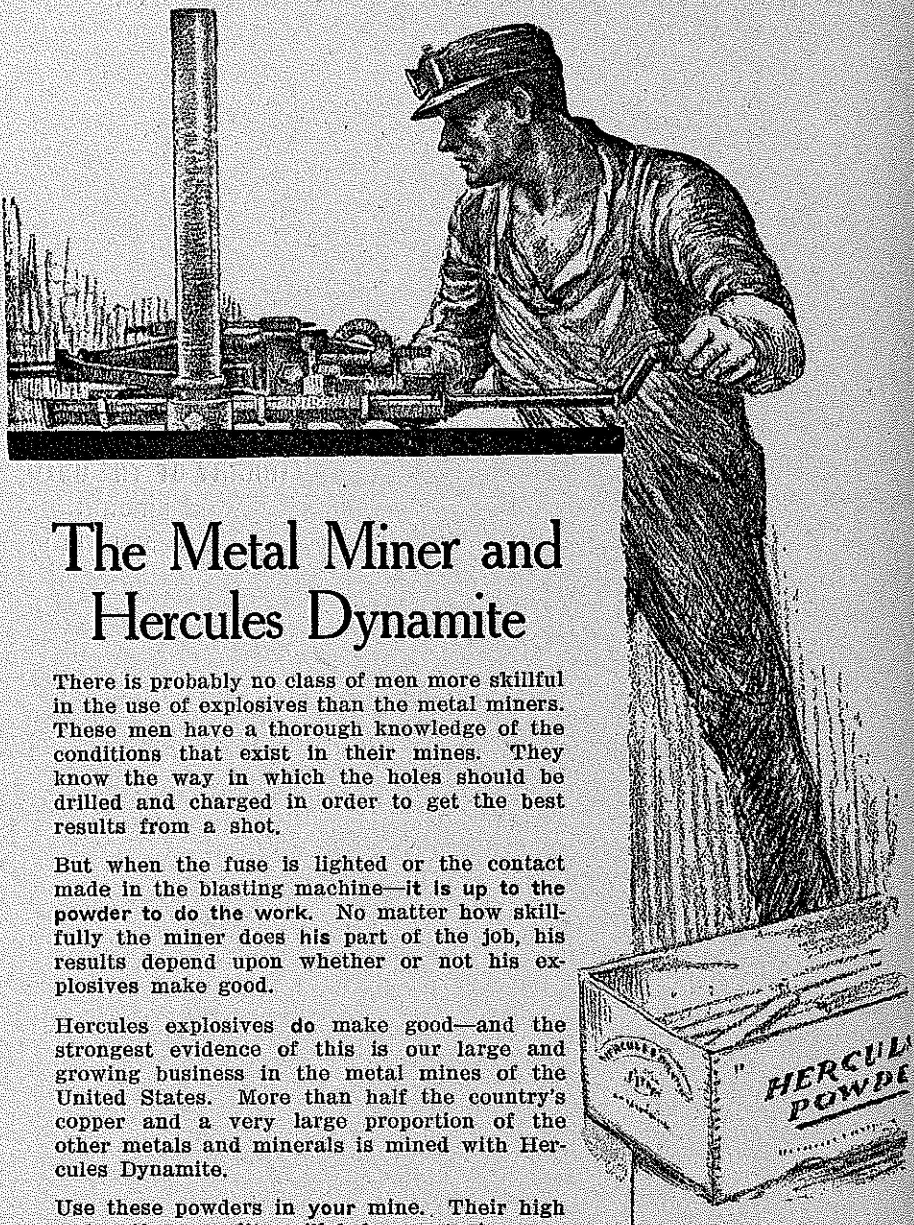
VOL. X JULY, 1920 No. 7

COLORADO SCHOOL OF MINES MAGAZINE

THE COLORADO SCHOOL OF MINES ALUMNI ASSOCIATION, PUBLISHERS, GOLDEN, COLO.



The Metal Miner and Hercules Dynamite

There is probably no class of men more skillful in the use of explosives than the metal miners. These men have a thorough knowledge of the conditions that exist in their mines. They know the way in which the holes should be drilled and charged in order to get the best results from a shot.

But when the fuse is lighted or the contact made in the blasting machine—**it is up to the powder to do the work.** No matter how skillfully the miner does his part of the job, his results depend upon whether or not his explosives make good.

Hercules explosives **do** make good—and the strongest evidence of this is our large and growing business in the metal mines of the United States. More than half the country's copper and a very large proportion of the other metals and minerals is mined with Hercules Dynamite.

Use these powders in your mine. Their high and uniform quality will help you to increase ore products and cut costs.

HERCULES POWDER CO.

Chicago	St. Louis	New York
Pittsburg, Kan.	Denver	Hazleton, Pa.
San Francisco	Salt Lake City	Joplin
Chattanooga	Pittsburgh, Pa.	Wilmington, Del.

The World's Tonnage Record is held by "LONGLIFE"

A GOODRICH "LONGLIFE" Conveyor Belt installed at a Utah copper mine in the Spring of 1914 carried 7,313,400 tons of ore during a period of four years at a cost of less than *twenty cents per thousand tons.*

Never—to Goodrich's knowledge—has this achievement been approached, let alone equalled. Further comment seems superfluous in the face of such mighty testimony.

Why not dictate a letter to Goodrich asking them to send you their Belting Catalog? Surely it will have an economic message for you.

Goodrich "Longlife" Conveyor Belts

THE B. F. GOODRICH RUBBER COMPANY
Akron, Ohio

COLORADO SCHOOL OF MINES MAGAZINE

Published every month in the year, at Golden, Colo., by the Alumni Association of the Colorado School of Mines.

C. ERB WUENSCH, '14, EDITOR.

Advertising rates on application.

Subscription Price...$1.50 per annum   Single Copies................25 cents

VOL. X   GOLDEN, COLO., JULY, 1920   No. 7

CONTENTS

Concentration of Chrome Ore, Black Sand, and Ferro-Chrome Slag

By J. C. Williams, '13.*

During the war when the demand for the rare minerals increased to such an extent that every available source was considered, the Department of Metallurgical Research of the Colorado School of Mines was called upon to make numerous investigations relative to the treatment of products normally of no commercial value. Among ores examined were those of radium, uranium, vanadium, tungsten, molybdenum, manganese, tin, and chromium.

This paper deals with chromium and three types of material are considered—an ore from Montana, a "black sand" from Oregon, and a slag resulting from the production of ferro-chromium in the electric furnace.

Before considering these particular cases some general information regarding chromium and its uses may be of interest.

Chromite.

The most important foreign deposits are those of New Caledonia, Turkey, and Rhodesia. In addition chromite is mined in small quantities in Russia, India, Australia, Greece, Canada, and Newfoundland. All foreign deposits occur as irregular masses, or pockets, similar to the deposits in California, so that mining and treatment methods similar to those used abroad can be used here.

The most valuable deposits of chrome ore in the United States occur in California, Oregon, Wyoming, and Alaska. The greater part of the country's supply is on the Pacific Coast and the demand is on the Atlantic. Transcontinental transportation from the producers to the consumers is, therefore, a large problem in itself.

In the United States chromite in commercial quantities was first discovered by Isaac Tyson, Jr., near Baltimore, Maryland, in 1827. The story of the discovery and development forms a most interesting chapter in the history of American mining. Tyson had become interested in the recently discovered element chromium and at that time was probably the only man in America who possessed the knowledge necessary to make use of his discovery. He one day noticed a farmer driving a wagon in which were barrels kept from rolling by blocks of a heavy, black ore. These blocks he determined to be chromite. He found the locality from which they came and acquired chromite bearing ground. He studied these deposits and came to the conclusion that chromite would be found only with serpentine, a line of reasoning that enabled him to discover chromite in other localities. From 1828 to 1850 the district near Baltimore supplied most of the chrome ore consumed by the world. The manufacture of chrome yellow was started there in 1828. The export trade from Baltimore came to an end about 1860 on account of the development of the larger and richer Turkish deposits.

The demand for chrome ore arises chiefly from its use in making ferro-chrome which is used in manufacturing steel for projectiles, for armor plate, and for cutting tools; in making refractory chrome brick and furnace lining; in chemical industries for the production of many colors and dyes; and in tanning. Its application for these purposes is increasing and the demand for it is steadily growing. On account of its great heat-resisting qualities, chromite is used as a neutral refractory lining for furnaces. It is either made up into bricks with various binders, or lumps of the ore are packed in tight to make a solid lining. Chromite has two valuable qualities for these purposes: it stands change of temperature well and also resists strongly the action of molten metals. For refractories an ore containing 38 to 45 per cent of chromic oxide can be used. The most important use, however, is for making ferro-chrome.

The word chromium is derived from the Greek word meaning color, on account of the wide range of color of various salts of chromium. Chromium also forms the coloring matter of several minerals. The green color of the emerald is due to chromium. Metallic chromium is not known to occur in the native state. According to Roscoe and Schorlemner, metallic chrome forms a light green, glistening powder which exhibits, under the microscope, aggregations of crystals of a tin white color, with a specific gravity of 6.81. The fused metal is usually

* Assistant Director, Department of Metallurgical Research, Colorado School of Mines.

as hard and tough as corundum, melts at a higher temperature than platinum, is not magnetic, and, when ignited in the air, is only slowly oxidized. Heated in the oxyhydrogen flame it burns brightly, with emission of sparks, and when fused with saltpetre or potassium chlorate, it is converted into potassium chromate. Pure chromium is claimed to have been obtained in 1894 by Moissan, by reducing the oxide with carbon in the electric furnace. It is most easily prepared in small quantities by the alumino-thermic process, which consists of reducing the oxide with aluminum powder. Metallic chromium made by this process is used to the extent of several hundred tons a year in the manufacture of high-speed tool steel, as some manufacturers prefer to add their chromium this way rather than as ferro-chrome.

The principal alloy of chromium is ferro-chrome; the alloy of chromium and iron, which usually contains 60 to 70 per cent chromium. It is produced in the electric furnace from high grade ores. Other alloys of more than scientific interest are chromium with nickel, cobalt, molybdenum, tungsten, manganese, copper, or vanadium, as well as different combinations of two or three of these elements. One of these alloys is called "Stellite," and is composed of cobalt, chromium, tungsten, and molybdenum. It was developed by Elwood Haynes, of Kokomo, Indiana. Two desirable qualities of this alloy are its resistance to corrosion and its ability to take and hold an edge equal to that of the best steel. It may be used for table knife blades, pocket cutlery, surgical instruments, dental instruments, small evaporating dishes, spoons, forks, or scissors.

Chromium is added to steel in the form of ferro-chrome or as a metallic chromium. This steel is particularly adapted for making armor-piercing projectiles, on account of its hardness and also its very high elastic limit. It is also used for armor plate for the same reasons, for parts of crushing machinery, and for very hard steel plate. It is extremely hard, tough, and dense, and possesses great tensile strength. It is especially adapted to severe service and where resistance to abrasion is desired. For the wearing parts of stamp mills, such as battery shoes and dies, cams and tappets, chrome steel has proved to be the most durable and economical material obtainable. Chrome steel in some respects resembles the higher grades of tool steel but in addition possesses properties combined in no other known steel. It can be made so hard as to be drill proof against the finest tools. These qualities are taken advantage of in the manufacture of burglar-proof safes and jail bars, built up of alternate layers of iron and chrome steel, which cannot be cut or broken. Armor plate contains about 2 per cent chromium and a certain quantity of nickel. Some steels with unusual qualities have been made which contain as much as 20 per cent chromium.

Although a number of minerals contain chromium, virtually only one-chrome iron ore or chromite is a commercial source of chromium. However, it is of interest to note that the discovery of the element chromium was made by investigation of the mineral crocoite (lead chromate). The discovery was made by Vauquelin, a French chemist, in 1797.

Chromite (Dana's Mineralogy) Isometric. Massive, fine granular to compact. Fracture uneven. Brittle. Hardness, 5.5. Specific gravity, 4.32. Luster, submetallic. Color iron-black to brownish-black, sometimes yellowish-red in thin sections. Streak brown. Translucent to opaque. Sometimes feebly magnetic. Composition—$FeCr_2O_4$ or $FeO.Cr_2O_3$ = chromium oxide 68 per cent, iron protoxide 32 per cent. Infusible before the blowpipe in oxidizing flame; in the reducing flame it is slightly rounded on edges and becomes magnetic. With borax and salt of phosphorus it gives beads which, while hot, show only a reaction for iron, but on cooling become chrome green; the green color is heightened by fusion on charcoal with metallic tin. It is not acted on readily by acids but is decomposed by fusion with potassium or sodium bi-sulphate.

Chromite is a common constituent of basic intrusive rocks, such as peridotites and pyroxenites, and especially of serpentine derived from them. All of the commercial bodies of chromite occur in these rocks. In place it is always found in association with serpentine, which has resulted from the alteration of basic rocks consisting of olivine, hornblende, and pyroxene. In these the percentage of chromium may vary from 0.05 to 0.5. Chrome is by no means an important element in the earth's crust. The average given by F. W. Clarke is 0.033 per cent. Although it occurs usually in basic igneous rocks, it is sometimes found in titaniferous iron ores to the extent of several per cent. It is rarely associated with other metallic minerals, except possibly magnetite and nickel minerals. The common form of occurrence is as rounded grains or more often massive granular masses, which resemble magnetite and have sometimes been confused with it, but differ from it in being at the most feebly magnetic. It is a most resistant mineral to weathering. For this reason it is often found in unconsolidated materials such as clay, or in stream materials derived from rocks by erosion. In the weathering of serpentine the more resistant chromite will be concentrated on or near the surface and be misleading as to the richness of the deposit below. Placer deposits of chromite are found where the minerals most resistant to weathering have been concentrated in stream channels, and where these drain areas of serpentine or basic igneous rocks. Along the Pacific Coast there are placers in stream beds and beach deposits which carry, besides chromite, resistant minerals such as gold, platinum, and garnet. The pockety nature of chromite deposits makes the mining very uncertain. There may be one or more of these pockets or lenses scattered through the deposit, but they do not occur with any regularity.

The production of a high-grade chrome concentrate may be made in two ways: (1) by hand cobbing, (2) by mechanical concentration. Hand sorting is generally practiced in mining the ore, by means of which a high-grade product may be made without the losses attendant upon crushing and milling. In milling chromite the general practice is to crush in Blake crushers and then by stamps. The crushed ore is treated by classifiers and fed to tables of the Wilfley type. For deposits such as beach sands, which contain, besides chromite, many minerals with different degrees of magnetic permeability, magnetic treatment is a practical solution of the concentration problem. In general, it may be said that a concentrate containing 45 percent of chromic oxide is sought.

Characteristic features of chromite, by which it may be recognized are: Lustre, vitreous, splendent to metallic or submetallic. Streak: dark brown. Infusible before the blowpipe, but may fuse slightly in the reducing flame and then becomes magnetic. Usually associated with serpentine. Each grain shows a very smooth conchoidal fracture with high lustre. Bead tests as described under "Ores of Chromium."

Concentration Tests of Chrome Ore.

The material upon which these tests were made was received as a mixture of different grades of ores. It was sorted so as to have three grades—high, medium, and low, and these grades were kept separate.

The tests were made with the purpose of ascertaining the following points: 1. Amenability of the material to table concentration and factors influencing such work. 2. Probable value of concentrate produced. No attempt is here made to outline a commercial method of treatment, as this lies outside of the field of the work done by the Department of Metallurgical Research. Such work properly belongs to an engineer interpreting results obtained here.

The material as received consisted of lumps. These were broken in a small jaw crusher so that the greater part of the material would pass a 4-mesh screen. It was then divided into two portions by means of a Jones riffle splitter, one part being retained for the test and the other held in reserve. The next step was to crush in a small set of rolls so that all the material would pass a 20-mesh screen. This reduction was gradual, the material being rolled and then screened so that there might be no excess of fine material produced. A sample of this material was then screened as follows:

Minus 20 mesh	Plus 35 mesh
Minus 35 mesh	Plus 48 mesh
Minus 48 mesh	

The different sizes were examined under a microsope and treated separately on a small Wilfley table which showed that the first size contained an appreciable amount of middling material—(particles of chromite attached to gangue); the second size a small amount of middling; the third size, minus 48 mesh, practically no middling. It can thus be seen that to obtain the best metallurgical extraction as a fairly clean concentrate, the grinding should be carried on so that the material passes a 48-mesh screen. It is not meant that best commercial results could be obtained this way. For one reason the tonnage of a given treatment plant would be smaller the finer the feed. The cost of regrinding is also a great factor. These are matters of operating costs in the mill itself and are influenced by factors such as grade of concentrate desired, tonnage to be obtained, and others of which no knowledge was available.

The material was sampled and weighed and treated upon a small Wilfley table. Two products were obtained—concentrates and tailings, each of which were weighed and sampled.

The gangue material contained quite an amount of heavy silicates, principally olivine. As the specific gravity of olivine is about 3.5, and of chromite about

4.5, the concentrates contained an appreciable amount of these heavy silicates. Owing to the small size of the table used, a close separation between the olivine and chromite could not be made. Probably this would not be the case when working with a full size table upon a properly prepared feed.

To ascertain the maximum amount of chromic oxide which might be obtained in these concentrates, and also the ratio of chromium to iron, samples of the low-grade and high-grade concentrates were cleaned by using a Weatherill magnetic separator. Olivine is slightly less magnetic than chromite and a clean separation can be made. Theoretically, chromite consists of FeO, Cr_2O_3 in the proportion of iron oxide 32 percent and chromite oxide 68 percent. However, as found, chromite contains MgO (magnesia), and Al_2O_3 (alumina), replacing the oxides of iron and chromium. The amount of replacement varies with individual deposits. For this reason, while the chromite itself may be absolutely free from gangue, the chromic oxide content may be far below the theoretical amount of 68 percent.

The mean analysis of the magnetically cleaned table concentrates was 40.74% chromic oxide and 26.96% iron oxide. Therefore, it can be seen that no table concentrate of a higher grade could be made. This is due to the high proportion of iron to chromium, that is, iron which is in chemical combination with chromium. Theoretically, the ratio $\frac{\text{chromium}}{\text{iron}} = 1.82$, but in this case the ratio $\frac{\text{chromium}}{\text{iron}} = 1.28$.

Summary of Results—Table Concentration.

	FEED		TAILINGS		CONCENTRATES		
Material	Weight in Grams	% Cr_2O_3	Weight in Grams	% Cr_2O_3	Weight in Grams	% Cr_2O_3	% Recovery
Low Grade....	4000	6.78	3160	3.05	500	37.0	68.3
Medium Grade.	3365	24.78	800	9.5	1810	39.04	84.8
High Grade....	4675	33.64	610	14.59	3750	38.36	91.3
Calculated Mean Grade....	12040	22.1	5980	5.57	6060	38.45	87.4

By table concentration an extraction of the chromic oxide content of the ore was made which ranged from about 70 percent to 90 percent, depending upon the chromic oxide content of the feed. In the case of the low-grade ore it is probable that by careful preparation of the feed and close attention to the table work, a greater extraction may be made than is here indicated. However, it is not the metallurgical efficiency of the treatment which is to be considered so much as the net commercial returns. That is, it may not pay to make a greater extraction as the expense of so doing might be greater than the increased value of the product.

The highest grade table concentrate it is possible to make from this ore contains about 40 percent Cr_2O_3, and 27 percent FeO, with a chromium-iron ratio of 1.28. This is of great importance in considering the commercial value of the ore for ferro-chrome manufacture, as it would not be feasible to produce ferro-chrome containing much over 55 percent chromium from this ore, and it would be necessary to mix it with ore containing less iron. Marketable ferro-chrome should contain 60 percent chromium or more. The high percentage of iron which is combined chemically with the chromium in this ore seems to limit its use to chemical manufacturers, refractories, and in a limited way to ferro-chrome production.

Concentration Tests on Black Sand.

In an article entitled, "Separation of Metallics from Pacific Coast Sands,"* Henry E. Wood discusses the extraction of chromite and other minerals from "black sand." The following paragraphs are taken from this article:

"Possibly the largest amount of chromium "in sight" today is contained in the black sands" of the Pacific Coast, which exist for many miles along the shores of California, Oregon, and Washington, where they are plainly exposed, not only at the present beach line, but also on the ancient sea levels, which are in view, in some regions, for several miles inland. For many years these sands have attracted the attention of miners, on account of their gold and platinum contents, and in many places sufficient evidence is present to warrant attempts to recover them. For over two hundred miles, as I know from personal experience, few localities exist where, by careful panning, one cannot obtain attractive showings of fine, flake gold and occasional scales of the harder platinum. The gold is in an exceedingly fine state of division, but satisfactory methods for its recovery have been demonstrated. As severe storms are of frequent occurrence, most of the equipment erected for such purposes has been wrecked, as is plainly evident to the visitor.

Disintegration of the serpentine formations in regions back from the coast, erosion, and wave and tidal action for unknown ages have been the prime factors in a concentration of all the heavier minerals, the hardness of these minerals also playing an important part. Naturally, the ratio of concentration is unknown, but undoubtedly it is a high one, possibly several thousand into one. A rough classification of the minerals is also evident from the fact that, of the sands which have been worked, all of the minerals sought are practically of the same size, 75 percent of their total weight being between 70 and 100 mesh."

* Separation of Metallics from Pacific Coast Sands. Henry E. Wood, Engineering and Mining Journal, February 7, 1920, p. 398.

The material used in the experiments was a chromite-bearing black sand said to come from near Bandon, Oregon. The sand contained in addition to chromite-magnetite, ilmenite, garnet, zircon, tourmaline, and quartz. An extended investigation would undoubtedly reveal the presence of other minerals also. The individual particles appeared to be entirely free from impurities, so that no further crushing was necessary. The chromite, garnet, and ilmenite grains, were for the most part rounded; the quartz, tourmaline, and zircon angular.

A screen analysis of the sand showed the following:

Screen Analysis.

Mesh	Weight in Grams	% Weight	% Cr_2O_3	Wt. Cr_2O_3 in Grams	Cr_2O_3 Distribution in %
Heads	1313	100	26.26	341.38	100.00
Through 28	1313	100	26.26	341.38	100.00
Through 28—On 35....	10	0.777 }	6.81	4.77	1.4
Through 35—On 48....	60	4.61 }			
Through 48—On 65....	335	25.77	20.26	67.87	19.9
Through 65—On 100...	810	62.31	30.70	248.67	72.7
Through 100	85	6.54	24.30	20.66	6.0
Totals	1300	100.00		341.97	100.0

In making the test the endeavor was to produce as clean a concentrate as possible with the idea that the value of a high-grade product would more than offset a slight loss in extraction occasioned.

A number of preliminary tests were made to determine the best conditions for carrying out the test. Briefly the procedure was:

1. Concentration on Wilfley table.
2. Wilfley concentrates dried and treated on Wetherill magnetic separator.
3. Chromite product of Wetherill treated on Huff electrostatic separator.

Wilfley Table Concentration.—A sample of the dry sand weighing 10 kilograms (22 lbs.) was fed automatically to a 24-inch Wilfley table, at a rate of about 13 kgm. per hour (10 kgm. in 45 min.). Two products were made—a quartz tailing and a concentrate containing chromite, garnet, and other heavy minerals. The feed was not classified as the proper determination of this point would have required more time than available.

Results of Table Test.

Product	Weight in Grams	% Cr_2O_3	Wt. Cr_2O_3 in Grams	Cr_2O_3 Distribution in %
Heads	10000	26.26	2626.0	100.0
Tails	1300	4.54	59.0	2.5
Concentrate	8510	30.06	2557.0	97.5
	9810			

Concentration Ratio — 1.17 into 1
Extraction — 97.38%

Magnetic Concentration.—The concentrates from the Wilfley table were dried and then treated on a Wetherill two double-magnet separator. The rate of feed was about 45 kgm. (100 lb.) per hour. The feed belt had a width of six inches and was driven at the rate of 50 feet per minute. The magnets were so set that no adjustment other than that of changing the amperage was necessary throughout the test.

Results of Magnetic Test.

Amperage	Product	Weight in Grams	% Cr_2O_3	Wt. Cr_2O_3 in Grams	Cr_2O_3 Distribution in %
	Heads	8290	30.06	2455.9	100.0
0.2	Magnetite	80	5.43	4.34	.2
1.0	Ilmenite	350	10.69	37.42	1.5
2.0	Garnet	1985	17.63	350.00	14.2
2.0	Garnet and Chromite Tails	3755	35.60	2048.78	83.4
		8170		2440.54	99.3

Concentration Ratio — 1.42 into 1
Extraction — 83.4%

The amperage was then raised to 4 and the tails, consisting of chromite, garnet, and heavy silicates put through. This resulted in a product delivered from the magnets of mixed chromite and garnet, and a tailing of heavy silicates, such as zircon and tourmaline, which remained with the heavy minerals on the Wilfley table.

Amperage	Product	Weight in Grams	% Cr_2O_3	Wt. Cr_2O_3 in Grams	Cr_2O_3 Distribution in %
	Heads	5660	35.60	2015.00	100.0
4.0	Tails	400	0.97	3.88	0.20
	Concentrate	5200	38.46	2000.00	99.25
		5600			99.45

Concentration Ratio — 1.09 into 1
Extraction — 99.25%

Electrostatic Concentration.—The mixed garnet and chromite product, resulting from magnetic concentration, was treated on a Huff electrostatic separator, using a single-roll roll-feed type machine, putting the material through ten times to approximate conditions of a 10-roll commercial machine. A toboggan-feed type of six electrodes was available, but the single electrode was used as being easier of adjustment. The voltage was maintained at 28,000. This resulted in two products—a high-grade concentrate and a tailing of garnet and chromite. This tailing might be returned to the Wetherill, using the Huff to produce a clean concentrate.

Result of Electrostatic Test

Voltage	Product	Weight in Grams	% Cr_2O_3	Wt. Cr_2O_3 in Grams	Cr_2O_3 Distribution in %
	Heads	5070	38.46	1950.0	100.0
28000	Tails	1145	15.16	173.6	9.0
	Concentrate	3860	45.82	1768.7	90.7
		5005		1942.3	99.7

Concentration Ratio—1.31 into 1
Extraction — 90.7%

Summary of Concentration.

	Concentration Ratio	Extraction
Wilfley	1.17 into 1	97.38%
Wetherill	1.42 into 1	83.42%
Wetherill	1.09 into 1	99.25%
Huff	1.31 into 1	90.69%
Final concentration based on Wilfley heads and Huff concentrate,	2.59 into 1	67.34%

Summary of Assays.

Sample	% Cr_2O_3
Heads	26.26
Table Tails	4.64
Table Concentrate	30.06
Magnetic Product 0.2 ampere (magnetite)	5.43
Magnetic Product, 1.0 ampere (Ilmenite)	10.69
Magnetic Product, 2.0 ampere (Garnet)	17.63
Magnetic Product, 2.0 ampere (Chromite and Garnet)	35.60
Wetherill Tails (heavy Silicates)	0.97
Huff Tails	15.16
Huff Concentrate	45.82

The ferric oxide content of the concentrate was 28.26%. Assuming that all chromium in the concentrate is present as chromite, and that the formula of this chromite is FeO, $Cr_2O_3(Fe_2O_4)$ by calculation there was an excess of iron equivalent to 4.46 ferric oxide over that necessary to combine with the chromium as chromite.

It will be noticed that extractions are based on weights and assays of products or can be calculated from assays alone. However, as it is very likely that the garnet contains chromium, this will show an apparent recovery of the chromite lower than is actually the case. Clean garnet and chromite products should be obtained and the chromium content determined. This would aid in arriving at the true recovery.

The advantages and disadvantages of sizing and classification should be studied. It is probable that sizing will be found preferable—making two products —plus and minus 65 mesh.

In concentrating it is rather difficult to tell by the eye until well trained, whether a clean product is being obtained. Some black particles which to the naked eye appear to be chromite, under the microscope are seen to be garnet.

Concentration Test on Ferro-Chrome Slag.

The material used in this experiment consisted of ferro-chrome in slag. The ferro-chrome occurred as irregular shaped pieces weighing half an ounce and less and shot the size of buck-shot and smaller. The angular pieces were for the most part rarely free from slag. The shot were imbedded in the slag.

Owing to the great difference in specific gravity between the ferro-chrome and slag almost any method of gravity concentration should be successful.

For this test a 4 x 6 inch two compartment Harz type jig was used. The material was first all crushed so as to pass a two-mesh screen. A screen analysis of this product showed the following:

SCREEN ANALYSIS.

(All Through 2 Mesh)

	Wt. Gm.	% Wt.	Cum. % Wt.	Assay % Cr.	Wt. Cr.	% of Total Cr.	Cum. of Total Cr.
— 2 + 4 mesh	1105	54.10	54.10	16.64	183.9	61.2	61.2
— 4 + 8 mesh	460	22.44	76.54	13.76	63.3	21.0	82.2
— 8 + 14 mesh	220	10.75	87.29	12.00	26.4	8.7	90.0
— 14 + 20 mesh	75	3.66	90.95	12.72	9.5	3.2	94.1
— 20 + 28 mesh	40	1.96	92.91	11.20	4.5	1.5	95.6
— 28 + 35 mesh	40	1.96	94.87	10.56	4.2	1.4	97.0
— 35 + 48 mesh	35	1.71	96.58	10.40	3.6	1.2	98.2
— — 48 mesh	70	3.42	100.00	8.40	5.9	1.8	100.0
Total	2045				301.2	100.0	

Wt. heads—2045 gm.
Assay heads—12.16% Cr.
Wt. Cr. in heads—248.7 gm.

The weight of the chromium in the heads (248.7 gm.) should equal the combined weights of the chromium in the different sizes in the screen analysis (301.2)

In the test 12825 gm. (28 lb.) of unsized feed similar to that indicated by the screen analysis gave the following products:

	Wt. Gm.	Assay % Cr.	Wt. Cr. Gm.
Concentrate	1455	53.60	780.0
Hutch product	650	15.60	101.4
Tails	10270	7.20	739.4
Slime (not saved)			
	12375	....	1620.8

Wt. heads........12825
Assay heads.....12.16% Cr.
Wt. Cr. in heads..1559.5

As the weight of the chromium in the weights of chromium in all jig products there are manifestly errors in either sampling or assaying. Therefore, no extraction can be accurately determined. Moreover, as the slag itself contains chromium, this tends to show an apparent extraction actually lower than the real one.

Almost any method of gravity concentration would probably be successful.

It may require grinding to finer than 2 mesh, but the larger pieces of ferro-chrome should be taken out first clean and then the tailings reground, as a saving in the cost of crushing would be effected thereby.

The discrepancies showing in the metal balances are due to the fact that accurate samples could not be secured, as it was desired to save a large part of each product for further examination. This lead to taking a smaller proportion of the products than good sampling re-

Calcium Molybdate as an Addition Agent in Steel Making*

By Alan Kissock, '12.

In the production of alloy steel, molybdenum, like most similar metals, is commonly added to a steel bath in the form of a ferro-alloy, usually less than a half hour before the furnace is tapped.

In the open-hearth furnace practice varies, from melting the ferro in a small electric furnace and making a hot metal addition, to crushing to about one-quarter mesh and adding it cold, or, as is perhaps most common at present, the alloy is thrown into the furnace, container and all, just as it comes from the manufacturer. In the electric furnace with its more concentrated heat, the manner of introduction is of lesser importance.

Formerly a ferro containing from 75 to 80 per cent molybdenum was generally specified. Because of the difficulty of securing an ore suitable for manufacturing such a high-grade alloy, and because of the high melting point of the metal, with attendant difficulties of production, the cost of this alloy was necessarily high. In the continued attempt to decrease production cost, and since there can be no real objection on the part of the steel manufacturers, more recent practice has been to produce a ferro containing approximately 50 per cent molybdenum. This grade of ferro, besides being less costly to produce, is perhaps the principal factor in the success of its direct addition to steel. Its lower melting point is responsible for less segregation and eliminates the necessity of pre-melting or fine crushing.

Merit and Cost of Molybdenum.

In the attempt to create or stimulate the use of anything new, the first requirement is to establish its merit and secondly to decrease its cost. The first requisite—the value of molybdenum as an alloy for certain steels— is continually becoming better known. Principally from lack of demand, the war-time price of ferromolybdenum has fallen considerably, but if the metal is to find extensive use it is necessary that a reasonable and more constant cost be established.

In deposits of commercial extent, molybdenum seldom occurs in percentages sufficient to permit, even by the most efficient known means of ore concentration, a recovery of greater than 10 lb. of metal per ton of crude ore mined. Often considerably less may be extracted. A great many costs, therefore, must be charged against these few pounds of metal recovered, from the mining, through the often-difficult concentration, to the final transportation.

To these must be added the cost of electric smelting with its heavy losses, even in the best of practice, the difficulties of coming within the customarily rigid specifications of the consumer, and the uncertainty of selling the product when finished. It is easily seen, therefore, that if a fair and reasonable return is to be made to the producer, ferromolybdenum cannot become cheap enough to compete largely with some of the more common steel-alloying elements. Assume that every possible cost of mining and treatment has been brought to its lowest point. Then if any further decrease in cost is to be obtained, it becomes possible only through some improvement in the metallurgical treatment or through the elimination of some step in the preparation of a suitable product for the steel manufacturer.

With these facts in mind, it occurred that it might be possible successfully to introduce molybdenum into steel by the use of a salt of the metal rather than by the use of ferromolybdenum. Could this be efficiently accomplished, then the electric-furnace reduction of ores and products would be eliminated and in its place a much lower-cost chemical treatment could be substituted.†

Chemical Compounds as Addition Agents.

The idea of introducing an alloying metal into steel by means of some salt or compound thereof is not particularly new. It has been tried, both in the furnace and in the ladle, with certain of the metals, and with more or less success. Several difficulties, however, are encountered in considering the more common salts or compounds of molybdenum.

The ordinary 60 per cent molybdenite concentrate, or even the higher grade, is unfit for direct addition for several reasons. All such concentrates contain a certain proportion of silica and in basic furnace practice it is desirable to avoid, as far as possible, any introduction of silica into the bath. Upon addition of molybdenite to steel at least a portion of the ore would be converted into the trioxide and as such would readily volatilize and be lost. The most serious objection, however, is the 25 to 30 per cent sulphur content of high-grade concentrates. In a test made at the plant of the Southern California Iron & Steel Co., in Los Angeles, an attempt was made, by the addition of high-grade molybdenite, to introduce 0.4 per cent molybdenum into steel. It was found that although a considerable proportion of the molybdenum entered the steel, sulphur, with its great affinity for iron, was also introduced to the extent of 0.25 per cent. By long treatment in the furnace, with manganese and lime additions, this sulphur content might have been lowered, but with the furnace-man's constant effort to keep the sulphur low in his product, a molybdenite would hardly be looked upon with favor.

Roasted molybdenite concentrate or trioxide of molybdenum would serve as a direct addition agent, were it not for the ease with which this compound is volatilized. At 1,200 deg. F. the vapor pressure of molybdic oxide is quite high, so that recoveries from an addition at steel-furnace temperatures would be unprofitably low. Such roasted concentrates would also carry the silica gangue of the unroasted material, and though it is possible to manufacture a more pure trioxide, the cost of such is prohibitive.

Since molybdenum unites in varying proportions with oxygen, it is possible that one or more oxides might be found which would not be volatile at furnace temperatures. The difficulty, however, of efficiently producing such oxides makes such compounds of doubtful value for consideration as addition agents.

Sodium molybdate might serve as another possible agent but for the higher cost of producing it of a sufficiently high molybdenum content.

In the case of some molybdenum ores, a step between concentration and the manufacture of ferro involves either a furnace or a chemical treatment for the removal of possible impurities and the production of an alkaline salt of molybdenum, preferably calcium molybdate. Although in the production of ferro from molybdenite it is not always necessary to precede electric furnacing by a roast or wet treatment, such a process can be readily applied and a calcium molybdate of high grade very easily produced.

Theoretically, calcium molybdate should serve as an excellent addition agent to steel. It can be easily and comparatively inexpensively made of a high-grade, containing practically nothing but the oxides of molybdenum and calcium. The salt is easily reduced and the lime apparently prevents loss by volatilization of the molybdenum trioxide. Upon reduction of the molybdenum, by the carbon or silicon in the steel, the lime would simply serve as a small added source of material for the ordinary basic slag.

Early in 1918, in New York City, several small steel heats were made. An experimental electric furnace was employed and molybdenum was successfully introduced by the use of calcium molybdate with a recovery of 95 per cent.

Encouraged by these tests and with the kind co-operation of P. E. McKinney, metallurgist at the U. S. Naval Gun factory, a commercial test was made at the Navy Yard in Washington, in September, 1918. The calcium molybdate was made from the wulfenite ores of the Mammoth Development Co., of Los Angeles, and furnished gratis by that company for the test. Using a Heroult furnace, six tons of scrap was melted and at the proper time sufficient calcium molybdate added to introduce about 1 per cent molybdenum into the steel. The molybdenum content of the product, as shown by final analysis, confirmed commercially the previous experimental results. At a later date, C. E. Margerum, metallurgist of the U. S. Naval Ordnance plant at Charleston, W. Va., repeated the success secured at the Navy Yard in Washington. A third electric-furnace test was made at the plant of the Carbon Steel Co., in Pittsburgh, Pa. A 6-ton Heroult furnace was employed, and a repetition of the success of the two previous heats gave ample assurance that calcium molybdate was a satisfactory addition agent for use in the electric furnace.

Molybdate in the Open Hearth.

Having succeeded in these attempts, it was conceded that because of the strong reducing action of the electric furnace, the results obtained were to be expected. That the same success could be secured in the strongly oxidizing atmosphere and action of the open-hearth furnace was, however, open to argument, and considerable skepticism had to be overcome.

Experimentation has shown molybdenum to have less affinity for oxygen than either iron or carbon. Industrially, this is again proved by the fact that once in

* Chem. & Met. Eng., June 2, 1920.

† Compare, for instance, J. P. Bonardi, "Notes on the Metallurgy of Wulfenite," Chem. & Met. Eng., Vol. 21, p. 264, Sept. 15, 1919.

the steel bath neither "oréing down" nor "boiling" appears to lower the molybdenum content.

Provided the molybdate could come in direct contact with the molten metal, it was thought that the salt might be reduced either by the metallic iron itself or by one of its reducing constituents. By the courteous aid of the officials of the Carbon Steel Co., 50 tons of pig iron and scrap was charged into one of the basic open hearths at their plant in Pittsburgh during November, 1918. At the proper time sufficient calcium molybdate was added to introduce the desired percentage of metal. Analysis of the ingots produced showed a high recovery of the molybdenum added, and the success so attained amply rewarded the effort expended.

Early in May, 1919, with the kind interest and co-operation of the staff of the United Alloy Steel Corporation, a second open-hearth test was arranged. Two 100-ton heats and a third but smaller basic furnace heat was made and the desired amount of calcium molybdate added in each case. The practically complete recoveries of molybdenum secured proved beyond question that molydenum in this form may be successfully, and very efficiently, introduced into steel made in the open-hearth. In all tests, rolling mill recoveries correspond with those usually obtained with the customary ferro addition.

In order that the molybdate may come in direct contact with the molten iron, it is necessary that the addition be made in the early stages of the heat. In one of the tests the molybdenum was in the open-hearth furnace over a 14-hr. period and under very severe oxidizing conditions. The fact that the molybdenum content remained practically constant is proof of another very important consideration in connection with the metal. It is conclusive evidence that molybdenum, like nickel, and unlike vanadium, "stays" with steel. In the use of molybdenum, therefore, the "crops" and scrap ordinarily encountered in all alloy steel manufacture can be remelted with but little loss, thereby reducing the amount of alloying metal required. Because of the economy that may be effected, the importance of this fact must be appreciated when considering molybdenum as an alloying metal to replace certain of the metals now being used, and for purposes in which it may serve equally well.

Method of Operation.

The introduction of molybdenum into steel by means of calcium molybdate involves no complications whatever, it being only necessary to bear the following in mind:

With the strongly reducing action and concentrated heat of the electric furnace, the time of addition is of less importance. Best results have been secured by introducing the molybdate immediately after skimming of the first, or phosphorus slag, the final or white slag indicating, of course, that reduction has been complete.

In open-hearth practice, the molybdate must be added in the early stages of the heat, not with the charge because of possible loss in the furnace bottom, but preferably a little before the melt becomes "level". In other words, in any type of furnace it is only necessary to remember that the molybdate must come in **direct contact with the molten iron,** and therefore in the basic open-hearth it must be added just before the lime begins to come up. A layer of slag would completely prevent contact with the metal. Shipped in sheet iron drums of convenient size, the molybdate is added, containers and all.*

Advantages.

From the standpoint of the miner the production of calcium molybdate is particularly advantageous. In almost every occurrence, molybdenite is associated with considerable percentages of both iron and copper sulphides. In order to produce a marketable concentrate, all of the copper and a considerable portion of the iron must be removed. This may be accomplished by selective flotation, but this cleaning process not only adds to the operating costs, but invariably means a lower extraction. In other words, any refining operation, whether it be in concentration or in the electric furnace production of ferro, is necessarily a costly one. Neither copper nor iron interferes in the production of calcium molybdate, so that the need of either of these refining operations is entirely eliminated. It therefore becomes unnecessary for the miner to make a high-grade concentrate or to separate therefrom any of the copper or iron sulphides that might be contained. The millman will readily appreciate the saving that may thus be effected.

* All rights to the process as outlined, both in the United States and foreign countries, are covered in U. S. Pat. 1,300,279, and are owned by the Steel Alloys Co., Investment Building, Los Angeles, Calif. It has been arranged that license to use the process will be furnished gratis by the Steel Alloys Co. to any steel company that may purchase calcium molybdate from such molybdenum producers or sellers as may be specified upon the license. Since it is expected, however, that the arrangement mentioned will be made with all principal molybdenum producers, no hardship to the steel manufacturer, either in payment of royalty or limiting of purchasing power, will be effected.

The production of calcium molybdate offers a further advantage in that the equipment for its manufacture does not involve great cost nor is especial skill required in the operation. The method is comparable to the cyanide process in that large tonnages may be readily treate and in many cases such may be carried out right at the mine. The electric-furnace production of ferro not only requires very large expenditures for tonnage treatment, but also necessitates particular experience and skill. Only in rare cases is the mining company in position to carry out such an operation, and it thus becomes dependent on some metallurgical concern to put its product into marketable form.

Calcium molybdate is readily made, and with high recovery, from all molybdenum ores by simple chemical treatment. The salt as usually furnished carries approximately 40 per cent metallic molybdenum and contains no impurities detrimental to good steel manufacture. It has been proved beyond question that molybdenum, in this form, is a very efficient addition agent for the introduction of the metal into steel.

The particular advantage of the process is that a carbon-free molybdenum addition agent may be afforded to the steel manufacturer at a price which will assuredly permit the competition of the metal with those at present in more general use. It is not within the scope of this article to attempt to point out the use or benefits of molybdenum in steel. The value of alloy steel in general is constantly becoming better appreciated. In the writer's opinion, molybdenum is the only metal commercially available in this country which is capable of developing in steels properties equivalent to those produced by metals which must now be imported. A possible strategic value exists in the ample and constant domestic supply of molybdenum that is now assured. From the results of the work that is being done by concerns, as well as indivduals of prominence, it is certain that molybdenum will shortly fill an important place in the alloy steel industry.

RADIUM SCARCITY.

Owing to the scarcity of radium—which is now priced at $100,000 a gram—and the failure to discover new sources of supply, it is feared the shortage will become exceedingly acute. In the meantime, it is reported that radium for use in medical research is being prepared by a special method. A weak solution is made which gives off radium emanations; these, which are detected only by delicate instruments, are collected in tiny sealed glass vials and the vials are sent to medical men. It is stated that the efficacy of such bottled emanations lasts one week.

WORLD PRODUCTION OF COAL IN 1919.

The world's production of coal in 1919 seems to have dropped back to the level of 1910. Preliminary estimates, necessarily rough, place the total output of all kinds of coal in 1919, at 1,170,000,000 metric tons, or 1,290,000,000 net tons. This is 162,000,000 metric tons less than the production in 1918, the last year of the World War, and about 171,000,000 tons less than that of 1913, the year before the war began.

This estimate is based by the Geological Survey upon reports to the Supreme Economic Council from countries which contribute about 85 per cent of the world's output. Obviously, returns from the other countries may materially alter this figure; if anything, they will probably reduce it still further.

The following table shows the estimated production of the world for each year from 1910 to 1919. Because of disturbances and interruptions in the compilations of Government statistics, particularly in central and eastern Europe, the figures since 1913 are not to be regarded as final. The metric ton of 2,205 lbs, is used because it is the prevailing unit in non-English speaking countries. Americans will remember it most easily as being roughly equivalent to the gross ton and the English ton.

World's Production of Coal 1910-1919.

(Metric Tons of 2,205 lbs.)

Year	Production, in Part Estimated	Per Cent Produced by U. S.
1910	1,160,000,000	39.2
1911	1,189,000,000	37.2
1912	1,249,000,000	38.8
1913	1,341,000,000	38.5
1914	1,208,000,000	38.5
1915	1,190,000,000	40.5
1916	1,270,000,000	42.1
1917	1,336,000,000	44.2
1918	1,332,000,000	46.2
1919	1,170,000,000	42.1

Comparative production in five of the

belligerent countries before and after the war is shown in the following table:

Production of Coal in Certain Countries, 1913 and 1919.

(In Millions of Metric Tons.)

United Kingdom	292	237
France (present boundaries)*	44	22
Belgium	23	18
Germany (present boundaries)†:		
Bituminous	173	109
Lignite	87	94
United States	517	494

It is pointed out by the Supreme Economic Council that from 1913 to 1919, the output of bituminous coal in the four European countries shown in the table has fallen from 532,000,000 to 386,000,000, the decrease being about 20 per cent in the United Kingdom and Belgium, and nearly 40 per cent in Germany. In the Saar Valley, whose output appears to have fallen from 12,000,000 tons in 1913 to about 8,000,000 in 1919, the percentage of decrease was over 30. The reduction in the French output is mainly due to the destruction of the mines in the Nord and Pas de Calais.

The output of lignite in Germany in 1919, though less than in 1918, was still greater than before the war, being 94,000,000 tons, as compared with 87,000,000 in 1913.

In the break-up of Austria-Hungary the bulk of that country's coal and lignite, the production of which amounted before the war to about 55,000,000 tons, was inherited by the Republic of Czechoslovakia. The 1919 production of Czechoslovakia was about one-third less than the same territory produced in 1913.

* Includes Alsace-Lorraine.

† Excludes Alsace-Lorraine and the Saar.

COMMERCIAL GEOLOGY.

The study of foreign mineral deposits and supplies by the Geological Survey, Department of the Interior, has for years been incidental to the published annual inventory of the mineral production and resources of the United States. During the war, however, this study took on new importance, and work was begun on the study of the distribution of the world's reserves of the essential minerals, resulting in the compilation, for the use of the Government, of a world atlas showing the production and resources of the more important mineral commodities.

After the data thus compiled had served the immediate confidential needs of the Government itself, the Secretary of the Interior warmly indorsed the proposal to prepare the material for publication, so as to make it useful to the general public.

The "Atlas of Commercial Geology", the first part of which is now in press, will exhibit graphically the distribution of mineral production and of mineral reserves. An effort is made to give the necessary world view by means of mineral maps of every continent. The basic importance of the raw-material resources to the country makes it a prime public duty of citizens generally to know the facts regarding the mineral industry, and to ascertain these facts; the intensive study of our own resources is not enough; we must also acquire a comprehension of what minerals other countries contain to supplement what we have at home.

If it were possible to construct a composite diagram showing either the current output or the future reserves of the essential minerals in all the countries of the world the graphic exhibit would show so large a centralization in North America as to suggest that here is a group of nature-favored nations. Yet the present industrial demands for fuels, metals, and other mineral raw materials force the American business man to look beyond the present decade and beyond the borders of the United States. "Commercial Geology" is simply the science of geology applied to the problems of industry in terms of trade. The "Atlas of Commercial Geology" will present the basal facts for use by the business man and thus show the relation of geology to national life. (Annual Report, Director U. S. Geological Survey.)

ROMANCE IN INDUSTRY.

Sensing a reality in the romantic or human interest side of present-day industry, Charles M. Ripley of the General Electric Company, has written a book entitled, "Romance of a Great Factory." In it he has pictured the curious, spectacular and awe-inspiring aspects of the achievements and life in a big industrial plant and describes the sights and sounds of the shop and its men, which he terms "a great industrial orchestra."

In an introduction, Dr. Charles P. Steinmetz, states that writers too often fail to see the wonders of our day. "In the modern factory," says Dr. Steinmetz, "there is far more romance and poetry than there has ever been in the history of the past, but we must be living with it to see and understand it. That is, we must be living with the men of our century and not sheltered in the dust of past ages.

The Olympic Games at Antwerp

By Arthur Drew.

For all Americans interested in amateur sport and recreation, 1920 is an important year, for the Seventh Olympiad will be held in Antwerp this summer. Throughout the United States, the elimination trials which will decide the personnel of the American Olympic team have revived the fervor of contest that flames up with the approach of every international competition. The departure of the hocky and golf teams and the tryouts for the other teams which will make up the American representation at Antwerp have been followed more enthusiastically than in any previous Olympic year. The Army and Navy, through a special committee, will take a more active part than heretofore in the trials.

Gustavus T. Kirby, president of the American Olympic Committee, points out that the spirit of the Olympic contest is peace and good will. More particularly is this true of the seventh of the modern series of games. The choice of Antwerp as the place for the contest was a happy one; Belgium is a dramatic if somewhat tragic figure among the nations that have sacrificed so much for peace and good will.

In former Olympic games, the United States has taken so prominent a part that the American team this year will be watched with unusual interest by the thousands of spectators who will crowd the stadium in Antwerp. All the more reason, then, why the best of our athletes, inside and outside the colleges, should be found on the American Olympic team. We are going to have a really representative team only in the event that every man boosts for fair play, for equality of opportunity, for sportmanship and for the amateur spirit.

Winning the largest number of points in the Seventh Olympiad will not be a glorious end in itself. Stamina and the will to win fairly, by-products of the contest, are far more important than bringing home the bust of Charles the Twelfth, which has been put up as a prize by the King of Sweden for the classic pentathlon, or the challenge cup offered by the father of the modern Olympic games, Baron Pierre de Coubertin, for the modern pentathlon.

It is an encouraging commentary upon American life that workmen, scholars, millionaire sportsmen, or business men can make the American Olympic team. That shows there is ample opportunity for any American, through the scientific application of his leisure time, to win the highest honors in the athletic world. Granted that there is just a litle too much emphasis upon the star system in American amateur athletics, the fact remains that more and more people are being drawn into recreation and sports. Every kid in a playground, every man on a university track, every worker who uses a community center can develop himself. It's a fair field for all that the American Olympic Committee offers to American athletes.

Consider for a minute the make-up of former American Olympic teams. Men from all corners of the United States, from all professions and callings, have been selected. The success of the American teams in earlier Olympiads speaks pretty well for the geographical distribution of stamina, fair play and sportsmanship throughout the United States. To carry this idea of geographical distrbution a little further, it is inspiring to see that winners of the different events come from so many nations. Think of the spectacular games at Athens in 1906, which were a part of the Greek and not the international cycle. A private soldier from Patras named Tophilos won the weight lifting. Mr. Taffy (this was the way the **Morning Acropolis** spelled Duffy's name) was beaten by the "terrible Robertson" in the trials of the 100-metre race. Canada won the Marathon, with the Crown Prince of Greece, bitterly disappointed at the defeat of his own country in this classic event, showing himself a good sport by running alongside the winner and cheering.

These dramatic triumphs in the Olympic stadium serve only to emphasize the success that may come at home to any man who makes the right use of his opportunities. The men who win in the Seventh Olympiad, after all, are those who have seized the chance presented to them through school gymnasiums, through college diamonds, or through play-grounds, and who have steadily fought their way up from obscurity to the first rank. There can be only one winner of the 100-metre race in Antwerp, but there can be thousands of aspirants, all of whom will be the better for having set an unattainable goal before themselves. It is because of the inspiration that the Olympiad has furnished the youth from time immemorial

—and these games go back almost into the prehistoric mists—that they were so important in classic days and are coming to mean so much in modern times.

The man who "goes out for" the American Olympic team is an inspiration to the other young men of his community, particularly if he makes his way up to the final elimination test in Boston in July. It is interesting to see that even when a man has gone across to compete with the great athletes of other nations, it is the thought of applause from his own folks that steels will and nerve to the ordeal. As when the victor in the ancient games returned to his community crowned with wreaths of olive leaves, to become the village hero, so the American athlete returns to his own people to be idolized for the time being. After all, a nation is no stronger and no weaker than are the representative young men of individual communities. If the spirit of the town is opposed to the development of sports and recreation, there is no likelihood that a great athlete will ever be produced there, or that the people of that community will be noted for their progressiveness or their fair play. If Waterloo was won on the playing fields of Eton and Harrow, much more so will the Antwerp Olympiad have been won on the gridiron or the ployground.

So closely are the famed Olympic games bound up with true recreation and sport in the United States that Community Service, Inc., the successor of War Camp Community Service, which organized so many athletic programmes for soldiers and sailors during the war, is assisting the American Olympic Committee in various ways throughout the country. The Secretary of War has pointed out that the work of the American Olympic Committee is important in physical education, apart from what it is doing in cultivating international good feeling. The interests of Community Service, Inc., and of the colleges and universities of America are identical with those of the Olympic Committee.

LARGE STEEL MANUFACTURER DECLARES METRIC STANDARDIZATION EASY; NOT EXPENSIVE.

Speaking for one of the large steel manufacturing companies of the United States, R. H. Page, Vice-President Truscon Steel Company, New York City, and Manager of the Foreign Trade Department of the Truscon Steel Co., of Youngstown, Ohio, has just declared to the World Trade Club of San Francisco, that in the steel industry, the advance to metric standardization could be made easily and without appreciable cost. Mr. Page declares that his company strongly favors the adoption of metric standards exclusively by U. S. America. He asserts that foreign transactions would be greatly simplified by dealing in metric units and that the foreign trade of the United States would be greatly advanced.

He declares that there are no real difficulties in the way of adoption of metric standards. "The heavy equipment in the basic industries—such as rolls in the steel industry—are of short life and could be entirely replaced with metric sizes in two or three years' time," he declares. "The more complex tools and dies would require somewhat longer to replace, but, meanwhile, the products thereof could be listed in their present metric equivalents. Many of our larger firms in certain lines already maintain duplicate equipment for the manufacture of metric sizes for their foreign markets, thus recognizing the importance of getting into step with the majority of the civilized nations."

Some of the other large steel manufacturers supporting the metric standardization are: R. T. Crane of the Crane Co., Chicago; The Tacony Steel Co. of Philadelphia; The Victor Animatograph Co. of Davenport, Iowa; Standard Steel Car Co., Butler, Pa.; Hamilton Watch Co., Lancaster Pa.; American Wire Fabrics Co., Chicago, Ill.; The Hydraulic Pressed Steel Co. of Cleveland, Ohio; The American Insulated Wire & Cable Co. of Chicago, Ill., etc.

X-RAY FINDS FLAWS.

The difficulty of detecting flaws and the presence of foreign bodies, of a metallic or other nature, in built-up mica which is used for insulating purposes, has caused one large manufacturing company to install a X-ray testing outfit for this purpose. With this apparatus foreign objects, such as pins, bits of wire, etc., as well as the weak or thin spots in the mica itself can be readily detected. The detection of these flaws before the mica is actually used for insulation purposes is highly important, as much damage and loss of time and money due to faulty mica are averted. Other materials can be examined in the same way.

The General Electric Company employing some 22,000 people in its Schenectady plant has launched an Americanization campaign designed to teach every non-English speaking employee the English language and a familiarity with American standards of thought and life in their broadest sense.

FUNDS SOUGHT BY AMERICAN COLLEGES TOTAL $250,000,000.

That following the example set by Harvard, more than one quarter of a billion dollars is now being sought for additional endowment by hundreds of institutions of higher learning in this country is pointed out by Eliot Wadsworth, chairman of the Harvard Endowment Fund, in an article which he has written for the March issue of the Harvard Graduates' Magazine. The Harvard Fund of $15,250,000 is fast approaching the $12,000,000 figure.

Mr. Wadsworth has gone to Europe to attend the first congress of the League of Red Cross Societies in Geneva as one of five American delegates. He was former vice-chairman of the American Red Cross, and because of his work in that organization he recently received the Distinguished Service Medal awarded by the President.

"The fact that individuals had any definite responsibility to the maintenance of our educational machinery was hardly recognized," says Mr. Wadsworth. "Citizens voted once a year for members of the School Board. College Alumni voted at Commencement for Alumni Directors and members of the Governing Board. This, to a large extent, was the measure of our interest and thought."

Looking back over the last six months since the Harvard Fund was started, Mr. Wadsworth says:

"It may be safely said that Harvard has played a very important part in leading this movement. While making the first plans for the campaign it was determined that the publicity for the Harvard Endowment Fund should have two objects: First, to show the need of Harvard; second, and far more important, to show the serious situation which confronted all educational work."

These objects have since been achieved, for the country has been aroused to the need of supporting higher education. There is a story, too, that is told in this connection. A well-known banker has asserted that the Harvard Endowment Fund caused him to realize that he owed his own alma mater for the start she gave him in life.

In the course of the article, Mr. Wadsworth says:

"With constantly increasing emphasis the fact has been borne in upon educated men and women that the schools and colleges needed their individual attention. We began to realize that our whole educational system was in danger of deterioration or even disaster.

"Hundreds of institutions have been brought to a realization of the seriousness of their financial conditions by the rising costs of 1919, with the result that campaigns for additional endowment have been inaugurated with a total amount asked for running over $250,000,000. Cities and towns have faced the same problem. Demands for additional pay by struggling teachers have been insistent. Special elections have been held; taxes have been levied to meet this universal cry from a hard-pressed profession.

"Together with the growing sense of the danger threatening our institutions, there has come a constantly growing cry for more education. The steel strike, the coal strike, the evident need for better Americanization have developed writers and orators galore all raising their voices in the same cause. More and better education for the masses; a higher and broader intellectual development of the college students, has been advocated in no uncertain terms. No political speech is complete without its mention of our needs for better Americanization—which means, as a fundamental, better education. No discussion of the industrial problems which confront the country fails to bring forth the need of a better understanding between employer and employee. Many methods for bringing this about are suggested, nearly every one of which involves more education.

"And so, side by side have arisen these two great changes in public sentiment: First, a sense of responsibility among individuals for the support of the educator and the upholding of the standard of education; second, the realization of the enormous importance of universal and proper education in the future development of America."

Mr. Wadsworth lays stress upon the practical support given by the late Henry C. Frick, who "wrote in his will a testimonial as to his opinion of the value and importance of our institutions of higher learning." Mr. Rockefeller, he says, "has expressed, in no uncertain terms, his feeling as to the importance of higher education to this country by his gift of $50,000,000 for distribution among colleges of the country."

According to scientists the ordinary flow of the river at Horse Shoe Falls, Niagara, is 275,000 cubic feet per second. developing an unharnessed horsepower of approximately 5,000,000 or the power of 15,000,000 strong draft horses, each horse being confined to an eight-hour day.

TECHNICAL REVIEW

GENERAL.

The Fixed Nitrogen Research Laboratory. By Arthur B. Lamb. (C. & M. E., May 26, 1920.)

This article deals with the problems confronting the War Department in the disposition of its nitrogen plants. The Fixed Nitrogen Research Laboratory was therefore established in Washington to investigate the uses of nitrogen as a fertilizer. This work includes the hydrating of lime nitrate, the granulation of cyanide and the production of various forms of ammonium. The operation of the plant using the Haber process depends on the finding of an active catalypt for the reaction between nitrogen and hydrogen. The process of fixation by the electric arc is being studied because it may be installed rapidly in times of emergency. German research work on these problems is said to have employed 250 chemists during the war. J. A. H.

Stabilization of Coal Industry Depends on Improvement in the Railroad Situation. By Howard N. Eavanson. (M. & M., June, 1920.)

Thirty per cent of the by-product ovens of the United States Coal and Coke Company have been closed because of the car shortage. This shortage has been so acute that private cars of the company have been diverted to other parts of the country and have not been returned. This shortage has caused ten per cent of the total loss of time in the past six years. The lastest recommendation for economy in coal consumption is by the electrification of industries. J. A. H.

The Fertilizer Situation. By Milton Whitney. (C. & M. E., June 2, 1920.)

The merging of the smaller companies which produced the old brands of fertilizers in large corporations has made it possible to elevate the trade into a real chemical industry. The present treatment of phosphate rock with sulphuric acid entails a loss of two-thirds of the rock because it contains iron, aluminum, and phosphate. Phosphoric acid is difficult to transport as an acid but it can readily be changed to a soluble salt. Cottonseed meal, animal tankage, and the other waste products which once supplied nitrogen to the fertilizer industry have become so prominent as animal feeds that their price makes them prohibitive for the former purpose. These materials are so necessary to give the fertilizer a proper mechanical texture that some substitute must be found. The logical source of supply is from fixed nitrogen products, such as calcium, cyanide, ammonia, or some of the compounds of ammonia. These products could be mixed in so concentrated a form that they would require 80 per cent of inert fertilizers. The diluting agents would be very economical as water, soil, or sand could be used. Dipotassium phosphate is prepared by fusion of a mixture of potash, shale, phosphate rock, and coke, and precipitation the volatile salts. The fertilizer industry of the future must be based upon chemical investigation and control. J. A. H.

GEOLOGY.

Diamonds. By Sydney H. Ball. (E. & M. J., May 29, 1920.)

Diamonds occur in all parts of the world associated with igneous rocks and possibly with metamorphic rocks. Although the common occurrence is in pipes of peridate there is good reason to believe that they may also occur in veins, and as a gangue mineral for metals. The more commonly associated minerals are gold, corundum, topaz, enclase, cyanite and platinum. The percentage of recovery, varies greatly in different localities, but the average size is much the same. J. A. H.

METALLURGY AND ORE DRESSING.

A Comparative Test Upon High-Speed Steels—I. By A. J. Langhammer, M.E. (C. & M. E., May 5, 1920.)

The manufacture of high-speed steel has grown in sixteen years from a metallurgical experiment to an important industry. The selling methods are disappointing as salesmen will often make tests with a special quality and fill orders with a much lower grade of steel. Buyers are also at fault in buying cheap steel, or steel of various brands, which may require different treatment, thus throwing the whole plant into confusion. Carbon steels are now falling into dis-use because of the premature dulling of the cutting edges. It was succeeded by mushet, or self-hardening steel, which increased speed 60 percent, but which is yet too slow for present use. Its speed was increased 400 percent by high-speed steel which will retain its cutting edge

to the point of breaking down. Stellite, an alloy of cobalt, chromium, and molybdenum is 100 percent faster than high-speed steel for cutting cast iron, and 700 percent faster for cutting bronze, but its efficiency is reduced by its inability to withstand sudden shocks. Cast high-speed steel is a promising innovation, but its value is not yet fully proved. English brands of steel, made without tungsten are still a failure. The chemical composition will generally betray a poor steel, but it is one of so many factors that it is no guarantee of a good steel. Tungsten is the most valuable component because it raises the strength of steel and the point of fusion. J. A. H.

A Comparative Test Upon High-Speed Steels—II. By A. J. Langhammer, M.E. (C. & M. E., May 12, 1920.)

This article describes the tests to which steel for the manufacture of Liberty motors under the Ford method was subjected. The thirteen elements which affect the cutting speed of tools were made as nearly constant as possible to reduce the number of variables. A cutting speed of 35 feet was chosen, which eliminated that variable factor. The quality of metal to be cut was made constant by using in the test Liberty airplane motor cylinders of a definite hardness. The chemical composition of the tool steel, and its heat treatment was necessarily a variable as various brands of steels were used. The thickness of shaming was the same throughout the test. The shape or contour of the cutting edge of the tool was made constant, while no coolant or cutting compound was used, making that factor zero. The depth of cut was 5-32 inch in every test. The element of duration or length of cut could not be made constant. The tool holders were made as rigid as possible, so that "chattering" was reduced to a constant approaching zero. "Diameter of work" was easily made a constant by selecting only specimens of equal diameter. Change of feed and speed possible was eliminated by establishing the cutting speed and the depth of cut at the beginning. The recogged construction of the lathe prevented any variation due to the "pulling and feeding power of the machine tool." The "human element" was made as constant as possible by having expert supervision. J. A. H.

A Comparative Test Upon High Speed Steels—III. By A. J. Langhammer, M.E. (C. & M. E., May 19, 1920.)

The fundamental factors of a test are the steel, the manufacture of the tool, its heat-treatment, its grinding, the working details, and the chemical and metallographic tests. In these tests, best grade steel was ordered, without mention of the tests. When the tools were made they were hardened according to the specifications of the steel manufacturers. Special precautions were taken in grinding to prevent overheating. In cutting, the life of the tool was calculated with a stopwatch and tables were prepared, detailing the performance of each brand. The chemical and metallographical tests were conducted in the Packard laboratory and when in doubt they were checked in two other laboratories. J. A. H.

The Remodeled Arizona Hercules Concentrator. By J. T. Shimmin. (E. & M. J., May 15, 1920.)

By the original flow sheet of the Arizona Hercules Mill, every day 1,200 tons of ore were crushed, classified, concentrated and prepared for shipment under the new flow sheet the capacity has been decreased, but the efficiency of concentration has been greatly raised. The author believes that gravity concentration should precede flotation on the flow sheet, as the flotation alone is not entirely dependable. J. A. H.

A Russian Copper Refinery Under Bolshevik Control. By R. G. Knickerbocker. (M. & S. P., May 8, 1920.)

The refinery on the Kyphtim estate, in the Ural Mountains was seized by the Bolsheviki in 1917. The whole operation of the plant was so poor that at least one quarter of the copper, gold, and silver was needlessly wasted. A commission of Russian engineers investigated conditions and reported fifteen suggestions, most of which regarded robbery the greatest cause of loss. In getting out of the country, Mr. Knickerbocker had the usual difficulties of Bolsheviki red-tape, miserable transportation accommodations and worse food.

J. A. H.

Reverberatory Copper Smelting in Arizona. By Charles F. Mason. (E. & M. J., May 8, 1920.)

It is said that the reverberatory furnace has doubled the efficiency of the blast furnace. Much of this efficiency has been due to a cut in expenses by using slack coal instead of oil. The furnaces are being made slightly wider with straight-line arches and larger uptakes and flues. Side-charging is the standard practice in Arizona, and the continuous slag tap is coming into general use.

Steam boilers are the most efficient agents for the recovery of waste heat, but the connecting flues must be as short as possible and of large cross-section, to prevent loss by radiation. J. A. H.

The Metallurgical Research Department of the Utah State School of Mines. By L. W. Chapman. (C. & M. E., May 12, 1920.)

The offices of the Department of Metallurgical Research, and of the U. S. Bureau of Mines have been installed in a large fire-proof building erected by state appropriations and public subscription. The ore-dressing laboratories are equipped with grinders, crushers, disc pulverizers, sample splitters, special grinding mills, jigs, concentrating tables, finishing tables, ball mills and jar mills. The flotation laboratory is equipped with testing machines, flotation machines, suction filters, and dehydration heaters. The equipment is arranged so that results of small-scale tests may be substantiated by large-scale tests, and so that the students may learn the calculations involved in the operation of the various machines. Fine crushing may be done in either a Marcy mill, a Hardinge mill, a Huntington mill or a stamp mill. The table equipment consists of two Wilfleys, a Deister-Overstrom finishing table, and an Overstrom roughing table, all having interchangeable riffles. The flotation equipment consists of a Janney machine, Anzinger machine, an M. S. machine, and magnetic separators. The chloride volatilization process is performed by crushing the ore to a suitable fineness, mixing with chloridizing agents, heating, recovering the volatilized chlorides, and treating them to obtain the values in saleable form. J. A. H.

Experimental Briquetting Plant. By Albert L. Stillman. (C. & M. E., June 2, 1920.)

The importance of briquetting has passed from anthracite coal to ore dust, saw-dust and metallic turnings. These materials are now being successfully briquetted by many companies. The greatest question was whether the careful work of the laboratory could be imitated on a commercial scale. The most important point in the industry is the difference in value of the briquets and the material from which they are made. To answer some of the other fourteen questions, the General Briquetting Co. established a complete operating plant for experimental purposes. Coal dust is thoroughly mixed with 5 per cent of heavy oil and rolled into eggettes. The equipment includes shredders and breakers, rotary furnaces, belt magnetic separators, and hydraulic presses. The general procedure is to determine whether a binder is necessary, what pressure gives the best results and whether the material permits of large scale operations. Lime is sometimes added to briquets of ore-dust to make them firmer and to aid in smelting. The article ends with a list of problems investigated and the results. J. A. H.

Scientific Control of the Filter Station. By Arthur Wright, M.E. (C. & M. E., June 2, 1920.)

Modern industrial filters will quickly drop below their capacity unless they are handled by an operator who knows his work. Clarity of filtration is due to the superlative straining of particles of suspension from the liquid. When fabrics are used the clarification begins after a layer of sediment has been deposited, but the use of sand gives immediate clarification at the surface. The filter cloth should be as thin as is practical in order that sediment may not be caught within the mesh. The use of two layers of thin cloth is objectionable because it has the disadvantages of both thin and thick fabrics. This plan is practical only when the thin fabric is reinforced by burlap or matting. In obtaining clarity one of the most important necessities is to have proper agitating devices. Filter aids will help if they have a low specific gravity, high filtering characteristics and an inert chemical composition. J. A. H.

The Bunker Hill Enterprise—X. By J. A. Rickard. (M. & S. P., May 29, 1920.)

Mr. Rickard gives an interesting account of the efforts of the Guggenheims to get control of the mine by direct negotiation and by apex litigation. This involved five law suits dealing with most of the problems of conflicts and extralateral rights. The whole Bunker Hill property is about five miles long and has a maximum width of 3¾ miles. The smelting of the ore was the cause of much litigation with the Guggenheim companies and resulted in the building of a smelter at the mine. The article ends with paragraphs on the principal people to whom the success of the enterprise was due. J. A. H.

Recent Developments at Yellow Pine Property. By Percy M. Cropper. (S. L. M. R., May 30, 1920.)

This mine is the largest shipper of zinc carbonate in the United States and one of the largest silver-lead producers in Nevada. It became important in 1911, when the concentration plant and a narrow-gauge railway to Jean were built. The ore is calcined, with the chloridization and subsequent recovery of the silver and lead. The milling equipment includes Hartz jigs, Deister-Overstrom and Overstrom-Universal Tables. By calcining, the zinc percentage of the concentrate is raised from 32 to 42 per cent, with a weight reduction of 34 per cent. J. A. H.

Flotation of Molybdenite at Empire, Colo. By Will H. Coghill and J. P. Bonardi. (E. & M. J., May 29, 1920.)

The ore occurs with pyrite, galena, sphalerite, and magnetite in the Ural Mine of the Primos Exploration Co., near Empire. The refining plant will treat low grade concentrates so that a high concentration mill is unnecessary. The ore-circuit was unsuccessful because the ore was being lost in the fine grinding which was thought necessary to separate the molybdenite from the siliceous gangue. The flotation of the ore was then investigated by the staff of the U. S. Bureau of Mines, by a microscopic study of the ore at different degrees of pulverization. These observations proved that a tiny flake of molybdenite on the surface of the gangue mineral would make it float, so that it was unnecessary to free the ore by very fine grinding. A sample of the pyritic concentrate from the tailings containing about 75 per cent of all the pyrite in the ore, assayed only 0.55 per cent of MoS_2, which proved that very little molybdenite was locked in the pyrite. Application of these discoveries to the mill at Empire reduced the percentage of MoS_2 in the slime to an average of 0.05. Previously, the only cell of twelve which produced a product of shipping grade. had been diluted with low-grade material from succeeding cells. J. A. H.

A Comparative Test Upon High-Speed Steels—IV. By A. J. Langhammer, M.E. (C. & M. E., May 26, 1920.)

It was found that steel of a good composition and structure failed because of faults in the process of manufacture. The more important conditions in the manufacture of good steel are a well-balanced organization, modern, high-grade equipment, carefully planned and executed work, experienced and careful workmen, and the best of raw materials and expert supervision. Mills should, whenever possible, control the production of their raw material. Melting should be carried on with the proper consideration of furnaces, crucibles, mixture ... essential in forging. Electric furnaces are of great advantage in the mixing of the alloys. The results of the tests demonstrated that tools of the same bar and treatment subjected to the same working conditions, gave widely varying results. The tests were checked by other single tests and the average results were practically unchanged. Nine other companies using tool steel supplied information which agreed closely with the Packard tests described. Superior tool steels effect a saving of from five to ten per cent in labor costs as they can be depended upon in critical times. The chemical analysis of the best steel reveals a large percentage of tungsten and chromium as compared with the other auxiliary elements. Microphotographs of annealed steel showed wide variations in structure. In the hardened steels practically all of the carbides were taken into solution. J. A. H.

Reliability of Materials and Mechanism of Fractures. By Charles De Fremenville. (C. & M. E., May 26, 1920.)

The needs of the automobile industry led to the first scientific investigation of what different types of steel would do under different conditions of shock and strain. The cause of fracture can be arrived at only by a study of the appearance of the fracture, which seems to indicate that the parting of a material is slightly preceded by cracking. In all cases the fracture begins below the surface of the material, even though the shock is evidently greater at the surface. J. A. H.

OIL.

The Market for Rocky Mountain Petroleum. By John D. Northrop. (E. & M. J., May 29, 1920.)

Until the last few years the petroleum industry of the West has been unable to obtain Eastern capital because of the apparent lack of a market for its product. Five important factors have dissipated this obstacle, which can no longer exist in the face of the staple nature of petroleum, the high grade of Rocky Mountain oil, the nature of the existing markets, and the promising future of the West. The region is admirably located to supply the demands of the vast territory where oil is not found, and of the ever-increasing population. New oil fields in the North, as well as in Colorado, New Mexico, Arizona, and Utah would find an immediate market for their product. The Midwest Refining Co. used this market for a profit of 66 per cent in 1917, and a daily capacity increased to 56,000 barrels of crude oil. The market is so large that there is still room for much more ...

PERSONALS

'92.

W. E. Hindry is located at Pasadena, Calif.

'02.

John V. Richards is with the Bishop Creek Mining & Milling Co., Bishop, Calif.

Montague Butler, Dean College of Mines and Engineering, Tucson, Arizona, was a Golden visitor recently.

'05.

P. Jay Lonergan's address is Leavenworth, Wash.

'06.

Rush Tabor Sill is located at 1011 South Figueroa Street, Los Angeles, Calif.

'08.

Morrison Harris is located at Claymont, Del.

Carl E. Lesher is editor of "Coal Age," 36th Street and 10th Avenue, New York City, N. Y.

'10.

George M. Lee is chief chemist, Granby Con. M. S. & P. Co., Amyox, B. C.

Jene McCallum is with the River Smelting and Refining Co., Florence, Colo.

J. Courtney Ballagh is president and manager of the Southwestern Welding Co., 506 San Francisco Street, El Paso, Texas.

'11.

R. G. Bowman is with the Anaconda Lead Products Co., East Chicago, Ind.

Walter J. Mayer is with the Aetna Life Ins. Co., 529 Idaho Bldg., Boise, Idaho.

P. M. McHugh, sales manager of the Dorr Co., was in Denver recently.

'12.

Alan Kissock is president of the Steel Alloys Co., Investment Bldg., Los Angeles, Calif. He reports the arrival of Jean McNeil Kissock.

C. L. Harrington, of the Radium Co. of America, is conducting tests at the Ore Testing Plant, Golden, Colo.

Paul Hillsdale of Salt Lake City is on a business trip in the East.

John Davenport, metallurgical engineer, 5 Custom House Street, Boston, Mass., is now with the Wausan Abrasives Co., Wausan, Wis.

'13.

Frank A. Downes is with the Dorrco Slate Company, Middle Granville, New York.

S. P. Warren, who has been working at the Ore Testing Plant in Golden for several months, is now at Climax, Colo.

Irving A. Chapman is in the Engineering Department of Jardine, Matheson & Co., Ltd., 25 Madison Avenue, New York.

James W. Dudgeon, formerly with the Basin Salvage Co., Basin, Mont., is now with the Davis-Daly Copper Co., Butte, Mont.

Mr. and Mrs. John R. Davis, of Bannock, Mont., are rejoicing over the arrival of an eight-pound daughter.

'14.

Frederick W. Foote is at present in London on business.

Neil M. MacNeil, of Bisbee, Arizona, is spending several weeks in Golden.

Adolph Bregman is located at 155 W. 84th Street, New York City, N. Y.

'15.

Van Cleave A. Olson has resigned from the Sinclair Consolidated Oil and Gas Co., Wichita Falls, Texas, and is temporarily at Park City, Utah.

'16.

John J. Cadot is production manager of the Hardinge Company, and is temporarily located at York, Pa.

Howard L. Minister is located at 309 South 8th Street, Laramie, Wyo.

Van Dyne Howbert was married to Miss Helen Louise Weiffenbach on June 10th, Denver, Colo. They will reside at Saltillo, Coahuila, Mexico.

'17.

Max T. Hoflus has returned to Belize, British Honduras, C. A.

George M. Cheney, formerly of Guayaquil, Ecuador, is now with the Andes Copper Co., Antofagasta, Chile, S. A.

'19.

Rene J. Mechin was married to Miss Carolyn Elizabeth Smith on June 23rd at Martin, Tenn. Mr. Mechin is in the engineering department, Cia de Santa Gertrudes, Puchuca, Hidalgo, Mexico.

'20.

Juan E. Serrano is with the Ingersol-Rand Co., Easton, Pa.

Quirico A. Abadilla's address is care Geological Department, Cia Mexicana de Petroleo, "El Aguila," Tampico, Mexico.

Victor J. Lynch is with the Phelps-Dodge Copper Co., Tyronne, N. Mex.

Herbert K. Linn's address is Cia Mexicana De Petroleo, "El Aguila," S. A., Tampico, Mexico.

George G. Goodwin has gone into business with his brother at Fresno Calif. His address is care Pacific Tent & Awning Co.

Luther J. Buck was married to Miss Marjorie Broad of Golden, Colo., at Butte, Mont, June 16th. They will reside at Anaconda, where Mr. Buck is employed in the mill testing department of the Anaconda Copper Co.

EX-MINES NOTES.

'83.

Walter H. Wiley's address is Palm Drive, Glendora, Calif.

'06.

Harold S. Munroe has resigned as manager of the Consolidated Copper Mines Co., Kimberley, Nev., to become general manager of the Granby Con. M. S. & B. Co., Anyox, B. C.

'10.

John A. Baker is in charge of the ore testing plant of the Dorr Co. at Wesport, Conn.

WHERE ARE THESE MEN?

Wm. B. Middleton, '83.
Mifflin M. Butler, '19.
Sidney W. French, '08.
Horace T. Reno, '02.
Chas. E. Wheeler, '94.
Wm. B. Patrick, '09.
W. P. Cary, '10.
R. A. Thurstin, '17.
W. A. Conley, '19.
Howard I. Flint, '20.
Walter A. Funk, '03.

SCHOOL NOTES.

Dr. Victor C. Alderson sails for this country from Liverpool July 21st, on the Olympia.

THE RED CROSS ROLL CALL.

The Fourth Red Cross Roll Call will be held from Armistice Day, November 11, to Thanksgiving Day, November 25, next. Hereafter every anniversary of the end of hostilities in the World War will be the occasion for the American public to renew its Red Cross allegiance through dollar memberships.

This was made known recently by Dr. Livingston Farrand, chairman of the Central Committee, when he announced that as a result of the last Roll Call the Red Cross now has more than ten million members. This is more than twenty times the pre-war membership of the society and does not take into account the fourteen million school children who are members of the Junior Red Cross.

The membership dollars will be used to further the gigantic peace time activities of the American Red Cross, which are:

To continue work for America's veterans of the World War, particularly the disabled.

At the Red Cross Institute for the Blind near Baltimore, more than half of the American soldiers blinded in the World War have already been trained for living and earning without their sight.

To serve our peace-time Army and Navy.

The Government has requested that the Red Cross continue this responsibility, particularly that of acting "as a connecting link between the enlisted men and their families."

To develop stouter national resistance to disease through health centers.

The Red Cross chapter in Seattle, Wash., alone is etablishing twenty-five Red Cross health centers in the towns of King and Kitsap Counties.

To increase the country's nursing resources and to co-operate with official health agencies.

When influenza visited New York City, the Red Cross supplied 12,600 blankets, towels, nightgowns, layettes, and other sickroom articles within a few hours. In Chicago, 14,000 women trained by the Red Cross during the war were called to sickroom service.

To continue preparedness for disaster relief.

Mobile relief units, consisting of food and medical supplies, are stored in Red Cross warehouses all over the country. In time of disaster they can be rushed to the stricken community.

To continue Home Service and community work.

Red Cross Home Service workers are in forty-five U. S. Public Health Service hospitals, with a possible population of 10,000 patients.

To complete relief work among the war-exhausted and disease-ridden people of Europe.

Ten millons of the 40,000,000 souls in the Balkan States alone were beneficiaries of Red Cross bounty in seventeen months of relief work there. The food and clothing and medical relief supplied are given as "gifts of the American people."

ELECTRIC TRACTION POPULAR IN BELGIUM.

Why Belgians want electric traction is brought out in a recent issue of Electrical World. The Belgian government has decided to start electrifying its railroads, beginning with the line from Brussels to Antwerp. Economically, steam lines are cheaper to operate than electric, and the installation costs are lower; but these are counterbalanced by the possibility of running increased freight and passenger service by electric methods.

PROFESSIONAL CARDS

BEELER, HENRY C.
Mining Engineer.
229 Coronado Bldg.,
Denver, Colo.

BURLINGAME, WALTER E.
Chemist and Assayer.
1736-38 Lawrence Street,
Denver, Colo.

BUTLER, G. MONTAGUE
Mining and Geological Engineer.
Dean College of Mines and Engineering, University of Arizona, Tucson.
Examinations and problems involving persistence, change in character, and loss of ore.
Diamonds and other gems secured for Miners or their friends at reduced rates.

CORRY, ARTHUR V.
Member Harper, Macdonald & Co.,
Mining Engineers, Butte, Mont.

DUGAN, WILLIAM F.
General Agent for Southern California.
Columbian National Life Insurance Company.
Old Line, Low Cost Life Insurance, Accident and Health Insurance.
716-718 Trust & Savings Bldg.,
Los Angeles, California.

HAMMOND, JOHN HAYS
Mining Engineer.
71 Broadway,
New York.

MILLIKEN, WILLIAM B.
Mining Engineer and Metallurgist.
709-10 Mining Exchange Bldg.,
Denver, Colo.

MONTANA LABORATORY CO.
E. E. BLUMENTHAL
Chemist and Assayer.
Phillipsburg, Mont.

H. N. STRONCK
Consulting Industrial Manager.
Problems of Finance, Organization, Production, Labor and Accounting.
743 Conway Bldg., Chicago, Ill.

TAYLOR, FRANK B.
Geologist and Oil Expert.
Reports and Investigations.
Box 325, Casper, Wyo.

WALTMAN, W. D.
1215 First National Bank Bldg.,
Denver, Colo.
Phone Champa 5236.

WOLF, HARRY J.
Mining Engineer.
42 Broadway,
New York.

Office and Residence, Cor. 15th and Ford Streets
DR. PAUL MEYER
Physician
Phone Golden 21 Golden, Colorado

PATENTS.
Booklet and information free. Highest references. Best results. Promptness assured. Send drawings or model for preliminary examination.
WATSON E. COLEMAN
Patent Lawyer
624 F Street, Washington, D. C.

THE
J. H. LINDER HARDWARE CO.
Hardware, Plumbing, Heating
Golden, Colorado

AUGUST BERNINGHAUSEN, Proprietor
CITY TAILOR SHOP
Cleaning, Pressing and Repairing
Golden, Colorado

Office Hours: 9 to 12 a. m., 1 to 5 p. m.
Phone Golden 164W
DR. LESLIE C. ANDERSON
Dentist
Rooms 9 and 10, over Rubey Bank
Golden, Colorado

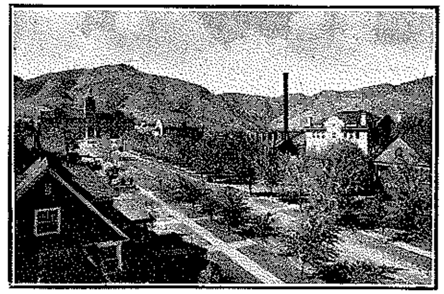
Telephone Golden 72
CITY MEAT MARKET
1118 Washington Ave.
Meats, Fish, Poultry, Vegetables, Butter and Eggs—Oysters in Season

---

COLORADO SCHOOL OF MINES

GOLDEN, COLORADO

UNEXCELLED LOCATION AND EQUIPMENT



HIGH STANDARD OF EXCELLENCE

A State institution in which tuition is free to bona-fide residents of Colorado. Offers four-year courses in Metal Mining, Coal Mining, Metallurgy and Mining Geology, leading to the degree of Engineer of Mines. Graduates generally in demand by best mining companies; employment secured through Capability Exchange maintained by the Alumni Association.

A well-equipped club and gymnasium provide social diversion and athletic training.

For further information address

THE REGISTRAR, COLORADO SCHOOL OF MINES, GOLDEN, COLORADO

HAVE YOU A SET OF THESE?

A new reprint of the following is ready for distribution:

"Notes on Fire Assaying," by F. W. Traphagen. A manual of methods of fire assaying for gold, silver, platinum, tin and lead ores. **Price $1.00.**

"Rapid Methods of Technical Analysis," by Frand D. Aller, '92. Manual of standard smelter laboratory methods used by the American Smelting & Refining Co. **Price $1.00.**

JEFFERSON COUNTY POWER AND LIGHT CO.
Golden, Colorado

LUTHER HERTEL
Clothier and Furnisher
Sole Agents: Arrow Collars and Shirts
"SINCERITY" CLOTHES
Golden, Colorado

N. Koenig, Pres. W. H. Bolitho, Sec.
The KOENIG MERCANTILE CO.
STAPLE AND FANCY GROCERIES
Washington Ave and 12th St.
Telephones: Golden 9, Golden 60 Golden, Colo.
Terms Strictly Cash and 30 Days.

DELICIOUS CANDIES.

To develop brain and muscle, we advise all students of the School of Mines to eat food bought of **The John Thompson Grocery Stores Co.** It can be relied on as being pure, healthful and nourishing, and they sell their goods cheaper than most of the stores in the State. They manufacture Candy, Ice Cream, Fancy Cakes and Bakery Goods, equal to many high-toned caterers, and sell at about half the other fellow's prices.

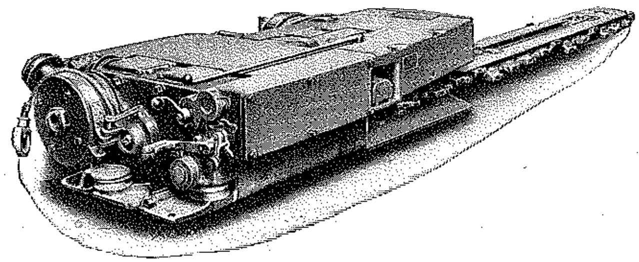
For social functions, or for your best girl—try their Chocolate Bon Bons, Ice Cream and Bakery Goods.

All the eatables and drinkables for a Dutch Lunch, Cigars, Tobaccos, etc.

Phone Golden 187
SOREN SORENSON
Staple and Fancy
Groceries
1214 Washington Ave.

Demonstrate where it pays to advertise. By identifying yourself and the Mines Magazine.

THE GOODMAN
LOW VEIN SHORTWALL MACHINE



Has passed its period of test in service and has proven itself perfect in design and performance.

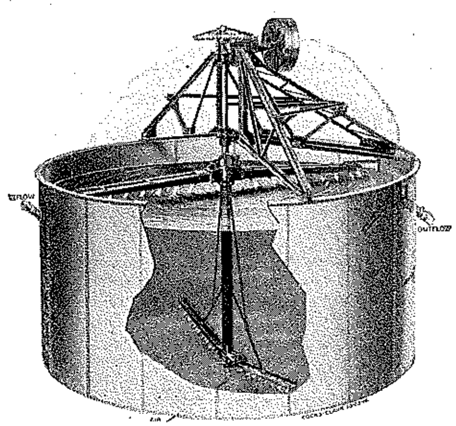
It is more than six inches lower than the Goodman Standard Shortwall Machine.

Book 203-S tells about it.

Goodman Manufacturing Co., Chicago, Ill.

New York, Cincinnati, Denver, Pittsburg, St. Louis, Seattle, Charleston, W. Va. Birmingham. (82)

THE DORR AGITATOR



The Dorr Agitator (Patented)

Uniform Mixing at Low Cost

The cost of agitating in 40′ x 25′ DORR AGITATOR at one large Cyanide Plant is $0.0023 per ton of pulp per 24 hours.

Get acquainted with Dorr Apparatus

THE DORR COMPANY
ENGINEERS

New York Denver London Mexico City

The Roessler & Hasslacher Chemical Company

709-717 SIXTH AVENUE
NEW YORK

Works: Perth Amboy, N. J.

CYANIDE OF SODIUM
96-98%

CYANOGEN 51-52 PER CENT

"CYANEGG"

SODIUM CYANIDE 96-98 PER CENT
IN EGG FORM, EACH EGG WEIGHING
ONE OUNCE

CYANOGEN 51-52 PER CENT

F. B. ROBINSON

HEADQUARTERS FOR SCHOOL OF MINES
BOOKS AND SUPPLIES

Subscriptions Taken to All Magazines and Periodicals

Mail Orders Promptly Attended To

F. B. ROBINSON - - - - - - GOLDEN, COLORADO

IMPORTERS DFC EXPORTERS

MAKE OUR STORE YOUR HEADQUARTERS FOR ALL LABORATORY REQUIREMENTS.

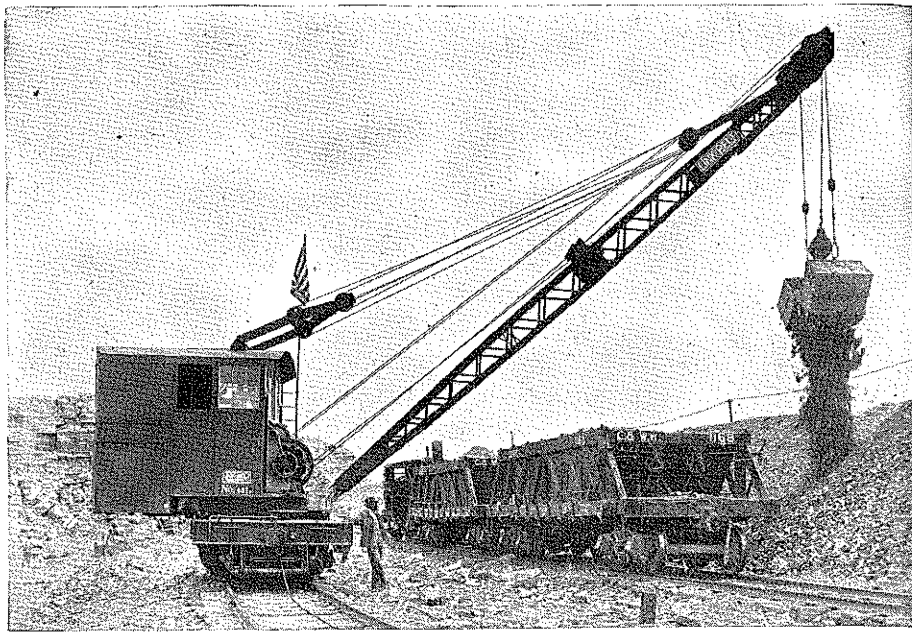
Rubber Aprons—Scientific Instruments—Chemicals—
Glassware—Metallurgical Clay Goods—Filter Paper

THE DENVER FIRE CLAY COMPANY

1742-1746 CHAMPA STREET, DENVER, COLORADO

SALT LAKE CITY NEW YORK CITY

For Reliable Mine Work



Locomotive Cranes occupy an important place in the art of handling materials and are adapted to a wide range of service and conditions—in many cases where the possibilities for savings in time, labor and money are great.

The Link-Belt Crane represents the highest degree of efficiency in design and mechanical construction known in the crane building art.

Let us tell you more about it. Send for catalog.

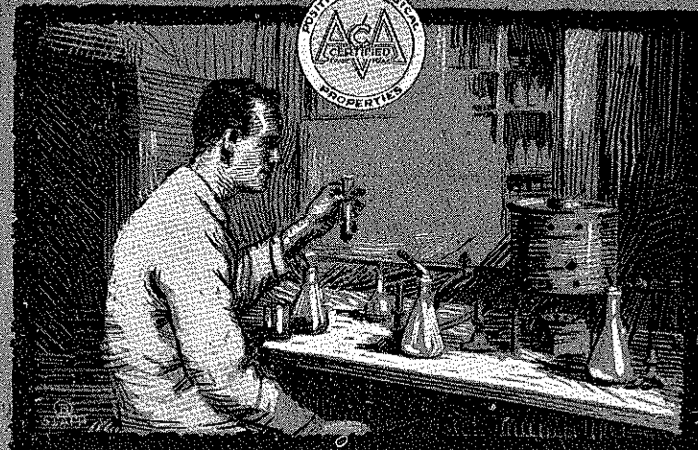
LINK-BELT COMPANY

Philadelphia Chicago Indianapolis

Denver—Lindrooth-Shubert & Co., Boston Bldg.

LINK-BELT

LOCOMOTIVE CRANES



YOU business men of the future cannot afford to risk your reputations for good judgment and business stability or incomplete knowledge.

You should understand the advantages and possibilities of high grade malleable castings called "Certified," such as those made by the holders of certificates described in our booklet.

This booklet places at your disposal a store of knowledge accumulated through years of research.

Full information as to the development of the Malleable Industry to its present day efficiency, will be gladly furnished upon request.

CERTIFIED MALLEABLE-CASTINGS

THE AMERICAN MALLEABLE CASTINGS ASSOCIATION

A C A CERTIFIED

1500 Euclid Ave. Cleveland, Ohio

Certificate Holders Quarter Ending March 31, 1920.

Albion Malleable Iron Co., Albion, Mich.
American Malleable Co., Owosso, Mich.
Belle City Malleable Iron Co., Racine, Wis.
Chain-Belt Co., Milwaukee, Wis.
Chicago Malleable Castings Co., West Pullman, Chicago, Ill.
Chisholm-Moore Mfg Co., Cleveland, O.
Columbus Malleable Iron Co., Columbus, O.
Danville Malleable Iron Co., Danville, Ill.
Dayton Malleable Iron Co., Dayton, O. and Ironton, O.
Eastern Malleable Iron Co.
 Naugatuck Malleable Iron Works, Naugatuck, Conn.
 Bridgeport Malleable Iron Works, Bridgeport, Conn.
 Troy Malleable Iron Works. Troy, N. Y.
 Wilmington Malleable Iron Works, Wilmington, Del.
 Vulcan Iron Works, New Britain, Conn.
Erie Malleable Iron Co., Erie, Pa.
Federal Malleable Co., West Allis, Wis.
Haskell & Barker Car Co., Michigan City, Ind.
Illinois Malleable Iron Co., Chicago, Ill.
Iowa Malleable Iron Co., Fairfield, Ia.
Laconia Car Co., Laconia, N. H.
Marion Malleable Iron Works, Marion, Ind.
National Malleable Castings Co., Cleveland, O., Chicago, Ill., Indianapolis, Ind., Toledo, O., E. St. Louis, Ill.
Northern Malleable Iron Co., St. Paul, Minn.
Northwestern Malleable Iron Co., Milwaukee, Wis.
Pittsburgh Malleable Iron Co., Pittsburgh, Pa.
Rockford Malleable Iron Works, Rockford, Ill.
Ross-Meehan Foundries, Chattanooga, Tenn.
St. Louis Malleable Casting Co., St. Louis, Mo
Stowell Co., South Milwaukee, Wis.
T. H. Symington Co., Rochester, N. Y.

VOL. X SEPTEMBER, 1920 No. 9

COLORADO SCHOOL OF MINES MAGAZINE

THE COLORADO SCHOOL OF MINES ALUMNI ASSOCIATION, PUBLISHERS, GOLDEN, COLO.