

Test No. 2. Chain Machine.—This cut was made in a 16-foot room with hard, smooth floor and dry at the time of the test. The cut was 16 feet wide and 4 feet deep and blocked in the center to a height of 18 inches.

Size	Pounds	Per Cent.
Over 1 1/4-inch fork.....	544	18.9
Under 1 1/4 inches over 1-inch screen.....	277	9.6
Under 1 inch over 3/4-inch screen.....	551	19.1
Under 3/4 inch over 1/2-inch screen.....	569	19.8
Under 1/2-inch screen.....	940	32.6
Total cuttings.....	2,881	100.0

Three samples of the portion that passed through a 1/4-inch screen, 940 pounds, gave the following average over finer screens:

Size	Ounces	Per Cent.
Under 1/4 inch over 3/8 inch.....	56.0	21.9
Under 3/8 inch over 1/8 inch.....	24.0	9.3
Under 1/8 inch over 3/16 inch.....	59.0	23.0
Under 3/16 inch over 1/16 inch.....	59.5	23.3
Under 1/16 inch over 3/32 inch.....	23.5	9.1
Under 3/32-inch screen.....	34.5	13.4
Total fines.....	256.5	100.0

Test No. 3. Electric Puncher.—This cut was made in a 20-foot room with hard, smooth floor, and dry at time of the test. The cut was 20 feet wide and 4 feet deep and about 18 inches high in the center.

Size	Pounds	Per Cent.
Over 1 1/4-inch fork.....	1,161	19.1
Under 1 1/4 inches over 1-inch screen.....	1,103	18.1
Under 1 inch over 3/4-inch screen.....	1,047	17.2
Under 3/4 inch over 1/2-inch screen.....	1,095	18.0
Under 1/2-inch screen.....	1,681	27.6
Total cuttings.....	6,087	100.0

Two samples of the portion that went through the 1/4-inch screen, 1,681 pounds, gave the following average over finer screens:

Size	Ounces	Per Cent.
Under 1/4 inch over 3/8 inch.....	69.5	36.1
Under 3/8 inch over 1/8 inch.....	18.0	9.4
Under 1/8 inch over 3/16 inch.....	41.0	21.3
Under 3/16 inch over 1/16 inch.....	32.5	16.9
Under 1/16 inch over 3/32 inch.....	12.5	6.5
Under 3/32-inch screen.....	19.0	9.8
Total fines.....	192.5	100.0

Test No. 4. Electric Puncher.—This cut was made in a 16-foot room, the cut being 16 feet wide and 4 feet deep and about 18 inches high in the center.

Size	Pounds	Per Cent.
Over 1 1/4-inch fork.....	464	11.5
Under 1 1/4 inches over 1-inch screen.....	542	13.4
Under 1 inch over 3/4-inch screen.....	777	19.2
Under 3/4 inch over 1/2-inch screen.....	760	18.8
Under 1/2-inch screen.....	1,500	37.1
Total cuttings.....	4,043	100.0

Three samples of the portion that passed through a 1/4-inch screen, 1,500 pounds, gave the following average over finer screens:

Size	Ounces	Per Cent.
Under 1/4 inch over 3/8 inch.....	61.5	25.5
Under 3/8 inch over 1/8 inch.....	21.5	8.9
Under 1/8 inch over 3/16 inch.....	55.5	22.9
Under 3/16 inch over 1/16 inch.....	52.0	21.5
Under 1/16 inch over 3/32 inch.....	20.5	8.4
Under 3/32-inch screen.....	31.0	12.8
Total fines.....	242.0	100.0

Calculating the figures on the fine screenings back to the basis of the total weights of the portions that passed through the 1/4-inch screen, we have the following as the final weights and percentages:

Tests Nos. 2 and 4 were made in harder coal which accounts for the smaller amount of total cuttings in these. It is noticeable, however, that these two tests show a greater percentage of the dust or under 80-mesh size, than the tests in softer coal.

This test also serves as a comparison of the amount of cuttings from a chain machine as against a puncher. The puncher cuttings exceeded the chain-machine cuttings by 35 per cent. The total cuttings compared with the total coal undercut in this region amounts to 6 per cent., which is a very small percentage of the slack contained in run of mine. The dust or finest size shown in above tests is only about 3/10 per cent. of the total coal mined.

## CRIPPLE CREEK REJUVENATED

High Grading—The Leasing System—The Mill War—Treatment of Low-Grade Dumps

Written for "Mines and Minerals," by R. L. Herrick

When the price of copper slumped and the mines of Butte were closed, some of the wisest miners headed for Cripple Creek. When the United States troops marched into Goldfield, Nev., some of its best miners marched out, headed for Cripple Creek. When the lead and zinc market went to smash, and the thoughts of miners turned from the baser metals to gold, Cripple Creek was the most talked of camp. Go to Cripple Creek today and you will find some of your friends late from Arizona, Montana, Utah, and Nevada that you used to know in the early days of the camp. They have come back to their first love richer in experience if not in coin, and determined to profit by their knowledge accumulated from the four corners of the mining world. A few months ago hardly 1,500 men were working in the entire district, today 4,000 is nearer the number. Many of this number knew the mines and their ores, before they left the camp; they also knew the chances of their obtaining their share of the treasure. High prices, labor troubles, the lure of the new Nevada, and the "wander lust"—what mining man knows them not? They left and they returned again—enough! They have returned because their chances are better now than ever before, and it is the reason of these improved chances that we have to discuss. To the uproarious labor turmoils of recent experience they contrast the quiet sobriety of the most peaceable live camp of today, and are content. Cripple Creek has the "lid" on and that alone in a large measure accounts for the absence of the "tin horn," and the consequent diversion of the miners' profits into legitimate channels.

High grading is, as of old, a bone of contention between the mine owners and some of the miners. The recent conviction of an offender, however, will do much to exercise a salutary influence on others. Several quasi assayers have suddenly transferred their place of residence to parts unknown in consequence. Possibly because there is less high grade than formerly to appropriate, partly because some of the influences are now eliminated that formerly were considered extenuating circumstances, and partly through fear of the law, the evil is in the process of eradication. The incident is worthy of mention here merely to show that the mine owner and lessor now come into a fuller measure of their own with less trouble than was ever before possible. Apropos of "high grading" a miner recently returned from Goldfield tells the following story:

"Just before the 'change house' regulations were put in effect on the Mohawk, certain of the lessors watched their men carefully as they came off shift in order to detect evidence of 'high grading.' Danny Sullivan was a suspect and he knew it. Coming off shift one evening the boss saw Danny's pockets

Size, Inches	CHAIN MACHINE				PUNCHER			
	Test No. 1		Test No. 2		Test No. 3		Test No. 4	
	Pounds	Per Cent.	Pounds	Per Cent.	Pounds	Per Cent.	Pounds	Per Cent.
Over 1 1/4.....	815	22.0	544	18.9	1,161	19.1	464	11.5
Over 1.....	447	12.1	277	9.6	1,103	18.1	542	13.4
Over 3/4.....	507	13.7	551	19.2	1,047	17.2	777	19.2
Over 1/2.....	606	16.3	569	19.7	1,095	18.0	760	18.8
Over 1/4.....	462	12.5	206	7.2	607	9.9	383	9.5
Over 3/8.....	133	3.6	87	3.0	158	2.6	133	3.3
Over 1/8.....	297	8.0	216	7.6	358	5.9	343	8.5
Over 3/16.....	228	6.1	219	7.6	284	4.7	323	8.0
Over 1/16.....	85	2.3	86	2.9	109	1.8	126	3.1
Under 3/32.....	126	3.4	126	4.3	165	2.7	192	4.7
Total.....	3,706	100.0	2,881	100.0	6,087	100.0	4,043	100.0

bulging while his gait was decidedly water logged. 'Hey you, come back here and get your time,' yelled the wrathful boss. 'Aw, cross me name off yer list,' bawled back Danny, slapping his pockets, 'O've got enough.'

But to return to the subject of the miners' improved chances in the Cripple Creek district. The improvement is due to three main reasons, aside from those already mentioned, namely, lower cost of living, the benefits of the new leasing system, and lower freight and treatment charges of ore than ever existed before. Concerning the cost of living it is merely necessary to say that prices of rent, food, and supplies are lower than in any camp recently visited by the writer. With the continuance of the present rate of influx, however, it is doubtful if this state will long continue. This influx started beyond doubt by the causes cited in the opening paragraph, began in the early fall and has continued at a daily increasing rate. As a result, the mines operating on their own account quickly became full handed, and the surplus turned their attention to leasing. This is the outlook for the new comer today—leasing—and that under the best conditions ever known in the camp. While complaint has been justly made in the past that the royalties exacted by lessors have been too high to give the lessee a fair margin of profit, the majority of the new contracts recently written are more fair in this respect. Royalty rates naturally vary with the amount of the development of the ground, its machinery equipment and the amount of pumping necessary to keep it from being flooded, etc. The better this development, the better the lessee's chances in return for a small outlay, hence the higher the royalty rates. Some lessors grant a flat royalty rate, say 15 to 20 per cent. on the net returns from the sale of ore, the majority, however, lease on a sliding scale varying with the assay value of the ore. As an example of royalty terms granted to a lessee by the United Gold Mines Co., Cripple Creek, E. H. Beebe, superintendent, the following sliding scale is given:

Royalty	Assay Value of Ore
10 per cent.	Up to \$10
15 per cent.	\$10 to \$20
20 per cent.	\$20 to \$40
25 per cent.	\$40 to \$100
30 per cent.	\$100 to \$240
50 per cent.	\$240 and over

While the assay value of the ore decides the rate which shall apply, the lessee actually pays the lessor the stated percentage of the returns, after deducting the freight and treatment costs. For example, a ton of ore whose assay value is \$20 costs the lessee say \$6 for freight and treatment charges. He pays the lessor, therefore, 20 per cent. of  $(\$20 - \$6) = \$2.80$ .

The above scale, however, applies to a block of ground in a mine well developed and well equipped with machinery enabling cheap handling of ore. On blocks of ground less favorably situated, the rates are much lower. Some leasing companies whose reputations for successful work are such that contracts with them are much sought by lessors easily obtain favorable rates in even well-developed mines.

The following is a sliding scale granted to the Western Investment Co., of Victor, F. V. Bodfish, general manager, one of the most successful leasing companies in the district:

Royalty	Assay Value of Ore
10 per cent.	Under \$10
15 per cent.	\$25 to \$40
20 per cent.	\$40 to \$80
25 per cent.	\$80 to \$250
50 per cent.	Over \$250

It is a safe estimate to say that more than a thousand men are now leasing in the district, the majority of whom are operating in mines of established reputation, others in prospects of uncertain value. Among the better known mines now operated either wholly or in part by lessors are the following: Stratton's Independence, Little Clara, Isabella, Vindicator, Jerry Johnson, Trilby, Ajax, Elkton, Dante, Anchoria Leland, Moon Anchor, Gold Dollar, Gold Sovereign, Doctor-Jack Pot, Mary McKinney.

The following is an approximate estimate of the lessees' profits for the year 1907 compiled by the editor of the Cripple Creek Times:

Lessee	Lease Profits
Henry P. Dahl, on Jerry Johnson	\$100,000
Humphries-Thompson, Little Clara	75,000
Beacon-Hill-Ajax, part 1906	75,000
British-American Leasing Co.	50,000
Colorado State Investment Co.	50,000
Stratton Estate lessees	50,000
Stratton's Independence lessees	50,000
Isabella lessees	50,000
Bull Hill Mining and Development Co.	30,000
Western Investment Co.	25,000
School Section Leasing Co.	25,000
Trilby lessees	25,000
Vindicator lessees	25,000
Ajax lessees	20,000
Christmas lessees	15,000
Mary McKinney lessees	15,000
Anchoria-Leland, Carey lease	15,000

United Gold Mines lessees	15,000
Moon-Anchor lessees	15,000
Union Leasing Co.	15,000
Gold Dollar lessees	12,000
Dump leases in district	12,000
Gold Sovereign lessees	10,000
Roach & Co., on Forest Queen	10,000
Julia V., on the Monte Cristo	10,000
Doctor-Jack Pot	10,000
Standard Leasing Co.	5,000
Arequa-Savage lessees	5,000
<b>Total</b>	<b>\$814,000</b>

It is believed that the recent leasing activity is only just beginning to show in the increased production of the district. That this production is steadily increasing, however, is shown by the following table from January, 1907, to January, 1908, inclusive:

	PRODUCTION BY MONTHS	
	Tons	Values
January	38,002	\$ 1,029,759
February	43,100	1,135,075
March	50,200	1,150,000
April	51,250	1,176,575
May	46,750	1,178,212
June	50,000	1,106,395
July	51,186	1,163,924
August	45,413	923,286
September	62,950	937,300
October	69,158	978,066
November	47,300	1,099,050
December	53,150	1,200,500
<b>Total</b>	<b>608,459</b>	<b>\$13,148,152</b>
January, 1908	56,785	\$1,355,820
February	58,222	1,242,313
March	61,062	1,385,177

These figures it will be recalled, show only the ore treated and marketed through the various reduction plants and smelters of the district, and not ore actually mined. It is therefore readily understood that the burning of the Golden Cycle plant which handles more than one-half the output of the district readily accounts for the slump from August to October, 1907. The productions for January and February, 1908, are the greatest for three years, and at this writing, that of March bids fair to further increase the gain.

Aside from the greater production due to leasing, the development of the larger mines at the lowest levels will soon begin to show in an increased output. Levels that have been under water for months are now being unwatered with this development in view. The steady pushing forward of the Roosevelt drainage tunnel is an encouraging sign for the future. Mr. A. E. Carlton, who now holds the contract, states that in the first 21 days under his management, the breast of the 6 ft. x 10 ft. tunnel advanced 210 feet using two new No. 6 Leyner drills and working two 8-hour shifts. The best previous record established by contractors was 219 feet in 30 days.

The mine owner and lessee are alike benefited by the lowest freight and treatment charges ever enjoyed by the district due to the competition between the two great plants at Colorado City, the Standard Plant of the United States Reduction and Refining Co. and the Golden Cycle Mill. Up to the summer of 1907 the former, commonly known as the "Mill Trust," had enjoyed a monopoly of the district. It charged two sets of rates, one set known as the open rate applying to small shipments continuing for short periods of time and the other set known as the contract rate applied to time contract shipments.

These are given in the following table:

Value	Open Rate	Contract Rate
Value up to \$10	\$ 6.25	\$5.75
\$10 to \$15	7.50	6.50
\$15 to \$20	8.00	6.75
\$20 to \$25	9.00	7.25
\$25 to \$30	9.25	7.50
\$30 to \$40	10.25	8.50
\$40 to \$60	11.00	9.25
\$60 to \$100	11.50	9.75
\$100 to \$150	7.50*	7.50*
\$150 to \$200	8.50*	8.50*

\* Plus \$4.50 for freight on \$150 ore; \$5.50 for \$200 ore.

The Golden Cycle mill was partially destroyed by fire soon after its completion in August, 1907, but when its rebuild-

OPEN RATES OF UNITED STATES REDUCTION AND REFINING CO.

	Established October 15, 1907	Established December 26, 1907
Up to \$10	\$ 5.25	\$ 4.50
\$10 to \$15	5.75	5.00
\$15 to \$20	6.50	5.50
\$20 to \$25	7.25	6.00
\$25 to \$30	7.50	6.00
\$30 to \$40	8.50	7.00
\$40 to \$60	9.50	8.00
\$60 to \$100	9.50	8.50
\$100 to \$150	12.00	10.00
\$150 to \$200	14.00	12.00
Over \$200		14.00

ing became certain, the United States Co. abolished its contract rates and made two successive cuts in open rates, the first on October 15 and the second on December 26, as shown by the preceding table.

The new Golden Cycle mill opened on January 1, 1908, charging the contract rates shown in the table below in column 1 guaranteed to hold from 3 to 6 years. To meet these the United States Co. made the still further reduction of rates shown in column 2. These are open rates and it is understood that no time contracts will be written at these prices.

RATES IN EFFECT FEBRUARY 20, 1908

	Col. 1 Golden Cycle Contract Rate	Col. 2 U. S. R. & R. Co., Open Rate
Up to \$8 per ton.....	\$ 4.00	\$3.50
\$8 to \$10.....	4.50	4.50
\$10 to \$15.....	5.25	5.00
\$15 to \$20.....	6.00	5.50
\$20 to \$25.....	6.50	6.00
\$25 to \$30.....	7.00	6.00
\$30 to \$40.....	7.50	7.00
\$40 to \$60.....	9.00	8.00
\$60 to \$100.....	9.50	8.50
\$100 to \$150.....	12.00	No rate given
\$150 to \$200.....	13.00	No rate given
\$200 to \$300.....	13.50	No rate given
Over \$300*.....	13.50	No rate given

\*Plus 1 per cent. assay value over \$300.

All the rates given in the several tables include both freight and treatment charges.

The Standard plant has a capacity of 400 tons per day treating ores first by the chlorination, then by cyaniding as described in another column. The Golden Cycle plant has a capacity of 800 tons per day and its treatment is a combination of fine grinding and roasting the sulphotelluride ores followed by simple cyaniding. The keen competition between the two plants has naturally been productive of partisanship among the shippers, and has aroused considerable discussion as to their respective merits, costs of operation, etc. The following cost data, which it will be distinctly understood are estimates, and not official figures, are therefore of timely interest. Experimental work some time ago demonstrated to the satisfaction of one metallurgist that the extraction results differed little whether the ore was treated by chlorination or cyaniding. The ore treated ran about \$20 in gold and the tails resulting from both processes ran about \$.80. He naturally favored the chlorination process, therefore, supplemented by cyaniding.

In comparing works of the same capacity, one a chlorination, the other a cyanide plant, the former would seem to have an advantage in first cost of crushing as it crushes only to 12 mesh at a cost of say \$.30 per ton, contrasted with that of say \$.50 for crushing to the 30 mesh required for cyaniding. In the supplementary fine grinding to 100 mesh given the chlorination tails in the cyanide plant, however, the costs of crushing must be nearly equalized.

In the cost of chemicals the two plants would not greatly differ, say about \$.16 per ton for chlorination, where the process of producing chlorine was similar to the electrolytic method employed at the Standard plant. This process likewise has the advantage of manufacturing caustic soda as a by-product which is used instead of lime for producing an alkalinity in the solutions of the supplementary cyanide plant.

Both processes require roasting of the ore. Chlorination, however, requires a preliminary sweet roast costing about \$.85 per ton, while for cyaniding, the rapid roast found to suffice costs but \$.50 per ton.

A chlorination works similar to the 400-ton plant of the Portland probably treats ore at a total cost of about \$3 per ton at a minimum. The cost at the Standard plant, however, is probably lower than this figure due to the electrolytic method before mentioned. The supplementary cyanide treatment of the tails carrying about \$.80 in values is said to make about a 90-per-cent. extraction at a probable cost of about \$.36 per ton. The total cost of treatment including the \$1 freight charges will therefore probably not exceed \$4.36 per ton.

The Golden Cycle plant, of 800 tons capacity, is the largest cyanide mill in the United States. Under the management of Superintendent John Tate Milliken, the cyanide process applied to the treatment of Cripple Creek ores has made the greatest advancement in the history of the district. It is yet too early to even estimate the extraction and costs at this plant. Being twice the size of the Standard plant, however, it is easy to see that the costs of management, office expense, etc., per ton will be but half those of its contemporary, while the expense per ton for labor will be about the same.

As the bulk of the ore shipped today runs from \$20 to \$25 the difference made to the Cripple Creek district by a choice between the two competitive rates above given, is more apparent than real. That this beneficial competition may continue

indefinitely is the wish of those with the best interests of the district at heart.

We have gone to this detail to show that up to the present time it is hardly profitable to ship dump ores for treatment running less than \$5 per ton, indeed it is hardly more than possible to simply recover the money spent on such ore. The visitor to the district is greatly impressed by the vast accumulations of dump on all sides, millions of tons that run anywhere from \$3 to \$7 and \$8 per ton, a dump's value often depending on how much it has been worked over by lessees. Every ton may be regarded as costing nearly \$2 for breaking, hoisting, and sorting, although in the majority of cases the costs were actually much higher and at some mines at least double these amounts. Costs are difficult to obtain but those taken from the cost sheets of the Portland Gold Mining Co., for January, 1908, given below, help considerably. During this month 33,000 tons of crude ore were broken and hoisted to the surface out of which but 7,635 tons were sorted for shipment, the remaining 25,365 tons going to the dump. The cost then, for every crude ton hoisted, was \$1.91 while concentration by sorting increased the cost of every ton on the cars ready for shipment to \$8.84. Sorting cost \$.21 per ton of crude ore and \$.90 per ton of ore shipped. Timbering cost \$.37 per ton of crude ore and \$1.55 per ton of ore shipped. A ton of rock on the dump therefore, represents an outlay of at least \$2.12. Costs in former years, however, were much higher than at present, so that even the Portland dump will average a cost of close to \$2.50 per ton. It should here be noted, however, that but few of the other mines timber so extensively as the Portland, and the average cost for timber will not much exceed \$.10 to \$.15 per ton.

While one or two mines, notably the Golden Cycle, are now said to average a cost of \$1.50 per ton of crude ore, such reductions are of recent date and the average cost will probably approximate \$2 per ton. The Portland dump cost, of say \$2.50, may thus be considered representative of those mines which timber extensively, and it may be stated that roughly speaking, each ton of Cripple Creek dump represents an expenditure of from \$2 to \$2.50.

This matter of costs has been entered into at length in order to show that these low-grade ores found on the dump today could not be profitably mined and treated, except as by-products associated with high-grade ores which stand all the mining costs. As it is, we assume that the dump ore costs nothing in its broken-up condition and lying on the surface ready for milling. It is therefore, merely a question of whether the values extracted will exceed the cost of milling by enough to return a fair margin of profit.

Close to the Portland dump is that of the Stratton's Independence, which may likewise be assumed to represent an outlay of at least \$2.50 per ton for hoisting and sorting. This dump is said to carry about \$3 per ton in values. The new 400-ton mill now nearly completed, designed by Phillip Argall, is expected to treat this dump without roasting to eliminate the sulphotellurides, but simply fine grind and cyanide the raw ores. This plant is the subject of considerable discussion at the present time and the giving out of detailed information concerning it is awaited with great interest.

The condition that confronts the designer is the necessity of making a high enough extraction for a fair profit without incurring the prohibitive expense of roasting. This, as before stated, costs about \$.50 per ton at Colorado City, burning gas made in a producer from cheap lignite coal. While this coal costs scarcely \$1 per ton at Colorado City, due to the proximity of the coal mines, it costs about \$3.25 laid down at the Stratton Mine at Victor, of which cost \$2.50 is due to freight alone. It is therefore readily seen why the cost of roasting a \$3 ore is prohibitive. If ever the coal companies at Colorado Springs or Florence, conclude to generate gas from their slack now wasted, and pipe the same over the intervening 30 miles to Cripple Creek, the problem of the metallurgist will be simplified. In the mean time he awaits the details of the rumored leaching process which dissolves the tellurium and leaves behind the free gold ready for cyaniding.

Apropos of fine grinding and cyaniding the experimental work of the Portland company done some time ago is of interest. The ore experimented with was one exceptionally favorable for such treatment as it was well oxidized. Fine grinding to an 80 mesh in a circulating cyanide solution, then leaching, gave an 80- to 85-per-cent. extraction.

In the foregoing discussion an attempt has been made to merely outline some of the conditions and problems at present confronting the Cripple Creek district. Whether or not they are all solved in the immediate future, will not affect the fact that several generations of miners and metallurgists must keep on pounding before its prospects for continued prosperity are pounded off the map.