The Evolution of a Water Power Scheme.

1854-1921.

Henry Ballantyne & Sons, Limited,
WALKERBURN, - - - SCOTLAND.

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Hydraulic Engineers:

Boving & Co., Limited,

56 Kingsway,

London, W.C.2.

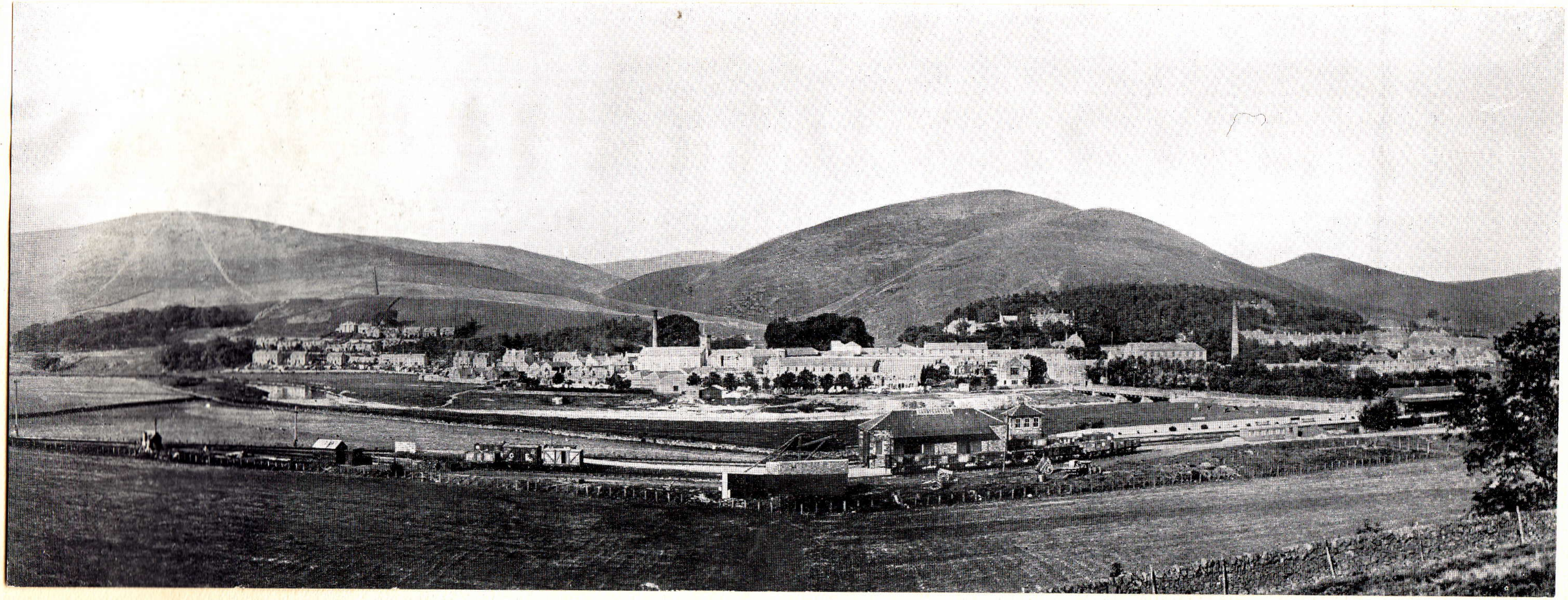
Henry Ballantyne & Sons, Limited,

Tweedvale Mills and Tweedholm Mills,

WALKERBURN,

PEEBLESSHIRE,

SCOTLAND.



Introduction.

ON the completion of a novel and somewhat enterprising Hydro-Electrical Power Scheme in connection with our two mills in Walkerburn, we take the opportunity of producing this series of progressive photographs and explanatory letterpress which may prove interesting and be the means of correcting certain misconceptions which have become current regarding the functions and design of the plant.

It is not within the scope of this brochure to enter into a highly technical description of the governing principles of the scheme, but the following will enable the reader to grasp the general working ideas.

Formerly Tweedvale Mills and Tweedholm Mills shared the use of the mill lade from the River Tweed, the former operating a pair of breast wheels on the upper fall of 5 feet 4 inches, and the latter, a pair on the lower fall of 4 feet $10\frac{1}{2}$ inches. The total power derived from these sources was estimated at 110 horse-power.

In order to do away with all steam, oil and gas engines, it was found necessary to obtain from water alone approximately 450 horse power.

The well-known Hydraulic Engineers, Messrs Boving & Co., Ltd., of 56 Kingsway, London, were consulted, and they, after surveying the whole situation, produced the scheme which is now in operation.

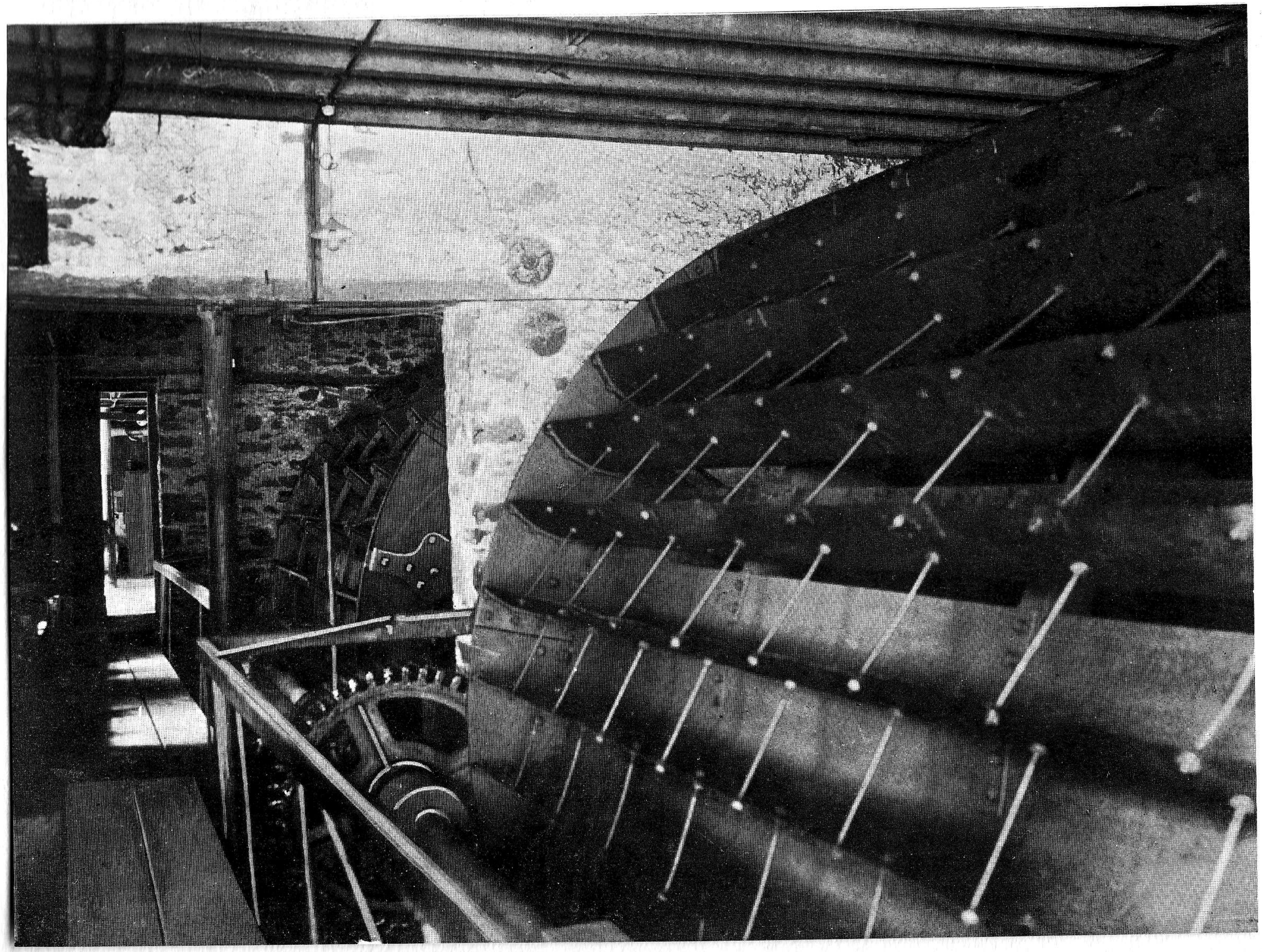
This scheme, which had for its object the continuous use of the water power available, required the uniting of the two falls by deepening the channel between them. The lower wheel house and all four breast wheels were demolished and the upper wheel house was converted into a central power station in which were installed the two low-pressure turbines which provide the initial power. These two turbines are capable of generating together 220 horse-power. It will thus be seen that, by the substitution of turbines for the existing water wheels, the original power is doubled, but the total still falls far short of the mills' requirements, namely 450 horse-power. When the mills close down this amount of power (220 horse-power) would normally run to waste throughout the night and at week-ends, it being impossible to store the large volume of water in the Tweed. A means was sought therefore of storing this surplus energy during the hours that the mills were not requiring the power.

The scheme decided on may best be described as "The Mechanical Storage of Power." The surplus power available when the mills are idle is used to pump water through a 9″ steel pipeline to a ferro-concrete reservoir, which was constructed on the top of The Kirnie Law, a neighbouring hill at a distance of some 2300 yards and a height of 1000 feet above the power station, or 1450 above sea level. During the working hours this water is allowed to return through the same pipe, feeding a pelton turbine which drives its own generator and produces an additional 230 horse-power. The pumps deliver 440 gallons per minute to the reservoir. This reservoir is 192 feet square by $15\frac{1}{2}$ feet deep, or roughly a capacity of $3\frac{1}{2}$ million gallons, thus taking about 132 hours to fill when completely empty.

During the working hours the low pressure turbines drive a single generator between them, but on the mills shutting down, the belts coupling the low pressure turbines to the generator are moved across to the pump pulleys and the pumps thus start to store the surplus power. On the mills re-starting, the low pressure turbines are re-connected to their generator, and the pelton wheel is started up, these two together giving the total output of 450 horse-power required. The power is transmitted by means of cables to independent motors throughout the mills.

The two main advantages of the system, apart from economy, are cleanliness and regularity of drive. The latter, as every textile manufacturer knows, is an all-important factor in the production of perfect work.

I.



Old Wheel House, Tweedvale Mills.

A VIEW is here given of the old wheel-house at Tweedvale Mills, showing the cumbersome and somewhat primitive breast wheels which have been replaced by the low-pressure turbines.

These wheels had one virtue: reliability. They practically never broke down during the 65 years they were running. Their efficiency of 40% was, however, far less than that of the modern turbine which gives 82% of the power theoretically available in the water.

II.

II.

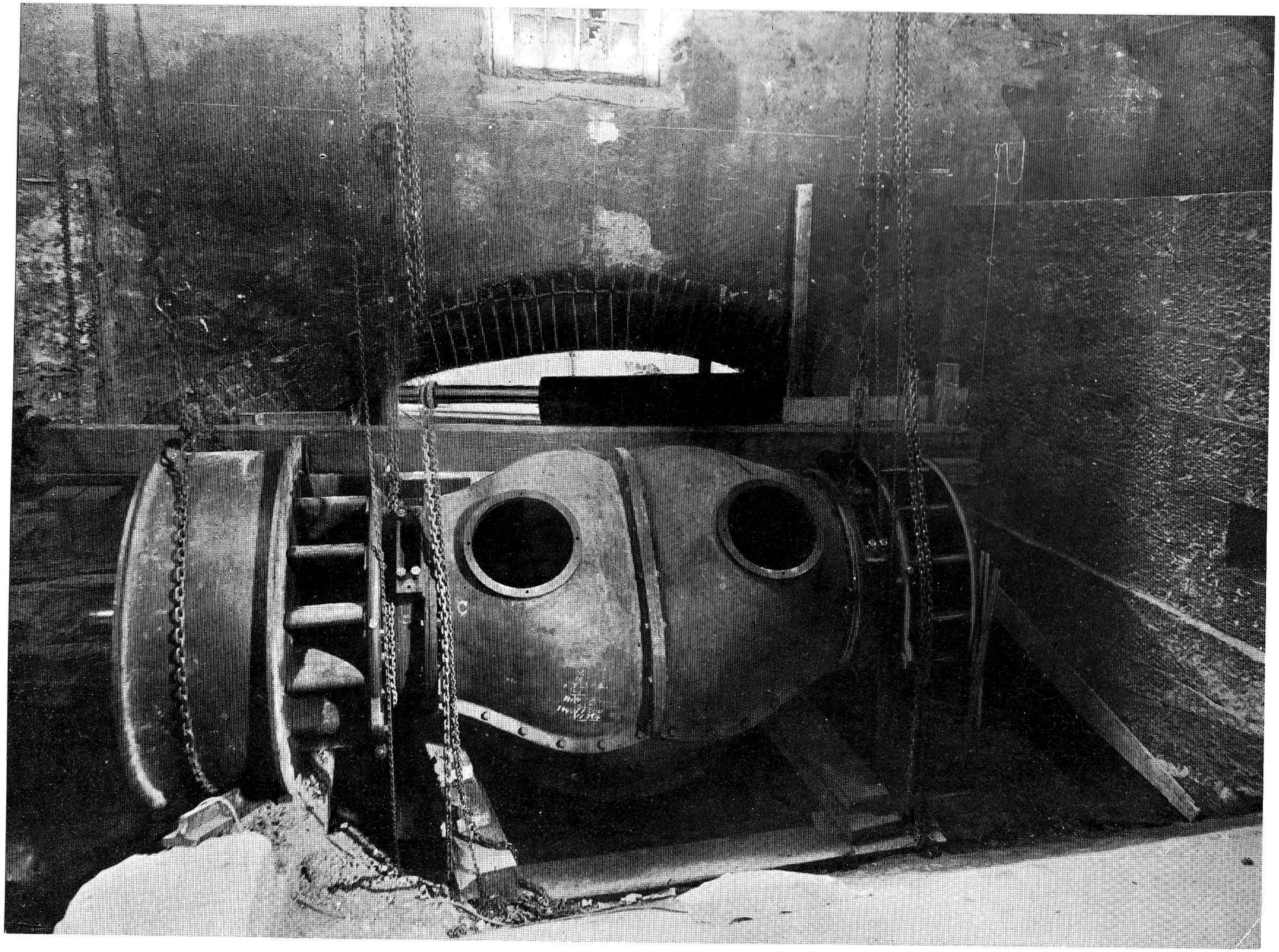
Excavation for Suction Pits. Discharge of Old Breast Wheels,

THE low-pressure turbines discharge through two inclined steel suction tubes into two large concrete pits, whose function is to seal the tubes and also allow the full head to be available for driving the turbines, whilst keeping the turbine shaft above tail water level. The special design adopted has the further advantage of allowing the water to enter the tail race without abrupt change of direction.

These pits are almost bowl-shaped and of considerable area. They are 5 feet in depth below the new level of the bed of the tail race. The excavation underneath and amongst high buildings in a gravelly soil was attended with much danger and difficulty, not the least of which was the infiltration of water from the river. Centrifugal pumps, running night and day, maintained the water at workable level until the two large concrete basins were constructed.

During the course of the excavations the bole of a large beech tree was discovered embedded in the foundations of the central pier of the arch.

III.



III.

Low Pressure Turbine Casing Practically in Place.

THIS picture shows one of the low pressure turbine casings and gives a good idea of the regulation vanes at each end which control the admission of the water to the turbine runners.

The circular openings in the casing are man-holes for inspection purposes and are covered by steel plates when the turbine is in operation.

The vanes are operated automatically from above by means of a powerful oil pressure Governor which ensures that the speed will be constant. The entire casting is submerged to a considerable depth when the plant is in operation.

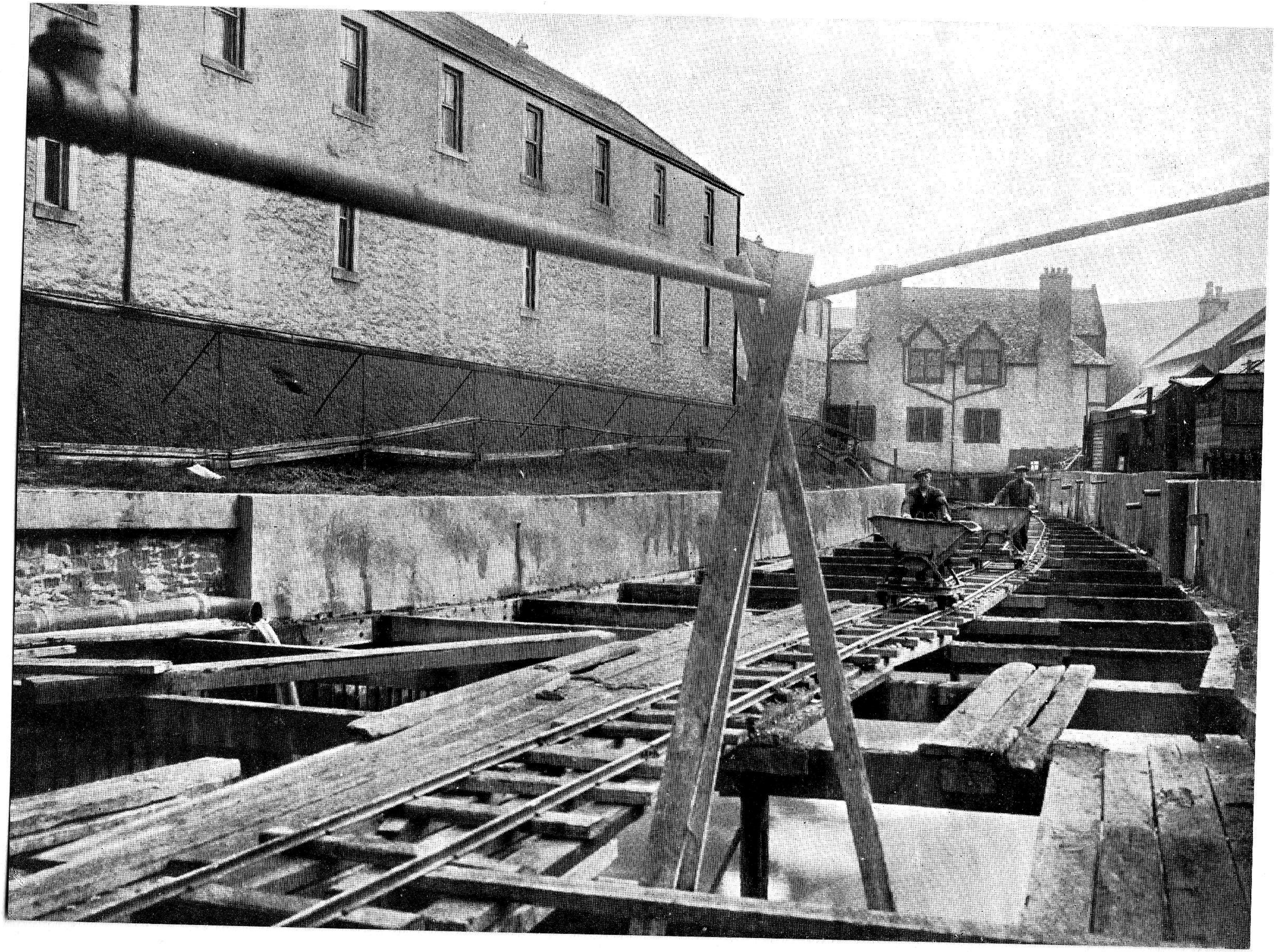
IV.

Old Wheel House at Tweedholm Mills in Course of Demolition.

IN this picture we are looking up the mill-lade and it was from this point that the deepening to unite the two falls was carried out.

The building in the central background is the Ballantyne Memorial Institute and is built on girders across the lade.

V.



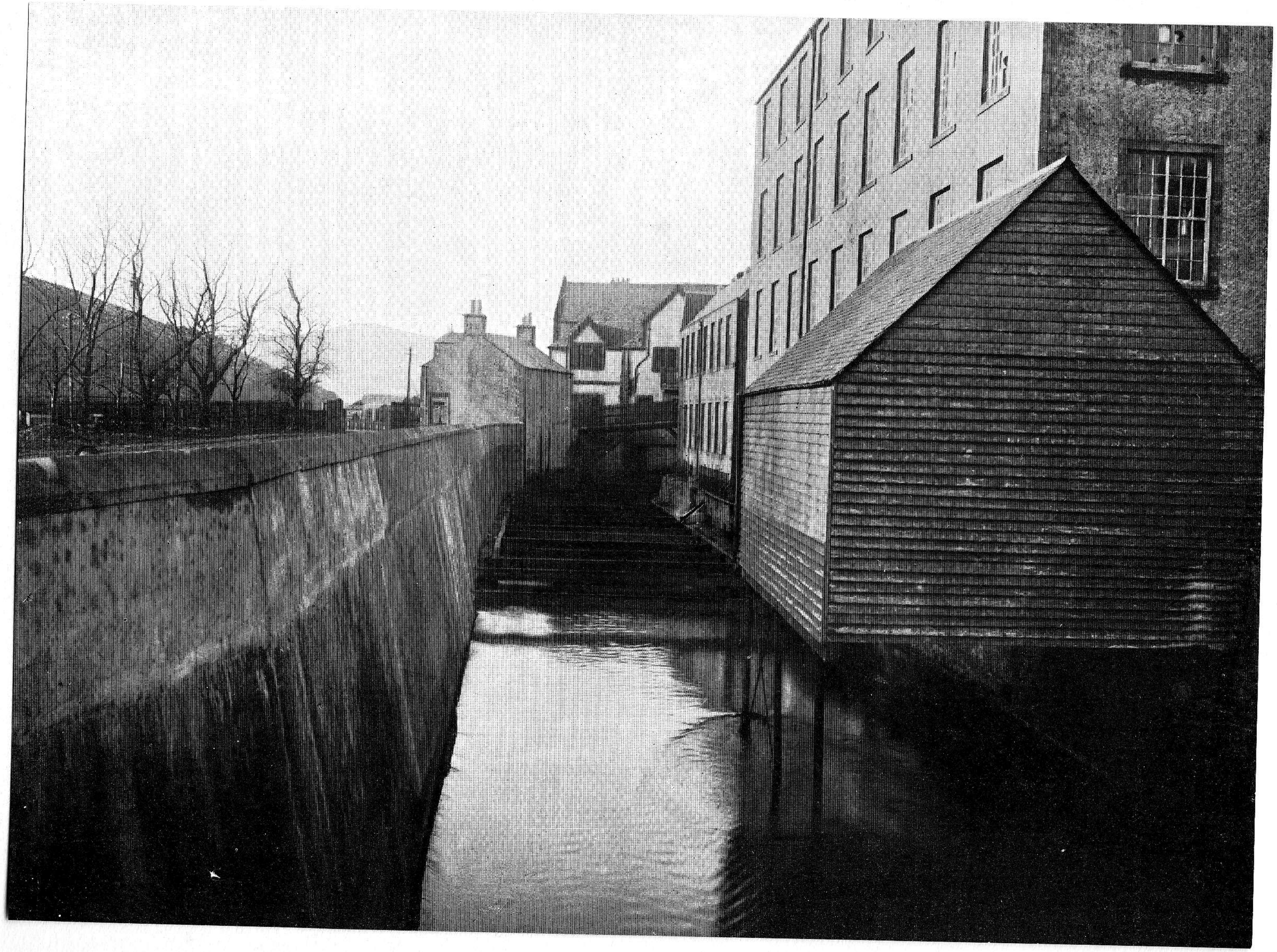
V.

The Lade after Deepening.

THIS view is taken from a point a few yards below the new power station and shows in the left hand corner the steel piling which it was necessary to drive for supporting the sides of the lade before deepening operations could be started. The piles were driven to a considerable depth below the desired new level and are prevented from collapsing inwards by heavy wooden beams at the top.

The temporary railway was laid on these struts and excavated material removed in trolleys. Here is seen the reverse view of the Memorial Institute of plate IV.

VI.

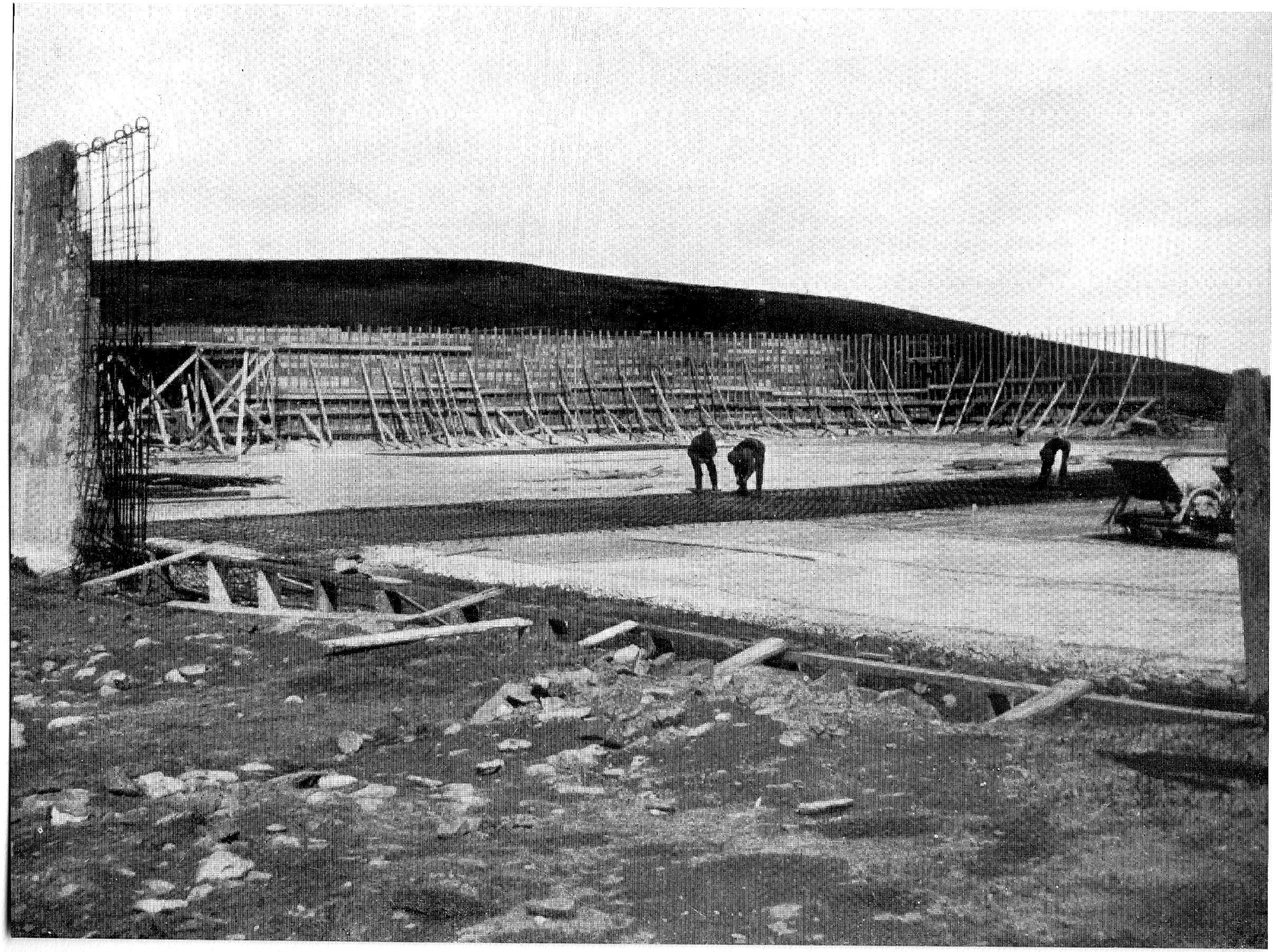


VI.

The Tail-Race at Tweedholm Mills.

THIS view is taken from practically the same point as plate IV. and shows the completed work. The high concrete wall on the left was built to retain the ground made up with excavated material from the lade. The termination of the struts marks the site of the old wheel house and the beginning of the deepened channel.

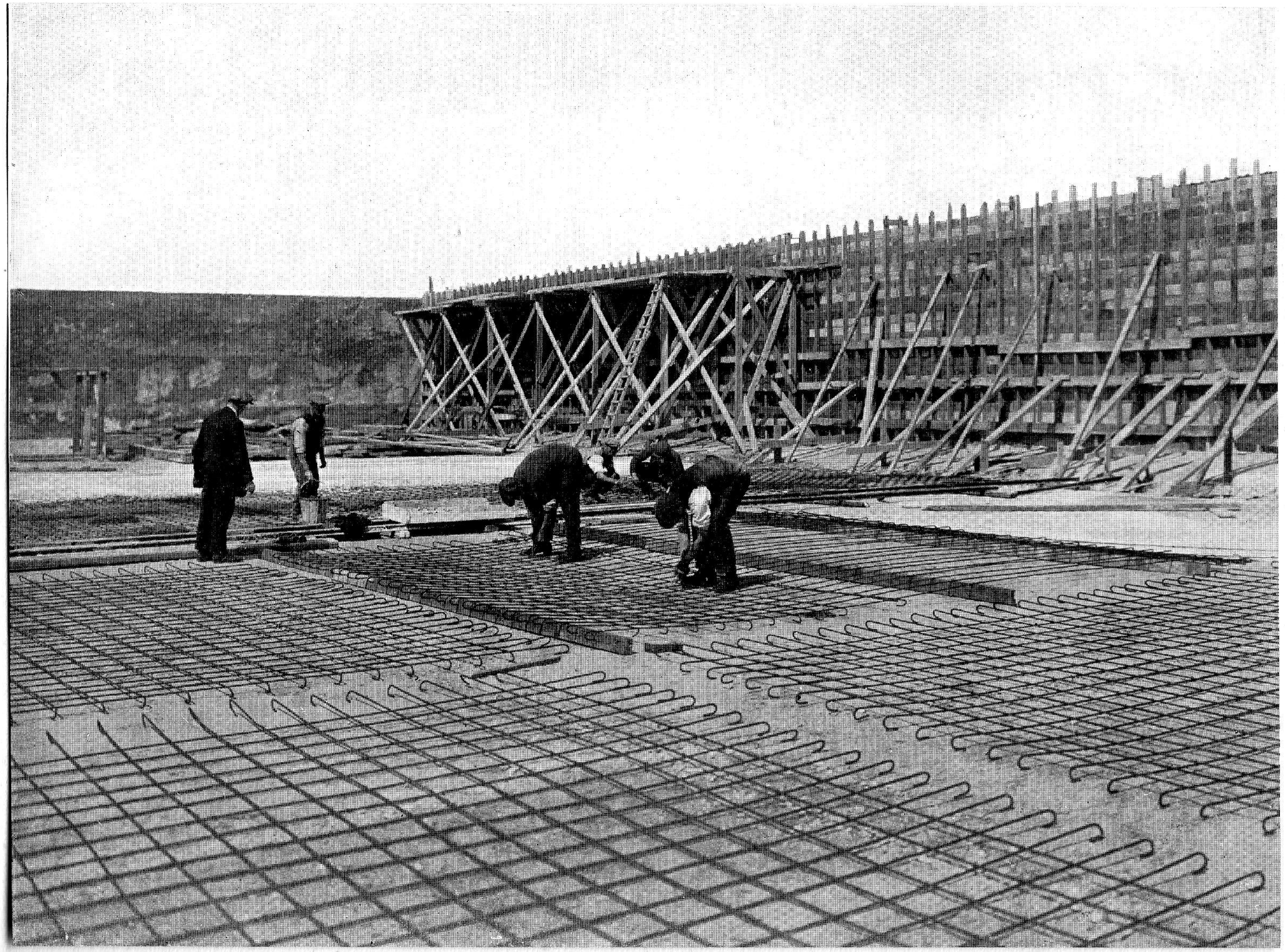
VII.



Reservoir in Course of Construction. 1.

THE reservoir is here seen about one-third completed. The steel rods of the reinforcement may be noted in the unfinished portion of the wall on the left. In the distant wall the reinforcement is seen in an earlier stage before being embedded in concrete.

VIII.



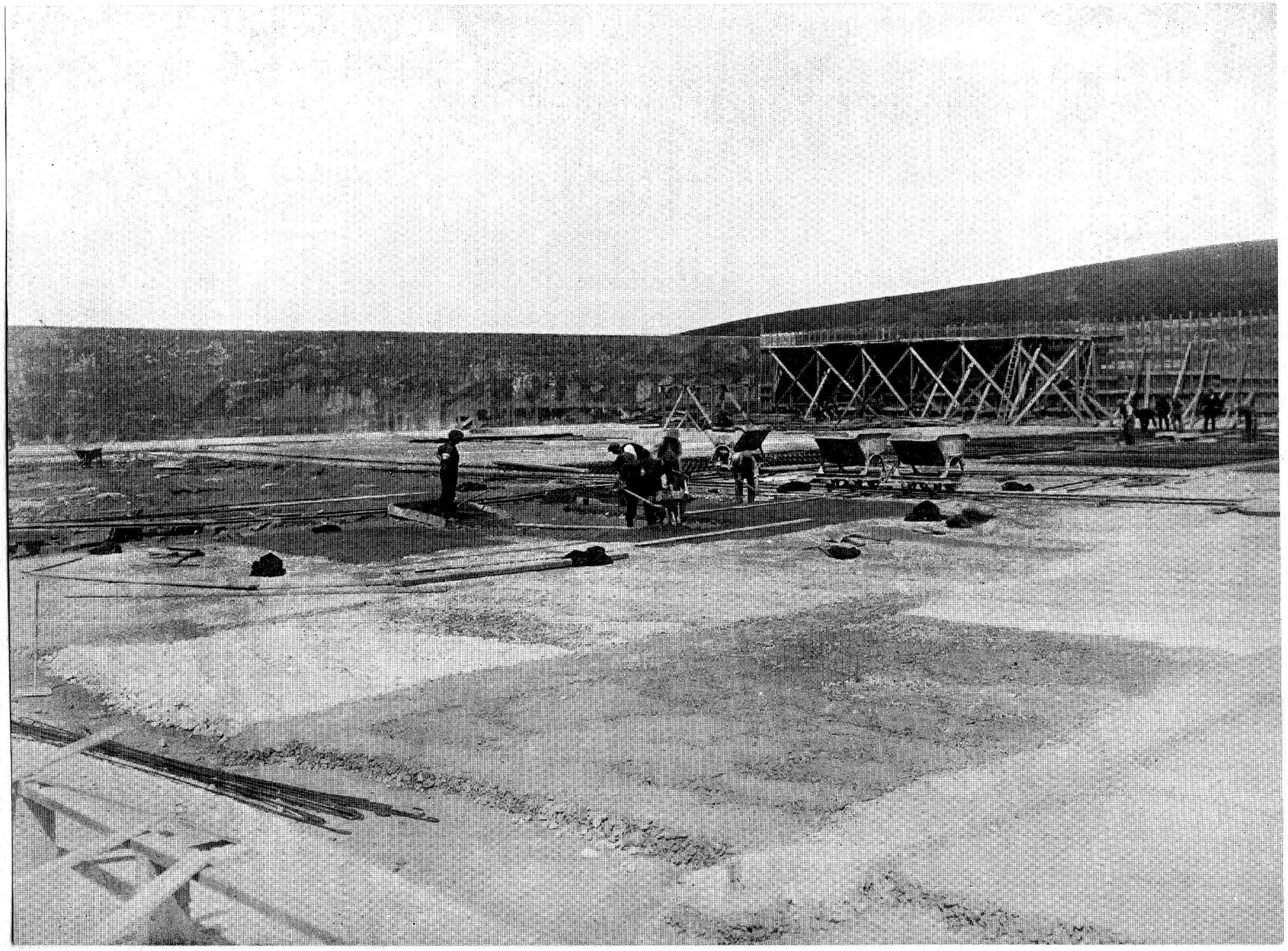
Reservoir in Course of Construction. 2.

THIS view is taken from the inside of the reservoir and more clearly demonstrates the principle of the reinforcement.

The sections being prepared on the floor are eventually linked up to each other and with the reinforcement of the walls. Any local strain is therefore borne by the reservoir as a whole. It is not rigid, but yields gradually to pressure.

The "shuttering" on the wall at the back is to retain the concrete in which the rods are embedded. When the concrete is set the timber is removed and a fine plaster finish given to the wall.

IX.



Reservoir in Course of Construction. 3.

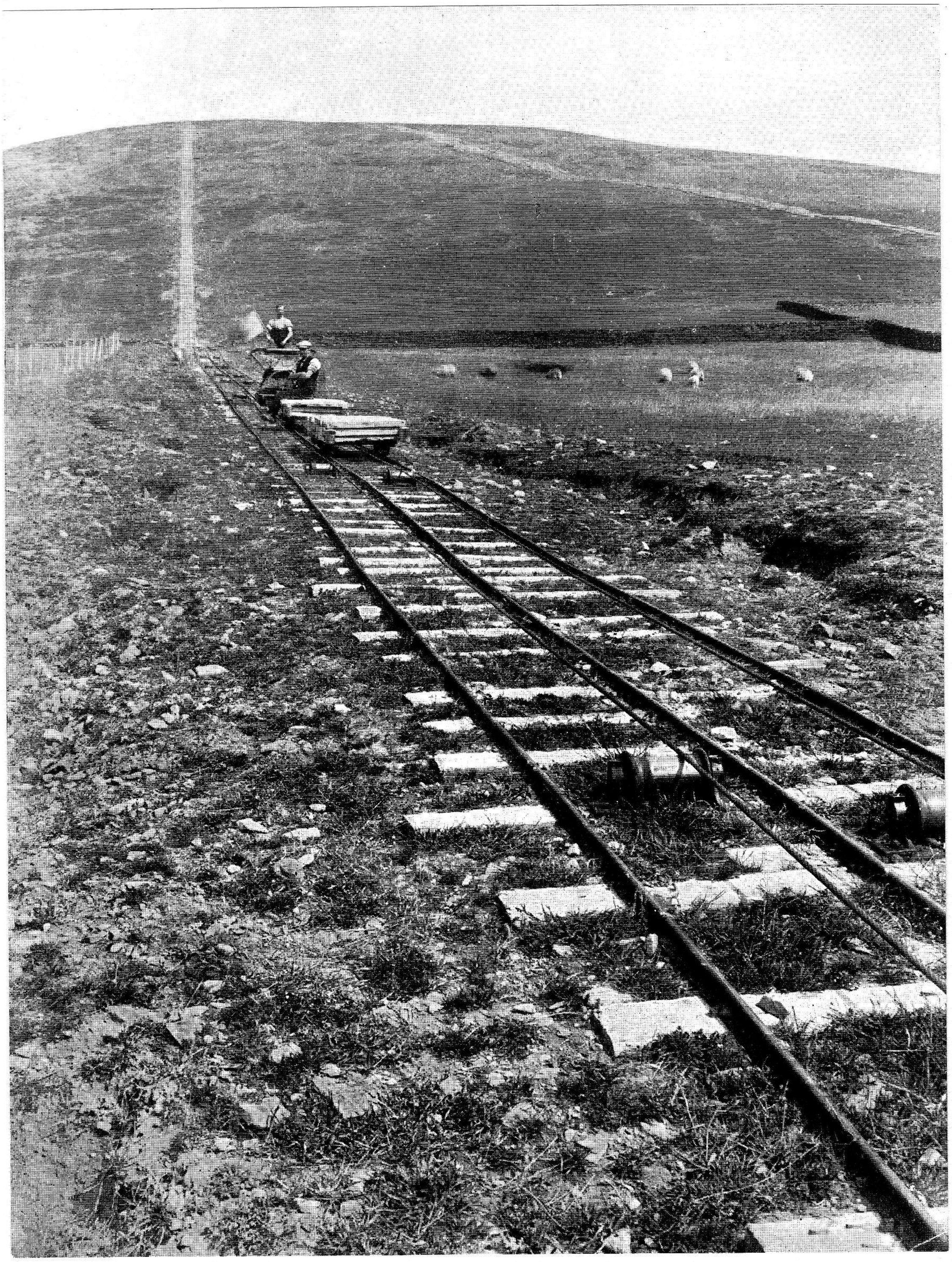
THE floor of the reservoir is here shown at a later stage, the reinforcement being covered by a 6 inch layer of concrete. The whole of the concrete used was prepared on the site of the reservoir, all material having been brought up by means of the wire rope railway.

X.

X.

Pipe Track.

THIS picture gives a splendid idea of the work of laying the 9 inch steel pipe. The packing of the joint flanges is of paramount importance, as any leakage would militate very greatly against the efficient working of the high pressure plant. The rocky nature of the ground rendered the cutting of the track a long and laborious work, care having also to be taken in refilling the trench that boulders were not dropped on the pipe.



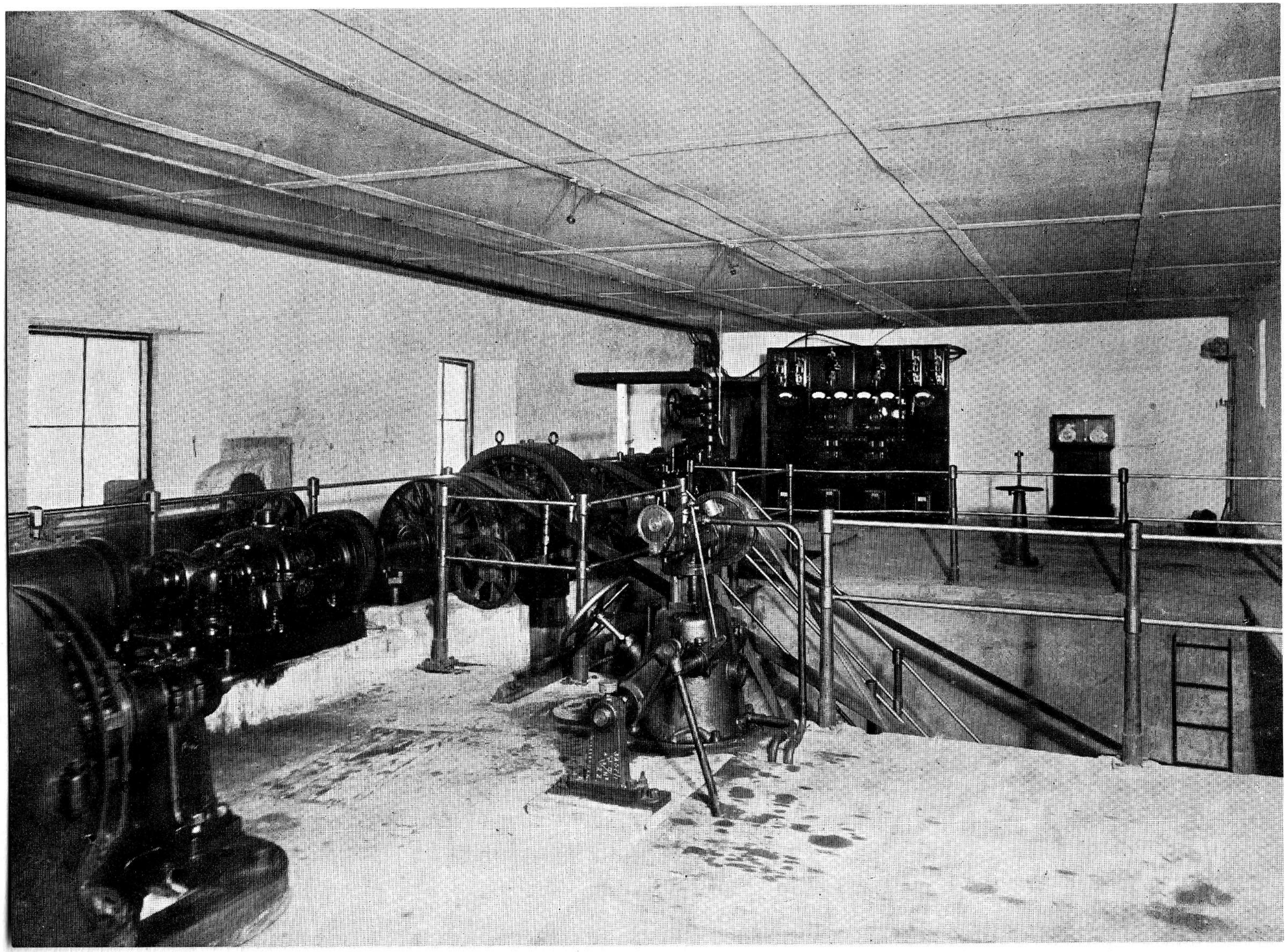
XI.

Service Railway.

A RAILWAY on the funicular system had to be laid from the main road for the purpose of hauling all material to the site of the reservoir.

The materials comprised cement, gravel, sand, steel reinforcements, timber, machinery for concrete mixing, and various pumping and other engines. The total weight thus transported amounted to approximately 3,650 tons.

XII.



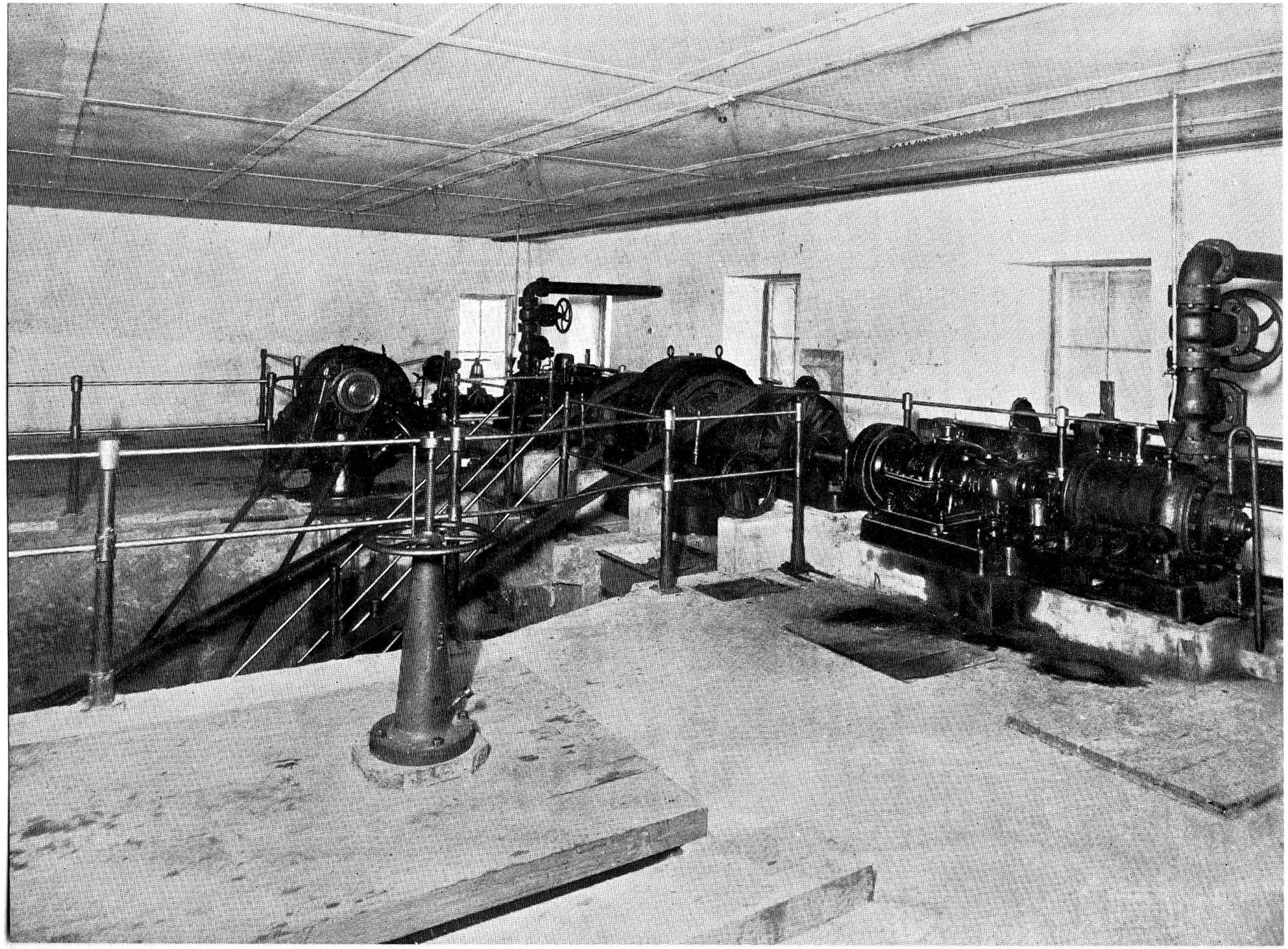
Power House from S.E.

THIS picture shows from left to right, a portion of the base plate and generator of the high-pressure unit, centrifugal pumps and gearing, transmission belts, pulleys and electric generator of the low-pressure turbines, the delivery pipe through which the water is pumped to the reservoir, control switchboard and transmission cables.

A reference to plate XIII., which shews the reverse of the lay-out, will help to make this more readily understood.

In the centre foreground is the Automatic governor of the low-pressure turbines which operates the vanes referred to in plate III. On the right, against the North wall, is an electrically operated instrument which records, on the Barograph principle, the hours of pumping, the volume of water pumped, and the level of water in the reservoir in feet and inches.

XIII.

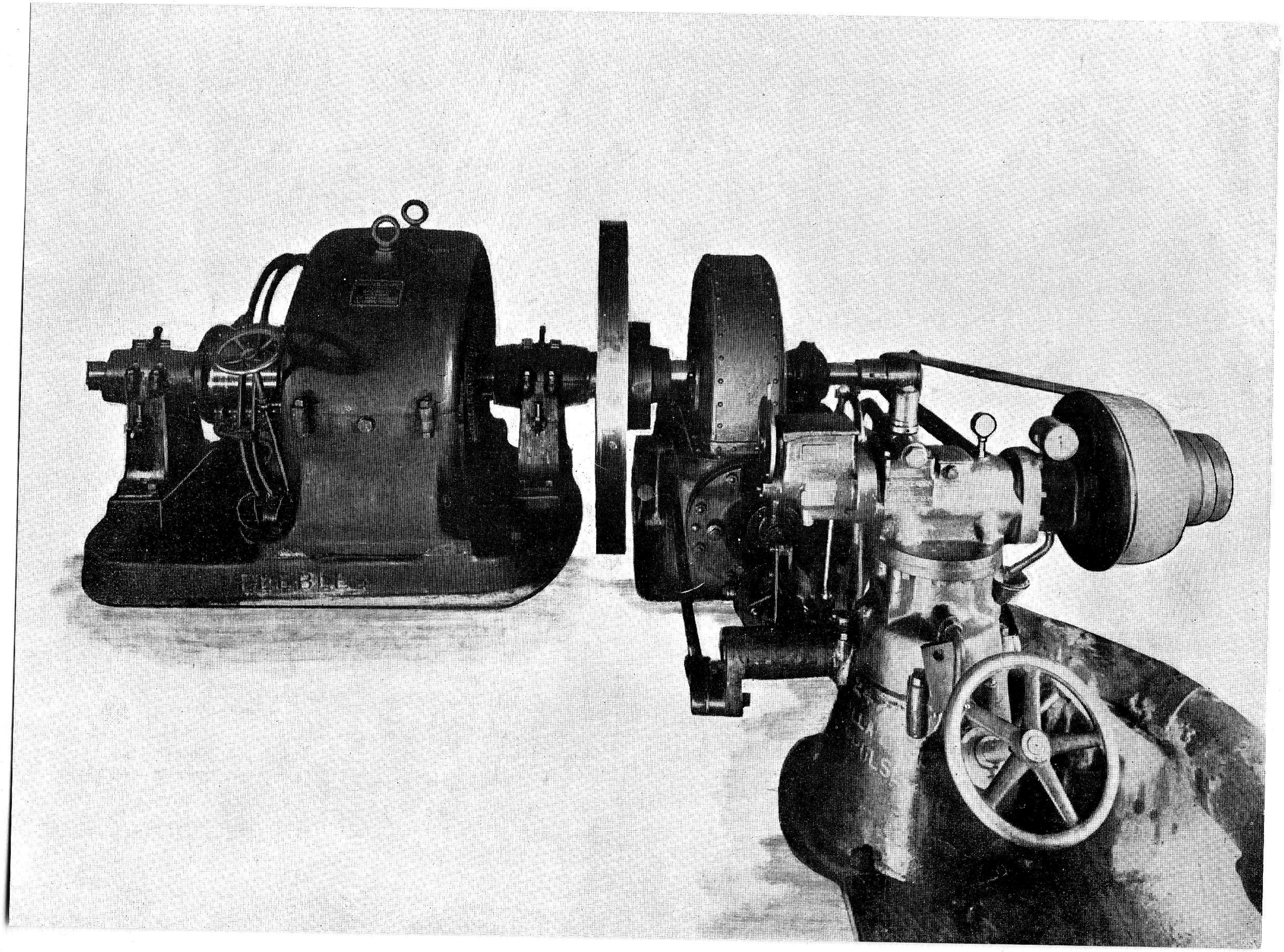


Power House from N.E.

THIS picture, being the reverse of plate XII., only requires description in one or two details.

The column in the near foreground is the hand-operated control of the low-pressure turbines, which is a standby in case of temporary failure of the Automatic governor. On the right of the picture is one of the two seven-stage centrifugal pumps, and a clear view of the two $4\frac{1}{2}$ inch delivery pipes is obtained. These pipes join outside the power station, and delivery is carried on through the 9 inch pipe. In the background is the Pelton Wheel unit, which is shewn in detail on plate XIV. As a protection from fire the ceiling is made of asbestos sheeting.

XIV.



XIV.

Pelton Wheel Unit.

TO the uninitiated the Pelton Wheel is a remarkably compact unit, especially if compared in size to the low-pressure plant. The high-pressure water from the 9″ pipeline, under a head of 1000 feet, issues from a jet $1\frac{7}{8}''$ in diameter at a velocity of 244 feet per second, or more than $2\frac{3}{4}$ miles a minute, and strikes a series of buckets, which are mounted on the circumference of a wheel, with terrific impact. The machine shown runs at 1000 r.p.m. and develops 230 horse power. This represents energy returned from the reservoir during the working hours, being derived from the surplus energy stored during the idle hours by means of the pumping plant described earlier.

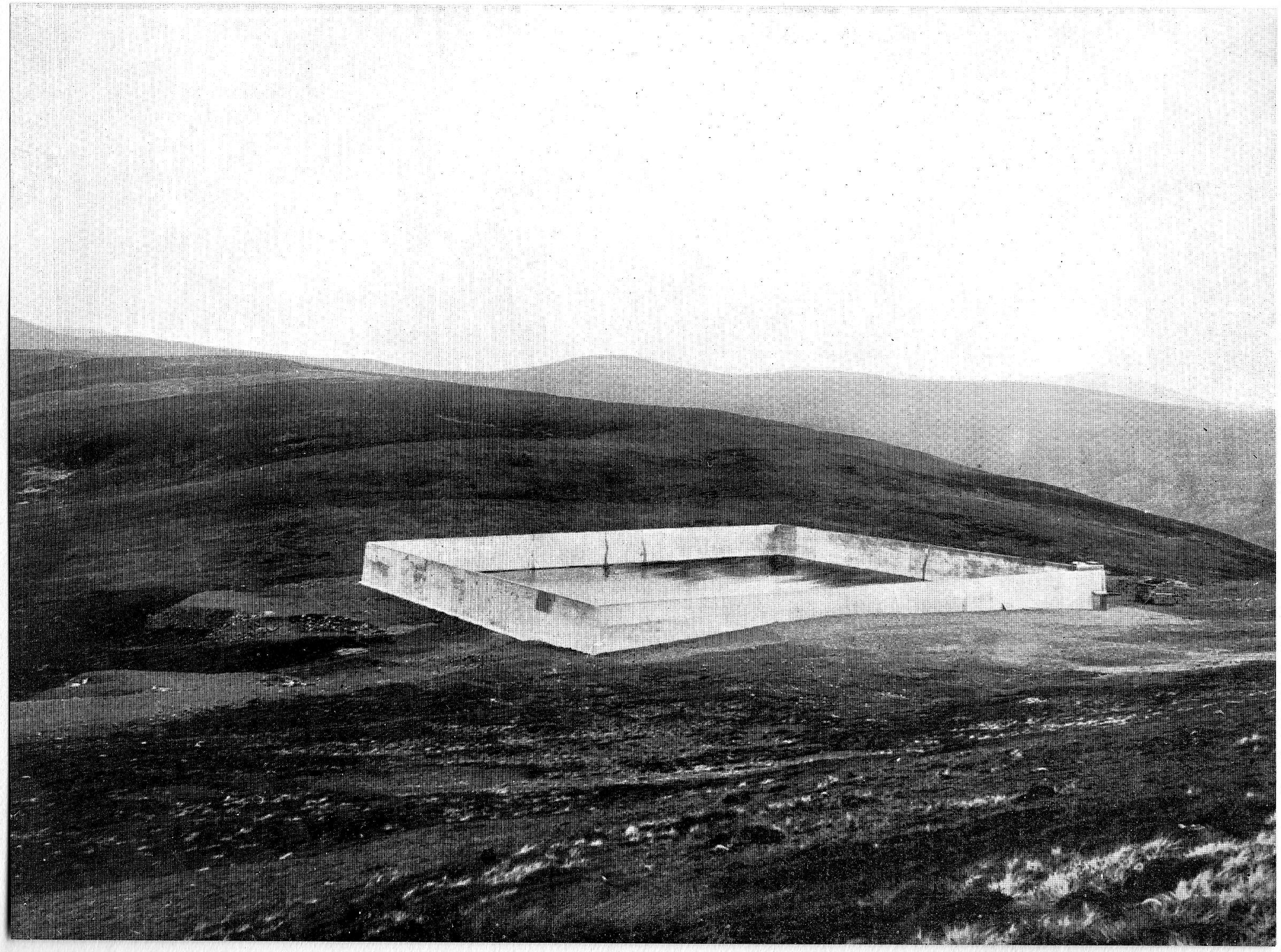
The rivetted metal casing in the centre of the picture contains the Pelton Wheel itself; on the left of this is the fly-wheel, and on the left of that again the electric generator. In the foreground is an automatic governor of the same type as that shown in plate XII. The delivery pipe from the reservoir to the nozzle is just distinguishable on the extreme right.

XV.

Railway at Summit.

THIS view is taken at the highest point of the railway. The reservoir is some 50 feet lower on the other side of the hill. A wide vista is obtained of the Border hills, the famous triple peak of the Eildons being just visible on the horizon. The breeziness of this elevation was sufficient at times to overturn loaded trolleys.

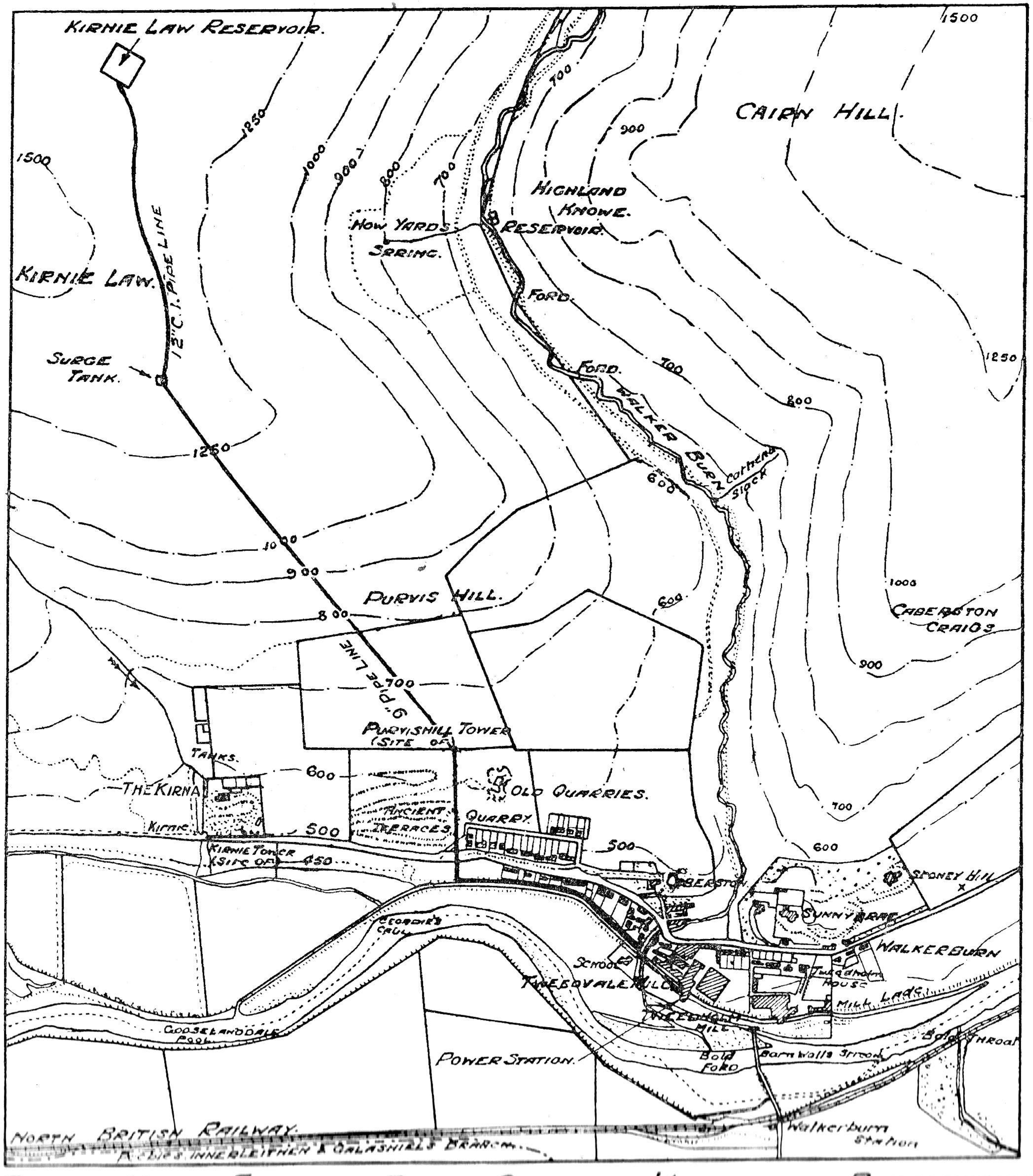
XVI.



Kirnie Law Reservoir.

THE completed and partially filled reservoir is here seen. At the right hand bottom corner are situated the outlet and inlet valve and electrical recording appliances in connection with the instruments shown in plate XII.

Amidst the solitude of the hills not a human habitation is visible, nor a sign of man's handiwork save the huge tank itself. When full, its 3½ million gallons of water represent a potential power of 230 horse power for 60 hours continuous running.



PLAN OF HYDRO ELECTRIC POWER SCHEME, - WALKERBURN PEEBLESSHIRE

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