,700 cu.m. of reinforced concrete was used in its construction. It passes 1.56 m. under the bed of the head-race.

Machinery and Equipment

In order to complete the scheme within the specified contract time, a vast array of plant and machinery was employed during the construction work. Enormous quantities of materials and machinery had to be conveyed to the site. As road conditions in the area were appalling, one of the first jobs to be undertaken was the construction of a standard gauge rail-link from Longpavement (on the Limerick-Ennis line) to Ardnacrusha. To speed



Illus. 13. Drop-hammer boring machines and steam-shovel excavator at rock excavation in the tail-race near Clonlara.

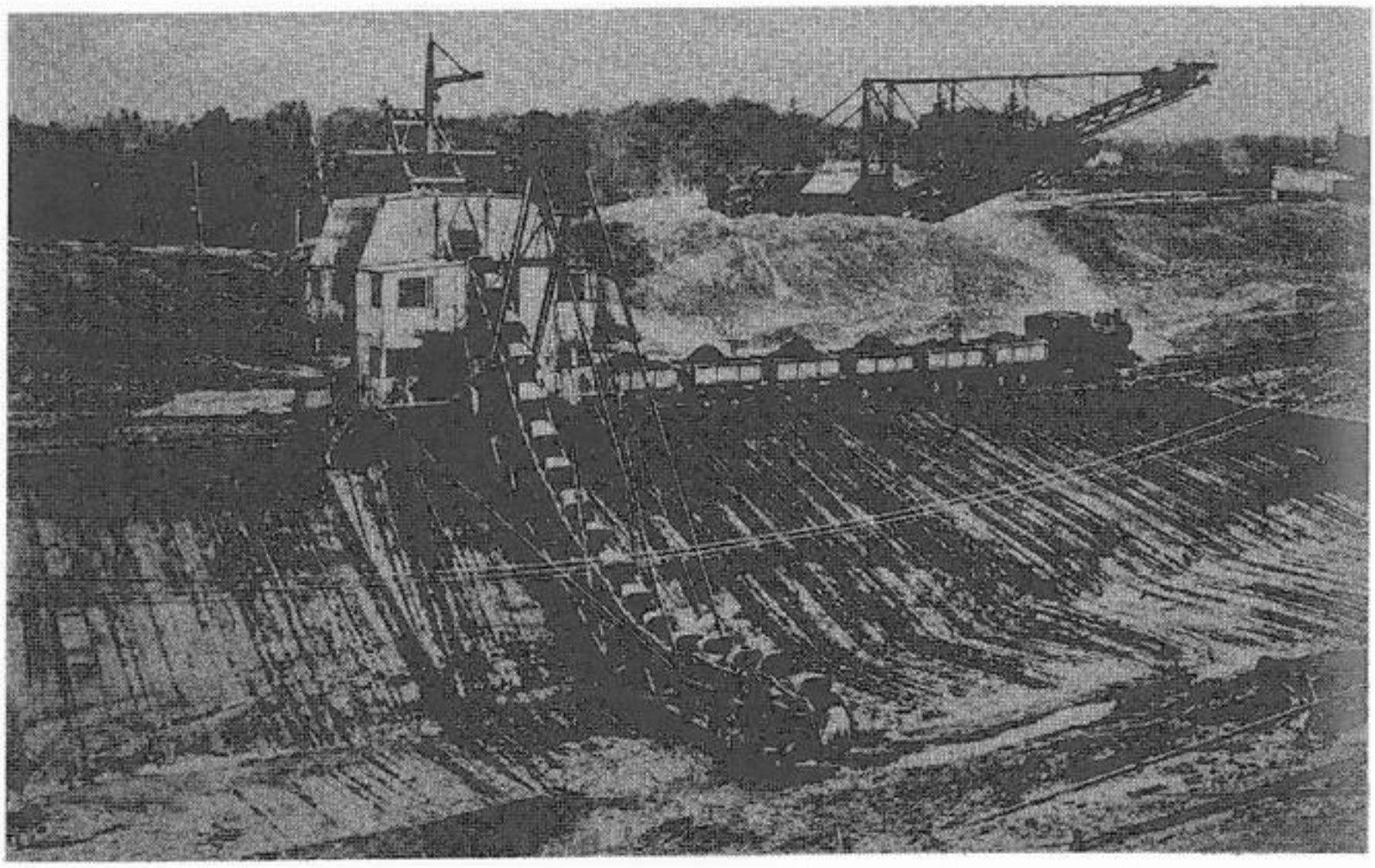


Illus. 14. Interior of temporary generating station.

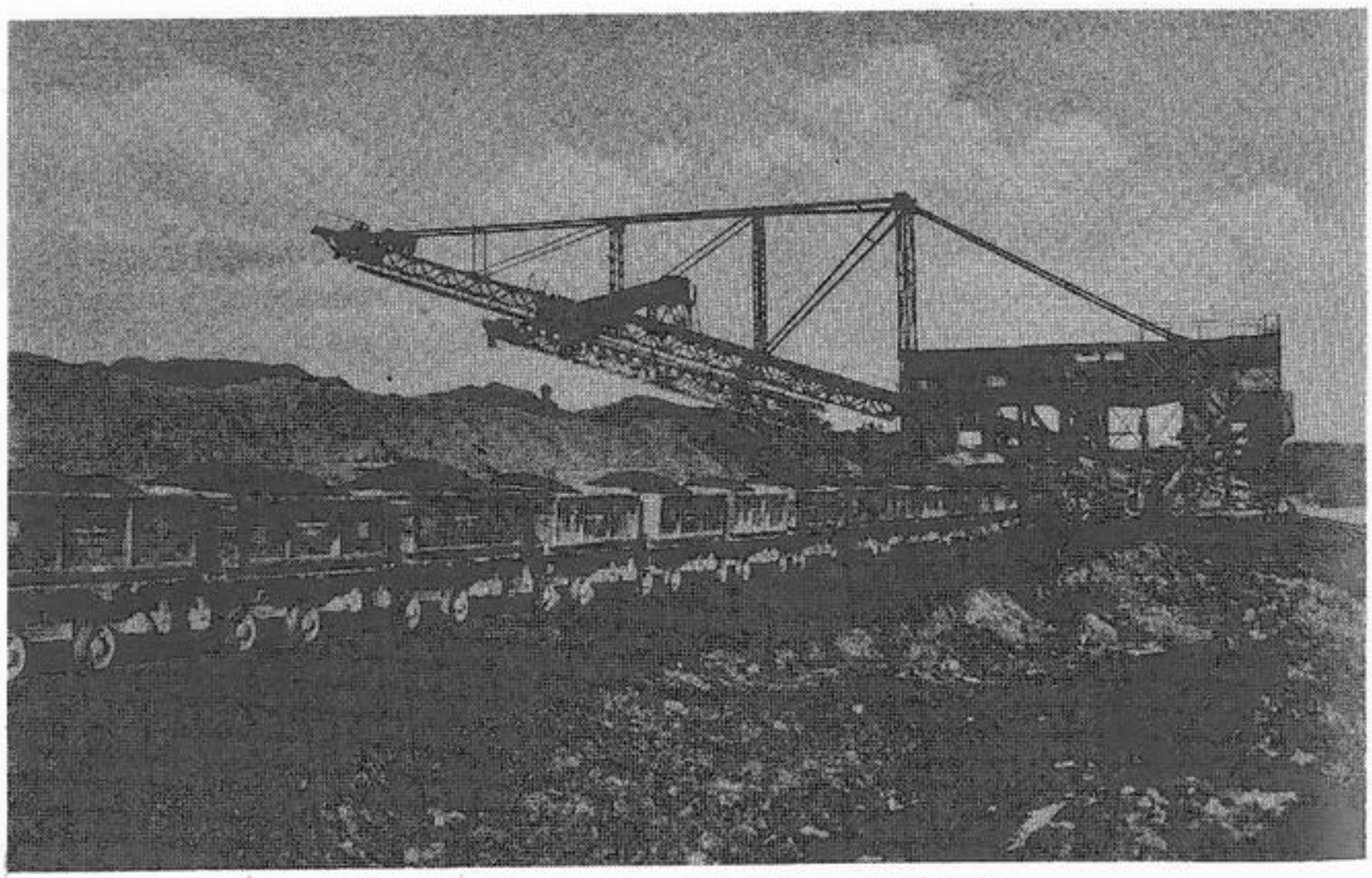
up delivery times, this section of railway line was electrified in 1927. Virtually all items used in the construction work had to be imported through Limerick docks, brought to Longpavement, and then conveyed by rail to the site.

On the construction site itself, some 100 kilometres of narrow gauge railway were used for transportation purposes. As this railway line was frequently moved as the work progressed, steam locomotives were used for haulage purposes. A track-shifting machine was used to speed up the work of re-positioning tracks. By this means whole sections of the line could be re-laid at one time. In all, some 96 locomotives and 1,350 wagons were used on the Shannon Scheme railway. All of these had to be transported over the main supply line from Longpavement, which was used to convey some 30,000 tons of equipment to the works at Ardnacrusha.

The locomotives and wagons were not the only equipment to use the narrow gauge railway. Six multiple-bucket electrically powered excavators were used during the course of the work. These travelled on rails parallel to the line of the races. The buckets scooped up the earth, dropped it into a large hopper where it was fed into wagons and then taken to the Absetzer or Transporter to be used in the building of the embankments (Illus. 15). Three Absetzers were used during the construction of the embankments. These machines were developed originally for work in the coal mines in Germany and the Shannon Scheme was the first location where they were used in embankment building. They were capable of dropping material from a height of 15 m., which ensured excellent compaction, over an operating width of 40 m. (Illus. 16). The trains brought the earth from the excavators, it was then tipped into a previously excavated trench, 2.5 m. deep. The chain-buckets attached to the Absetzer, having scraped up the earth, dropped it into a hopper, from there it was fed on a system of conveyor belts to the delivery head of the machine, and then dropped to form a compacted layer of the embankment. The Absetzers were track-mounted and so could be moved along, building the embankment in one solid continuous mass.



Illus. 15. Multiple-bucket excavator at work. Note train load of excavated earth ready to be taken to the Absetzer, which can be seen in the background.



Illus. 16. Absetzer at work building embankments.

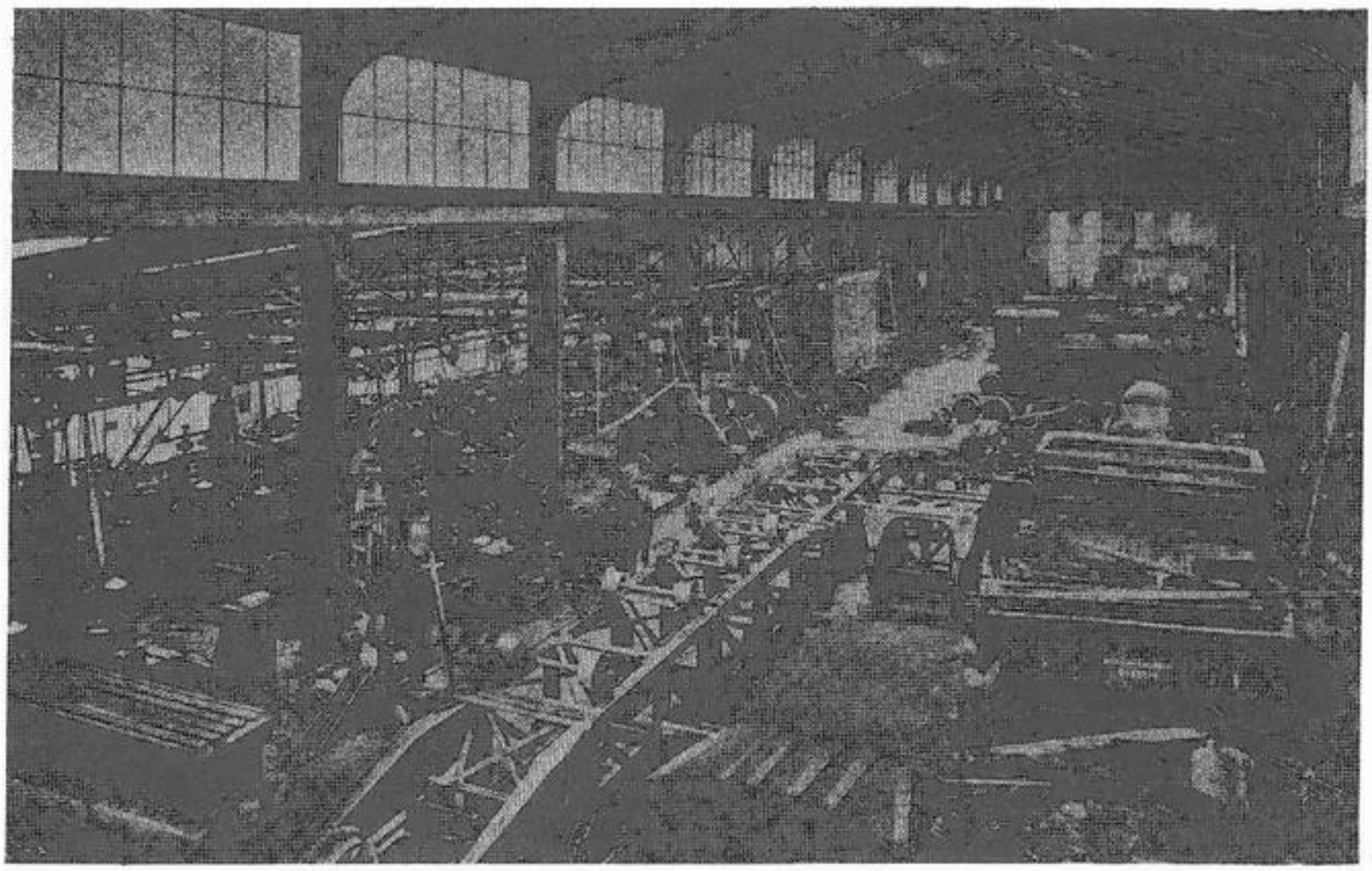
As well as the massive amounts of excavation and fill, an enormous quantity of concreting work had to be carried out during the works. Much of this latter work was carried out using two cable cranes (Illus. 24). Each crane consisted of twin steel towers, each 36 m. high, connected by a cable spanning the 325 m. distance between the towers. The towers incorporated concrete mixers which fed directly into the buckets of the cable cranes. These cranes were electrically operated, and as they could move on rails they could cover a working area of 35,000 sq.m. One of these machines was used to place some 60,000 cu.m. of concrete in eleven months.

Temporary Power Station

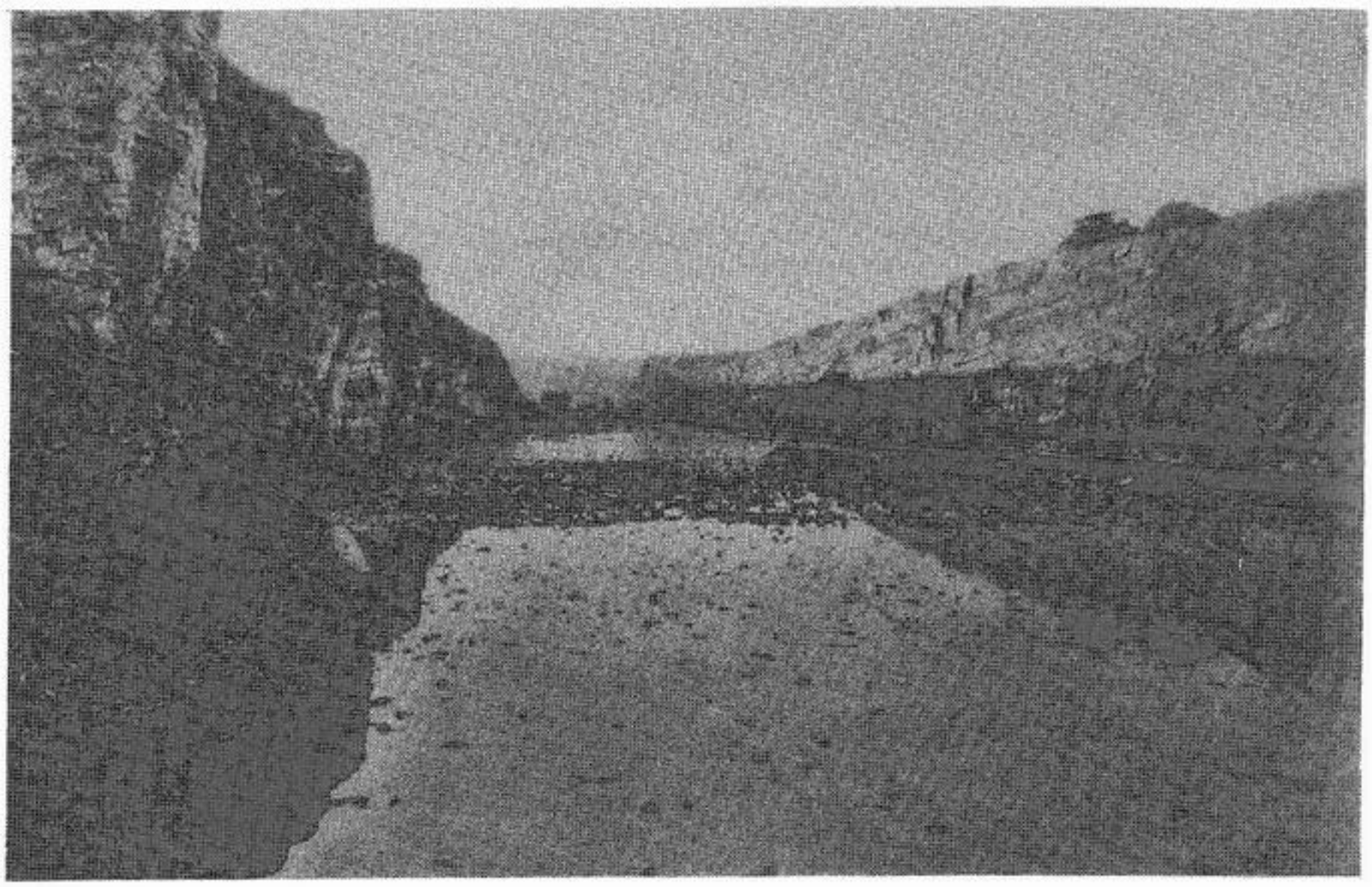
One of the first works undertaken on the Scheme was the construction of a temporary power station at Ardnacrusha (Illus. 14). This was necessary to provide power for all of the electrically powered plant and equipment utilised during the construction work. Without this equipment, the completion of the scheme would have taken a much longer period to accomplish. Nine diesel driven generators were installed, with a total output of 4,200 horse-power.

Workshops and Stores

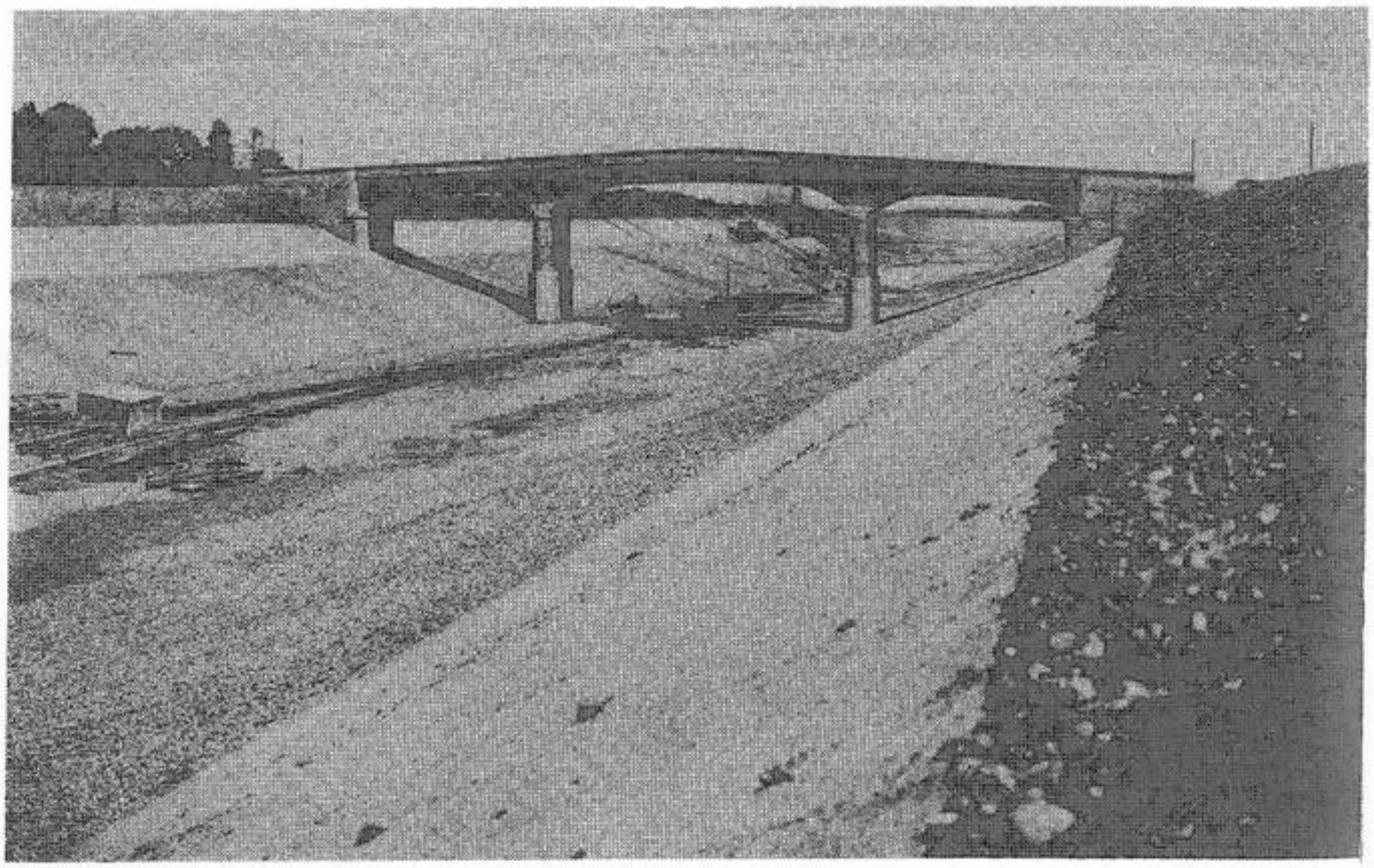
All of the machinery used for the civil engineering works described above had to be imported from Germany. In order to eliminate delays in obtaining spare parts, a large stock of parts for all the machinery had to be maintained. Special facilities had to be provided also for the storage of oil, coal, cement and timber. In addition, workshops had to be built. The mechanical workshops (Illus. 17) included a smithy, tool-making and welding departments, and a general repair shop. A carpentry workshop had to be provided to cut down timber for use in shuttering and formwork, as well as for general building work.



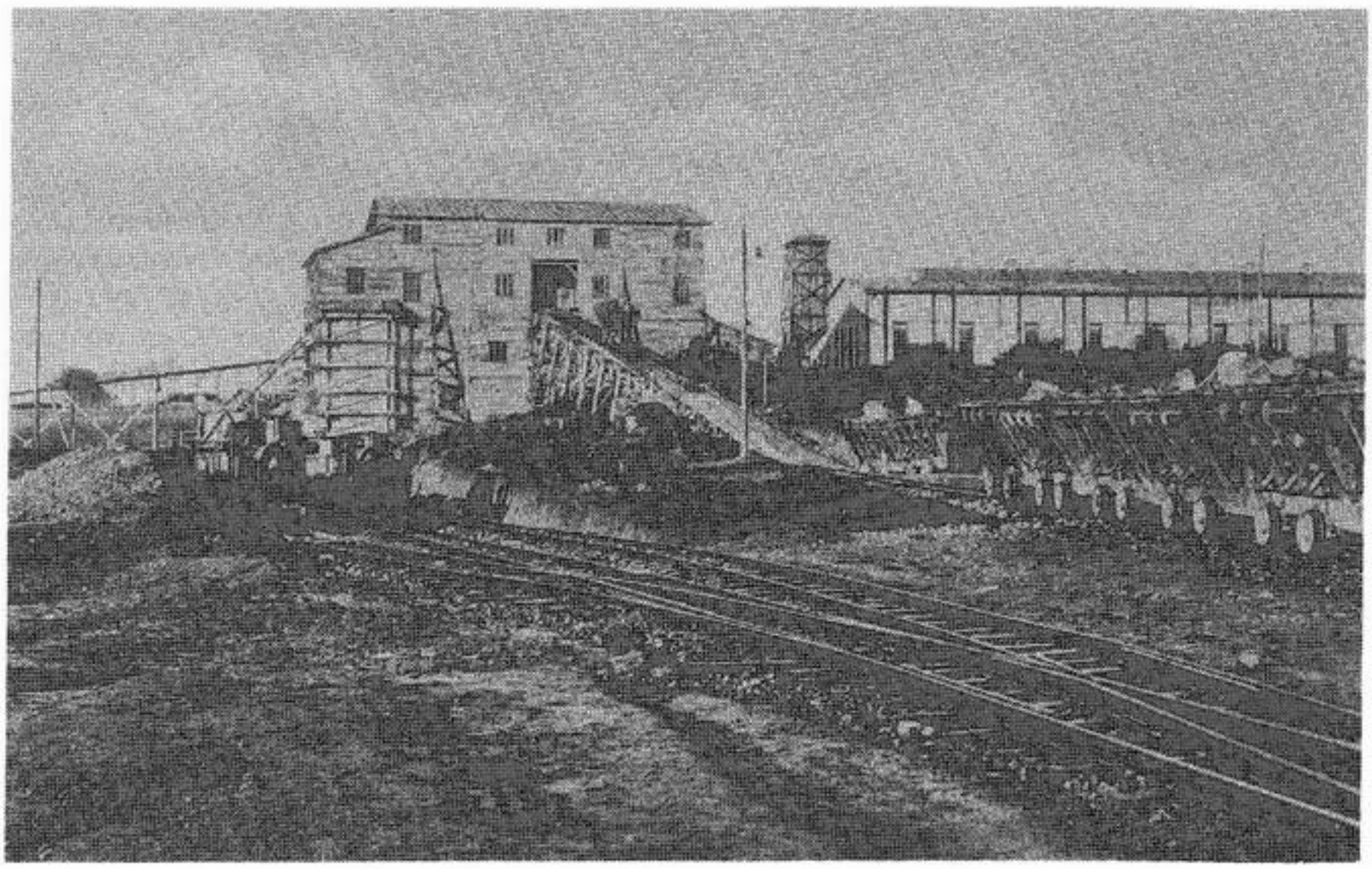
Illus. 17. Interior of mechanical workshop.



Illus. 18. Finished rock excavation in the tail-race near Clonlara.



Illus. 19. Blackwater Bridge and finished faces of the embankments.



Illus. 20. Stone-crushing plant at Ardnacrusha.

Stone Crushing Plant

During the course of the works, huge quantities of material had to be excavated. All of this material was re-used during the construction work. The top-soil removed was used to dress the outer faces of the embankments, whilst the underlying earth was utilised in their construction. The excavated rock was taken to stone crushing installation to be broken down into sand, aggregate and rip-rap. Some 350,000 cu.m. of rip-rap alone was used for dressing the inner faces of the embankments and the sides and bottom of the head-race canal. The aggregate and sand were used in the manufacture of concrete. Three large stone crushing units were installed on the Scheme, at O'Brien's Bridge, Clonlara and Ardnacrusha. The Shannon Scheme railway was used to convey the rock to these locations, where it was crushed, graded and washed to remove impurities before being stored in silos for re-use. The plant at Ardnacrusha (Illus. 20) was capable of producing some 50 cu.m. of sand, aggregate and rip-rap per hour.

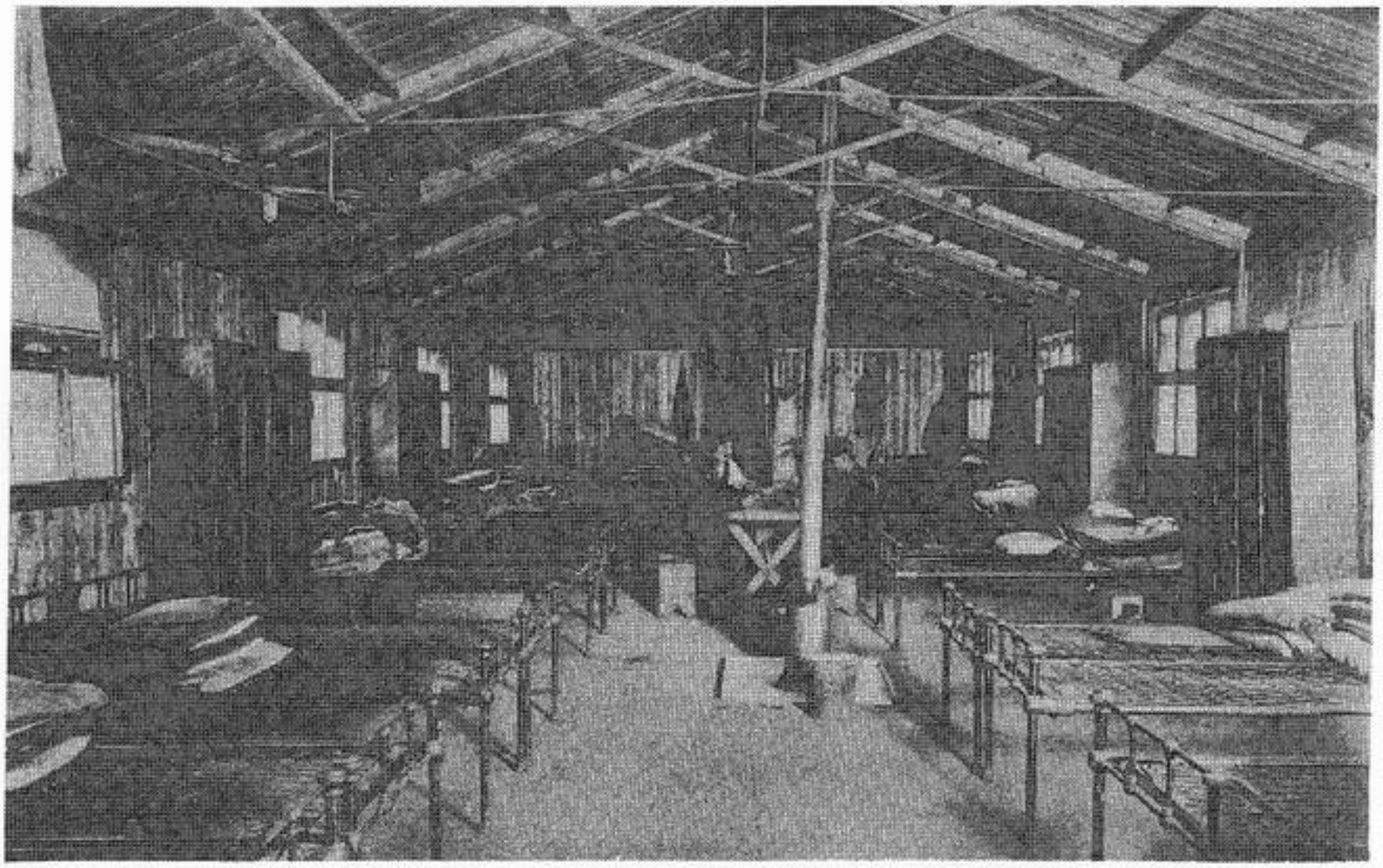
The men who built the Scheme

To attribute the successful completion, on time, of the Shannon Power Scheme solely to German efficiency and technical expertise is an over-simplification. The original concept and driving enthusiasm for the project came from an Irishman, Dr. T. A. MacLoughlin, whilst the goad to succeed was applied by Patrick McGilligan and the Government. Indeed, the Government's determination that the Scheme should be completed on time was so strong that they threatened to invoke the contractual penalty clauses if the completion date was not met. MacLaughlin insisted that where suitably qualified Irishmen were available they would get preference for employment. The issuing of work permits to German technical staff was strictly limited, and one ship-load of such staff had to return home without disembarking because the necessary work permits had not been issued. MacLaughlin's

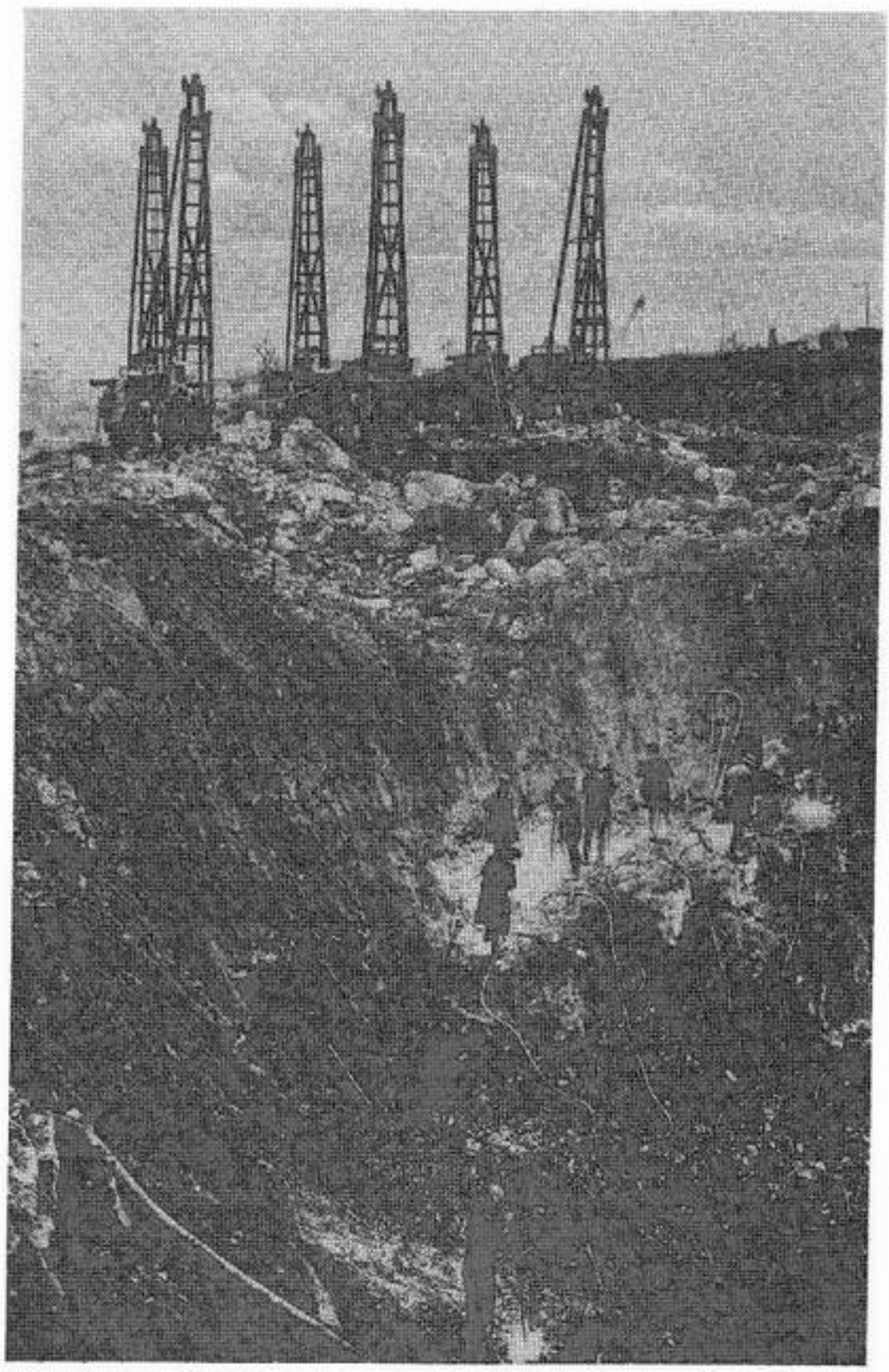
insistance on preferential employment status for Irish people was a wise one, as it created a pool of highly skilled personnel from which the E.S.B. recruited the staff it needed both to run the power station when completed and fulfill its obligations to establish and manage the national electrical supply system.

The vast majority of the workforce were Irish. These men came from many backgrounds and from the four corners of the country to seek employment. A large group of ex-servicemen from the Irish Free State Army was taken on, as were many of the engine drivers from the Lartigue Railway which had closed in 1927, fishermen from Connemara, and small farmers from Roscommon and elsewhere. The workforce was drawn from virtually every large town in the country. At the height of the Scheme over 5,000 men were employed. Some, though limited, accommodation was provided for the workforce, in three camps specially set up for this purpose. The largest of the camps was at Ardnacrusha, and had accommodation for 750 men in seven large and four small huts. Most of the large huts contained three rooms, each of which could accommodate thirty men (Illus. 21). The camp also contained a bath house, a large recreation hall, a dining hall capable of seating 600 men, a large kitchen, a canteen and a provisions shop. In addition, cinema and concert performances were provided at weekends. A camp library and a games room were also provided. A camp doctor was provided to look after the health needs of the men, and the camp was run by an Irish camp commandant. Smaller camps were provided at O'Brien's Bridge and Clonlara; at the former a disused mill was converted into a dormitory building.

The camps, however, could only cater for less than one-third of the total workforce, so many men had to make do with whatever temporary accommodation they could get. This 'accommodation' varied from place to place, and in some areas consisted of disused pigsties or stables. One farmer charged two shillings (10p) a night for sleeping accommodation in his stable, which often housed fifteen men. An infamous location was



Illus. 21. Interior of workmen's accommodation hut at Ardnacrusha camp.



Illus. 22. Rock boring using compressed air.

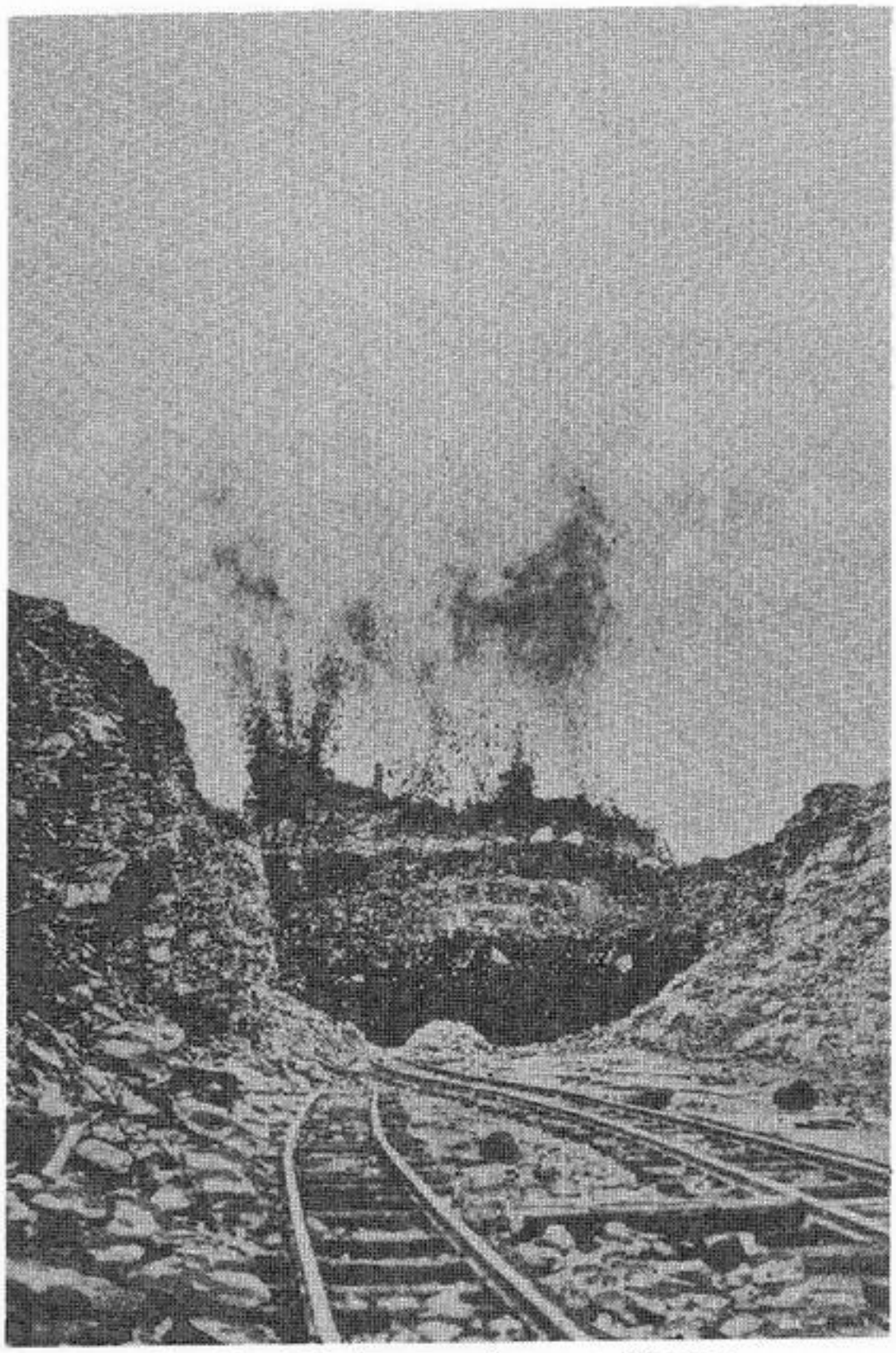
a farmyard and stable near Blackwater. Here, in 1928, a total of ninety-four people comprising twenty-one different family units rented accommodation at £1 per family, a week. Dr. Enright, the Medical Officer for the district, reported in February of that year that one typhoid sufferer had to be removed to hospital from these, far from select, accommodations. For those unlucky enough not to have a place in the camps, there was at least the chance of having subsidised meals at the canteen for eleven shillings and eightpence (58p) per week. However, the rate of pay was only thirty-two shillings (£1.60) per week, so many of the men had little chance to save or send money home. The rates of pay led to a strike at the commencement of work in 1925. However, the workers demand for parity with the going rates in Counties Limerick and Clare was not conceeded and the strike eventually fizzled out in early 1926.

The German workforce had better accommodation facilities than those available to the Irish, but then it was much easier to cater for them as they were a far smaller number.

Certainly, it would have been difficult to attract the skilled engineers, technicians and site managers from Germany without reasonable facilities being provided to cater for them. Many of the Germans brought their families with them and they were provided with housing at their camp at Ardnacrusha. A school with a German school-teacher was provided for the children. With typical efficiency, delicatessen foods were laid on, and the German engineer's canteen at Doonass House was well stocked with wine. They forgot, however, to obtain a licence, and a group of German engineers, scientists, and electricians were prosecuted under the Sheebeening Acts and 1,400 bottles of wine were seized. The unfortunate mess steward was fined £10.

Acknowledgements

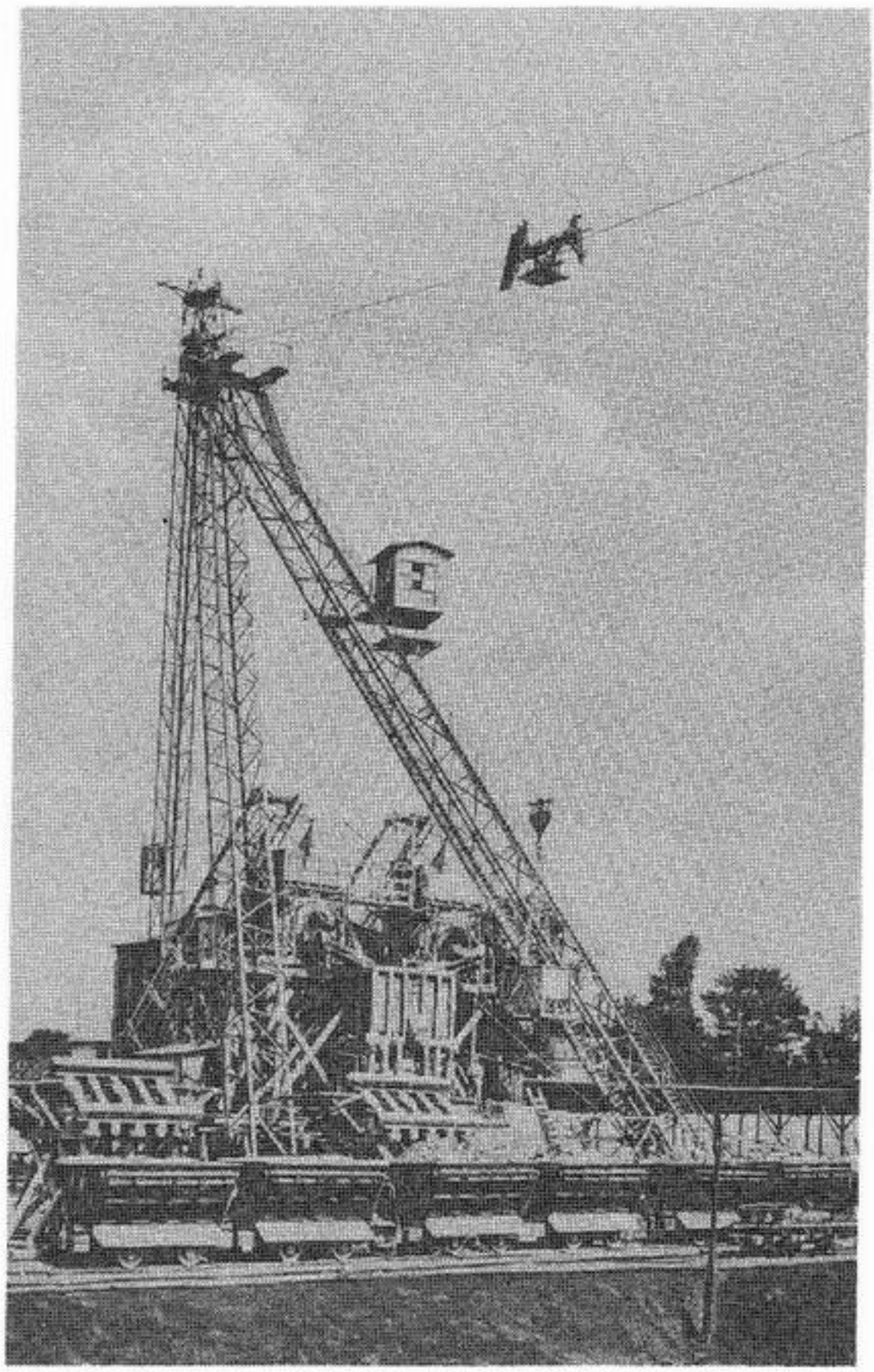
The illustrations are all from post-cards issued during the construction works at Ardnacrusha. Special thanks are due to His Excellency the late Dr. Michael Rynne for generously presenting me with those used for Illustrations 2, 8, 9, 10, 12, 18 and 19.



Illus. 23. Blasting operations near Clonlara.

EPILOGUE

On Monday, 22nd July, 1929, the official opening of the Shannon Scheme took place when Premier Cosgrave of the Irish Free State Government, by pressing a switch, opened the sluices in the intake at Parteen Villa and water began to trickle into the head-race canal. By October of that year electricity was being generated at Ardnacrusha and the Shannon Scheme came under the control and management of the fledgling E.S.B.



Illus. 24. Electric tower crane with concrete mixing plant.

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