The Landmark Trust

DANESCOMBE MINE

History Album

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The Landmark Trust Shottesbrooke Maidenhead Berkshire SL6 3SW
Charity registered in England & Wales 243312 *and Scotland* SC039205

Bookings 01628 825925 *Office* 01628 825920 *Facsimile* 01628 825417
Website www.landmarktrust.org.uk

KEY FACTS

Built	**Early 19C, first record of mining production 1822**
Leased by Landmark	**From the National Trust before restoration**
Restoration	**1972-3**
Architects	**Paul Pearn of Pearn and Proctor**
Contractors	**E.L. Greening and Sons of Tavistock**

Contents

Danescombe Mine

Summary

Danescombe Mine is a former copper and arsenic mine, which was worked on and off throughout the 19th century. Its beginnings are obscure, but it was working before 1837 when it was restarted under leases granted by Lord Ashburton and the Earl of Mount Edgcumbe. This company was wound up in 1842 and the 30" pumping engine was sold to the South Hooe lead mine on the other side of the river, and the steam whim to Marke Valley in Linkinhorne. There were further operations at the mine and the closely related Wheal Calstock mine between 1846 and 1868, the company's name being changed to Calstock Consols in 1850. The machinery was sold off in 1872. Then the mine was restarted again in 1888, and both copper and arsenic were produced. After 1900 production ceased, though there was some later prospecting in the valley.

The varying fortunes of the Danescombe mine, and the replacement of copper by arsenic as the main product, were the result not only of the unpredictability of mining, but also of the changing economic situation. Copper mining was rendered unprofitable in Cornwall by the discovery of deposits in Cuba, South Australia, Chile, and then Michigan, culminating in the great copper slump of 1866-8.

Tin became the mainstay of Cornish mining after copper declined, but the opening-up of the Australian tin deposits brought about a slump in the 1870s, then those in the Malay states, and after 1900, in Bolivia, further injured the Cornish tin mines.

In 1891 there were 6,156 men and boys classed as miners in Cornwall; seven years later this number was 2,749. Thus the events in Danescombe are representative of the experience at all Cornish mines, and even today, the decline of the world tin price can make Cornish tin uneconomic to mine, and thus what was once the country's main industry is virtually extinct.

The restoration of the mine

The part of the mine buildings which are now leased by the Landmark Trust from the National Trust and let out for holidays was restored in 1972-3 by architect Paul Pearn of Pearn and Procter, of Plymouth. The grouping formerly housed an engine, and a Cornish boiler and crushing plant. The building was extremely dilapidated: only the structural walls were sound, and there was no roof or windows. All the machinery had been taken out in the 19th century.

During the restoration a new staircase of steel strings and traditional cast-iron open chequer type treads was introduced and new floors were inserted at the levels of the original platforms. A concrete slab was poured at the entrance level over the pit which formerly housed the condenser. This and the higher ground floor were finished with the salvaged slate flagstones.

The upper floors were laid over now softwood joists; the new floor covered what would have been the large hole for the tall condenser. The roof trusses, of softweed, were left exposed, whilst the covering is random width Delabole slates with a grey clay ridge tile. It is almost certain that the original slates would have come from that famous Cornish slate quarry or one very near it. The cast-iron window frames were reinstated.

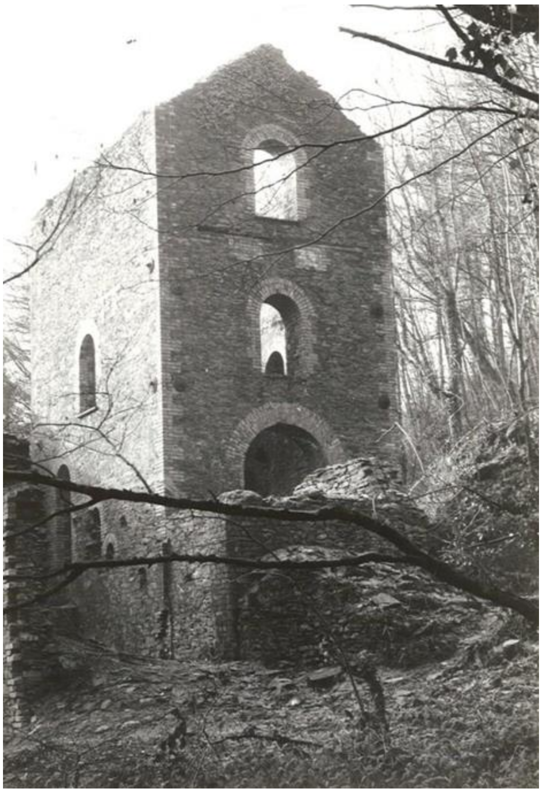
The buff-coloured bricks for the quoins which had originally been made at Calstock nearby, were matched and a new flight of steps was made between the boiler house and crushing plant building. A terrace of open timber slats was created at the top of walls which once carried the axles of the winding gear and balance wheels, surrounded with a traditional balustrade of diagonal criss-cross members painted in the red-oxide colour still commonly in used in the county.

Almost the only alteration which was made to the original plan was the new top window, formed by glazing the gap where the lever of the main engine once protruded. Under the Pearn restoration scheme, this formed a top bedroom with a wonderful view down the valley and an en suite bathroom, with a twin room beneath, with a separate loo and washbasin. The iron staircase descended direct into the kitchen, with an open plan sitting area beneath.

This configuration lasted happily until 2022-3, when more stringent fire regulations and a desire for better insulation prompted a re-think, to the building's current configuration for two people. The staircase has now been boxed in to provide a better fire exit route, and the kitchen has moved to the first floor.

Danescombe Mine remains one of Landmark's quirkiest and best loved buildings, keeping alive the memory of arsenic mining in Cornwall.

Danescombe Mine before restoration



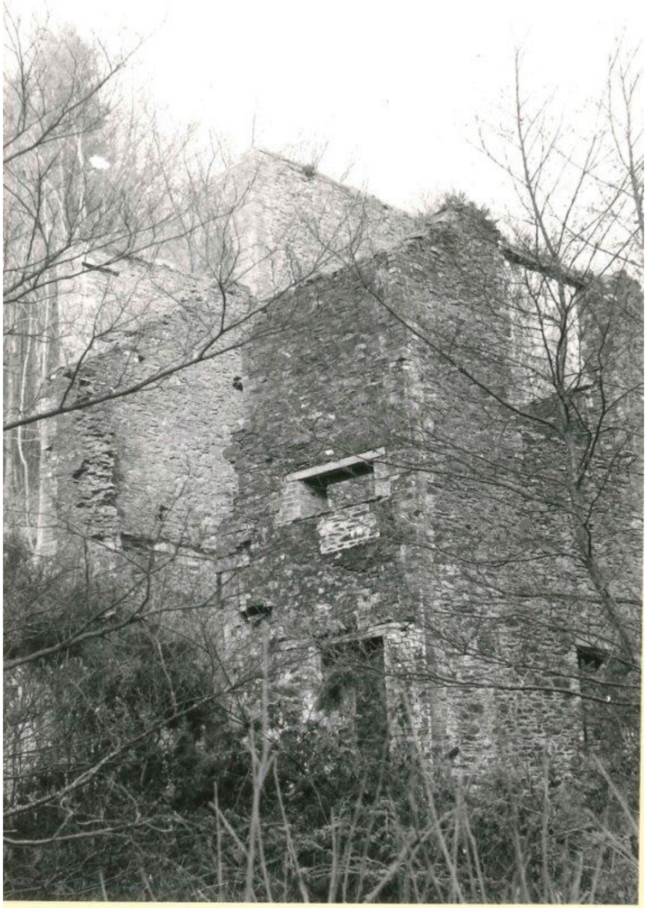
Restoration of Danescombe Mine

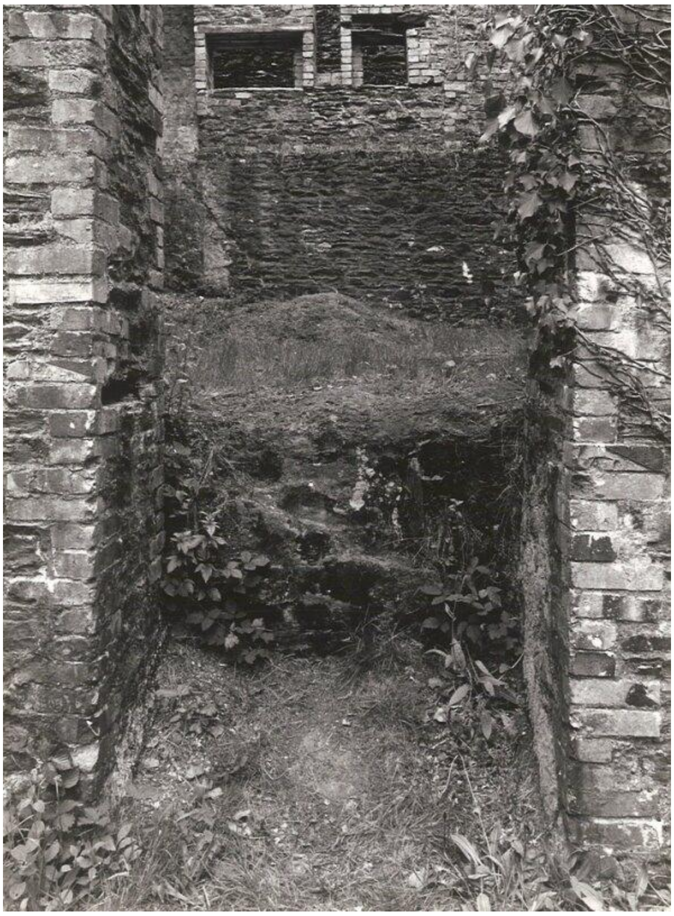
The mine buildings which the Landmark Trust lease from the National Trust was restored in 1972-3 to plans drawn up by Paul Pearn of Pearn and Procter, architects, of Plymouth. They formerly housed an engine, and a Cornish boiler and crushing plant. The builders who worked on the project were E.L. Greening and Sons, of Tavistock. When work began the building was extremely dilapidated: only the structural walls were sound, and there was no roof. All the machinery had been taken out in the 19th century, and the cast-iron window frames were also gone.

In the course of restoration the following alterations were made. A new staircase of steel strings and traditional cast-iron open chequer type treads was placed at the north end of the building and new floors were inserted at the levels of the original platforms, whilst a concrete slab was poured at the entrance level over the pit which housed the condenser. This and the higher ground floor were finished with the used slate flagstones.

The upper floors were laid over now softwood joists; the new floor covered what would have been the large hole for the tall condenser. The roof trusses, of softweed, were left exposed, whilst the covering is random width Delabole slates with a grey clay ridge tile. It is almost certain that the original slates would have come from that famous Cornish slate quarry or one very near it.

By great good luck, it was found possible to reinstate the cast-iron window frames. A firm was found, Irons Bros. of Wadebridge, which still had the moulds for the window frames of the right size, and new ones were cast.





The original configuration of the restored ground floor.

The buff-coloured bricks for the quoins which had originally been made at Calstock nearby, were matched with some from the brick yard of Messrs Hexter Humpherson, of Newton Abbot. From these a new flight of steps was made between the boiler house and crushing plant building.

A terrace of open timber slats was made at the top of walls which carried the axles of the winding gear and balance wheels, surrounded with a traditional balustrade consisting of diagonal criss-cross members. This has been painted in red-oxide, a colour still commonly used in the county.

Almost the only alteration which was made to the original plan was the new top window. The gap where the lever of the main engine would have protruded was glazed over, forming a top bedroom with a wonderful view down the valley. Under the original restoration, the glazing was arranged in small pieces and allowed to overlap, a sensible form of re-use of small panes found in early industrial buildings.

This configuration lasted happily until 2022-3, when more stringent fire regulations prompted a re-think, to the building’s current configuration for two people. The staircase was completely boxed in to provide a better fire exit route and fire doors introduced. The kitchen was moved to the first floor, with kitchen new units crafted in the Landmark workshop at Honeybourne.

Sitting room and double bedroom remain where they were in the original, 1970s scheme. Double glazed window units with black anthracite Aluminium frames were introduced to the window in the second-floor bedroom, keeping to the same fenestration and opening configuration. Replastering and making good throughout were carried out in lime render and mortar.

The first floor when configured as twin bedroom, until 2023.

The Danescombe Valley

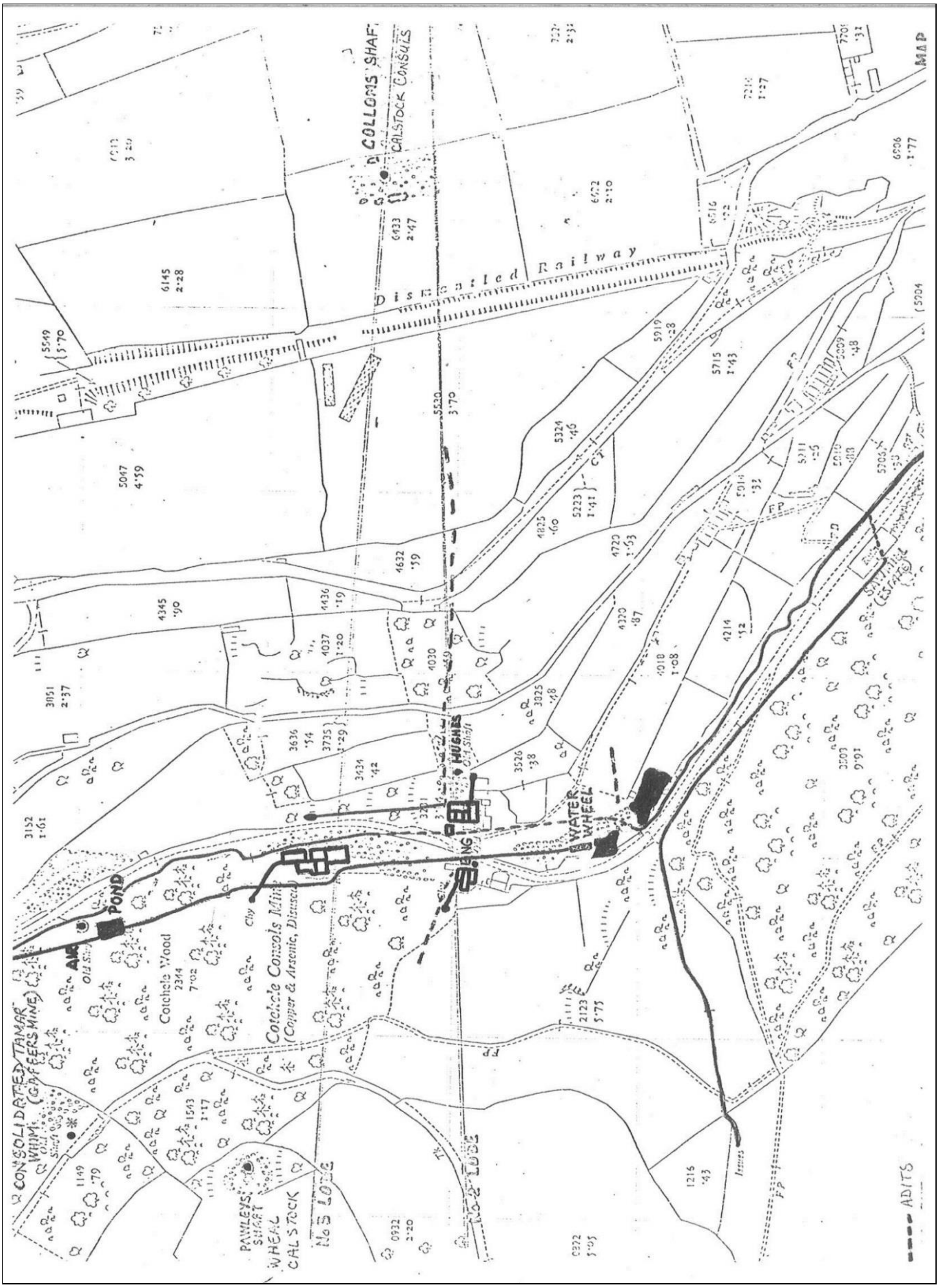
Danescombe is believed to have been named in 835 AD when the Danes landed; the invading force marched through the valley (or combe) to Hingston Down where they were defeated by the English troops led by Egbert.

The valley has been the subject of sporadic mining adventures over the course of two centuries. Events are sparsely recorded due to the passage of time and not until 1860, when a Royal Commission was set up, were any practical steps taken to ensure adequate records. The Commission's findings resulted in the Act of 1872 which required on the closure of any mine a plan of the workings and shafts "to prevent loss of life and property which would ensue from the lack of adequate records".

The Mining Record Office was taken over by the inspectorate of Collieries and Metal Mines in 1882.

The valley today presents a tranquil scene compared with that of the 19th century, all that remains of the landing stages at Kelly Rock are the rotten stumps of timber silted over by the river Tamar. The Ashburton Hotel has been renamed the Danescombe Valley Hotel, although the post box set in the wall retains the original name.

From the Hotel the lane passes the ruin of a cottage and the track to Kelly Gardens, the next row of cottages, which are still in use, overlooking the Danescombe Quay. A branch from the incline railway to Calstock ran along this quay, just past the footpath to Cotehele are the remains of the Sawmill, which was used as an explosives store at the end of the 19th century.



Dismantled Railway
COLLOMS' SHAFT
CALSTOCK CONSULS
HUGHES
WATER WHEEL
POND
Cotehele Consols Mine (Copper & Arsenic, Disused)
Cotehele Wood
CONSOLIDATED TAMAR (GAFFERS MINE)
PAWLEYS' SHAFT
WHEAL CALSTOCK
No 5 LODE
No 2 LODE
ADITS
MAP

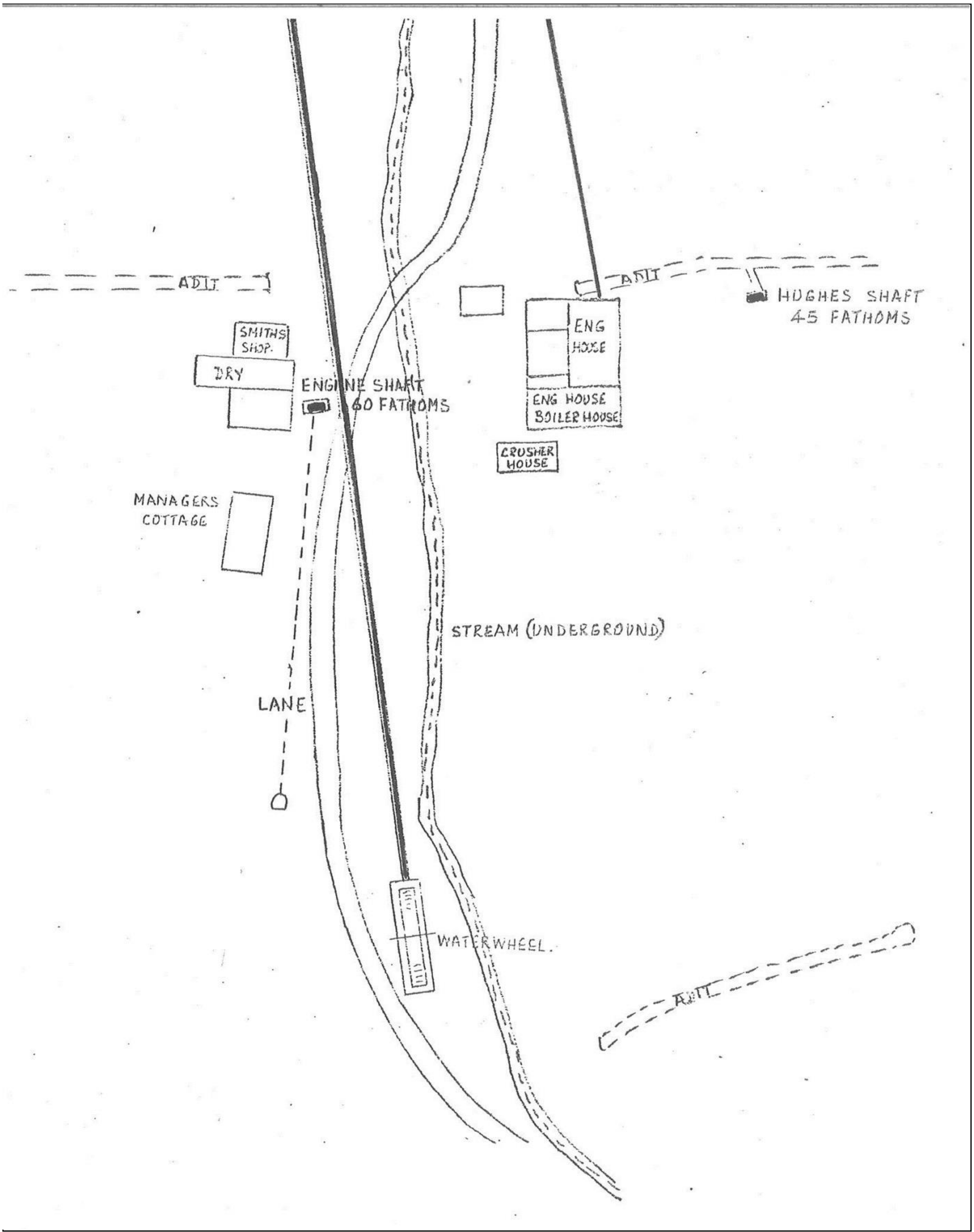
Map A

The Sawmill provided timber for the Cotehele Estate and for the mine carpenter, a railway track ran down to Kelly Rock to facilitate loading and unloading the timer onto the ships. The power for the mill was provided by the stream, which runs through the wood on the western side of the valley, the water was diverted into a leat before reaching the valley floor - as shown on map 'A'. The leat ran along the side of the valley and entered the Sawmill on the far side. The hole can still be seen. In fact animals can occasionally become trapped in there. The water flowed diagonally across the centre of the mill passing through an undershot centrifugal turbine type of water wheel, the saws being driven either directly or by belt and shafting.

The lane now climbs steadily, the main stream running on the right hand side, this side of the valley is still used as a market garden, daffodils and strawberries being produced. In the last century strawberries and cherries from the Tamar Valley were held in high esteem, but due to difficulty of cultivation and the overcropping, the soil became sour and much has been turned into scrub and woodland. Potatoes being immune to arsenic do well in this area, strawberries being a good crop to follow.

The first traces of early mining exist on the eastern side just before the corner, in fact, opposite the stream which fed the sawmill leat. An adit entrance can be seen at stream level, the mouth has been blocked but water still issues forth - this level was not driven very far (22 fathoms). To the left of this adit are the burrows of waste from the dressing floor of the mines.

Further up the stream there is a large pool formed between high banks this was the site of a water wheel believed to be 40 feet diameter by 3 feet breast, the water was fed by an elevated launder which ran down the left side of the valley from one of the reservoirs - see Map 'A'. Between 1890 and 1900 this waterwheel was used as a pumping engine driven by means of a flat rod supported on pulleys to the engine shaft.



Map B Plan of mine 1897 scale 1"=8 fathoms

A short distance away from the wheel on the opposite side of the lane was the exit of the brick lined drainage tunnel, which connected to engine shaft at about 4 fathoms (24 feet), the idea being to channel the water away from the vicinity of the shaft and also to reduce the height to which the water had to be pumped. This water was led to a pool by the wheel.

The first two buildings at the mine are owned by the National Trust and have been renovated. The cottage was used by the Mine manager (Captain Philip operated the mine over the later years of the 19th century). The next building was reputed to be an engine house, having adjacent to it the miners' changing room known as the 'dry', which would have contained a boiler or other means of heating; the end shed being the smith's shop, a flue led to the chimney on the hillside. The smith would have been busily engaged in repairing machinery, sharpening the drill steels used to bore holes for the charges, and making any additional equipment required by the miners. These buildings were connected to the Wheal Calstock 1822 operations which worked on the western side of the valley.

On the eastern side there are two buildings known as "Mispickel I and II" (Mispickel being the Cornish name for Arsenopyrite Fe-As-S also known as Silver Nundic) and the walls of another old building, this comprises the remains of Danescombe Valley Mine.

Referring to Map "B", Mispickel II housed a crusher driven from the combined Engine and Boiler house which existed before Mispickel I, the remains of one of the boiler flues and water tank now lie out in the open. A whim engine would have been housed in the engine house adjacent during the period when ore was hauled out of Hughes Shaft on the hillside above. In the late 1890s the ore was trammed from the adit and roughly crushed before going to the large crusher further up the valley, where it was reduced and dressed before transportation to the refining works. The other buildings at Danescombe Mine were probably used for storage of equipment. Behind the Engine and Boiler House the two flues led to a chimney stack on the hillside, the base of which still stands.

The next mine is reached by following the lane up the valley - see Map "C" - the tall engine house and building are now being restored by the Landmark Trust. The mine was called Cotehele Consuls, the engine house was built in approximately 1880, the engine being a rotary type of 40" cylinder diameter driving a Taylor type of roll crusher. This engine was also used to drive the pump rods at Engine Shaft lower down the valley. The same method of transmission was used as for the water wheel i.e. flat rod on rollers. There was also a drive to the two buddle pits set in the dressing floor.

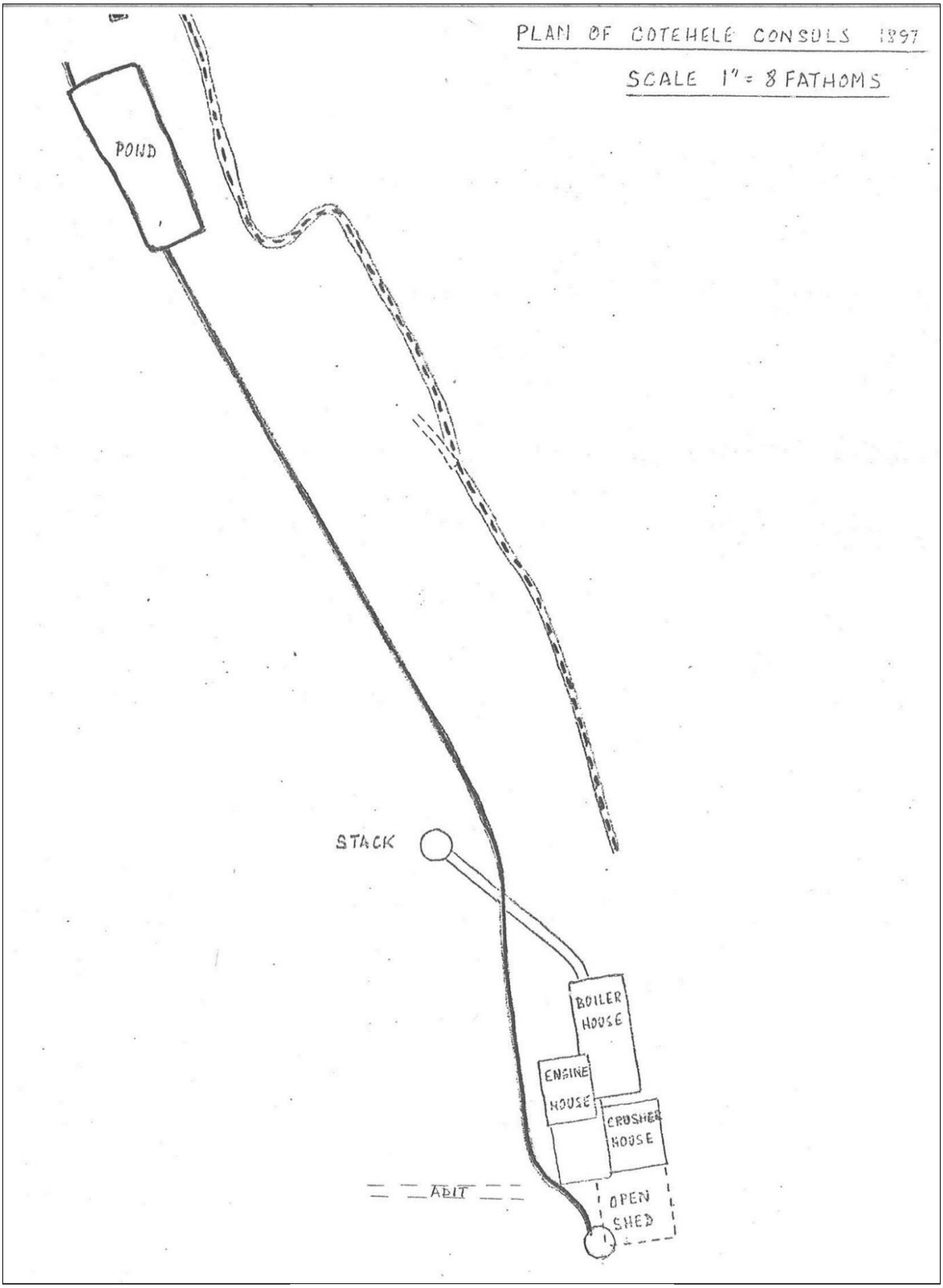
When the engine was out of use, and many engines only ran for a third of the time due to breakdowns and overhauls, the waterwheel was used for pumping, a reserve of water being held in the pond shown on Map "C".

At the head of the valley beyond the Miners Inn, which is now a farmhouse, lay the remains of Danescombe Papermill, which was waterpowered. Above the mill was another reservoir which was used to ensure a good supply of water in a dry season.

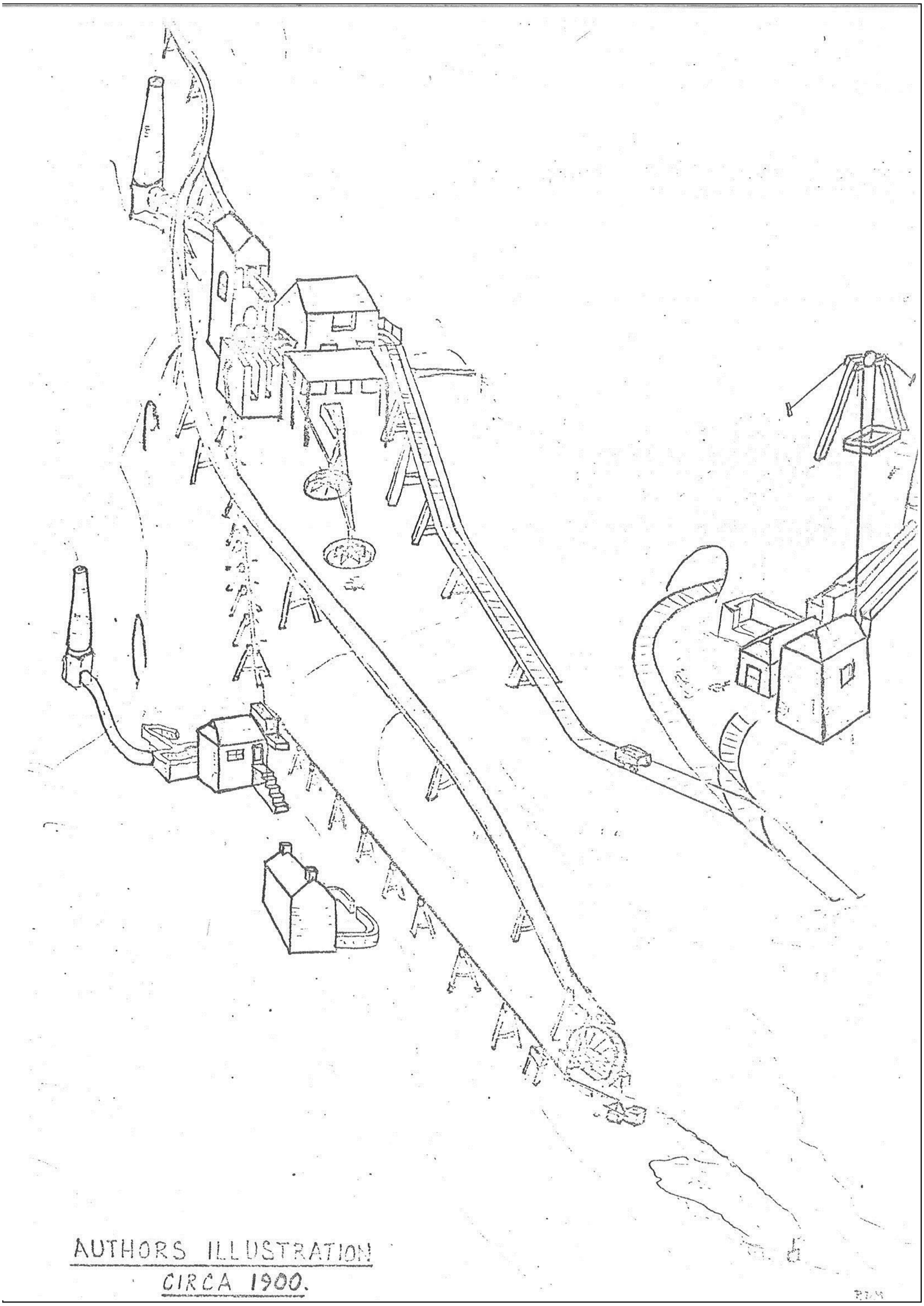
The abandoned shafts of Consolidated Tamar lie in the woods above Cotehele Consuls Mine, no traces of the buildings remain.

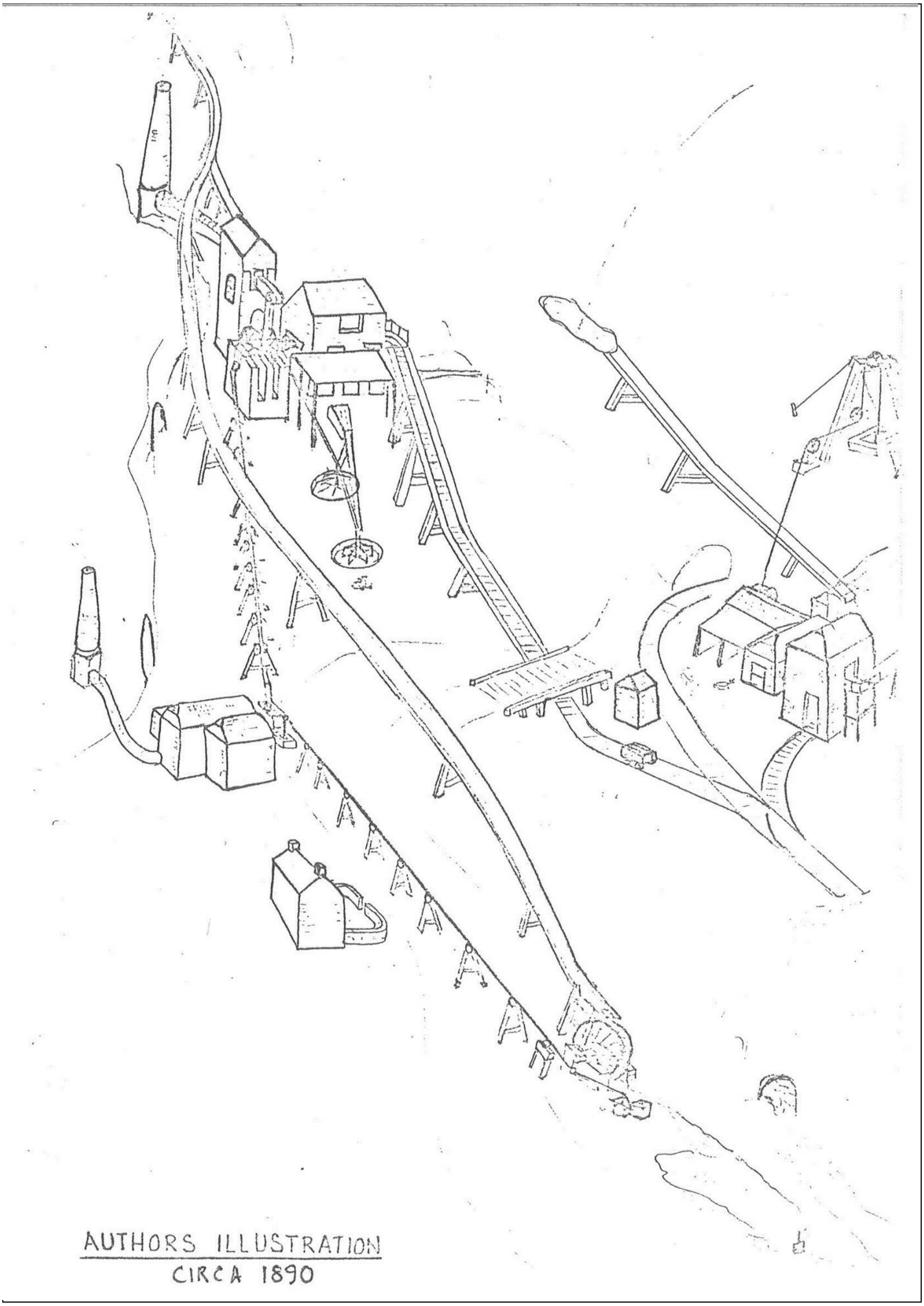
Adjacent to the Air Shaft shown on Map "A" was an early mine where the ore was hauled to the surface by means of a horse whim. A tramway led to the lane via a bridge over the stream.

Opposite the Cotehele Consuls Engine House was a pond which supplied the 'Mispickel' boiler house by means of a launder along the side of the valley. The water ran down the eastern slope from Butts at the top of the incline railway.


PLAN OF COTEHELE CONSULS 1897
SCALE 1" = 8 FATHOMS
POND
STACK
BOILER HOUSE
ENGINE HOUSE
CRUSHER HOUSE
ADIT
OPEN SHED

Plan C

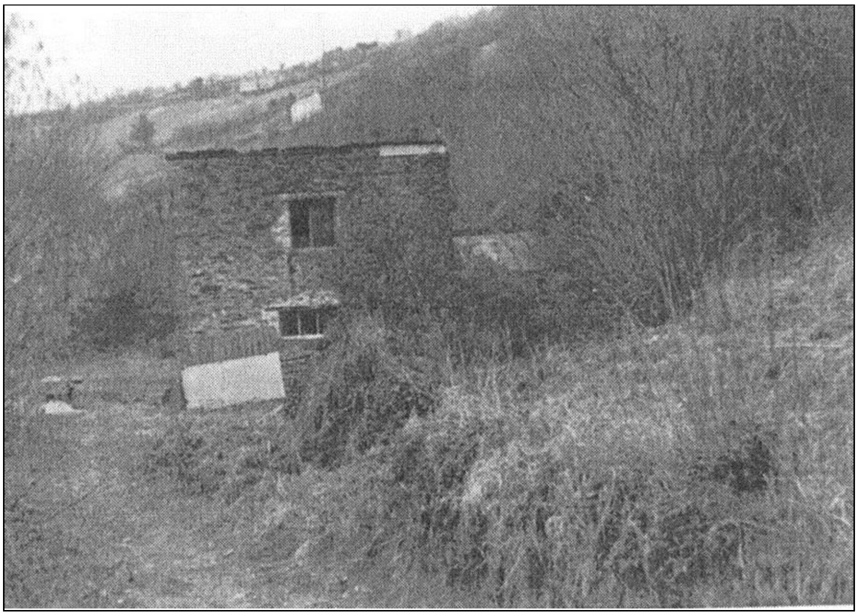

AUTHORS ILLUSTRATION
CIRCA 1900.



AUTHORS ILLUSTRATION
CIRCA 1890

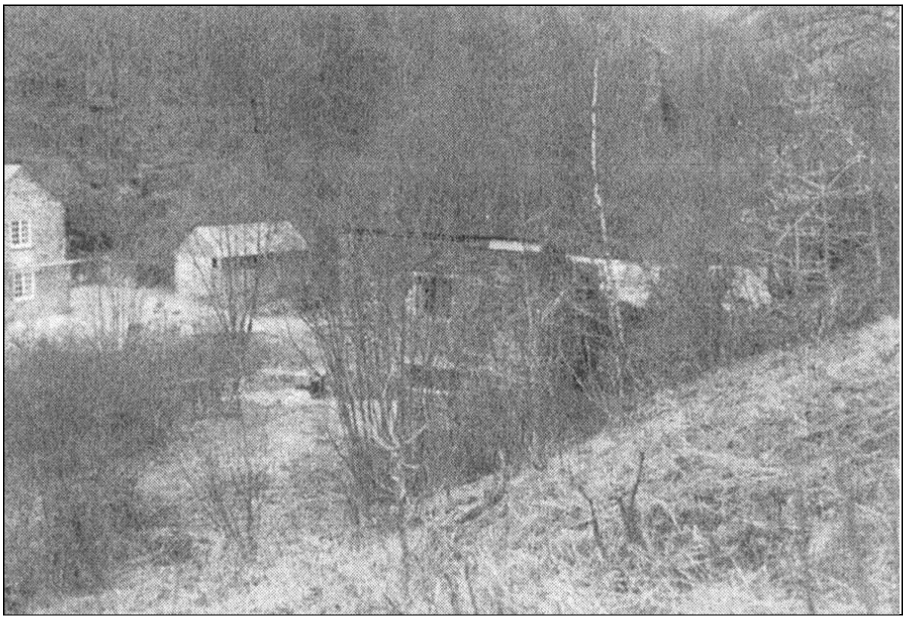
Historical development of the valley

1822	Wheel Calstock - 92 tonnes of copper realised £500.
1837 - 1842	Danescombe sett of Wheal Calstock with 30" Pumping Engine, 18" steam whim, 40ft. water wheel and stamps. (September 1843 - Pumping Engine sold to South Hooe Lead Mine, Whim to Marke Valley).
1846	Wheal Calstock restarted.
1850	July - Wheal Calstock Mining Company now comprised of four setts, proposals to extend East and West into Duchy land. Name of Company changed to Calstock Consuls.
1868	Operations ceased, machines remained on site until 1872.
1880	Cotehele Consuls recorded output of 6 tons 81/4% copper ore; 323 tons of Mispickel.
1880	Reworking of Danescombe Valley Mine with Calstock Consuls.
1882 - 1884	Cotehele Consuls taken over by Okel Tor Mine. Pyrites taken there for extraction of arsenic. This arrangement was short lived.
1882 - 1885	Calstick and Danescombe Mines 390 tons of 41/2% copper ore; 3,141 tons of pyrites partly arsenical.
1888 - 1900	Part of Danescombe Valley reworded in conjunction with Cotehele Consuls. Mispickel taken to Coombe Arsenic works for processing. Output 2 tons of Black Tin; 960 tons of copper ore; 11,104 tons of Mispickel.
1915	The mines were prospected but not restarted.
1939	A lode containing ferberite exposed in the old railway cutting near Calstock Consuls' Colloms Shaft, further trials showed an 18" Galena bearing cross course. Samples were analysed but no further action was taken.
1942	The lode re-investigated under the name of East Calstock as a source of Tungsten but lack of labour during the war prevented further action.

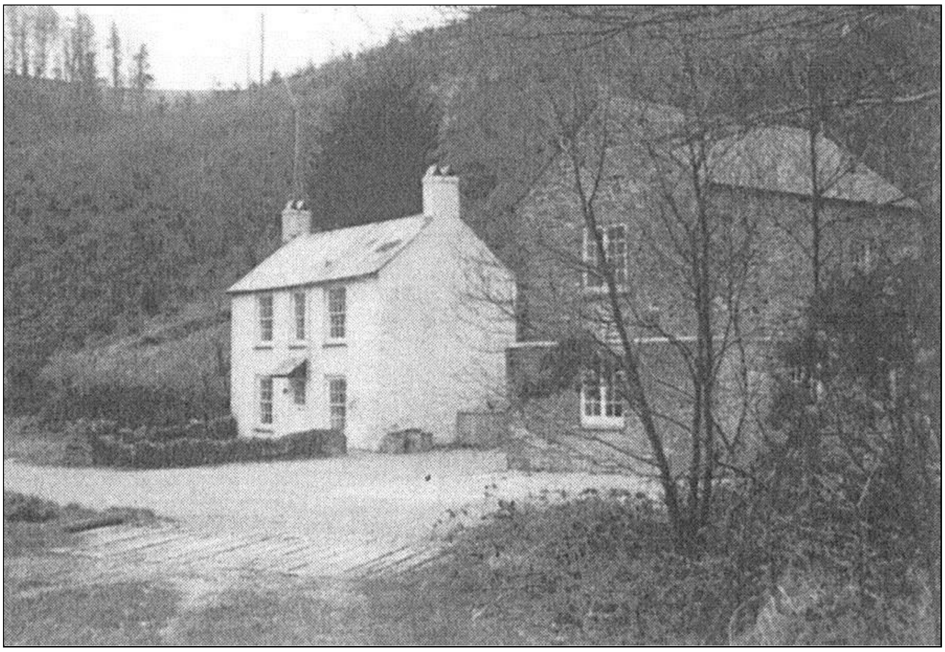


Crusher house looking up the valley.

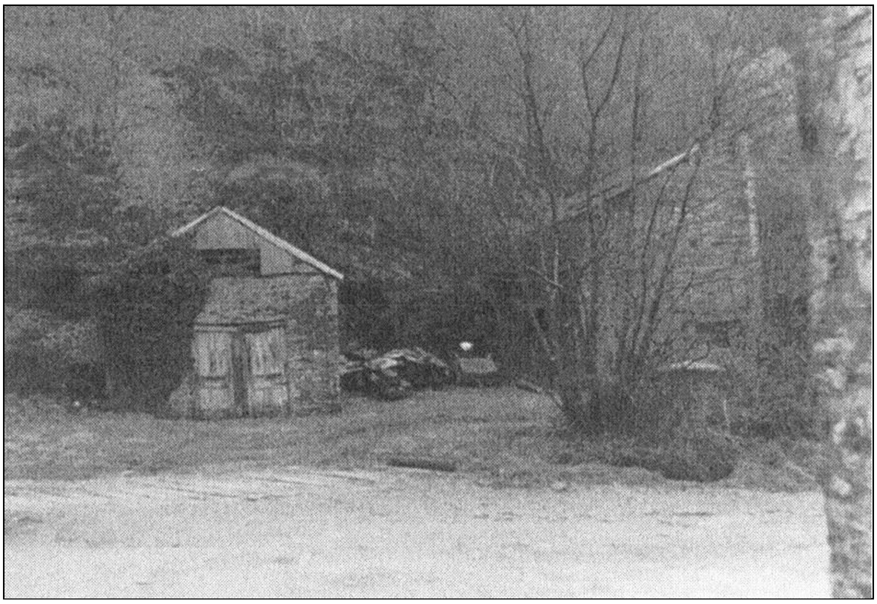
The valley today presents a totally different aspect, very few traces remaining bear witness to the activities of the miners during the 19th century. The photographs show the buildings as they were in the late 1960s.



View across the valley showing Engine House Cottage, Crusher House and ruins of Cotehele Consuls Engine House.



Mine Manager's Cottage and Engine House by Engine Shaft, restored by the National Trust.

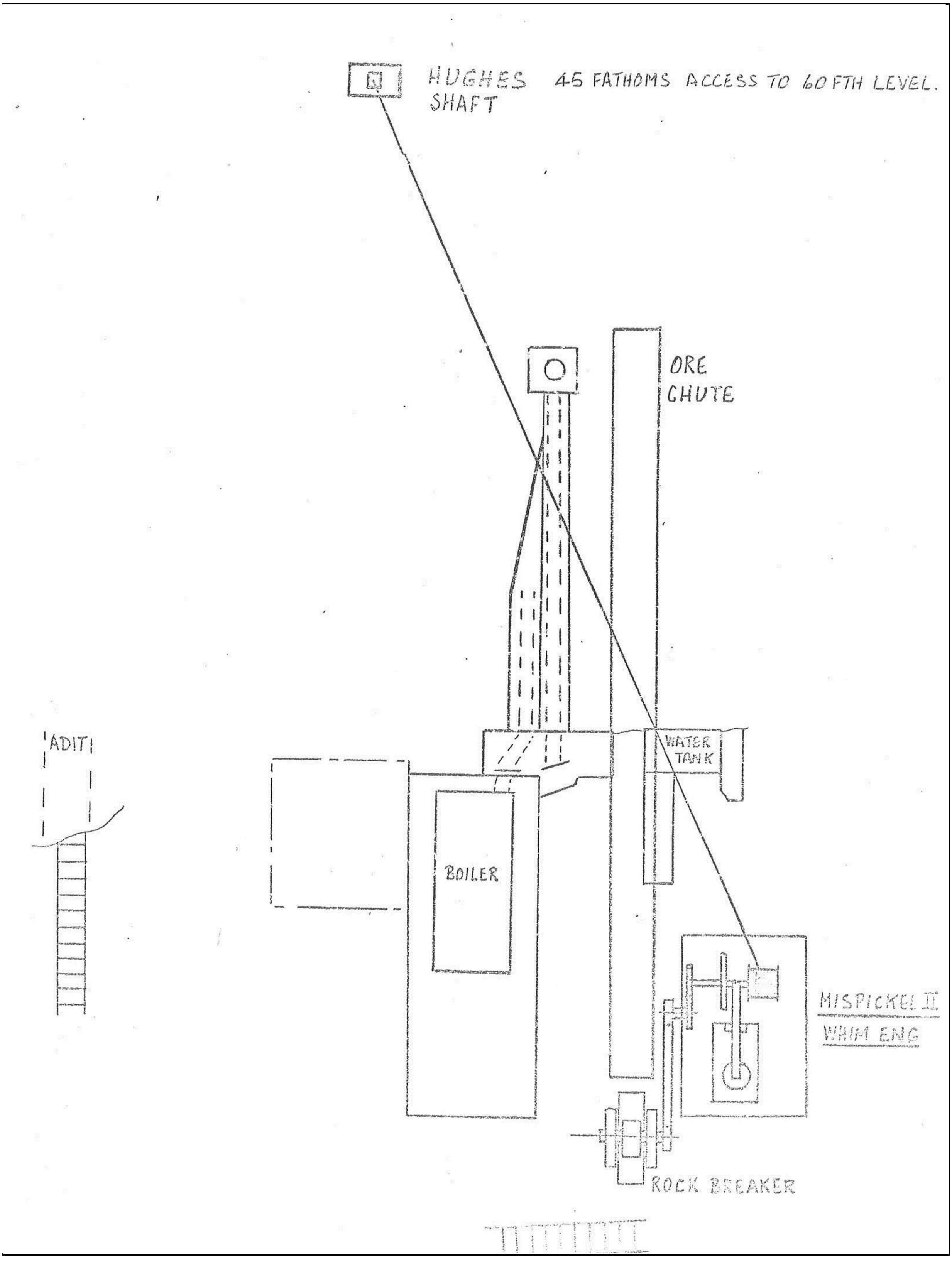


Boiler / Engine House and Crusher House

All the foregoing information was based on the survey by Mr. James of Mary Tavy in 1897. From information subsequent to that survey, the Danescombe Buildings were later modified. The National Trust Engine Cottage had a blacksmith's shop with double doors at ground level, the upper floor was reached by means of exterior stone steps leading from the manager's Cottage. The upper floor was the miner's dry or changing room, where they washed and changed into their underground clothes.

The Mispickel I building contained a boiler, which supplied steam to a whim engine housed completely inside Mispickel II, between the two building was a stone breaker also driven by this engine.

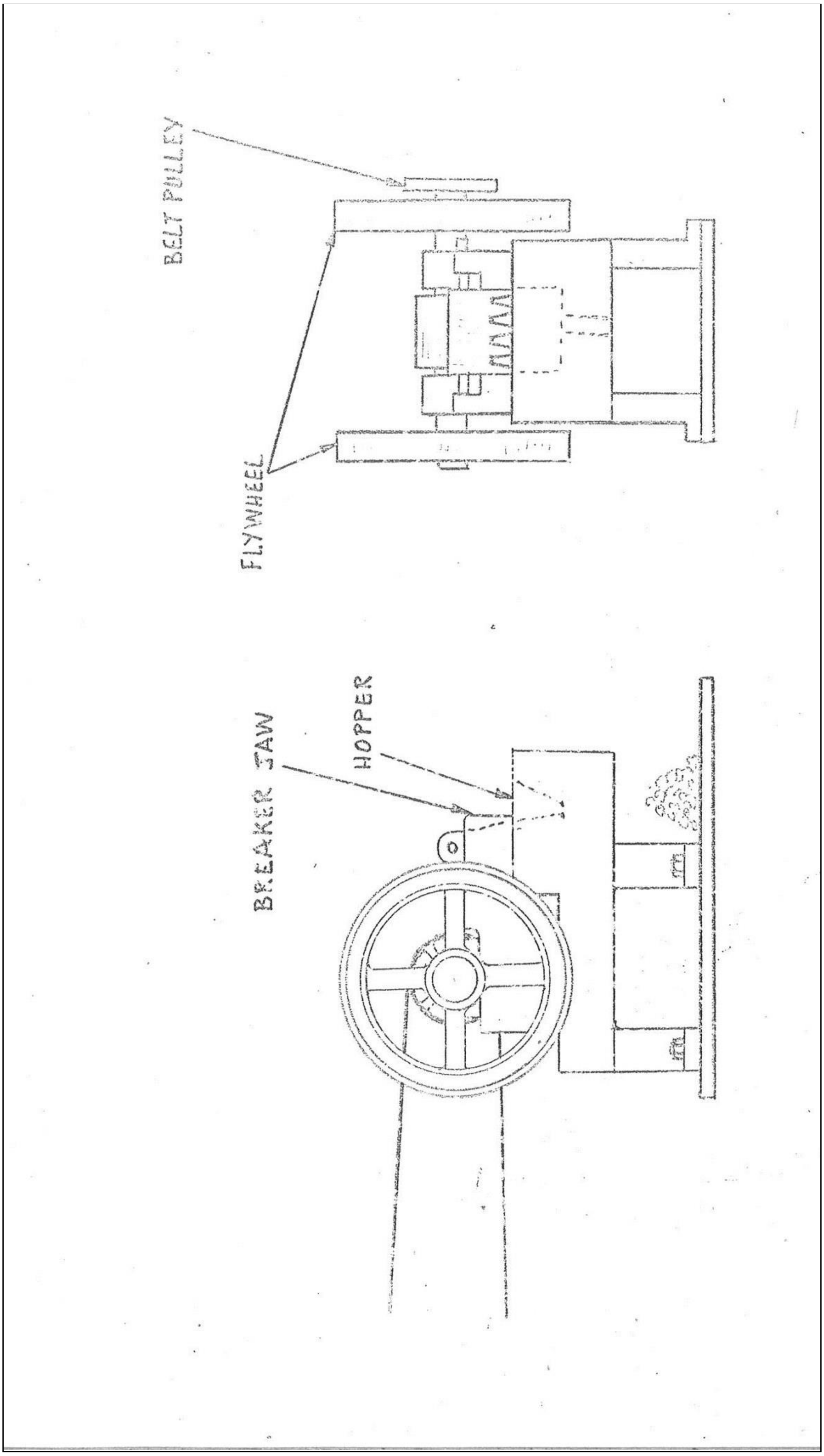
The ore slid down a chute from Hughes Shaft to the crusher. The rope from the whim was fed through a hole in the end wall of Mispickel II as the whim cage was inside the house.



Mispickel II

At this time the stream ran underground between the Cotehele Engine House and to below the waterwheel where it ran out under the burrows of waste. The two shallow ponds at this point were occasionally dug over to retrieve any material that had been carried off the dredging floors. The stream culvert was also dug out to remove accumulations of silt, this culvert ran much closer to the Mispickel buildings. The incline rail track to the crusher house (Cotehele) passed under the lane being below ground level to facilitate loading of ore from the rock breaker. A man and woman fed the breaker from the chute, breaking up any very large stones with the 12lb sledge hammer.

The stone breaker was introduced into this country in 1858. The crushing surfaces consist of two fluted jaws of chilled cast iron with removable faces. One of the jaws is fixed, while the other swings on a shaft above and is reciprocated by a toggle joint, formed of two plates, one butting against the lower part of the movable jaw and the other against the fixed framing of the machine; the toggle-joint is straightened by a connecting rod from an eccentric on the belt driven fly-wheel shaft and is restored by a spring. The stones drop deeper in to the hopper like space at each reciprocation and are crushed as the jaws close. The distance between the jaws can be adjusted by means of a wedge, placed between the back plate of the toggle-joining and the framing, so as to pass the fragments when reduced to the required size of 2" cube.



Blakes Stone Breaker

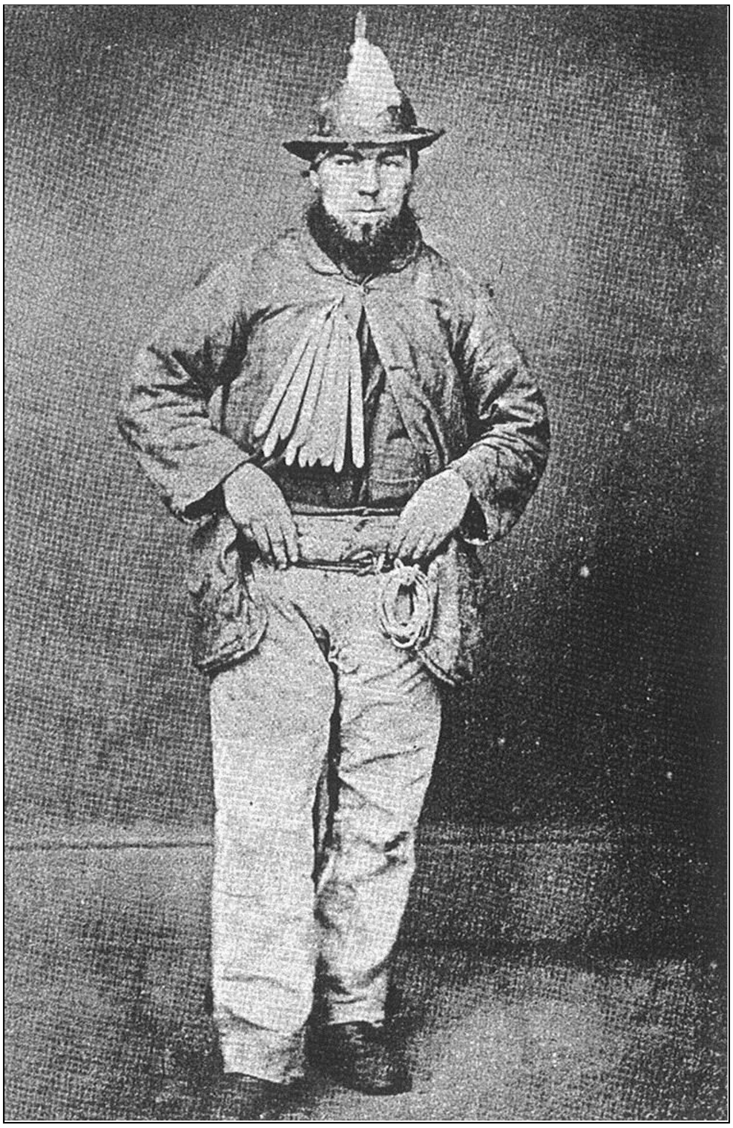
The Cornish Miner

Mining in Cornwall is very ancient, going back at least to the third century before Christ, and there it is a tradition that Joseph of Arimathea was a tin-worker. There were four Cornish stannaries, mining-districts, in Cornwall, of which the earliest charter is in 1201: Foweymore in the north, between Launceston and Bodmin; Blackmore - Hensborough Beacon with Roche, Luxullian and St.Austell: Tywarnhail - the north coast inland to Truro; and Penwith and Kerrier - between Lelant and the Land's End, and north of Helston.

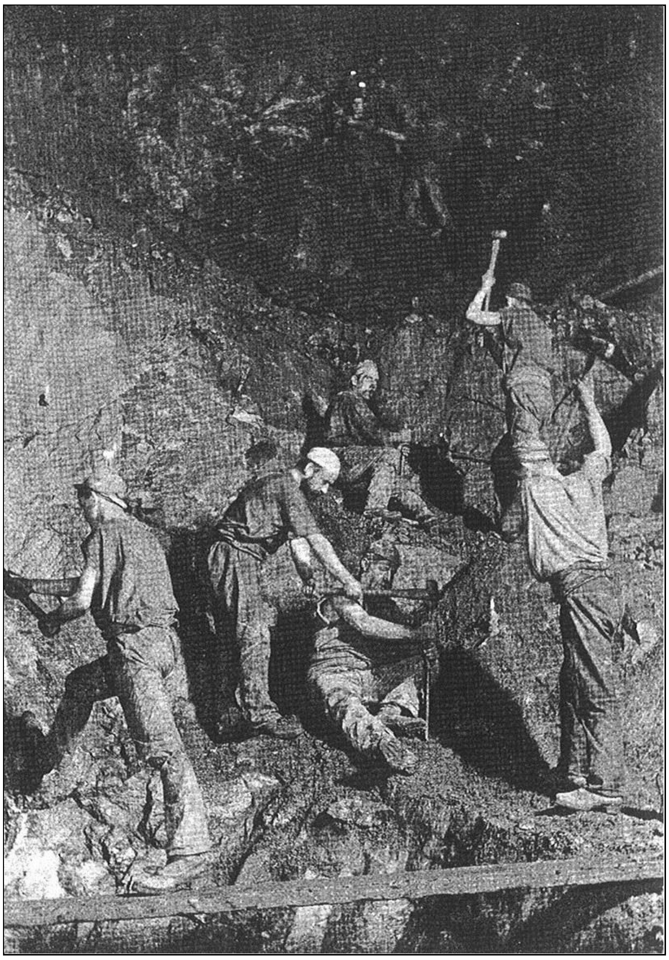
There was probably very little underground work until the 15th century, but after that the system developed, until the Cornish miners were a brave and skilled group of workers with a good deal of independence and laws and customs of their own, although they were not rich. However, as the 19th century proceeded the ancient rights of 'bounding' - by which any man might stake a claim in unenclosed land and work it for his own profit; and 'tributing' which was a kind of sub-contracting, so that the quicker the miner the more he earned, were being eroded, and the miner more and more became a mere skilled labourer.

The work was hard and unpleasant. The early photographs were taken by flashlight and do not reveal the atmosphere underground - thick with the fog of smoke from the candles and the gunpowder used for blasting. What ventilation there was ineffective, particularly in the deeper mines, and tuberculosis and other lung diseases were common among miners. Then at the end of the day they had to climb up a nearly vertical ladder to the surface. They were old men at 40, and 25% died before they were 30, compared to 18% of all other classes. Accidents could take the form of falls, shaft collapses or flooding.

The potato, as in Ireland, was the staple diet of the poor miner, who grew it himself. The mines being short-lived, his place of work was constantly changing, and there was no housing by employers. The men built their own cottages, and often walked many miles each way.

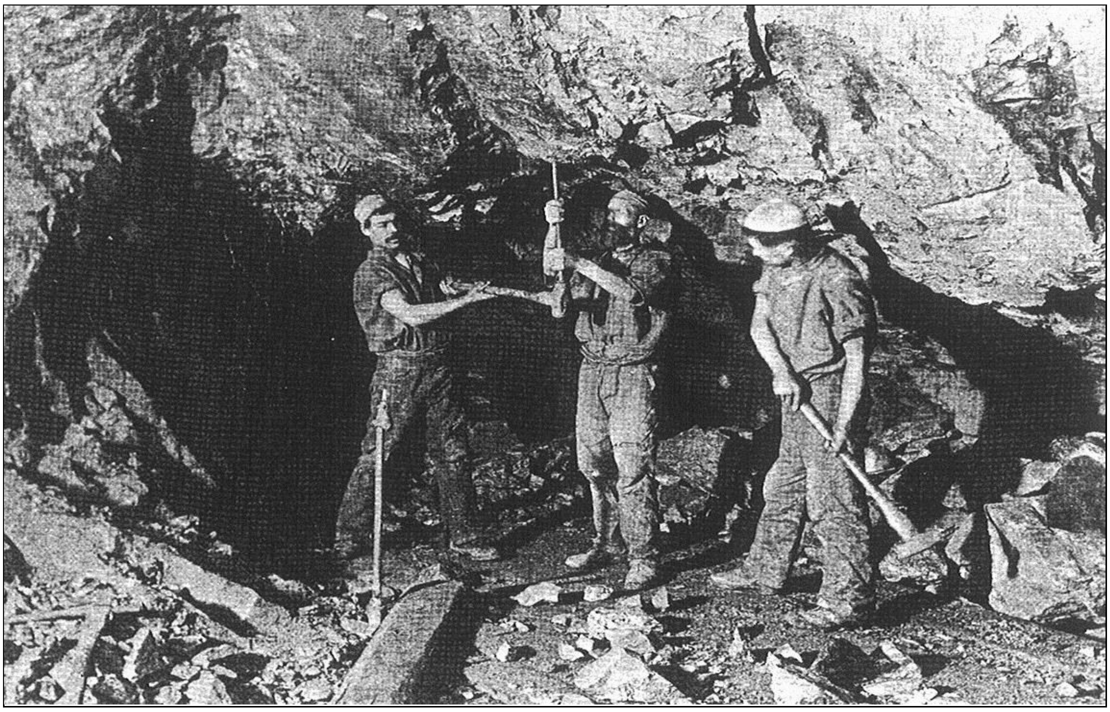


An unknown but typical Cornish miner c. 1900. He has coiled fuse at his waist, candles hanging from his neck and another stuck with clay to his hard felt hat.

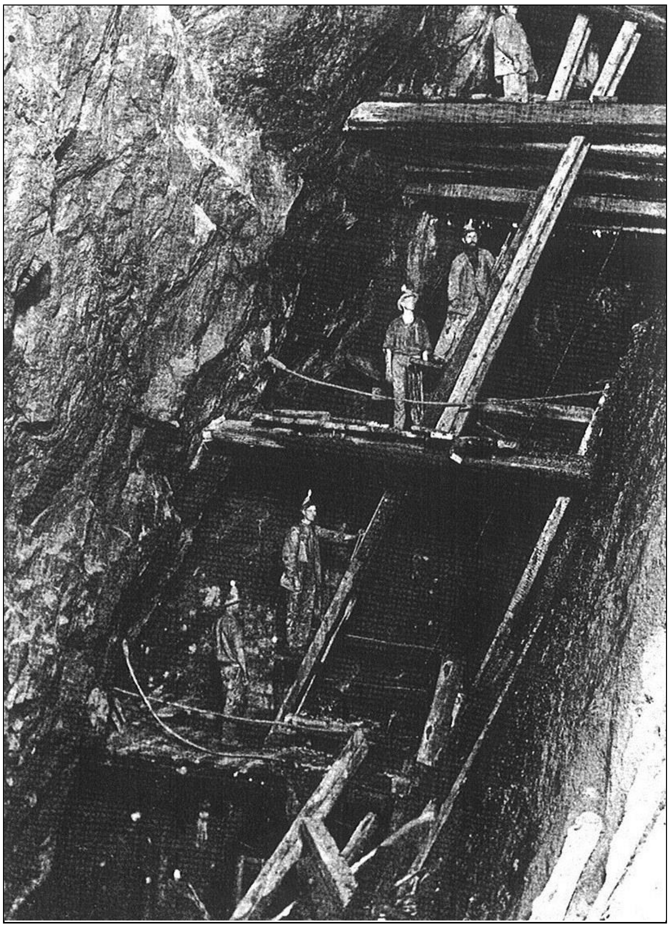


Underhand stopping at the 170 fathom level.

East Pool Mine, Illogan. A hole bored upwards is called an 'upper'. To 'beat an upper' requires great dexterity.



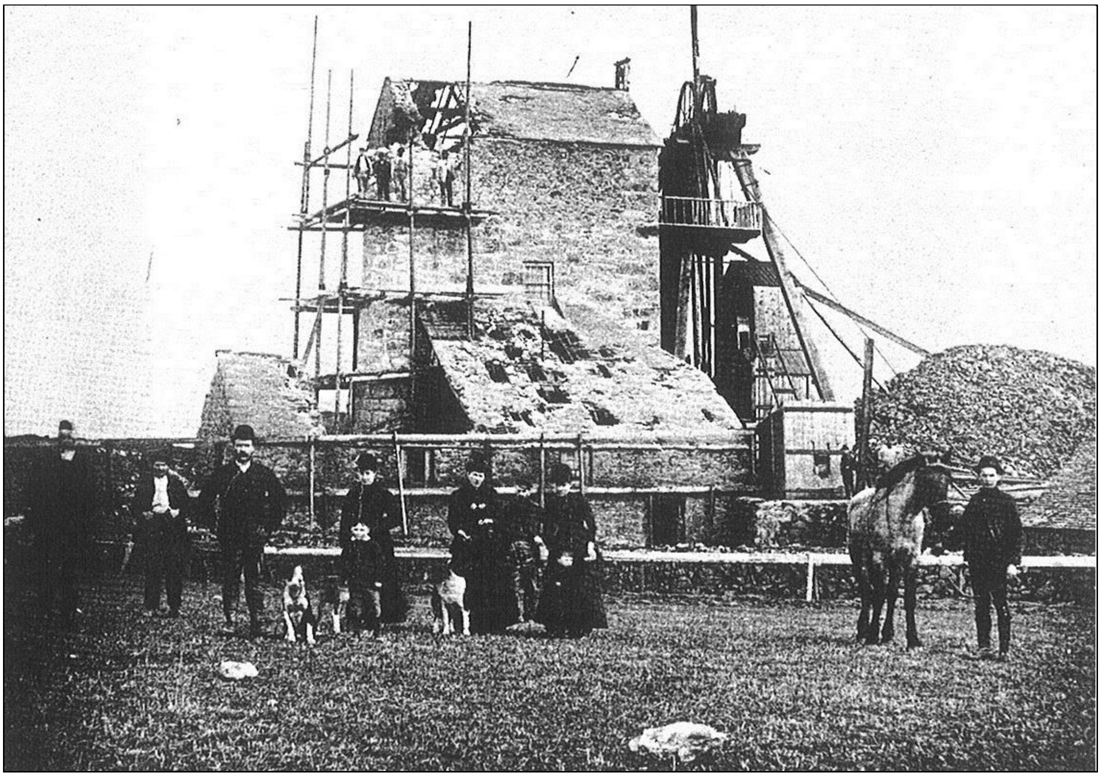
East Pool Mine, Illogan. Miners enjoying the usual 'croust time' having performed the first part of the day's labour. It is possible to see that they are eating pasties.



Dolcoath Mine, Camborne. The man-engine at the 234 fathom level.

The poverty of the region resulted in a good deal of emigration during the 19th century, and the miners, as skilled workers, were to be found wherever the lessons of Cornish mines could be taught. DB Barton observes that:

> *Men from Chacewather and Lanner, St Just and St Day were scattered far and wide across the face of the earth, not only a the well-paid pioneers in the art and science of deep mining but also as emigrants who had, perforce, been driven from their native land. Until about 1870, almost every mine of note, from Norway to the Cape Province, from Spain to New Zealand, employed Cornish captains. They were to be found working lead in the arid hills inland behind Malaga and at Linares; amid the yellow fever that raged through the notorious copper mines of Cuba, where even negroes had to be replaced by imported Chinamen; at Fresnillo and Real del Monte in Mexico; in the Wallaroo and Burra Burra bonanzas of South Australia; in Brazil's Morro del Belho, infamous for its employment of slave labour; in the incredibly rich copper mines of Copiapo and Ande, where anything less than 30 per cent pure ore was left as worthless; and in the howling snow-bound wilderness of the Lake Superior copper region.*



Wheal Sisters, Lelant. The Wheal Mary engine house under repair after being struck by lightning on 31 March 1886.

**Bal maidens from Dolcoath Mine, Camborne, C. 1900.
Bal maidens were surface workers who broke up the
larger pieces of ore.**

Anyone interested in mining in this area ought most certainly to pay a visit to the museum at Morwellham Quay, just a little way up river on the Devon side. Here there are many displays and exhibits which help to evoke the life of a miner in the 19th century, and it is possible to visit the mine itself, with perfect safety and rather better lighting than the miner would have enjoyed.

Historical bibliography

Oral testimony from Mr Paul Pearn, the architect; Mr H Douch, the archivist of the Royal Institution of Cornwall; and Mr Edwards, of the County Record Office in Truro.

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J.C. Burrow and W Thomas, *Mongst Mines and Miners* 1893

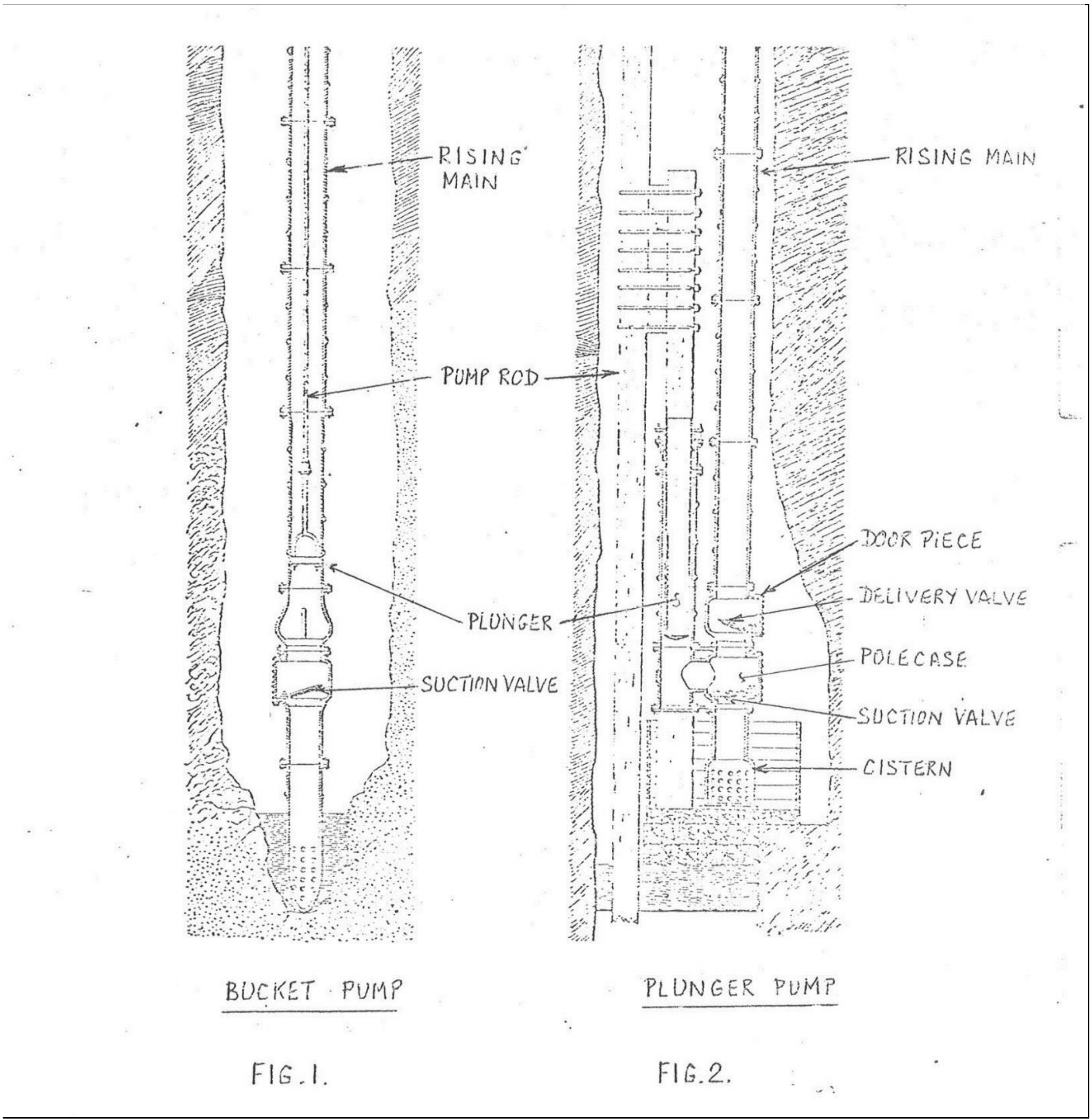
Method of working Danescombe Mine

The mineral lodes were formed over 200 million years ago in the Triassic age. In Devon and Cornwall the minerals occur in several areas, the rocks being killas (clay slate) or granite, which is composed of quartz, mica and orthoclase felspar. The Cooling of the Earth's crust and subsequent upheavals produced the faults and cross courses, which plagued the early miners when following a promising lode.

The first minerals were found on hilltops where the surface layers had been eroded away exposing the lode, trenches known as gossan pits were dug along the path of the find. The other method was tin streaming, minerals being carried along streams after heavy rains. Minerals normally run in a specific direction i.e. tin and copper run east-west, silver and lead run north-south.

The Danescombe Valley is in killas country, thus the mines suffer from water. In granite areas mines are usually dry. To overcome the water problem, shafts were driven from high ground on the probable course of the lode. From the valley bottom, levels were driven in to intersect the shafts; these levels being known as adits. The adits ran slightly uphill to aid the drainage of water, which could collect from all the rocks above this lever. As the search for minerals continued, intermediate shafts were put down along the levels, they were known as winzes. These shafts helped the air circulation in the mine and were usually at 50 fathom intervals.

At the bottom of the main shaft a sump was dug to house the pumps, which were driven by either a water wheel or a Cornish Beam Engine. The pumps were of the bucket (fig.1) type (similar to a bicycle pump) used until 1810. After this date the plunger pump (fig.2) was used, this worked on the downstrike, water being forced up the rising main of each section (or lift) into a cistern, on the cylinder (called a polecase) through the suction valve.

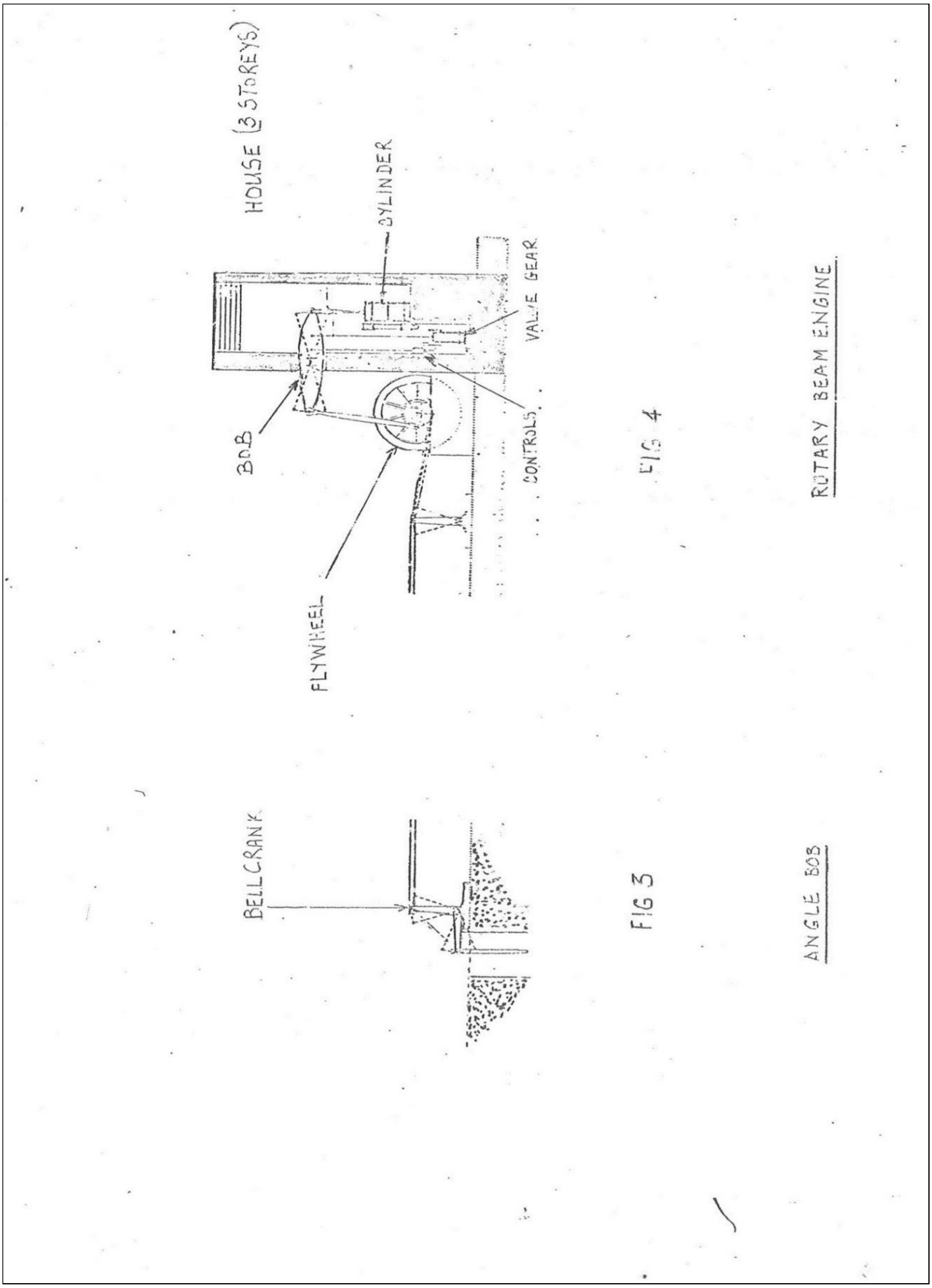


Figures 1 and 2

On the downstroke, the water was displaced from the polecase through the delivery valve into the rising main, the suction valve being closed by the pump pressure. The valve boxes were known as door pieces and the valves being of the flan type were known as clacks due to the noise made on seating. If the mine water was very corrosive, pipes and valves were lined with wood, the clack valves were normally faced with buffalo or hippopotamus hide.

The early miners used simple devices for bailing, a bucket on a rope hoisted by means of a windlass; the next development was a wheel pump, working on the opposite principle to a water wheel, it collected water at the bottom and delivered it into a trough at the top. Several varieties of chain pump followed, pots fixed at intervals or lumps of rag, collecting the water which was pulled through a hollow log to carry the water to the surface. These were sometimes driven by man power prior to the use of horses and water wheels.

The pump in the engine shaft at Danescombe was driven by the 40" Rotary Cornish Beam Engine in the Engine house. The engine drove, through a crank on the flywheel, a line of flat rods supported on pulleys which ran along the dressing floor to the shaft; here a belcrank was used to turn the motion through a right angle in order to drive the pump rod (see figs. 3 & 4). The pump rods were made of danzig pine or oak, if one broke much damage could be caused unless the engine man quickly shut off the steam to the engine. So that the pump rods could be changed, headgear or shears were erected above the shaft, the rods being raised and lowered by means of a six armed windlass (see fig 5).
This pump was also driven by the water wheel lower down the valley, presumably when the engine was being overhauled or if there was a surplus of water. The wheel was supported on tourmaline granite bearings, brass ones being rare; the wheel pit was masonry lined to prevent erosion. A crank drove the line of flat rods, usually made of wood or wrought iron; to lessen the friction the pulleys were lubricated with a mixture of tar and grease, the creaks and groans could be heard for several miles at night when the drive became dry.



Figures 3 and 4

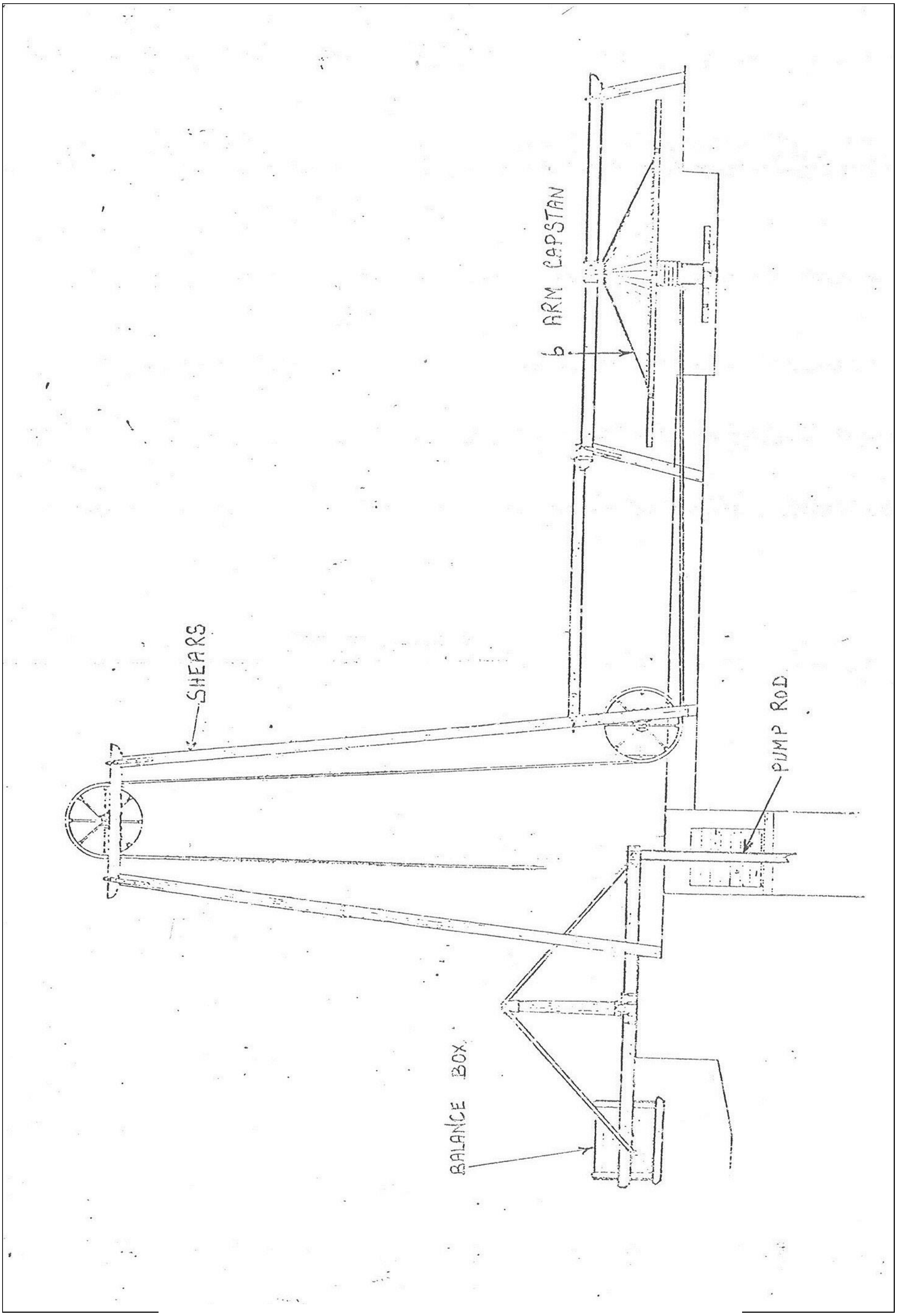


Figure 5

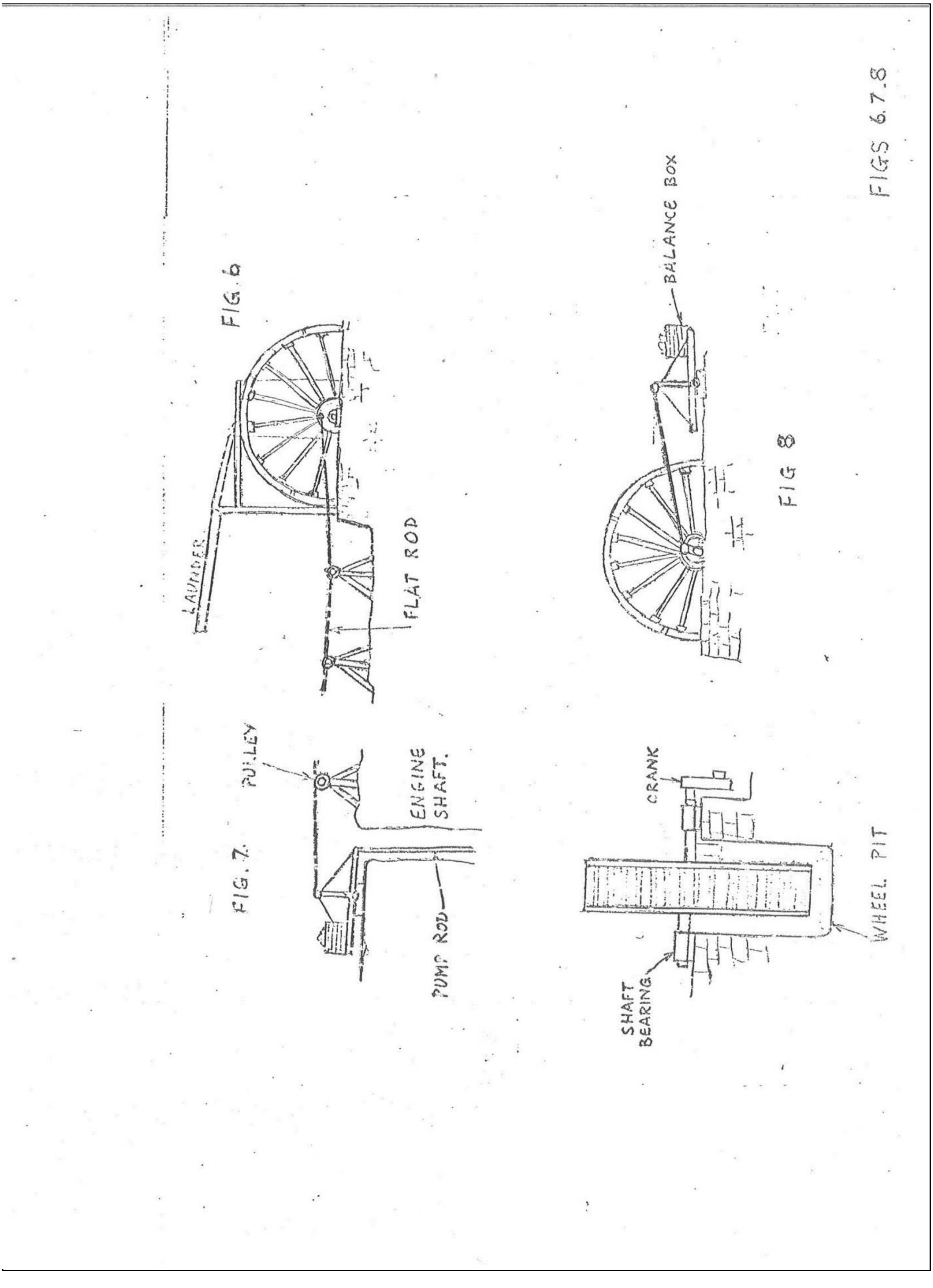
The wheel axle was made from an oak log, with steel bands shrunk on, cast iron axles tended to crack during the winter frosts. The wheel was probably of the pitch back type (see fig.6), the supply launder feeding from the north end the second or third bucket from the top to give an anticlockwise rotation, the tail race flowing south to join the stream. The pumping speed could be reduced by diverting the flow of water from the launder.

This waterwheel had a balance box fitted at the rear (see fig.6) in order to keep the drive rods in tension and even out the power requirements. The pumping stroke occurs between 9 o'clock and 3 o'clock the rods being pulled by the wheel, thus pushing the pump rod down: from 3 o'clock to 9 o'clock the pump is idle, the balance box at the shaft (see fig.7) moving the pump rod upwards, the balance box on the wheel (see fig.8) maintaining tension in the drive rods.

The ore as mined contains waste rock, some sorting being carried out underground the "deads" being thrown into a convenient winze (shaft between two levels). The ore was loaded into kibbles (see plate 1 above) for hauling to the surface by a whim engine or into skips which ran on narrow gauge rail track.

Hughes Shaft had a set of shears, so that during the 19th century ore was hauled out by means of a whim engine in the building shown as engine house on Map "B" above, the kibble was landed by the man called the Lander, he hooked a chain into the bottom handle of the dibble, the whim was reversed and as the kibble descended the lander pulled the chain to direct the ore into a barrow or a chute. To prevent accidents caused by ore falling down the shaft, a pair of doors were fitted to the top of the shaft, these were opened when the kibble was passing through.

The ore would now pass to the dressing floor to undergo various processes according to the type of mineral, the amount of waste present with it, and the purity required for marketing.



Figures 6, 7 and 8

The ore being dirty and mixed with clay rock (gangue) undergoes a washing process provided sufficient fall and volume of water is available. Hand picking was often used for the initial separation, the large pieces of ore known as prills, the ore mixed with rock known as dredge sent for cobbing, waste pieces sent to hillock or burrow.

The skips or kibbles were emptied into chutes where the large rocks were broken (ragged) by the use of sledge hammers (12 pounds weight) and then spalled by a 3 pound weight hammer. The broken ore was then fed to the ore crusher in Mispickel II, the crusher being driven by shafting from the boiler and engine house shown on Map "B" above. The ore crusher would be similar to the model introduced by John Taylor in 1806 at Crowndale near Tavistock, he utilised two old pump barrels for the rolls. The crusher principle was introduced from Cardiganshire but the Cornish Engineers introduced the weight lever, riddle and raff wheel, the principle of operation being based on the action of a mangle. The ore was trammed or barrowed to an opening in the top of the building on the second floor (see fig.9).

The ore was emptied on the floor and fed into the hopper passing through the rolls which were held together by means of a weighted cranked arm. If a large or very hard piece of rock entered the rollers one could spring away to allow it to pass through. The crushed ore then fell into an inclined trommel or rotating sieve (see fig.10). The size of mesh being coarse for this operation. The small ore fell through the mesh into a wagon. Pieces that were too large for the mesh rolled down the slope onto the wooden raff wheel which carried them upstairs to the chute that fed the hopper. The boilers would be of the Cornish type (see fig.11) having a single fire tube, the outlet to the flute being towards the bottom at the rear of the cylinder. The damper plate can still be seen today in the right hand flue. The normal size was 30 feet long by 5 feet 6 inches diameter, the single long fire tube being 2 feet 6 inches diameter, the boiler would be in the region of 10 tons.

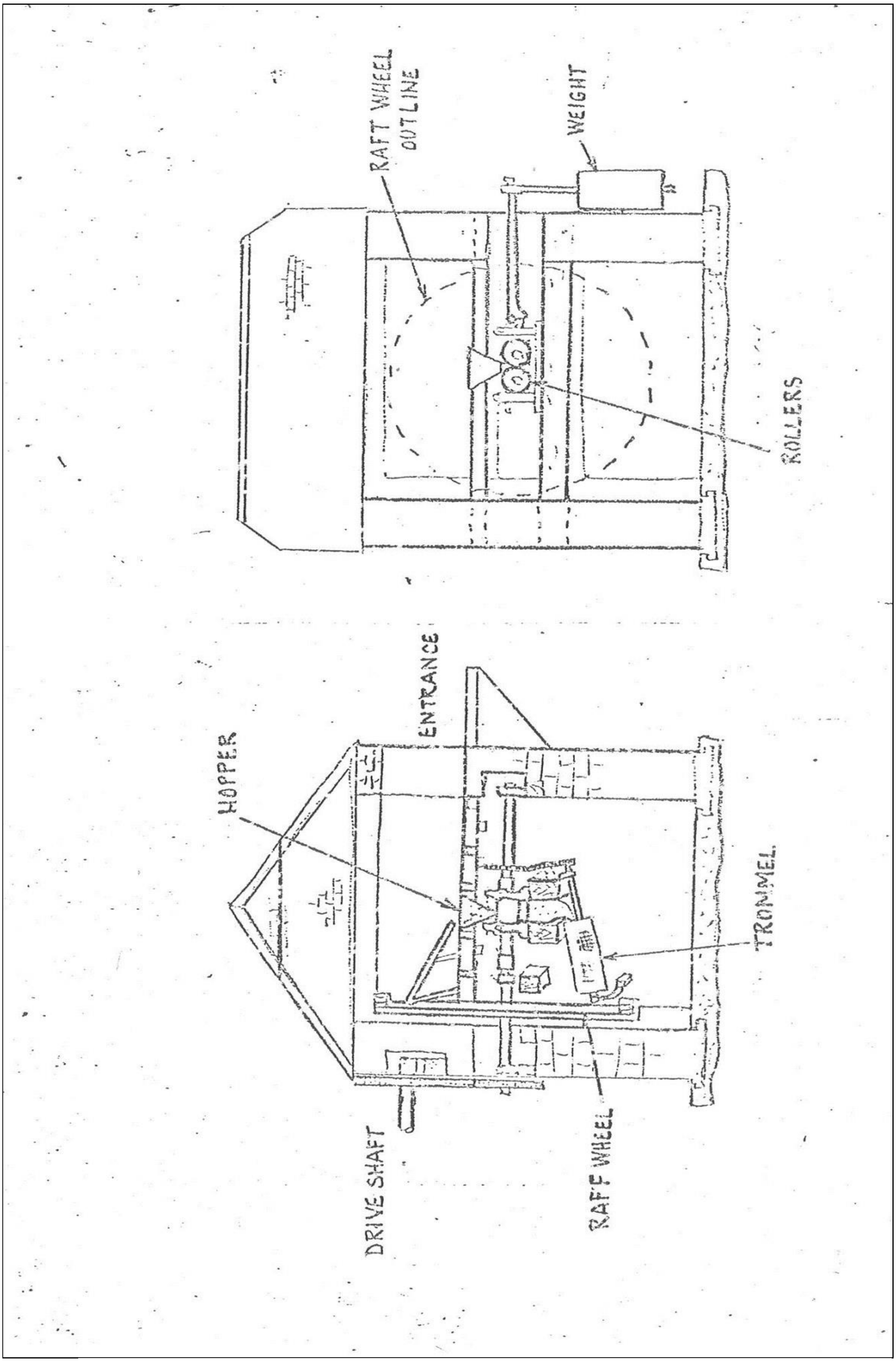

RAFT WHEEL
OUTLINE
WEIGHT
ROLLERS
ENTRANCE
HOPPER
TROMMEL
DRIVE SHAFT
RAFT WHEEL

Figure 9

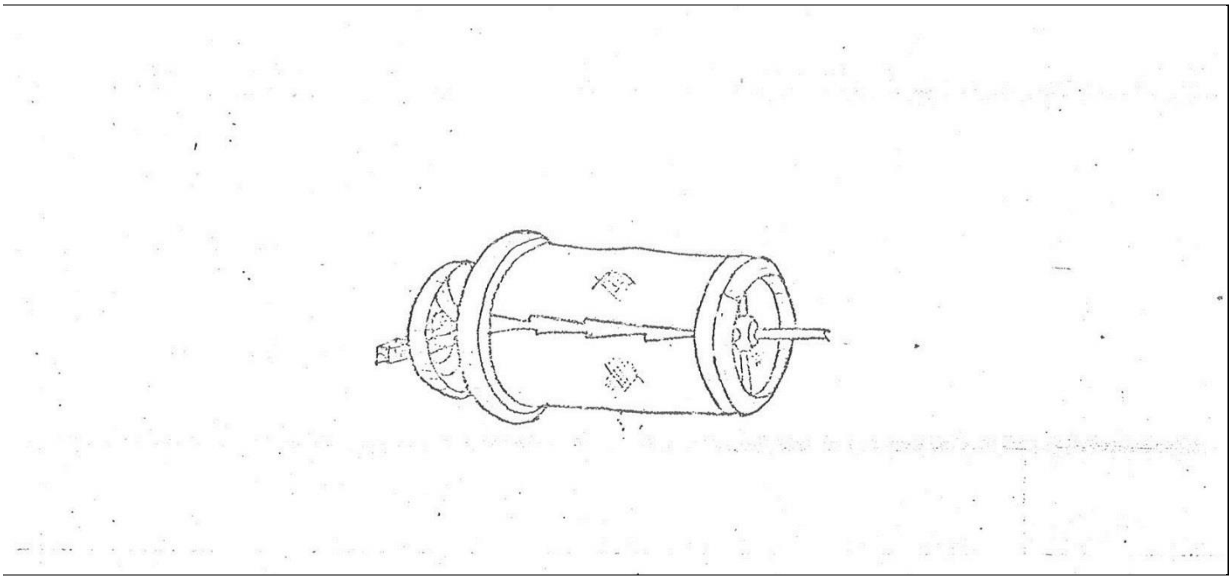


Figure 10 - Trommel

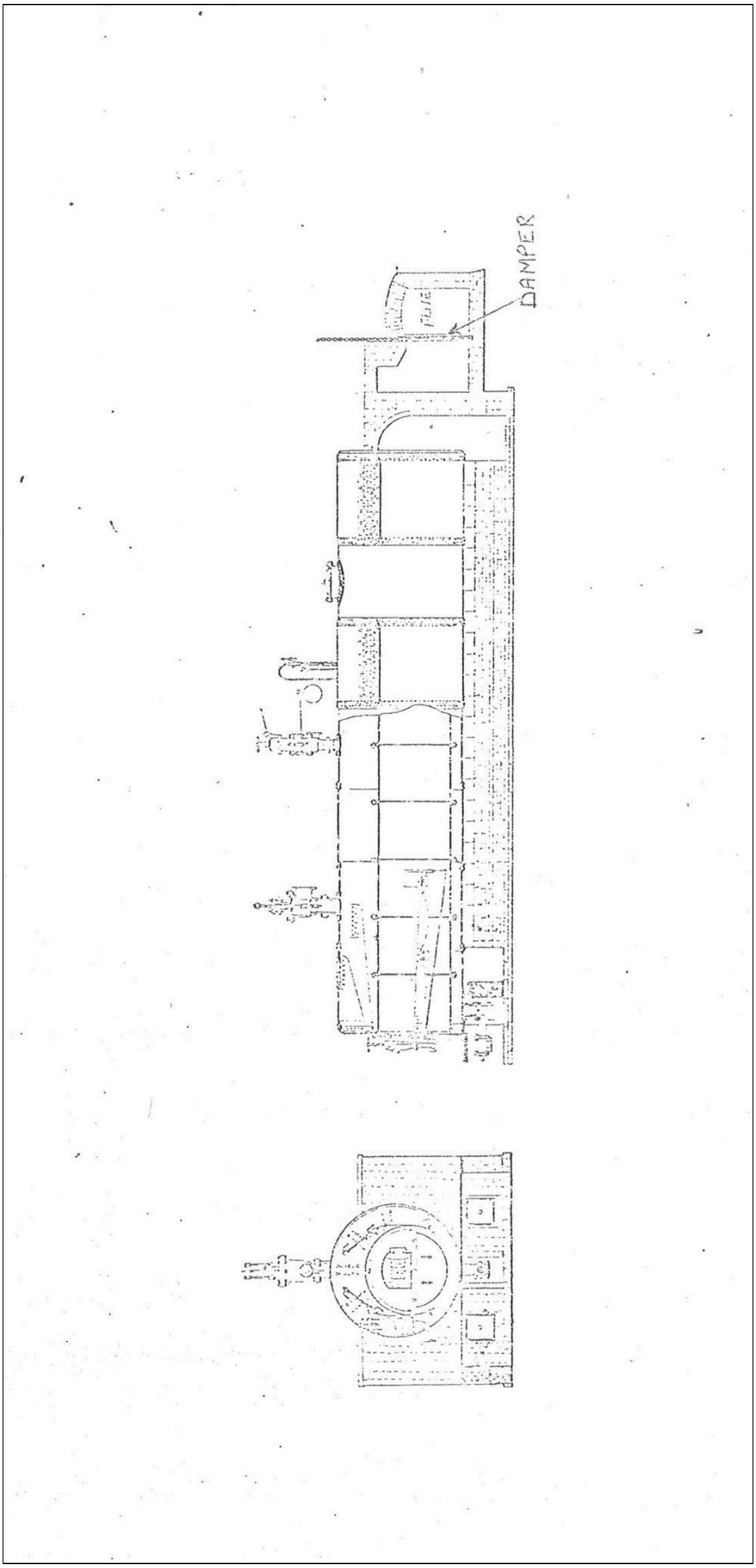


Figure 11 – Cornish boiler

If the water contained acid from the rocks, potatoes were added monthly to neutralise the corrosion which would otherwise occur.

The whim engine was housed in the building nearest the adit entrance; the wire running from the whim cage to the shears above Hughes Shaft (see fig.17 below). The engine would be similar to that shown in fig.12. The whim cage could have been enclosed in the building as was sometimes seen at other mines. The drum was often of the double pattern to allow one kibble to descend the shaft whilst the other was ascending. Ore was also brought from the adit in trucks and pushed to the dressing floor.

The relationship of Cotehele Consuls to the Danescombe Mine is uncertain, but from 1890 to 1900 when the mundic was sent to Coombe Arsenic Works for refining, the mines worked together, the trucks being hauled to the crusher house (see Map "C" above and Fig.13 & Fig.14) for final crushing of the ore to about 1/2" mesh before being loaded into horse drawn carts which were driven to Coombe via Trehill.

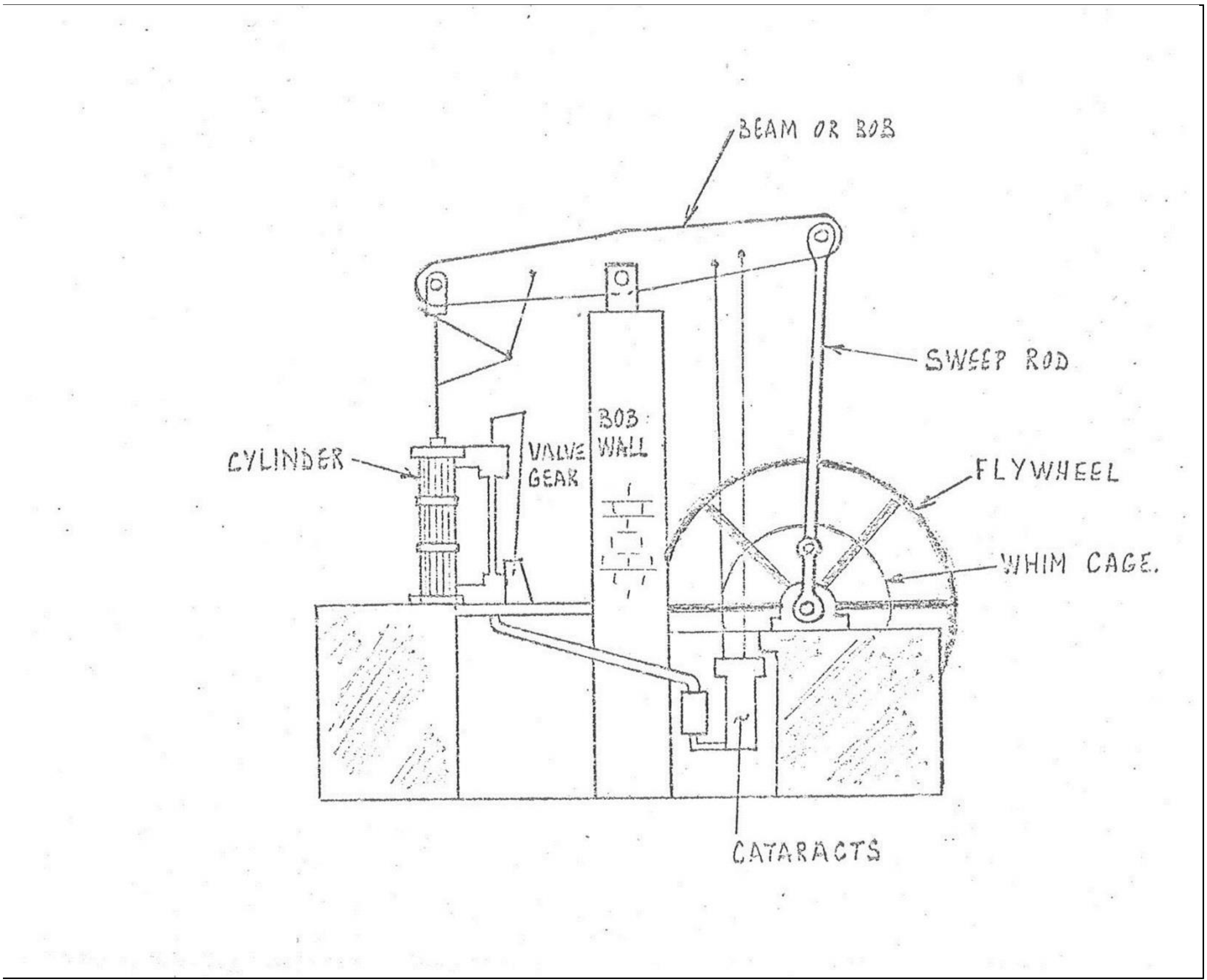


Figure 12 – rotary beam engine

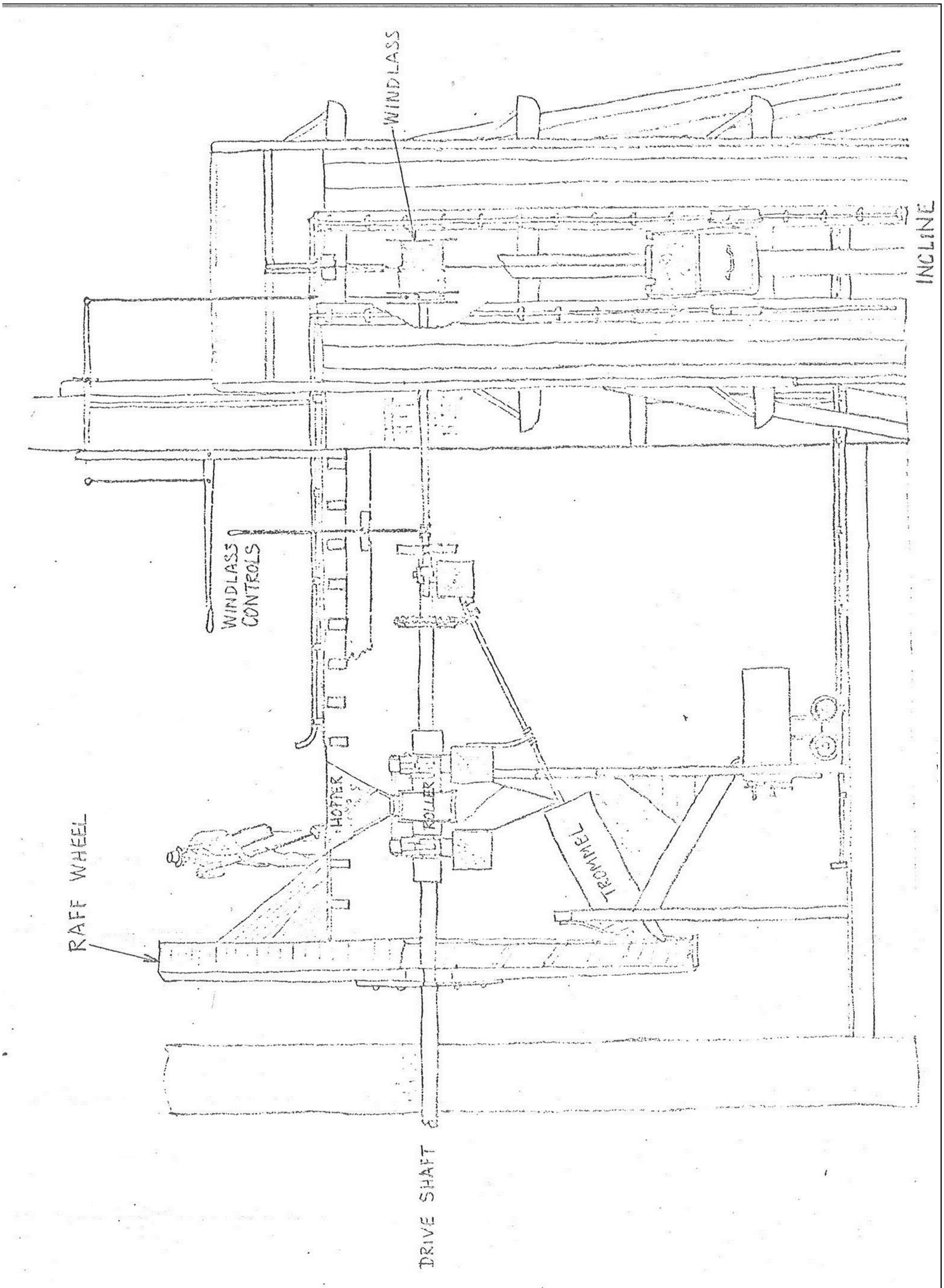


Figure 13 – section through roll crusher

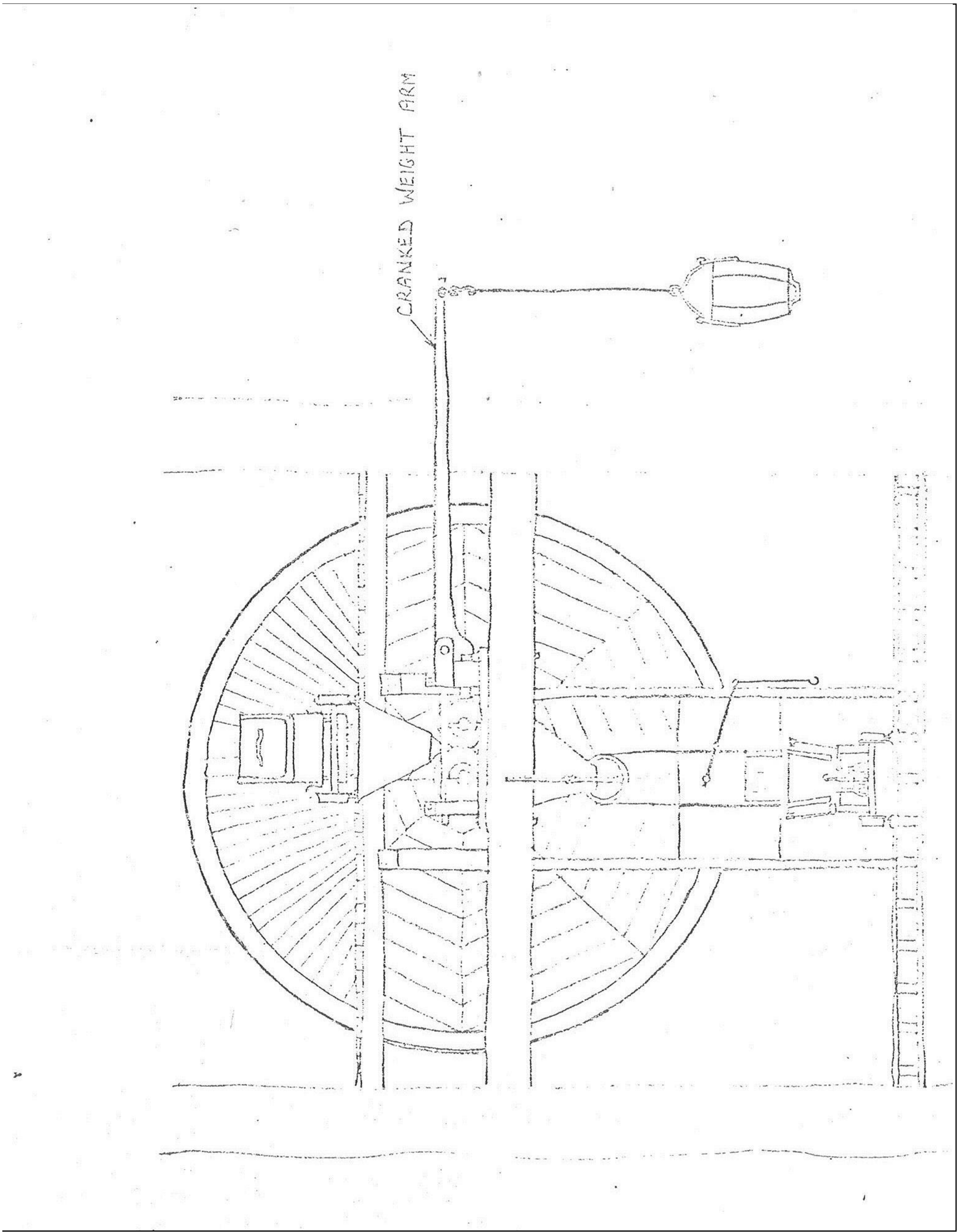


Figure 14 – end view of crusher

The engine driving the crusher was a Rotary Cornish Beam Engine reputed to be of 40" diameter cylinder but on scaling the holding down bolt centres it is more likely that the engine was a 30", the beam being approximately 14' centres from piston rod to bob wall bearing, the sweep rod drove through a crank; the main shaft, which had two large flywheels, gearing was taken from the shaft to drive the buddle pits, the main shaft being coupled to the crusher drive. The opposite end had a crank which drove the line of flat rods for pumping the engine shaft (see fig.16)

The boiler was in the building alongside, the long flue led to the chimney in the woods.

The same principle of separation applies to this crusher as previously described, but in addition there was a powered windlass to enable the heavy trucks to be hauled up the ramp to the side entrance (see fig.13), the winch being controlled by the crusher operator. Rails ran into the building so that the rocks could be tipped directly into the hopper. Below the trommel was a storage hopper with a hatch which could be opened to fill the skips.

An open sided shed attached to the front of the crusher house covered dressing machinery used for processing ores by the jigging machine (fig.15a) driven by the engine, the slimes passing via a launder to the buddle. The buddle pits (see fig.15) driven from the main shaft were used in the recovery of copper and tin from fine slimes.

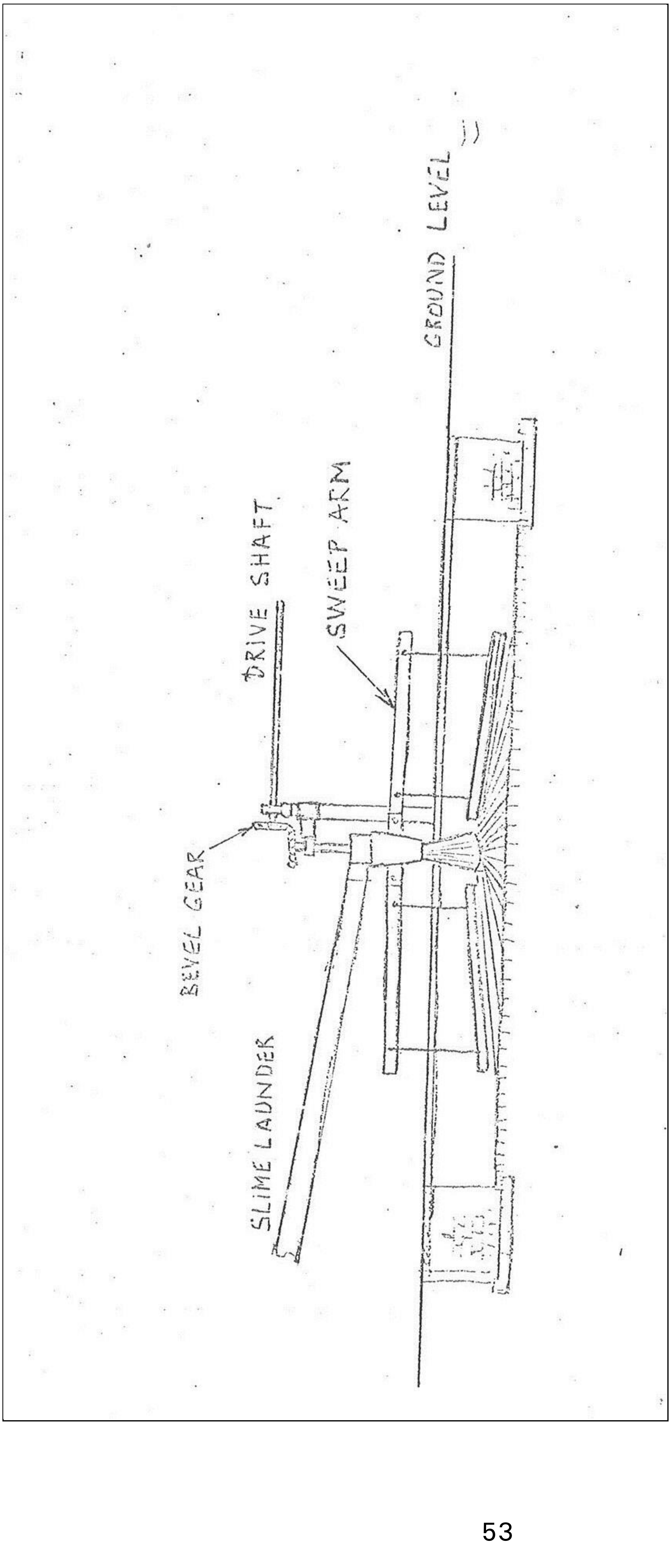


Figure 15 – circular buddle

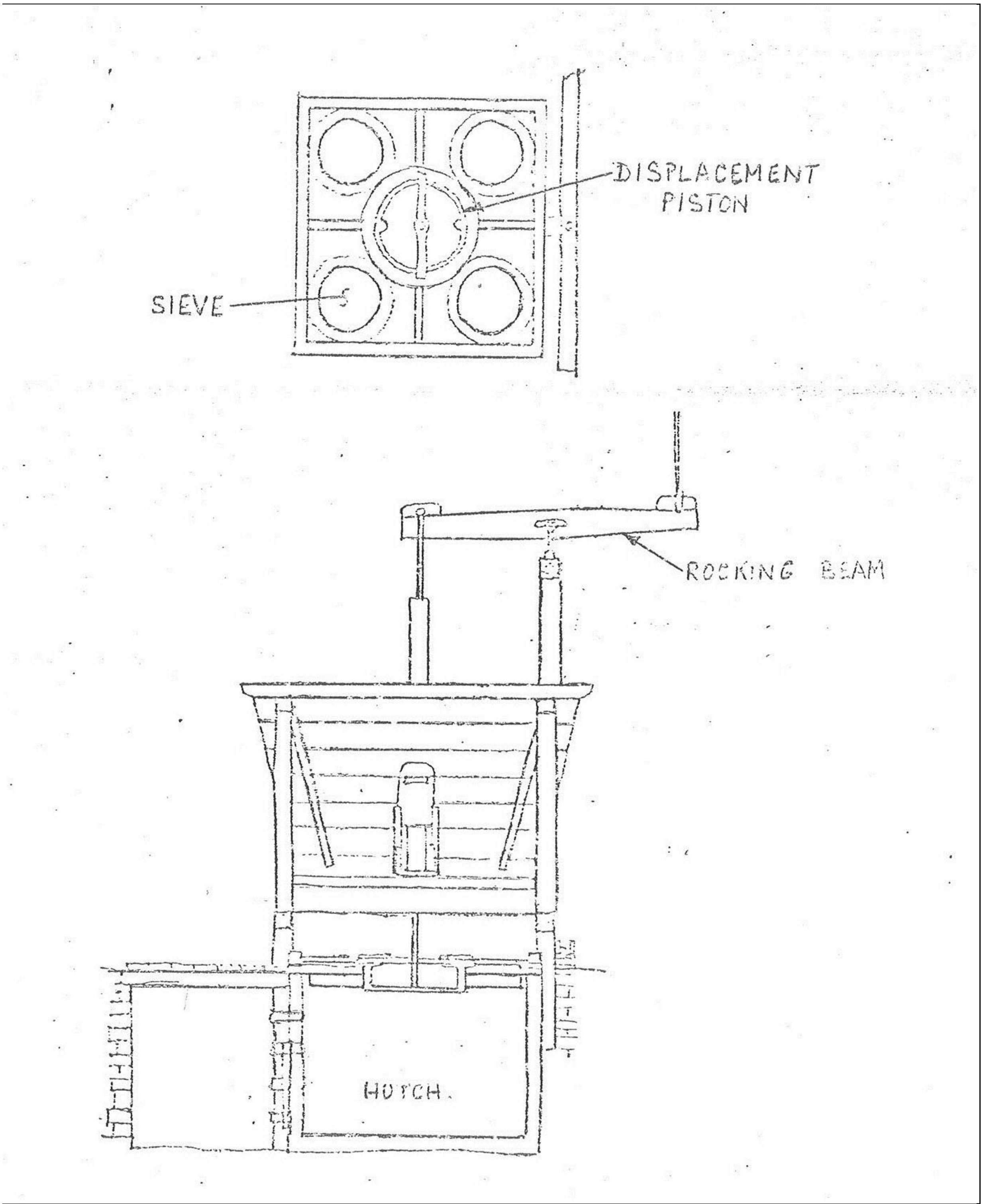


Figure 15 a – mechanical jigging machine

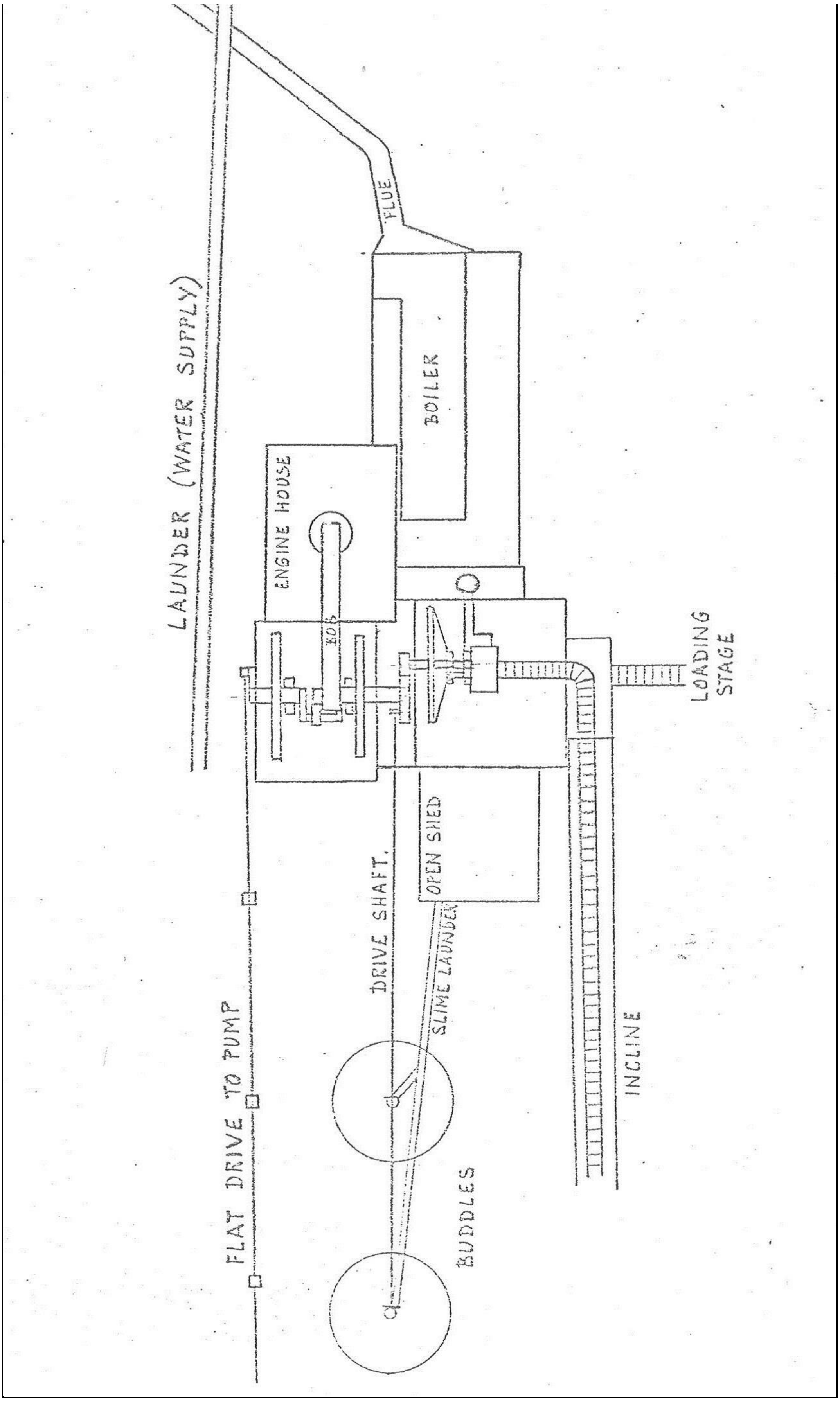


Figure 16 - Plan of Cotehele Consuls

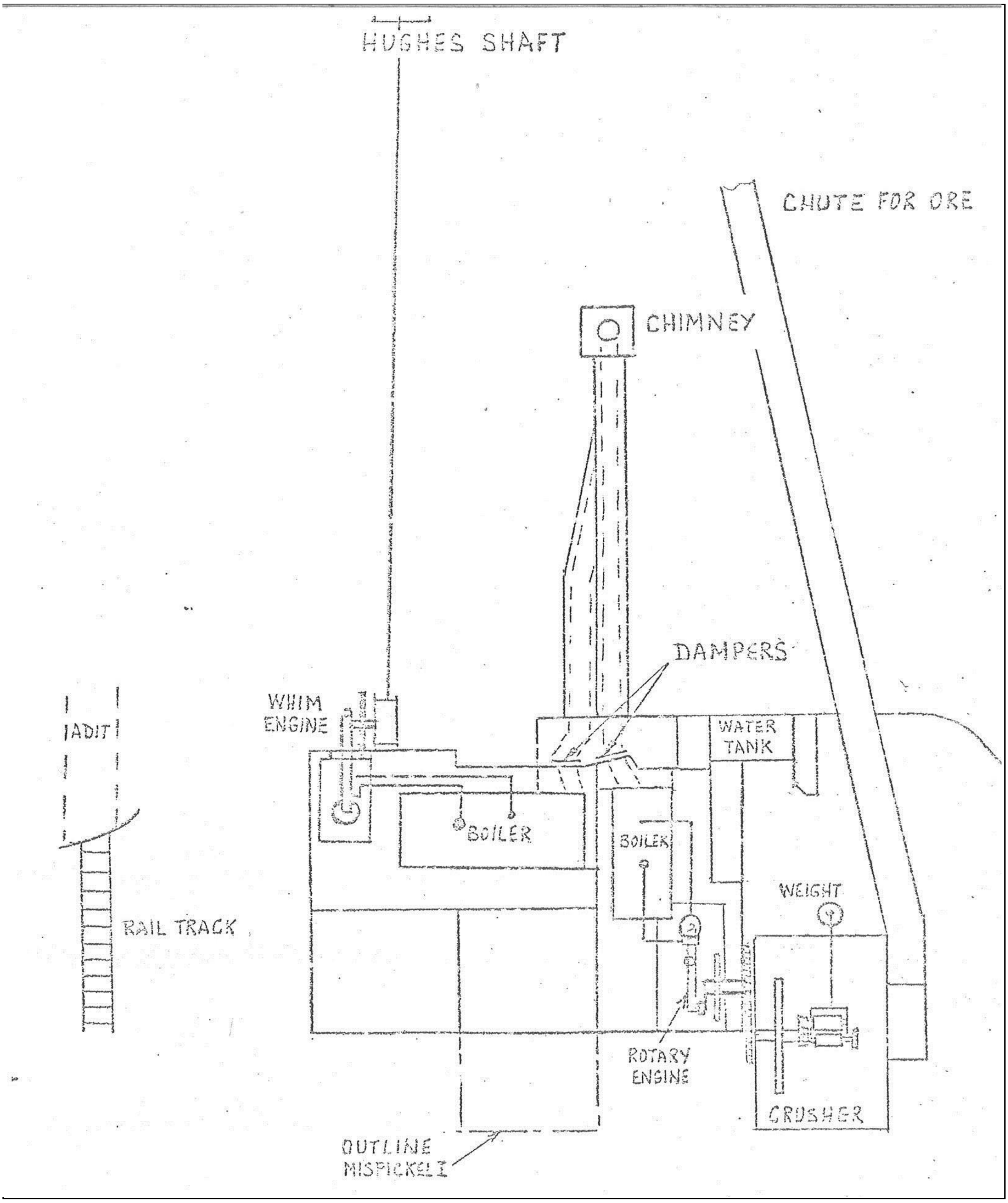


Figure 17 – Plan of Danescombe Mine scale 1″ = 2 ½ fathoms

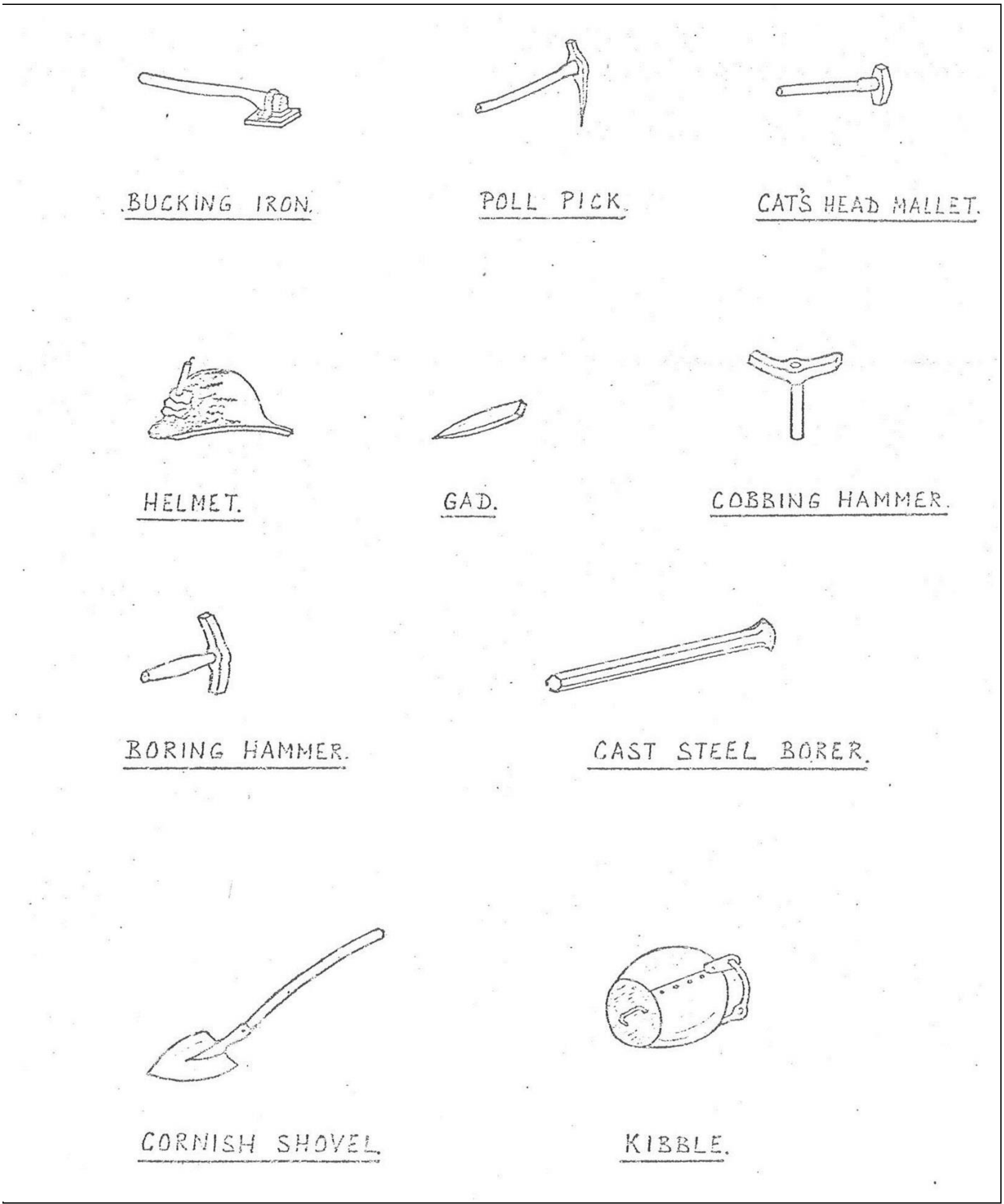


Plate 1 – Mining equipment

Processing of Copper Ore - (Refer to Plate 1 for Tools)

The Copper ore brought up from the levels is tipped from the skips into divisions below the elevated rail track called slides (see fig.18). Here men using 12 pound sledge hammers break up the large lumps, this is called ragging. The smaller pieces pass to the bal-maidens, who worked in the open sided sheds, they used three pound hammers to spall the ore, pieces of rock were also broken off with cobbing hammers at this time. Any small ore from the slides was riddled in a hand sieve or a revolving inclined sieve known as a hurdy gurdy rotated by means of a handle, the mesh being 3/4". The ore was then divided into three portions - (1) pure ore called prills, (2) second quality ore known as dradge - where the ore occurs in the rock as specks, (3) leavings or halvans.

The prills are sent to the crusher; prior to the use of crushers, the Bal-maidens bucked the ore by means of a flat hammer on a steel plate, the ore being carried to them in hand barrows.

Children were employed to pick out lumps of good ore from the various piles, the remainder was thrown on to a perforated plate and washed with water. The pile was stirred with a shovel so that the fine particles fell into a hutch beneath.

The larger particles were again picked over by the children, the refuse being thrown under the table. The smalls from the hutch were taken to the jigging machine. Here a sieve of four holes per square inch was swirled in a tub full of water, the bottom of the sieve had a layer of iron pyrites on it, a quantity of copper ore was placed on top, the ore that fell through was put aside for sale, whilst the heavier ore remaining in the sieve was also fit for sale.

The middle part was again bucked or crushed and then rejigged, the upper portion being thrown with the halvans.

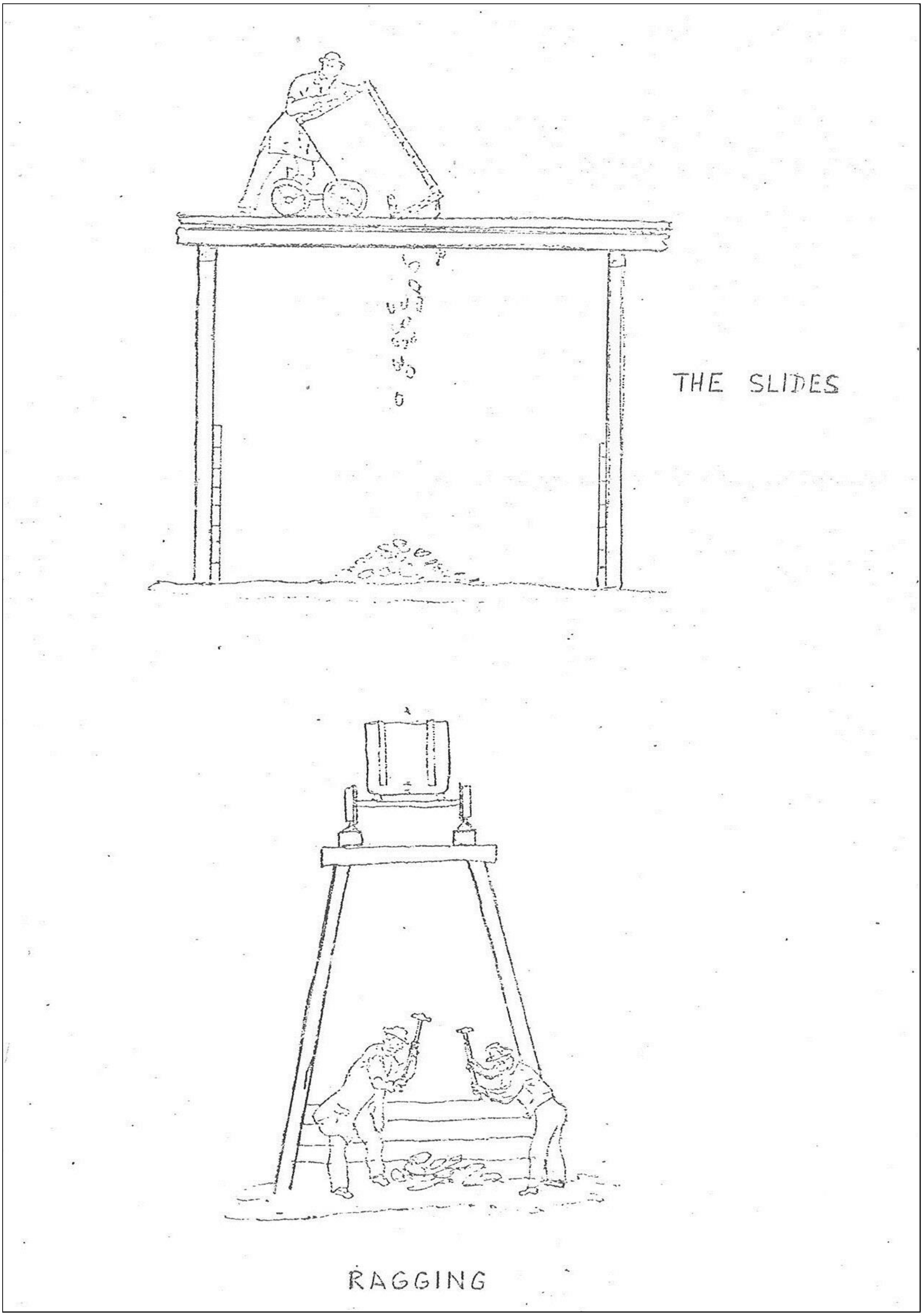


Figure 18

Engine or waterwheel jiggers were used on larger mines where the quantity of ore justified it, the small mines used the simple hand sieve or a level operated jigger (see fig.19). Some copper ores (such as Chalcopyrite) are so light and crumbly that they were only cobbed and picked before sale.

The halvans are cobbed and bucked, jigged and trunked and then buddled with the slime from the washing plate hutch. As mentioned previously the dressing floor had two circular buddles, the fine ore was carried by a stream of water into the centre of a buddle along a launder (see fig.15). The buddles were approximately 2 feet deep by 18 feet diameter with a raised centre portion, a wooden floor falling at a slope of 1 in 30 over a six foot length. The centre spindle, which revolved, had a perforated disc with spouts leading away from it. The slime ran into this disc and was spread onto the centre portion of the buddle in a thin film, which flowed gradually outwards to the periphery, the heavier particles in the liquid being deposited nearest to the centre.

A perforated wooden partition at the periphery controlled the outflow of water and waste. Holes were progressively plugged as the level rose in the buddle. To ensure uniform spreading of the stuff and to prevent gutters or channels forming in the deposited ore, small pieces of cloth or brushed were suspended from the saw arms which revolved with the centre spindle, these were called sweep arms. Their height was periodically raised as the deposited stuff accumulated, the sweeps and spouts were driven at 5 to 6 rpm. After ten hours the buddle would be full and the flow from the supply launder was diverted to the second buddle.

The contents of the full buddle were then divided into three concentric portions (1) head (2) middle (3) tail, the head being nearest the centre. The head was jigged or tossed in water to remove any impurities then it was ready for market. The tail was rejected and sent to the waste heap, the middle being re-buddled. The copper refining was usually carried out in South Wales.

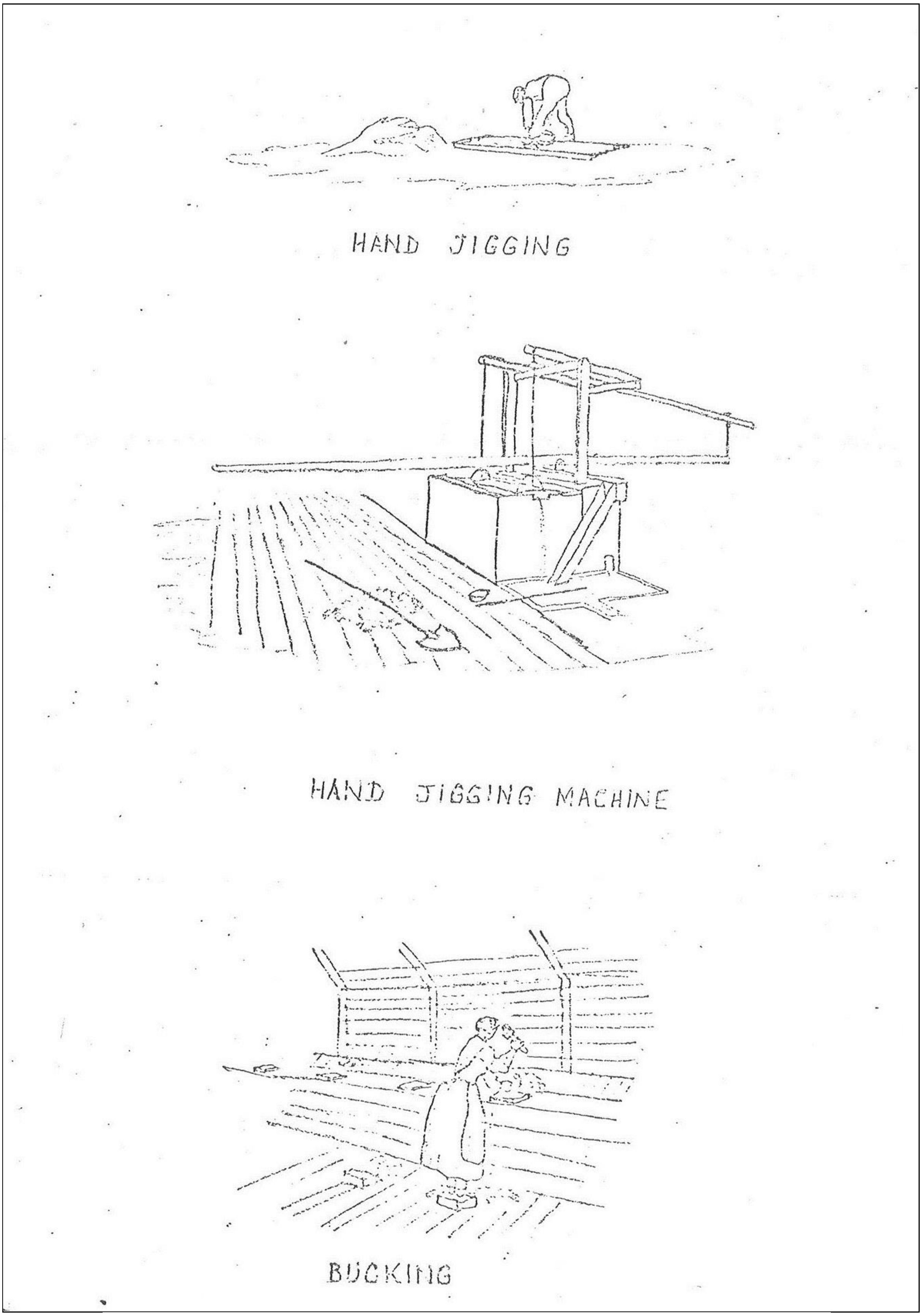


Figure 19

Copper also existed at some mines in the form of grey vitreous copper (CuS) known as Chalcocite or Redruthite, this ore was formed by the crystallisation of minerals from solution of surface ores dissolved by water. A process of cementation was used to refine the copper. The solution was fed into a pit containing scrap iron, the copper dissolves the iron and is precipitated. The copper was then reclaimed by wire brushing the iron.

Processing of Tin Ore

Small quantities of tin ore (SnO) known as Cassiterite were also mined in the valley. Pure tin oxide is colourless, but due to the presence of ferric oxide, the colour of ore varies between brown and black hence the name of black tin. Any arsenic impurities made the refined tin hard, less ductile and less shiny.

Tin oxide was normally found below copper ores hence mines were always deepened well below any copper deposits in searching for tin.

The dressing of tin ore was similar to that of copper, except that the tin crystals occur distributed in the rocks in small pockets. The ore was hand-picked, broken by hammers and then stamped by means of Cornish stamps driven by a rotary beam engine or water wheel (see fig.20). The stamp heads weighed up to 140lbs; the resulting powder passed through a grating at the bottom, one foot square and with holes 1/10" diameter. This pulp passed to slime ponds and buddles. Poor tin was also jigged and sieved. The tin was sent away for roasting with charcoal at the smelting works or blowing house.

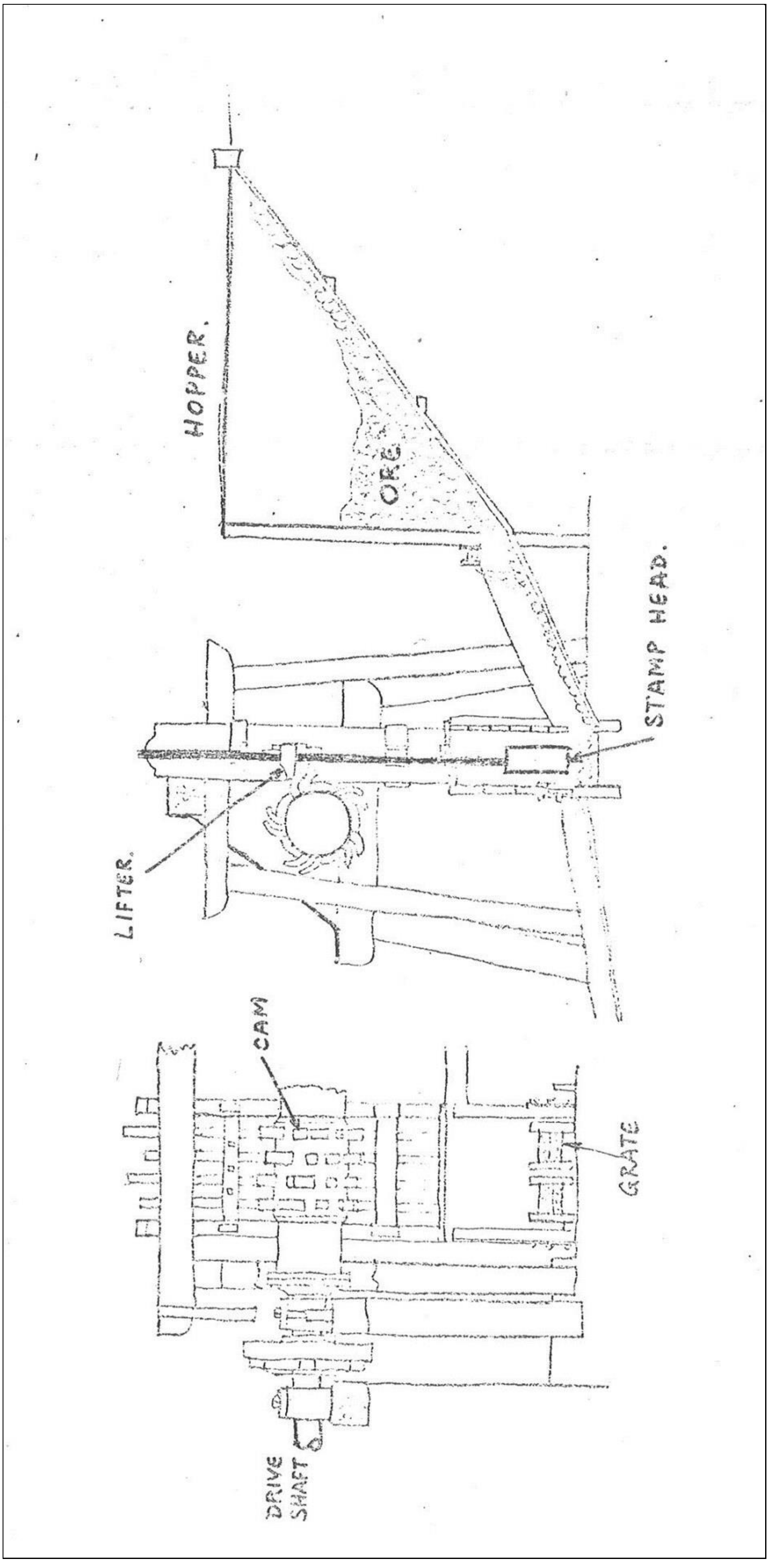


Figure 20 -stamps

Other Minerals at these Mines

As the levels were driven eastwards towards Colloms Shaft at Calstock Consuls Mine, other minerals were found, iron pyrite (FeS) known as mundic; lead and silver sulphide (PbS) (Ag S) known as galena; and zinc sulphide (ZnS) known as blende or Black Jack; these minerals were associated with the quartz and chlorite veinstone in the lode.

Further up the valley from Engine Shaft was the Consolidated Tamar Mine which yielded some copper ore, also Mispickel and a little wolfram and tin.

Principle of the Cornish Beam Engine (see fig. 12 above)

The sweep rod is connected to a crank which turns the whim cage on a rotary engine; for direct pumping, the sweep rod is discarded and the first pump rod connected directly to the bob. To operate the pumps, steam is admitted to the upper side of the piston via the inlet valve, the equilibrium valve being closed. The exhaust valve at the bottom of the cylinder is open to the condenser which has water sprayed into it to condense the steam under the piston thus producing a vacuum. The piston is pulled down under the action of the vacuum below and the steam above. This pulls the bob down indoors and upwards outdoors, thus pulling up the pump rod. As the piston nears the bottom of the cylinder the inlet valve is closed and the steam above the piston expands to complete the stroke.

The exhaust valve and condenser water spray valve are then closed, the equilibrium valve opens allowing steam to flow beneath the piston equalising the pressures. The weight of the pumps now allows the pump rod to descend and the piston to rise. Just before the piston reaches the top of the cylinder the equilibrium valve closes, the trapped steam cushions the piston as it comes to the end of the cycle. The valve gear is operated by rods from the bob, and the speed of operation controlled by devices called 'cataracts' which are similar to water filled dashpots with adjustable orifices. Each valve is operated by its own shaft. These shafts are interlocked by means of quarter round segments called 'scoggans' to prevent malfunction of the valve system. The condenser water spray valve is operated from the exhaust valve shaft. Speed ranges from one to fifteen strokes per minute.

Mine buildings

The roofs were gabled and slated, the walls were of the local killas stone, granite was preferred if available; adjacent to the Cotehele Engine House is the small quarry in the hillside used for these buildings. Bricks were obtained from the Calstock Brick and Tile Company.

The interior of the engine house had turned woodwork finishes, the cylinder was lagged and covered with mahogany, teak or polished wood bound with polished brass bands. The stonework was whitewashed inside and out. The timber for the doors, window frames, shears etc., was painted red. The floor was kept clean and well scrubbed. The whole of the interior was full of the sweet smell of hot oil. The upper floor had doors to the walkway around the nose of the beam or bob, this piston red leading to the top of the steam cylinder, here also the valves and steam pipes were connected to the cylinder. On the next floor the engine man would stand to start, stop and regulate the number of strokes. Set in the floor would be a granite slab with the four cylinder holding down bolts screwed into it. Below this floor, usually in a pit, were the cataracts, condenser, and the feed water pump operated by small rods from the beam. The boiler was fitted in an adjacent house often of a lean-to construction. Whim engine houses usually had only one or two floors due to the smaller size of engine.

Arsenic mining and refining

To the tin or copper miner the arsenical pyrites found in the ore were a nuisance which had to be eliminated. The tin miner had to dress the ore to 65% purity, and arsenic was produced when the ore was roasted, if arsenopyrite was present with the cassiterite (oxide of tin). If the arsenic was not removed before smelting, the metal was relatively hard, less lustrous and less ductile than it should have been. Arsenic also caused atmospheric pollution, and death to vegetation and livestock. The demand for arsenic rose during the 19th century as a consequence of technical developments in making various types of glass, and increased demand for its use in lead shot and firework manufacture, in tanning (where arsenic disulphate was used) and in particular in the manufacture of arsenical pigments, which were extensively used for colouring cotton fabrics, wallpaper, etc. Arsenic acid was used in the manufacture of magenta, and its salts, especially sodium arsenate, for calico printing.

A grain of arsenic is a dangerous dose for a human; two grains are usually fatal. But for those working in arsenic production there was no great danger: they used cotton wool in their nostrils, a handkerchief over the mouth, overalls, fullers' earth on face and hands, and had a good wash after work. One hazard was the overpowering small of garlic produced by arsenic smoke. Since the body by degrees becomes immune to small quantities of arsenic, those who lived and worked in an arsenical environment would gradually have become impervious to ill effects. Tiny quantities of arsenic used to be used to improve the complexion, so those engaged in arsenic refining were possibly exceptionally good-looking!

The heyday of arsenic manufacture in Cornwall came and went during the 1880s, but the industry persisted in the county until it finally died out in the 1930s. Today Sweden produces the world's arsenic supplies.

The pyrites mined at Danescombe would not, of course, have been refined on the spot, and we know that during the 1890s they were taken to the Coombe Arsenic Works.

To obtain arsenic from "Mispickel" or Mundic", which contains up to 30% arsenic, the ore was washed and broken into pieces small enough to pass through a 1/2" sieve, this was done at the mine. It was then sent to the processing works where it was roasted in calciners to produce arsenic soot, which was further refined to produce arsenic crystals.

There were two types of calciners:

(a) The Brunton Calciner ;

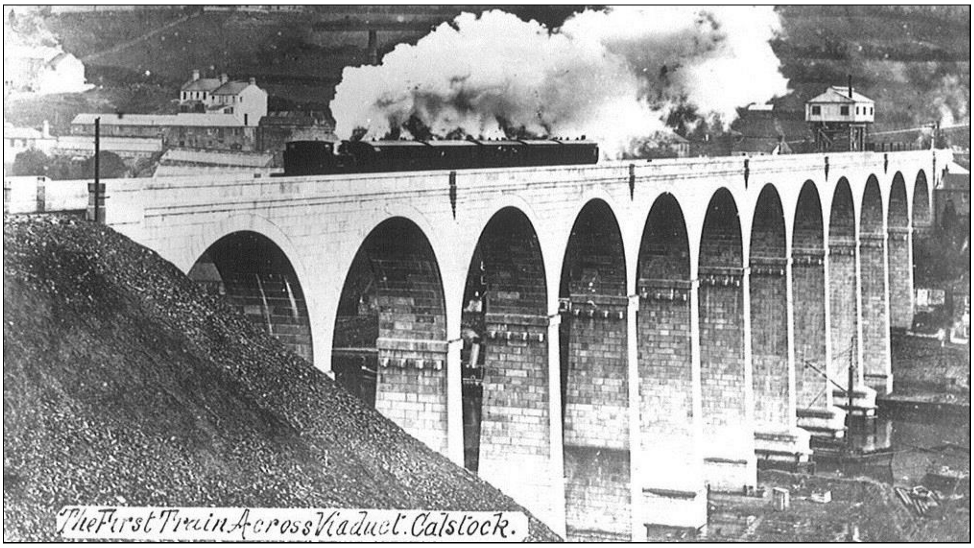
(b) The Oxland cylinder which was the more generally used.

(a) The Brunton Calciner was a dome shaped structure with a circular bed of bricks laid on an iron plate above a furnace. The plate and brick bed were revolved by means of a water wheel, as they revolved a series of obliquely set teeth stirred the ore to ensure that it was completely roasted. The arsenic vapour from the roasting ore, yellow in colour and smelling faintly of garlic, was discharged through regulating dampers into a series of flues with masonry walls 30" thick, these flues were connected to a labyrinth of brick chambers where the arsenic vapour condensed on the walls and floors in the form of grey crystals, from these chambers further flues carried vapour over limestone screens to extract the residual arsenic and sulphur, and thence to the familiar tall stack built on high ground so that fumes were not trapped in the valleys.

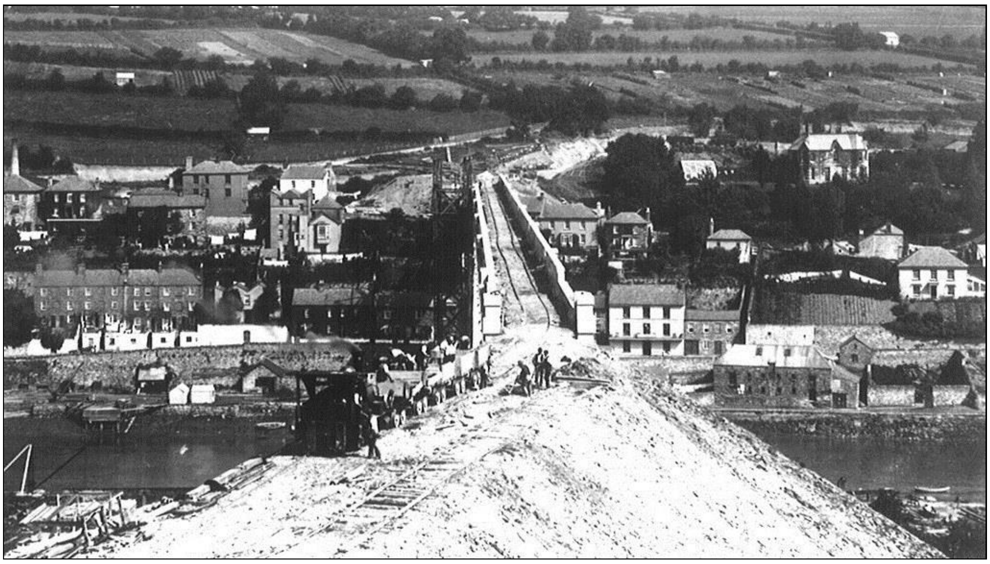
After this first roasting the arsenic was approximately 80% pure. A further process consisted of roasting in a refining furnace, heated by a mixture of anthracite and coke (smokeless fuel), the vapour passing into a series of brick chambers with clean tile floors where it condensed into deposits of clean white crystals, which were dug out by hand. The workers wore mouth masks, ear plugs, and muffled their feet and ankles in sacking to avoid sores from the caustic crystals. Two changing rooms were provided to ensure cleanliness.

The final process was grinding the crystals between two granite millstones into a flour like powder, which was packed in 4cwt wooden casks lined with blue paper. This arsenic powder was 99.5% pure, one sixth of a teaspoon being sufficient to kill a person.

(b) The Oxland cylinder comprised a 50 foot long wrought iron tube lined with firebrick. The tube being mounted on rollers and inclined at a slight angle. The ore was shovelled in at the highest end; rotation of the tube worked the ore along the tube to the furnace at the lower end, the sulphur content helping to complete combustion. The vapour was led to flues and chambers as in process (a). The arsenic was used in chemical industries, manufacture of glass and enamel, insecticides, medicines, paints, dyes, and as copper arsenate to fix pigments in fabrics and wall papers.


The First Train Across Viaduct. Calstock.


CALSTOCK. 1907.



Holidays in Cornwall are "better than in Italy"

From Anon, [J.R. Leifchild] *Cornwall: Its Mines and Miners, with Sketches of Scenery; Designed as a popular Introduction to Metallic Mines* (1857) 62-3.

"I wish I could but persuade some of the multitude of fashionable tourists to take a trip or two here! I believe I should be really benefiting them by my advice. I am patriotic, and a zealous advocate for this home-touring. What unjustifiable folly is it to spend thousands annually upon Gallic cheats and German landlords, to travel in order to feed Neapolitan tyranny, Romish pride, and Tuscan despotism, in order to see sights and scenes not always nor often more interesting than may be witnessed at home! Instead of being present at, and thereby countenancing Popish mummeries, and their idolatrous musical services, come down here and listen to the magnificent music of the Atlantic on a starlight [sic] night, from a seaward moor or cliff! Instead of inhaling the sickening fumes of Popish incense, come here and inhale the invigorating breezes that sweep with loudly flapping wings over the wide Atlantic! Instead of gazing ignorantly at stiff Madonnas with gingerbread-gilt aureoles, come here and gaze upon Nature's pictures, vast and varied. Leave the frescoes of Michael Angelo, and the quaintness of Giotto, and the stiffness of Pre-Raphaelites, (for ten to one if any of you ever *really* enjoy them, and come and look at the fretted rocks on this granitic coast-range! And as to diet, fling away your 'vin ordinaire' and your Italian wines, and your olive oil, and your 'ragouts' and your soups, and put up with the hard, healthy fare of these wild districts; and then, what with the sharpening sea breezes, the calm, pure thoughts, the grand scenes, the solemn weird moorstones, the fitful moonlights and starlights, the hours of sea-shore meditation, the sketches you make of striking points, of obelisk-like rocks, and of fishermen's cottages and nets and what also, with your familiar intercourse and acquaintance with the persons, lives, trials, and discipline of the simple peasantry; - I say, what with all these, you will be a wiser and better man than if you had seen the Bay of Naples, dived into Pompeii, ascended Vesuvius, mangled the Italian language, kissed the old Pope's hand or toe, and heard the miserere' in the Sistine Chapel at Rome!”