MACHINERY

FOR

METALLIFEROUS MINES:

A PRACTICAL TREATISE

FOR MINING ENGINEERS, METALLURGISTS

AND MANAGERS OF MINES

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SECOND EDITION, Rewritten and Enlarged

With nearly Four Hundred Illustrations

LONDON

CROSBY LOCKWOOD AND SON

6 7, STATIONERS' HALL COURT, LUDGATE HILL

1902

W3 2490
Cwmystwith Concentrating Mill.—The 100-ton lead and blende concentration plant erected at the Cwmystwith Mine, in Cardiganshire, is one of the most recent installations of this kind, and was built from designs prepared by Mr. J. Buss, Ph.D., and myself. The machinery was supplied by the Liihreg Ore Concentration Company, Limited, of 32, Victoria Street, London, S.W., and was erected under my own supervision, as consulting engineer to the mining company.

The general outside arrangement is shown in fig. 302 (Plate XIV.), taken from a photograph; and various views of the interior, of a similar kind, are given in Plates XV.—XIX. The main building (A) contains the concentrating machinery, which is shown in plan and section in Plate XX. The motive power is supplied by a 120-horse-power, Vertex turbine made by Messrs. Gilbert Gilkes & Company, of Kendal, working under a head of 190 ft. The stream of water shown at \( b \) is the overflow at the upper end of the turbine pipes, and the lower end of the 3-mile water-course running up the valley until it joins the river Ystwith which is the source of water supply. In addition to this a small water-gas-plant is seen in front of the mill which furnishes gas to the engines inside as auxiliary power when water is scarce.

In the building marked \( c \) the air compressing plant described on page 174 is fixed, and this is driven by a Pelton wheel of 168 horse-power, working under a head of 800 ft. The water for this Pelton is obtained from a series of lakes on the hill above, the overflow from which is seen streaming down the hill. The arrangement of the gearing for the Pelton wheel will be found described on pages 18-19. The waste water from this wheel supplies the mill with water for the concentrating machinery sufficient for 10 tons per hour of crude ore.

The buildings marked \( d \) are the smiths’, carpenters’ and fitters’ shops and saw mill; while in the upper portion is placed the small 15 horse-power Pelton and dynamo used for the electric lighting of the mill. This is described on page 19. The water for this Pelton is derived by a branch-pipe from the main Pelton pipe-line; and the wheel in addition to driving the dynamo is used as the motive power for the saw mill, replacing a 30-ft. waterwheel originally placed there for that purpose. The mineral is tramined from the mine, and after being weighed is tipped into the hoppers in the rear of the mill, as shown on Plate XX. The concentrates of lead and blende are tramined from the mill to the ore
bins, seen in front of and below it, and here after being drained, mixed and sampled they are bagged for sale.

The gangue is quartz and slaty rock and so presents no difficulty in its separation from the mineral.

The prevailing feature in the design of the plant is the gradual reduction of the ore, so as to avoid as far as possible the crushing of the ore further than the point required to liberate the grains of mineral from the gangue—in fact to smash the shell of the nut without damaging the kernel. The crushing is followed by the close sizing of the ore, after which it passes on automatically to the various concentrating machines.

The system of gradual reduction also avoids the creation of an undue amount of slime, and thus diminishes the loss of metal from this cause, which loss alone has in many instances been the reason of failure in other systems. Nor is this the only benefit, for the capacity of the mill is materially increased by the avoidance of useless crushing of the ores, and the working expenses decreased. Another great point is the automatic nature of the whole arrangement, for, as will be seen from the following description, the ore after entering the mill is practically untouched by hand until it leaves it in the form of concentrates or tailings. This, while also reducing the working expenses, makes the plant to a large extent independent of unreliable and unskilled labour.

The general idea is that the plant consists of two distinctly separate systems, in one of which the crude ore as it comes from the mine is treated; while in the other the middlings or "chaff" resulting from the first system, are retreated. The keeping apart of the two classes of ore is a distinct advantage as not only are the middlings richer in metal than the crude ore, but they are also in a finer state and will, when recrushed, produce a greater proportion of fine sands which will require finer jigging than those from the first section.

Referring now to the plan and section of the Cwmynswith Mill as shown in Plate XX. (p. 458), the ore from the mine is trammed into the storage hoppers, which have a capacity sufficient for one day's run. These hoppers are fitted with sliding doors as shown in fig. 303, which regulate the feed of the ore on to the shaking screens (1) of Plate XX. These screens have perforated bottoms with 1-in. holes, and receive a longitudinal kick which causes the large ore to travel towards the stone-breakers (2), while the small stuff falls through the screen, and so into the main sorting trommel (3), where the large pieces, now broken to road metal size, also join them. This trommel is provided with a double mantle, the inner screen having holes of 1½-in. and the outer screen ½-in. The fine stuff that falls through the ½-in. holes goes straight to the main elevator (4), and is raised to the sizing trommels.

The sizes between 1½-in and ½-in. fall on to the two crushing rolls (5 and 6), while the sizes above 1½-in. are discharged on to a picking
band (7). It will thus be seen that at this stage the whole of the material is sorted into three classes, viz., that from \( \frac{1}{2} \) in. and under which does not require further grinding and is ready for sizing; next, that from \( 1\frac{1}{4} \) in. to \( \frac{3}{4} \) in. which is discharged onto the crushing rolls (5 and 6), and is here reduced to sizes below \( \frac{1}{2} \) in.; and finally the sizes above \( 1\frac{1}{4} \) in. which go to the picking-band. On this they are hand-picked by boys who throw away the waste into hoppers on the lower floor, whence they are trammed to waste. The clean lumps of galena and blende are also picked out on this table and are deposited into separate receptacles.

The unpicked material remaining on the band which acts as a conveyor is carried on to a circular picking-table (18) on which the material is finally examined and picked over again.

The ore remaining on the table is now automatically scraped off, and falls into the large crushing rolls (9), the steel rollers of which have a diameter of 36 in. and run at a speed of 45 revolutions per minute. The larger lumps are crushed in these rolls, and falling into the main elevator (4), are lifted up together with the material from the roller mills (5 and 6) and the fines from the sorting trommel (3). The elevator (4), which has unperforated buckets, discharges the crushed material and slimes, first into the vibro-screen (12) which has three screens with 12, 5, and \( 1\frac{1}{2} \) mm. perforations. The object of this screen is principally to drain the muddy water and slimes containing fine material from the coarser sands, and to effect a preliminary sorting into three different classes before these are discharged separately into the classifying trommels (13, 14, and 15). This system has been found very advantageous, since the muddy water being drained off first does not flow into the classifying trommels, which thus get only clean grains for further sizing. The classification in the trommels, which are exceptionally large, is very perfect, and very clean grains are discharged into the jigs and this greatly assists the jigging process.

The ore rejected by the vibro-screens falls back to the rolls for recrushing, while the sizes between 12 and 5 mm. are discharged into the first trommel having 9 mm. and \( 6\frac{1}{2} \) mm. perforations. The sizes from 5 to \( 1\frac{1}{2} \) mm. flow into the second trommel which has 5 and \( 3\frac{1}{2} \) mm. perforations, while the fines below \( 1\frac{1}{2} \) mm. go straight to the spitzlutter.

The third trommel with \( 2\frac{1}{2} \) and \( 1\frac{1}{2} \) mm. perforations receives its charge from the second trommel. All classified grains now fall automatically and separately through shoots into the jiggers (10) which are of an improved Hartz type, each of which has four compartments 3 ft. long \( \times \) 1 ft. 6 in. wide. The shafts of these jigs run in swivel bearings, and the products are discharged through a special sliding valve from the lower box. The speed of the jigs varies from 280 to 150 revolutions per minute, according to the sizes of the grains under treatment.

Clean lead concentrates are produced in the first compartment of each jig, and clean blende concentrates in the third.
The middlings from the second and fourth compartments of all the jigs are automatically discharged into the middlings elevator pit (16) on the lower floor; while the products ready for market are discharged into the concentrates hoppers (c), and these are trammed to the storage house.

The middlings from the jigs are now raised through the middlings elevator (16) and recrushed in the middlings or chat mill (17), from whence they are raised again by the elevator (18), and discharged into the vibro-screens and classifying trommels (19, 20, 21), where the classification takes place in the same manner as described before in the crude ore system except the perforations of the trommel screens are smaller.

**Fine Sands and Slimes.**—The fine sands below $\frac{1}{2}$ mm. and the slimes flow from the classifying trommels, first into spitzlutter or hydraulic classifiers, and here the sands are separated from the slimes, which latter flow on into the large spitzkasten (s). The fine sands down to $\frac{1}{4}$ mm. are jigged on fine grain jiggers, the sands from the crude ore system being kept separate from those coming from the middlings system.

The whole of the slime waters are now thickened and the slimes classified in the large spitzkasten, from which the condensed pulp or slimes flow into distributing launders, and these discharge the proper amount of each class of slimes separately on to the Lührig vanners (22) on the upper floor. Here, again, clean lead and blende are made and discharged into product boxes. The lead and blende middlings from all the upper vanners are retreated on the lower range of vanners (23), and the middlings from these are returned for retreatment by means of the sand pump (24).

**Tailings.**—The tailings from all the jigs flow into the tailings hopper (7) on the lower floor, from whence they are trammed to the dump, while the fine slime tailings flow from the vanners to waste.

**Results.**—The following assays are from careful samplings of the concentrates and tailings taken while the mill was in full work.

<table>
<thead>
<tr>
<th>Lead concentrates:</th>
<th>76.33% Pb.</th>
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</thead>
<tbody>
<tr>
<td>Coarse jiggers</td>
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<tr>
<td>Fine</td>
<td>78.54%</td>
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<tr>
<td>Vanners</td>
<td>81.96%</td>
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<table>
<thead>
<tr>
<th>Zinc concentrates:</th>
<th>55.33% Zn.</th>
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<td>Coarse jiggers</td>
<td></td>
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<tr>
<td>Fine</td>
<td>57.54%</td>
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<table>
<thead>
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<th>Tailings:</th>
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<tbody>
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<td>Coarse jiggers,</td>
<td></td>
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<tr>
<td>Lead trace</td>
<td></td>
</tr>
<tr>
<td>Fine</td>
<td>1.22%</td>
</tr>
<tr>
<td>Vanners</td>
<td>2.00%</td>
</tr>
</tbody>
</table>

**General remarks.**—The men required to work the plant are two at the stone-breakers, one on the trommels, one at the roller mills, three at the jiggers, and one man and three boys at the vanners. In addition to these there are the boys required at the picking-belt and the picking-table,
usually ten to twelve, but this can be varied according to the nature of the ore, which, when the mineral is finely disseminated, requires more careful hand-picking. Three men are also employed moving the tailings. When running at its full capacity of 10 tons an hour, the whole plant can therefore be worked by eight men and three boys, with, say, ten boys at the picking-table in addition. The plant, as was stated already, is driven by water power and absorbed 120 horse-power. As a reserve in case of drought a water gas-plant and gas-engines were also installed.

The whole arrangement being automatic, the milling costs were reduced to a minimum, and the whole mill worked to the entire satisfaction of the mining company, of which at the time I was the engineer.