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THE RECOVERY OF THE PUMPS FROM WILLS FOUNDER SHAFT - WINSTER

by L. Riley. Note on pumps by L. Willies

ABSTRACT

The second phase of recovery of the Wills Founder water pressure engine and pumps took place during summer 1978, and resulted in the excavation of washed-in sand to a depth of 96 feet below the engine chamber. The top lift of pumps was lifted but the other remains in place. A depth of 465 feet was reached.

As members may recall, the society raised the Water pressure engine from Wills Founder mine during 1976 and it now stands in the museum at Matlock Bath. At that time it was not possible to go any deeper in the shaft due to the accumulation of sand and silt around the engine; indeed it took four days to dig out the base of the engine. The rods, pipes and pumps beneath therefore had to remain for the time being. There was much speculation, calculation and guessing as to the depth of the shaft below sough level and eventually the figure of 120 ft was used as a basis for operation. As it was to turn out we were wrong.

During the intervening two years much consideration was given to devising a suitable system for pumping out the filled shaft. The fill in the shaft was mainly sand and mud with very few larger stones, and once in suspension in water we expected to be able to pump it out. After a brief calculation of the shaft volume (approx. 250 cubic yards) it was decided that this volume of sand could be accommodated in the blind winze and its access level both of which were pumped dry and explored in 1976 (see diagram).

Since the 1976 project several items of extra equipment had been obtained including a 3 ton headgear, 20 KVa generator, heavy winch and a compressor. This meant that the project was not so limited to a short time scale as previously. The shaft was inspected at regular intervals during the spring of 1978 so that as soon as the water receeded to its summer level work could proceed at weekends with the installation of timberwork, cables and other fixtures. It was June before much could be done but meanwhile the equipment was being built and serviced at Magpie. Cables and compressed air pipes were installed first followed by a large wooden platform at sough level with a 15 feet long R.S.J. above to allow people in the chamber to work over and in the shaft with safety. The new headgear, generator and other technical equipment was beginning to assemble on site and finally a site cabin and tarpaulin shelters were erected. All was ready to begin the full time working at the beginning of the third week in August. During the first three days there were many technical problems much to everyone's disgust. However, on the fourth day, the equipment did not break down so much, so it was decided to work round the clock to make up time. There were sufficient people available to divide into three teams, each team generally of four persons, one on the surface, one in the chamber controlling the water and pumps and two in the sump with the suction pipe and water-feed pipe. These teams worked six hours underground followed by twelve hours off, continuously for six days. During this period help was received from casual workers who filled odd spaces in the shift rota and eased the work of the regular members. Progress downwards was slow but steady, and although some delays were caused by technical problems, inch by inch the rising main of the pump was uncovered, each pipe being 9 ft long with flanged joints. After a while access to the sump became difficult due to depth and so a "fixed" ladderway was constructed down the side of the pipes from the chamber.

The conditions at the bottom were described in various ways, 'grim' being about the most polite. Because of the hours worked such items as dry suits very soon wore out. The only bright spot in a shift was the tea and sandwiches wound down halfway through and each man would take it in turns to have his break whilst the others kept the pump running. Unfortunately during the second week there was a shortage of people to work and the pumping was restricted mostly to two shifts per day.

After two weeks of work, on the Sunday afternoon, the message came from below that the pipe below the newly uncovered flange was of a smaller diameter than the rest of the column. The depth by this time was about 80 ft from the chamber.

Encouraged by the fact that we must be uncovering the barrel of the pump some work was done during the third week but many people had by now returned to their regular jobs. However, the shaft was still dry ready for the weekend. This was a problem encountered every Friday from then on. During the week the shaft refilled with water to sough level and had to be drained before work could proceed on Saturday. Some of our members with more flexible working arrangements would start the pump on Friday afternoon and it would be left running all night.

Several weekends of pumping finally revealed the pump barrel, clacks and cistern leaving the final depth of the shaft which was reopened at 105 feet below the sough (465 feet from surface), being about 8 feet x 6 feet in section except at the top and cistern. By this time it was late October and it was decided to remove the lift of pumps immediately and to suspend pumping out for the second lift.

Whilst the finishing touches were being applied to the new heavy winch the column of pipes was chained to the wall and timbered to prevent movement during dismantling. Also equipment and fittings were rearranged to permit lifting through the platform in the chamber. To allow access to each joint in turn down the column of pipes a raft was built, and as the water was pumped out, safe access to each joint was possible as the raft floated down. The joints were secured by bolts which were cut away with oxy-propane burning equipment, except for those on the pump itself which were undone and saved for reassembly. With the practice of lifting the engine previously, the pump proved to be no great trouble except that minor modifications were necessary to the headgear, which delayed the operation for a week. As the sections were brought up they were stacked and finally loaded onto a heavy trailer for transport to the museum for preservation and display.

All that remained to do was to clear up and remove all the equipment that had been brought to the site during the preceding 6 months, a task which was finally completed in the snow on the last weekend in November.

TECHNICAL INFORMATION

Power was supplied by a 20 KVA diesel generator with a manual excitation control which permitted compensation for voltage drop. Also fitted were an earth leakage system and overload fuses. Power was transmitted via the climbing shaft to contactors in the chamber for operating the pumps.

The overall fuel consumption of the generator was 1 gallon per hour. It ran for a total of 550 hours during the project. During full-time working the engine was stopped every 24 hours and the water, oil and fuel checked and general maintenance carried out for about 15 minutes while shifts changed. The pump used for moving the sand was a Mono CD 72 fitted after early failures with a tool steel rotor and soft rubber stator. These, when fitted, reduced the wear tremendously and lasted the remainder of the project. The sand was delivered through a 2 inch alkathene pipe some 180 ft long. At the pump end there was a main flow valve and a relief valve to enable starting under no load conditions and also to prevent syphoning back when the pump was disconnected. In order to fit the pump in the shaft it was mounted side by side with its 10 hp motor and driven by vee belts at a speed of 720 rpm. The pump could only move the sand if it was in suspension in water, so a continuous feed of water was brought from higher up the shaft (40 ft above the chamber), to stir up the sand. This was then drawn into the suction pipe of the pump. The pump itself was suspended by a Tirfar from a girder in the chamber and hung about 15 ft from the bottom of the sump so as to be out of everyone's way. Unfortunately more water entered the sump than could be handled by the pump and also when used for moving the water that filled the shaft during the week the mono pump was very time-consuming. The answer proved to be a Flygt 11 hp twin stage submersible pump. It was able to drain the shaft relatively quickly and also keep the water level constant whilst pumping sand with the mono pump. Also as it would run continuously without water it could be left for long periods without attention. It delivered its water through fire hose, which, through not ideal, was very quick and convenient. Fire hose was also used for the agitation water feed with a short length of pvc pipe on the end to push into the sand. A branch was taken off the water feed to supply clean water to the mono pump inlet direct. This was essential as without water this type of pump will wear out in minutes.

Once the sand and water mixture had been picked up by the pump it was transported to the flooded winze where in the still water the sand settled out almost immediately and gradually filled up the space. The sand-free water was then able to flow down the level to a sand bag dam where it was piped across the wooden shaft cover and down the sough (see diagram).

Other equipment used on the site included, the hydraulic man riding winch built for the original engine project; an Atlas Copco compressor giving 160 cfm of air; a petrol driven 10 cwt materials winch; the diesel driven heavy winch built for this project to lift 3 tons; a Winster, Matlock type loudhailer units in addition to ordinary telephones; and the headgear, which breaks into sections for transport and is designed to lift 3 tons. Much other smaller equipment and home combarts were installed and necessary arrangements were made to floodlight the site at night.

THE PUMPS

Speculation about the total depth reached by the pumps below the engine was based on the known minimum of 100 ft of basalt in the nearby winze, and the Geological Survey note of 120 feet. On the assumption that the two pumps were equally loaded, then the minimum depth of the upper or top lift would be 60 - 70 feet. In the event it was 96 feet below sough level, i.e. it had an effective lift of about 92 feet above the level of water in the cistern. It was thus placed as low, bearing in mind a possible inrush of water, as the miners would reasonably dare: whether this was based on calculations of the basalt thickness at outcrop, or on an exploratory borehole ahead of sinking is not known.

Assuming the same size pumps on the bottom lift, an equal head would require the engine to operate at 45% efficiency, which is within the 50% claimed for the Trevithick engines, and makes a total lift of up to 180 feet feasible. Taking an optimistic view, since the balance bob was attached to the top-lift side of the crosshead, it could well be less rather than more. However, with the Darlington type valve control gear, it would be possible to get more power, but since there are grounds for believing it was still being fitted at abandonment, deeper sinking was probably envisaged, or larger pumps, but was not carried out.

The pump itself is of conventional bucket type design, lifting on the upstroke. The pump barrel is 12 feet x 11½ inch diameter, giving a stroke of about 11 feet. The clack piece and windbone below it sat in a wooden cistern, the whole weight of pump and pump pipes supported by a single 12 x 10 inch beam. The top pipe of the bottom lift discharged via a short wooden launder into the cistern, for which a curved iron splash plate was fitted (see diagram).

The windbone was seven feet long below the clack piece, with a slightly enlarged base with somewhat irregularly placed holes. The clack piece was fitted with a bolted-on door, with a chain to prevent accidental dropping. Inside the clack was in position, seated in a 'cup washer' of felt-like material. The leather flap of presumably rhinocerus hide, 'nothing else would do', was in good condition. A second clack (probably that found in the chamber two years earlier) could be lowered inside the pump tree to a position just above the clack piece, if the first failed.

The piston (see diagram) had a valve very similar to the clack. Its sealing ring was made of leather, very smooth and hard when found. Connection to the pump rod was by a muff type joint, as also for the rods to the engine crosshead. The rods were 4 x 4½ inch, jointed if dry by lapping and screwed staples, if wet by scarfing and reinforcing with bolted iron plates. Rods were up to 30 feet long, but rotting prevented proper measurement. It was of interest to note that rotting did not take place where the rods were compressed by iron plates or staples.

Piston repairs, or insertion of the second or top clack, required the rods to be withdrawn at fairly frequent intervals: a windlass barrel of large size probably suitable for this purpose was found amongst other debris in the shaft, about 30 feet down. It was fitted (see diagram) with iron saddles, so that it could be used like a small capstan. Presumably it was fitted in the beams above the engine. The barrel axle is slightly off centre, showing it was fitted after the saddles.

The shaft, below where the engine sat, took on an egg-shaped plan, about 8 x 6 feet at the narrower end. It lengthened to about 10 x 6 feet at the cistern level. The far side was equipped with stemples to form a climbing way, with stemples about 18 inches apart. This would probably be separated (as in the winze), by boards hung vertically on the stemples, from the winding compartment. Somewhat surprisingly very few stemples, or suitable stemple holes, were found to separate pumping and winding: the three 'platforms' found appearing more to guide the pump rods than to stabilise the pipe or separate compartments. This is somewhat different from the usual Cornish practice of having the climbing way un the form of ladders, in the pumping compartment, so as to facilitate maintenance.

The pump is currently being conserved at the Museum, and will be installed in a new 'shaft' during late 1979.

ACKNOWLEDGMENTS

As with the initial project, this one would not have been possible without the co-operation of Mr. Ted Dale, the owner of the field where the Main Shaft is situated. We are not only grateful to Ted for this, but also pleased his interest made him a frequent visitor to the site. Mr. Elliot and Son allowed access to the shaft in the adjacent field, used for cables, etc. The following persons and organisations greatly assisted the project by providing equipment, supplies or services in a very generous manner:

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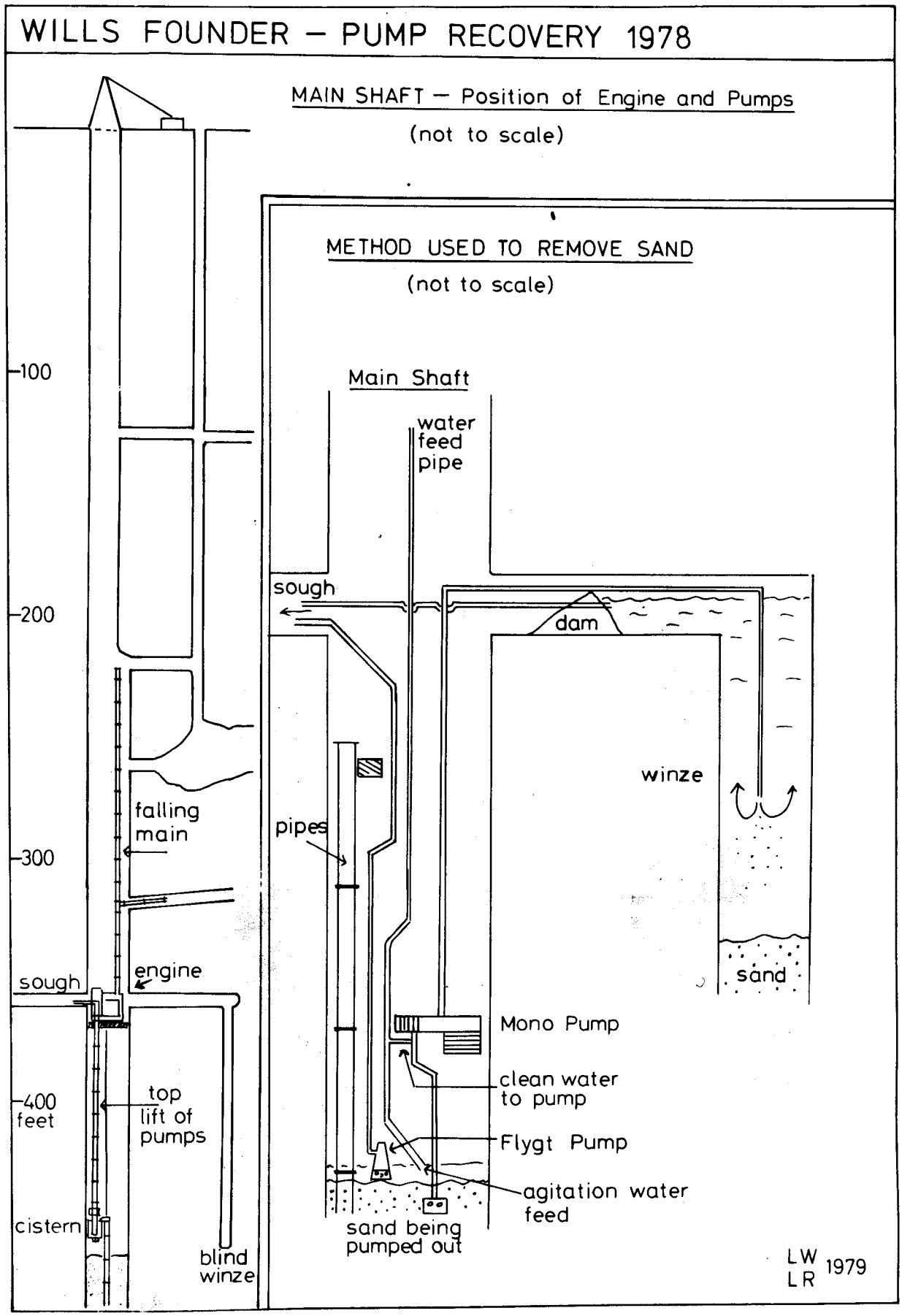
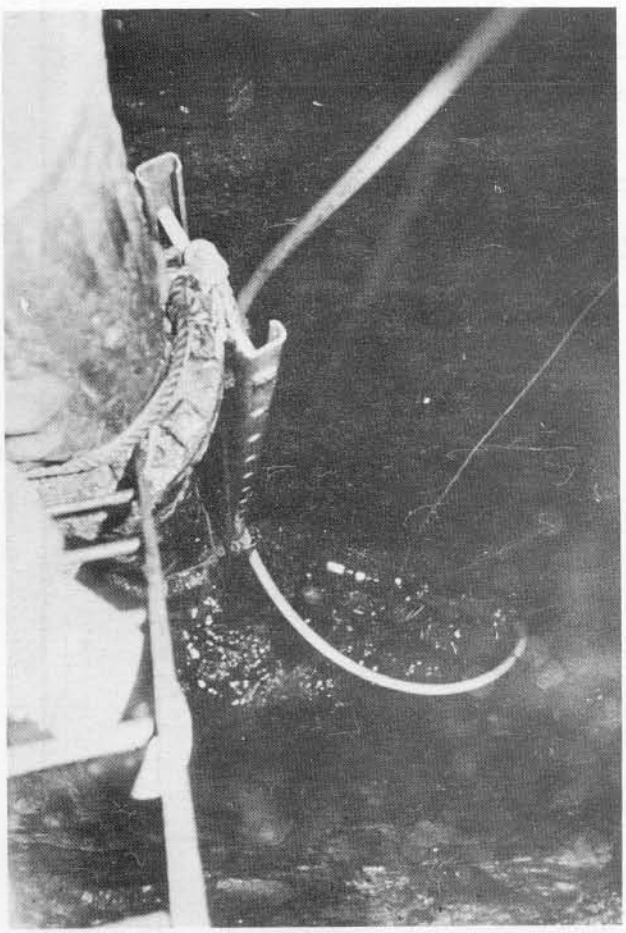
WILLS FOUNDER – PUMP RECOVERY 1978



EXCAVATING THE PUMP FROM WILLS FOUNDER SHAFT



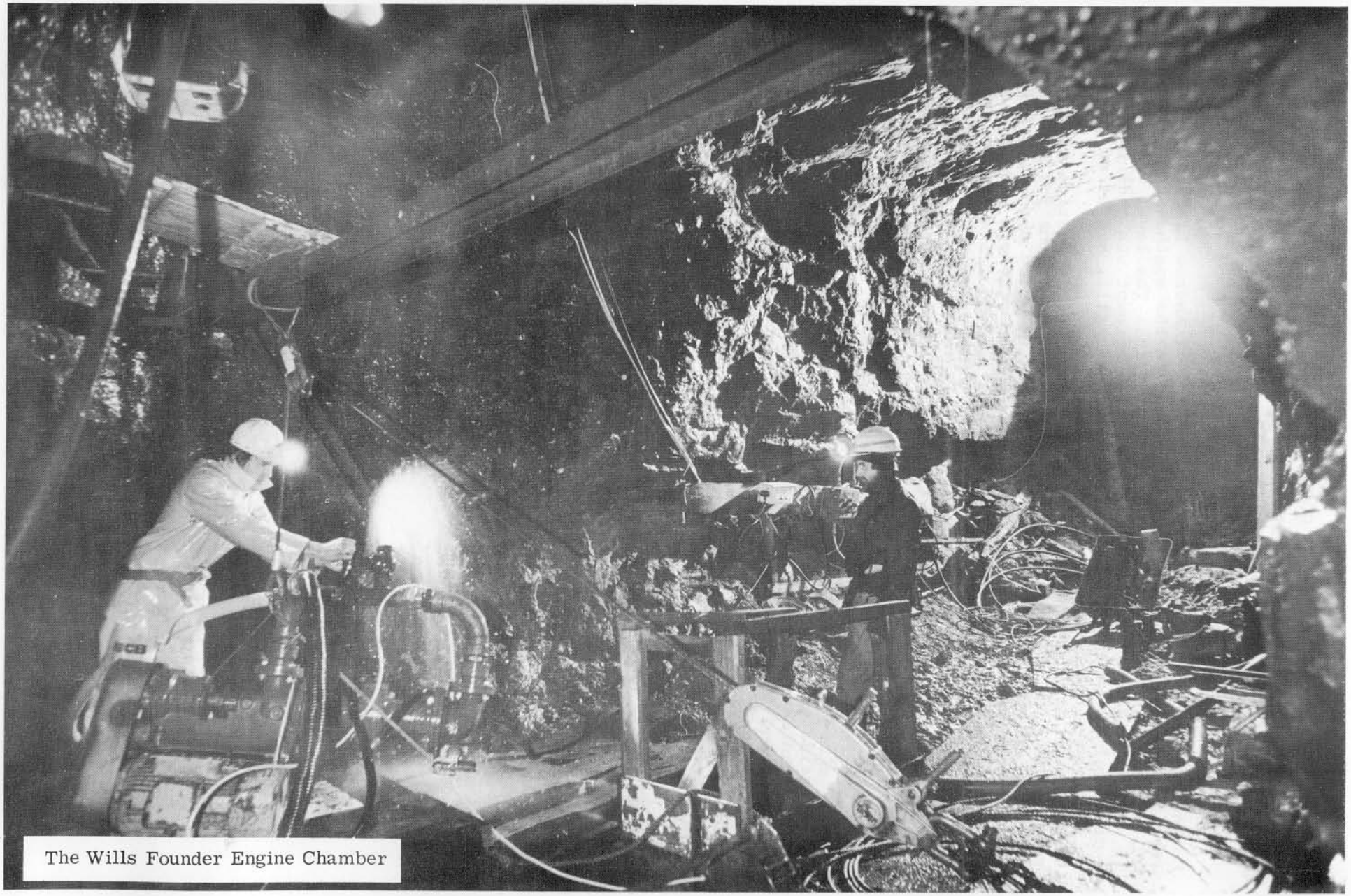
Looking down the pump shaft to the working site.

At the bottom with the suction hose and pump.

photos by Peter Challis

Raising sections to the surface.

Photo by Harry Parker



The Wills Founder Engine Chamber