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Mining, concentration and refining of American flake graphite by the Griesemer Graphite Company

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MINING, CONCENTRATION AND REFINING OF AMERICAN
FLAKE GRAPHITE BY THE GRIESEMER GRAPHITE COMPANY.

By

Joseph C. Barton

A

T H E S I S

submitted to the Faculty of the
SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF
MISSOURI.

in partial fulfillment of the work required for

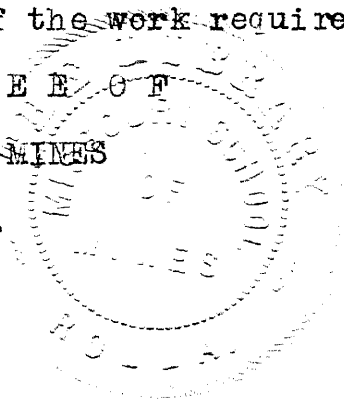
T H E D E G R E E O F

ENGINEER OF MINES

Rolla, Mo.

1920

Approved by


Chase Clayton
Associate Professor of Metallurgy & Ore Dressing.

To the Thesis Committee,
Missouri School of Mines,
Rolla, Mo.

Gentlemen:

The subject matter treated within
this thesis is offered for your approval as suitable
and sufficient for my advanced degree in Mining
Engineering.

Respectfully submitted,

Joseph C. Barton

SUBJECT :--

Mining, Concentration and Refining
of American Flake Graphite by the
Griesemer Graphite Company, located
at Ashland, Alabama.

By

J. C. Barton

Samples of graphite, beginning with the ore as found in the mines, and leading through the different stages of milling and refining, to the finished product. Samples attached.

Sample No. One -- Average ore.

This sample is typical of this field and contains approximately 3% carbon. The average ore sent to the mills is about $2\frac{1}{2}\%$ carbon.

Sample No. Two -- Ore ready for classification and concentration.

This is an average sample of the crushed and screened ore ready for classification. It assays about $2\frac{1}{2}\%$ carbon.

Sample No. Three -- Flotation feed.

This sample is from the overflow of the Akins Classifier and is the feed to the Brown Flotation Machine. It assays about 8% carbon.

Sample No. Four -- Flotation tails.

This sample is of the Brown Flotation tails. Assays about .41% carbon.

Sample No. Five -- Classifier tails.

Coarse sands to waste from the classifier. Assays about .8% carbon.

Sample No. Six -- Table feed.

This sample is the product of the hydraulic classifiers located beneath and connected to the Akins classifiers. This constitutes the table feed. Assays about 6%.

Sample No. Seven -- Rough Concentrates.

This sample is the concentrate resulting after the first table concentration and roughing flotation treatment. This product is reworked on finishing tables. Assays about 60% carbon.

Sample No. Eight -- Finished concentrates.

This is a sample of the concentrates, ready for the refining plant. Assays about 75% carbon.

Sample No. Nine -- No. One Flake.

Finished flake, 16 to 90 mesh. Assays plus 90% carbon.

Sample No. Ten -- No. Two Flake.

Ninety to 120 mesh. Assays plus 90% carbon.

Sample No. Eleven -- No. One Dust.

Finished dust. Assays plus 50% carbon.

Sample No. Twelve -- No. Two Dust.

Finished dust. Assays plus 60% carbon.

Blue Prints of Griesemer Graphite Plant, showing, --

- 1, -- Crusher Room.
- 2, -- Concentrating Room.
- 3, -- Roll and Concentrating Rooms.
- 4, -- Crusher Room and Classifier Floor.
- 5, -- Concentrating Plants and Shops.

INTRODUCTION

The Greisemer Graphite Company was incorporated June 3, 1916, under the laws of Alabama, for the purpose of mining, milling and refining of flake graphite. Construction was immediately begun on the plant and it was finished in February, 1917. After being in operation for only six months, the plant was partially destroyed by fire. Reconstruction was begun and the plant was again operating by August, 1919.

The mill of the Griesemer Graphite Company is located in NE $\frac{1}{4}$, Section 21, Township 20 S., Range 7 E., and is about four miles west of Ashland. The company also owns a large area of land in Sections 15, 16, 21 and 22, of the same township. It is claimed that there are six workable veins of graphite schist from 50 to 100 ft. wide on this property. The strike is about N 75° E and the dip is 65° SE. The mill, which has a capacity of 500 tons per day, is one of the largest in this district.

Owing to strong competition in the graphite game, it will be impossible to give many interesting facts and figures in this thesis. The screen analysis worked for after each operation is carefully watched and the preparing of the ore, as well as the sizing of the flake, is

one of the most important features in the production of flake graphite, especially that grade required by the crucible makers and the lubricating manufacturers. The carbon content is also equally important. Then, on the whole, the milling and refining of flake graphite is a very delicate operation and requires close supervision through the whole flow sheet.

GRAPHITE

Graphite, because of its peculiar physical properties, such as infusibility, chemical inertness, high conductivity, extreme softness and low specific gravity, is fitted for many and varied uses. As found in the crystalline form in Alabama, it is used mainly in the making of crucibles. It is especially adapted to the manufacture of these and like articles because of its highly refractory character and low ash content. Other important uses of graphite are to be found in the manufacture of stove polish, foundry facings, lubricants, paints and lead pencils. In certain forms it is used in electrical appliances, polish for gun powder and to remove boiler scale. In fact, the value of graphite depends upon its ability to resist the action of heat and corrosive agents, to conduct heat and electricity, and upon its thin soft flake, which, under pressure, forms a smooth frictionless surface or a black, glossy coating. Other features to be considered are the opaque black color of graphite, its streak which is both durable and easy to obtain; and the absence of occluded gases such as are present in amorphous carbon.

Crystalline graphite, when treated by a strong oxidizing reagent, such as nitric acid, form graphitic acid ($C_{11}H_4O_5$). This is a certain test for crystalline flake graphite as amorphous graphite will not respond to the reagent.

The mineral which we call graphite often passes under such names as plumbago, black lead, kish, plumbagine, potelot, aschbler, reiss blei, fer carbure, crayon noir, carbo mineralis, etc. The terms graphite, plumbago and black lead are most commonly used in this country, and while all refer to the same thing yet their difference in use is brought out very clearly by the following passage, stated by Malcom McNaughton.

"While these terms are synonymous, there have come to be certain peculiar applications in their uses -- thus, we import "plumbago" from the island of Ceylon, and "black lead" from Germany, Austria and Italy, and, at the same time, we export "graphite" from this country to all the other countries of the world. There are lead pencils, plumbago crucibles and graphitic lubricants; black lead stove polish, plumbago foundry facings, and graphite paint. This confusion of names may seem to be somewhat misleading at times but there is considerable method in it."

GEOLOGY

The crystalline graphite of Alabama is distributed through a graphitic micaceous schist. The age of this schist is probably carboniferous. Genetically, the flake graphite of Alabama is organic, being possibly the result of the alteration of coaly or carbonaceous material contained in the sedimentary sandstones prior to their metamorphism. The ore is very friable and contains a large percent of quartz, sand, mica, some feldspar, iron pyrite and crystalline graphite. The upper portion of this graphite bearing schist is known as the "oxidized zone. It is this part only that is now being worked in this field. Beneath the overlying "oxidized zone" is found the hard "blue rock" which is not worked at the present because of the difficulty in crushing. The "blue rock" often contains a higher percentage of graphitic carbon than does this oxidized zone.

The "blue rock" also contains pyrite and is hard to separate by gravity method (owing to a low specific gravity ratio). The "oxidized zone" can supply enough ore to keep the plants running for some time.

The strike of the graphitic schists is very irregular, due to much faulting and folding. This faulting and folding causes considerable trouble in the mining and renders large and extensive open-cut work impossible in many places.

MINING

The Griesemer Graphite Company has six workable "veins" of ore ranging from thirty-five to one hundred and thirty feet in width. These "veins," locally called, are simply the outcrop of the several members of schist which contains graphite of economic importance.

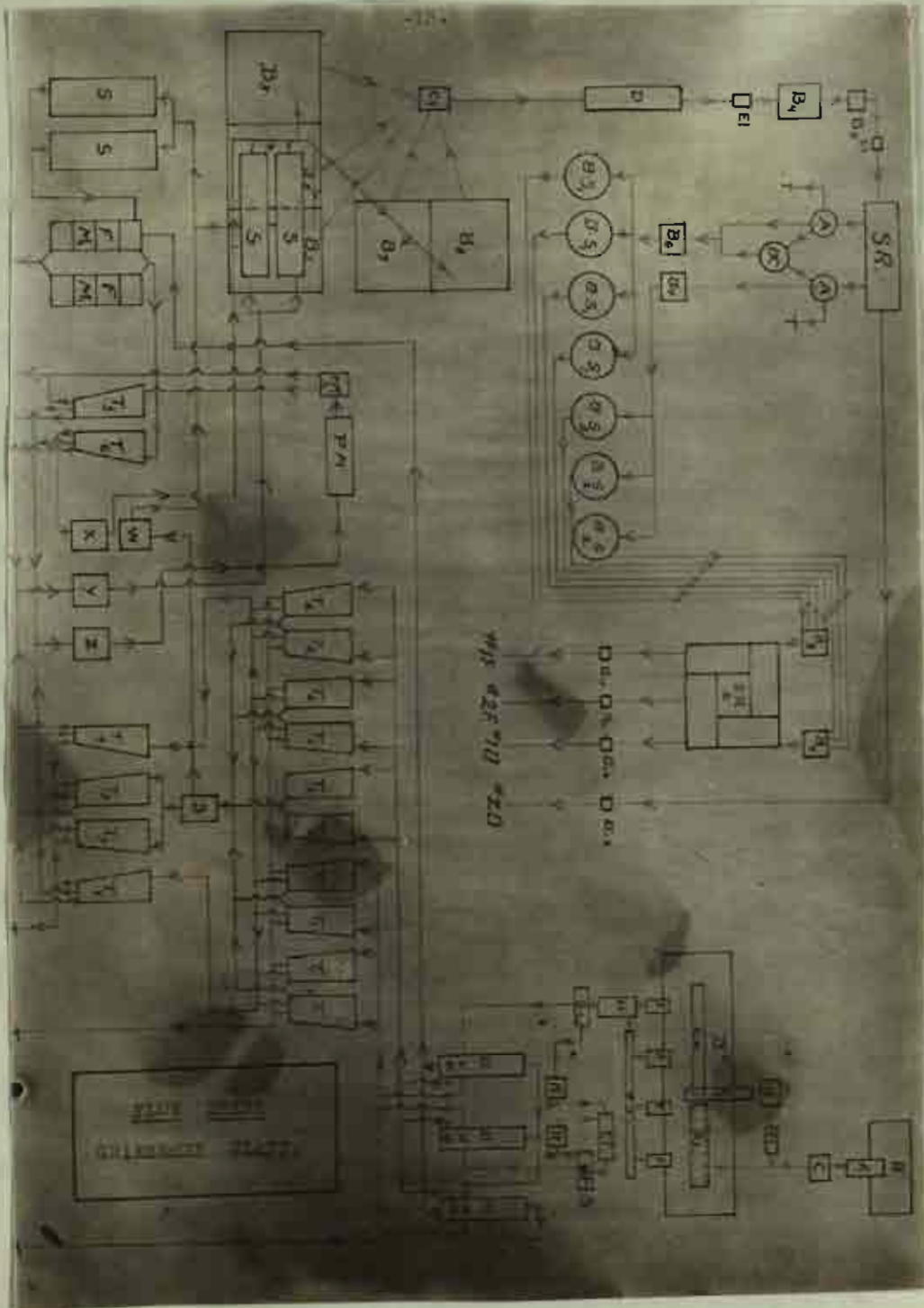
The strike of these "veins" is usually along the crests of the ridges and affords excellent opportunity for open cut work. In mining, a vein of ore is entered at some convenient point at ninety degrees to the strike and at a depth determined by the water level. The "vein" is then quarried along the strike in each direction, thereby forming two working faces to each open cut.

Up to the present time, all drilling has been carried on by hand drills using a very sharp fan bit. These bits are made on steels, two feet long and which are connected to a one inch pipe by means of a threaded sleeve. The holes, which are drilled at possibly thirty feet in depth, are chambered with dynamite and then loaded with black blasting powder. A thirty foot hole, loaded with ten kegs of FF black blasting powder, breaks on an average of one thousand tons of ore.

All loading has been done on contract by negro shovelers at ten cents per ton. Three ton, bottom dump, cars are used to transfer the ore from the "cuts" to the mill bin.

The ore from two of the Griesemer Company's open cuts is sent to the mill by means of a gravity tram, while ore from the third cut is hoisted over a narrow gage track to the mill bin.

Therefore, the mining is very simple and is carried on a very low cost per ton.



MILLING

The milling method used will be taken up and followed in close reference to the flow sheet on page 13.

The ore from the cuts is dumped into a four-hundred-ton bin "B", and is from here fed into a 36"x 18" jaw crusher "C" by means of an apron feeder "F". The crusher has a capacity of forty five tons per hour for a two and one half inch product. Just ahead of the crusher is an iron grizzly which permits the "fines" to drop on a conveyor belt, and forms a blanket on which the crushed ore falls after passing through the crusher. The crushed material is conveyed to a 2½'x 8' shaking screen "S". This screen is a punched 3/16 inch steel plate with 3/4 inch square holes, staggered. The screen is run by an eccentric.

The "overs" from the screen fall on the conveyor "C", and is carried to a 42"x16" set of corrugated rolls "R". The crushed product is elevated by a bucket elevator to the shaking screen, completing its circuit. The "throughs" of the shaking screen are distributed to different sections of a 650 ton fine ore bin "B₂".

The fine ore is taken from "B₂" by the means of four apron feeders F₂, a conveyor "C₃", and an elevator, to a Mitchell electric vibrating screen "S₂". This screen

gives a 16 mesh product which is ready for the classifier. The "overs" from the screen are sent to 42"x16" rolls, elevated and then screened over another Mitchell electric screen (16 mesh). The "overs" from this second screen are sent to 36"x16" rolls and are in closed circuit with the second screen. The "throughs" from this second screen are sent to a second Akins classifier. The coarse sands from the first two classifiers go to a third Akins classifier and are retreated there.

The Akins classifiers are run at such a speed and with such a slope as will permit the overflow to run a minus 30 mesh product. Small cone hydraulic classifiers, made into the bottom of the Akin classifiers, gives three sizes of plus 30 mesh material. These small hydraulic classifiers control their product by merely increasing or decreasing the amount of water pressure. The three sizes of coarse sand (16 mesh to 30 mesh) are then treated on double deck Wilfry concentrating tables; the minus 30 mesh "overflow" from the Akins goes to the Brown Flotation machine, and the coarse sands after having been reworked in the third classifier are sent to waste.

The concentrates from the roughing tables "T₁ and T₂", working on the 16 to 30 mesh feed, are dewatered and screened by passing over a 50 mesh shaking screen while the middlings go direct to a middling table

"T₄" and the tails to waste.

The "overs" of the 50 mesh screen, being treated on Wilfry tables "T₃," and the "throughs" are sent to the pump sump "W" and are then dewatered by passing over a hundred mesh shaking screen. The "throughs" go to waste and the "overs" go to the Brown Flotation machine.

The Wilfry tables T₃ and T₄ then give a concentrate that goes to the pump sump "Y;" a middling that goes to the pump sump "Z;" and a tail that goes to waste.

The pump sumps are each connected to a small centrifugal pump which distributes the various pulps to their respective machines.

The concentrate "Y" is pumped to a 100 mesh shaking screen, while the "overs" go to one of the concentrate bins "B₃", the "throughs" go to the Brown Flotation machine.

The middling "Z" is pumped to a pebble mill which uses a feed of 75% water and 25% solid matter. The ground pulp is then passed through a small flotation machine, using only jets of water to carry on agitation and carry in water. The tails go to a second machine and then to waste while the concentrate is sent to a Wilfry table "T₅". The concentrate from this table "T₅", goes to sump "Y", the middlings to sump "Z", and the tails to waste.

The Brown Flotation Machine makes a tail that goes to waste and a concentrate that is reworked on Wilfry table T₆. The middling and tail from this table is treated the same as for the tables T₃, T₄ and T₅, while the concentrates are pumped direct to the concentrate bins "B₃" from the sump "X".

REFINING

The bins "B₃" are 4'x 8'x 5' each and are lined with coca matting which permits the water to drain and the concentrates are dewatered to about 20% moisture. This concentrate is sent to a rotary dryer "D" by means of conveyor "C₄". This dryer is fired indirectly by coal and gives a product that is very dry and also very warm. The dried concentrate is elevated by a steel elevator into a large steel bin "B₄" and allowed to cool, then dropped into a concrete bin "B₅", and is elevated to the top of the finishing mill. The cooled concentrate is then put through a large Wolf sifter which dusts and grades the concentrates. This dusting and grading is done over silk cloth. The concentrate in passing through the sifter "SR", passes, first, over a No. 12 XX silk cloth (125 mesh). The "throughs" are known as the first dust or No. One Dust. The "overs" are sent over a 16 mesh cloth which takes out the wood fiber, mica and large impure flake. This product is thrown away. The "throughs" of the 16 mesh silk cloth are then put over a No. 3 XX silk cloth (54 mesh). The "overs" go to Wolf aspirators "A₁" and the "throughs" go to aspirator "A₂". The aspirator consists of a revolving disc upon which the sized material is fed at the center and allowed to travel toward the outer edge by centrifugal force. The sand,

which is heavier in weight than graphite and round in shape, is not affected by a strong suction of air (caused by a suction fan) as is the thin, flat, and light flakes of graphite. The sand goes to waste and the concentrate from "A", goes to bin "B₆"; and the concentrate from "A₂" goes to bin "B₇". The exhaust of the suction blower is connected to a large dust collector and the flake thus caught goes to bin "B₆".

The product from bin "B₆" (plus 54 mesh approximately) is ground over Buhr stones "BS" and, likewise, the product from bin "B₇" (minus 54 mesh and plus 125 mesh) is ground on Buhr stones "BR₂". The ground material from "BR" goes to bin "B₈", and the ground material from BR₂ goes to bin "B₉".

The Wolf square sifter "SR₂" is made up into four sections, and the product from bin "B₈" is fed to two sections; the product from bin "B₉" is fed to the other two sections. Each section consists of eight number twelve (125 mesh) XX silk cloth and two number 6 (74 mesh) silk cloths. The "throughs" of the No. 12 cloth go to sack as No. Two Dust and the "overs" go to the No. 6 cloth. The "overs" of the No. 6 go to sack as No. One Flake and the "throughs" as No. Two Flake. Each product is sacked in a heavy close woven burlap bag (150# bags) and is tagged and stacked in their respective places. The bags of graphite are then hauled by wagon to Ashland (4½ miles) and are

stored in a large warehouse located on the A. B. & A. R. R. These bags of graphite are stacked according to their screen size and carbon content and are sold upon guaranteed specifications. For instance, the Crucible Steel Company of America requires a 16 to 90 mesh (Tyler std.) product which runs plus 90% carbon and is free from mica. A few of the crucible makers require only a plus 100 mesh (Tyler std.) product which runs plus 85% carbon.

The lubricating trade requires a very high grade, plus 90% carbon and minus 100 mesh (Tyler std.) This product is then reworked by them before putting the same into lubricants. For the lubricating users the product must be absolutely free from grit.

The various other users of graphite require different respective products.

The large number of competitors, as well as the various grades required by the different users of graphite, give the graphite producer still another duty-- the sales end--which is probably the most important at the present time as there is no fixed price on any of the grades or sizes of crystalline flake graphite.

A FEW REMARKS ON MILLING

In review of this flow sheet it may be well to state that the main object in dealing with graphite is to save the large flake and to free that flake from as much impurity as possible. The punishment of the soft flake should be reduced to a minimum, unless the ore is produced for the lubricating trade exclusively.

There are two systems of crushing or preparing the ore for concentration in this field; the first is the crushing in one step, as with a ball mill with a classifier in closed circuit; the second, is the crushing by stages as with rolls. Both systems have their advantages and disadvantages. As one will readily see, the Ball mill will produce a maximum of fines or grind up a large amount of the large flake. The unattached flake will float when oil is used, but the flake to be freed from the gage is punished. The simplicity, however, as well as the better recovery when flotation is used, is apparent and is a strong argument in favor of this system in preparing the ore for concentration.

The graded crushing by rolls gives a minimum punishment to the large flake but in order to free all the attached flake it becomes necessary to use a number

of rolls which are expensive in upkeep.

An ideal method would be to crush the ore to possibly $1/4"$, screen out the minus 16 mesh and let the over size go to a ball mill. In this way, the large free flake is taken out of the way and the attached flake remaining in the plus 16 mesh material is all that is subject to the destructive grinding of the ball mill.

In short, it may be said that the present milling systems used in this district are all very far from ideal as little better than 50% recovery has been made up to the present time. A 68% recovery has been made by grinding the ore very fine and then floating, but this destroys the valuable flake. The main loss in graphite occurs during the coarse concentration. In short it can be said that the concentration of graphite is only in its infancy.

POWER

All of the power which is used is furnished by the Alabama Power Company of Birmingham, Alabama. A three phase, alternating current, 66,000 volts power system is brought to the electric station, located at the mines and there is transformed to 550 volts for plant use and 110 volts for domestic use. All the motors are of the squirrel cage, induction type. The motors used are as follows: -

Hoisting -----	50 H.P. motor
Crushing Department -----	200 H.P. motor
Classifying and Elevating -----	150 H.P. motor
Rough Concentrating -----	40 H.P. motor
Fine Concentrating -----	30 H. P. motor
Finishing Mill and Dryer -----	150 H.P. motor

The power is very expensive in this field and is not dependable as to voltage, which fact is a very serious draw back in concentrating in so delicate a system.

WATER SUPPLY

All the water is supplied by a 700 gallon per minute centrifugal pump from a small creek. The water is pumped to a large 700,000 gallon concrete tank and flows to the mill by gravity.

ORGANIZATION

The main object in the organization of the Griesemer plant is the development of "team work," and everything possible is done in order that "team work" will appear above individual show. About one third of the daily wages of the men is based upon the number of pounds of graphite made during the day. This plan results in keeping the men more interested in their work and in the interest of the daily production of the plant. Again, a small bonus is paid for the saving in costs from month to month. Regular meetings are held with the employees where suggestions of improvement are offered and discussed. The daily efforts from the different departments are carefully recorded and a simple statement made and posted each week which shows just what has been accomplished. A daily report is made by each of the operating departments as shown on pages 48-50. These reports are gone over and their results recorded on a wall chart. This chart as shown on pages 51-58 is carefully watched each day and has proven a wonderful help in obtaining a large amount of necessary information at a glance. For example, each motor is to be cleaned and oiled every week. When this has been done it is reported to the office and is checked

up on that date. If a motor is overlooked, the manager or superintendent readily catches the negligence by his examination of the chart. Likewise, the various important facts to keep in mind are so recorded on this chart.

The system of bookkeeping and the statement forms are exceptionally good.

The following instructions give a basis for the system and can be changed to fit most any similar organization:

BOOKS OF ACCOUNT

The following books of account will be maintained at the mine:

Cash Book
Journal
General Ledger
Pay roll Register
Vouchers Payable Register

Cash Book - Receipts. The entire cash receipts should be deposited and entered in the Cash Book, crediting the account from which the money was received and charging the bank in which it was deposited. Discount allowed in consideration of cash settlements must be charged against discount by entering the amount of the discount in the column headed "Discount."

Cash Book - Disbursements. All payments should be made by check, charging the amount of each check to the account for which the expenditure was made. When discount for cash is deducted, the amount of the discount must be credited to the discount account by entering it in the column headed "Discount."

At the end of the month one summary entry should be made for the receipts and payments for the month, crediting or charging, as the case may be, the various accounts in the general ledger.

Journal. Entries should be made to cover distribution of Pay Roll, Vouchers Payable, Sales of Graphite and Miscellaneous transactions.

General Ledger. This record will contain the plant and equipment accounts, accounts for capitalization, sales accounts, general and operating expense accounts and the various other accounts of the business. A Trial Balance will be taken monthly and a Balance Sheet and Profit and Loss Statement prepared therefrom.

Pay Roll Register. This record will contain all pay roll transactions including not only the wages of mine and mill employees, but also salaries of officials and office employees. The distribution to expense accounts and deductions for rents, loans, etc., will be made in the columns so captioned.

At the close of each month a journal entry will be made charging and crediting the several accounts and crediting the net total to "Pay Rolls" account in the General Ledger.

Vouchers Payable Register. All purchases or miscellaneous expenses payable should be entered in the Voucher Register, and the charges distributed to the various accounts in conformity with the official classification of accounts. Sufficient columns in the Register are provided for that purpose.

At the end of the month a journal should be made incorporating all the accounts charged and the total thereof credited to "Vouchers Payable" account in the General Ledger .

GENERAL LEDGER ACCOUNTS

Account Numbers. The number prefixing the name of each account marks its identity, facilitates the distribution of entries and distinguishes the several classes of accounts. Following are the accounts:

- 100 Capital Stock - Authorized - Common
- 101 Subscriptions of Capital Stock - Common
- 102 Unissued Capital Stock - Common
- 103 Capital Stock - Authorized Second Preferred
- 104 Subscriptions of Capital Stock Second Preferred
- 105 Unissued Capital Stock Second Preferred
- 106 Capital Stock - First Preferred - Authorized
and issued
- 107 Profit and Loss
- 108 Surplus

- 200 Land -)
Ore -)
- 201 Old Plant, Machinery, Equipment and Buildings
- 202 Mill and Office Buildings
- 203 Plant Machinery and Equipment
- 203a
- 204 Foundations
- 205 Mine Plant Account - Mine Construction
- 206 Mining Cars
- 207 Water Supply System
- 208 Furniture and Fixtures
- 209 Cottages
- 210 Automobiles
- 211 Live Stock

212 Tools
213 Roads and Bridges
300 Cash
301 Accounts Receivable
302 Notes Receivable
302a Advances
303 Redmond & Company
303 (B)
304 Finished Graphite
305 Material and Supplies
306 Explosives
307 Crusher and Roll Parts
308 Coal and Oil
309 Sacks
315 Unexpired Insurance Premium
316 Unexpired Taxes

400 Vouchers Payable
401 Notes Payable
402 Accrued Interest on Notes Payable
403 Unclaimed Wages
404 Fire Loss Payment
410 Reserve for Depreciation
415 Pay Roll - Clearing Account
416 School Collections and Payments - Clearing
Account
417 Dividends
418 Reserve for Depletion
500 Graphite Merchandise

501 Graphite Manufacturing Account
502 Mine Expenses - Explosives
503 " " Drilling
504 " " Loading
505 " " Conveying
506 " " Miscellaneous
507 Mill Expenses - Crushing
508 Mill Expenses - Concentrating
509 " " Pumping
510 " " Finishing
510a Night Watchman & misc. mill
511 Administrative Expenses - Officers' Salaries
& Expenses
512 Administrative Expenses - Office Salaries
513 " " Office Supplies & Expenses
514 " " Miscellaneous
515 General Expenses - Automobile Expenses
516 " " Road Maintenance
516 a " "
517 Taxes Accrued
518 Insurance
519 Interest Accrued
520 Cash Discount on Sales
521 Depetion of Ore
522 Depreciation
523 Sales of Graphite less Returns
524 Cost of Graphite Sales
525 Delivery of Graphite - Cartage

526 Delivery of Graphite - Freight Out
527 Interest on Investments
528 Cash Discount on Purchases
529 Rents and Expenses - Cottages
530 Miscellaneous Income.

EXPLANATION OF GENERAL LEDGER ACCOUNTS

100 - Capital Stock - Authorized - Common.

Credit this account with the amount of Authorized Capital Stock - Common.

101 - Subscription of Capital Stock - Common.

Charge this account with the amount of subscriptions of Common Stock.

102 - Unissued Capital Stock - Common.

Charge this account with the amount of Capital Stock Authorized.

103 - Capital Stock - Authorized - Second

Preferred. Credit this account with the amount of Authorized Second Preferred Stock.

104 - Subscriptions of Capital Stock - Second

Preferred. Charge this account with the amount of Subscriptions of Second Preferred Stock.

105 - Unissued Capital Stock - Second Pre-

ferred. Charge this account with the amount of Second Preferred Stock - Authorized.

106 - Capital Stock - Authorized and Sub-

scribed - First Preferred. Credit this account with the amount of Authorized First Preferred Stock which has been subscribed for.

107 - Profit and Loss. The net result of

the operations of the month as indicated in accounts 500 to 529 should be charged or credited to this account.

108 - Surplus. The credit balance in

Profit and Loss Account at the close of the year should be credited to this account. Surplus account should be segregated, if occasion requires it, as follows:

- (A) The portion representing operating earnings.
- (B) The portion representing appreciation of capital.

200 - Land. In this account is included the total cost of the mining lands, also all legal expenses in acquisition thereof, expenses incurred for examination of ores, surveys and preliminary prospecting before operation.

201 - Old Plant, Machinery, Equipment and Buildings. In this account is included the total cost of the old plant, machinery, equipment and buildings as of February 2, 1918 under which date fire destroyed the larger part of such property. This account should be carried in this manner until an appraisal is made, and the cost determined, of the property destroyed.

202 - Mill and Office Buildings. Represents the total cost of all new buildings constructed since February 2, 1918 and consists of Mill and Office Buildings, and improvements to the Finishing Mill.

203 - Plant Machinery and Equipment. Represents the total cost of machinery and equipment and includes shop tools.

204 - Foundations. Represents the total cost of concrete foundations for mill buildings. Separation from cost of buildings desired for insurance purposes.

205 - Mine Plant Account. Includes the total cost of mine construction, tunnels, ore bins and sand dam.

206 - Mining Cars. Represents the cost of mine cars and fixtures.

207 - Water Supply System. This account represents the cost of the water system, additional pipe line and additions to pumping stations.

208 - Furniture and Fixtures. Includes cost of furniture and fixtures.

209 - Cottages. Represents improvements and repairs to cottages during reconstruction period. All income from such cottages should be credited to this account during reconstruction period.

210 - Automobiles. Includes cost of automobiles.

211 - Live Stock. Includes cost of horses, mules, etc.

300 - Cash. All cash disbursements should be credited and all receipts debited to this account. The balance therein at end of each month should be reconciled with bank statements.

301 - Accounts Receivable. Separate accounts receivable should be set up on the General Ledger with various individuals and companies to whom graphite is sold.

302 - Notes Receivable. Includes amount of notes given by employees for small loans and any other loans that may be made which are secured by notes.

303 - Redmond & Company. This account represents all transactions with Redmond & Company covering transfer of cash, sale of stock, bonds, expenses of directors.

304 - Finished Graphite. Periodically, and at the close of the calendar year, physical inventory should be taken and the amount thereof charged to this account and credited to account 500 - Graphite Merchandise.

305 - Material and Supplies. All miscellaneous material and supplies purchased should be debited to this account and as material is used credit should accordingly be made. The balance should be representative of material and supplies on hand which should be inventoried periodically, and any difference adjusted.

306 - Explosives. The above described principle applies to this account.

307 - Crusher and Roll Parts. The above described principle applies to this account.

308 - Coal and Oil. The above described principle applies to this account.

309 - Sacks. The above described principle applies to this account.

315 - Unexpired Insurance Premium. Insurance premiums paid in advance for period of over one month should be charged to this account. A proportion, usually 1/12, is credited to this account each month and charged to expenses.

316 - Unexpired Taxes. The same principle and method governs as described in account 315 - Unexpired Insurance Premiums.

400 - Vouchers Payable. This account is a control for the Vouchers Payable Register. Credit this account with total vouchers entered at the end of each month and charge vouchers paid or cancelled. The balance should agree with detail statement of unpaid accounts drawn off from Voucher Register.

401 - Notes Payable. Represents notes payable for money borrowed from banks, individuals and companies.

402 - Unexpired Interest on Bonds and Notes Payable. This account should be credited each month and account 519 - Interest, charged with the monthly accrual of interest on Notes Payable; when interest is paid charge this account.

403 - Unclaimed Wages. Represents wages unclaimed by employees. Unpaid pay checks should be re-deposited in bank and amount thereof credited to this account; when unclaimed wages are paid this account should be charged.

404 - Fire Loss Payment. Included in this account is amounts received from Insurance companies in settlement of claim for damages caused by fire February 2, 1918. This account should be carried until appraisal is made to determine the cost of damage to property by fire.

410 - Reserves for Depreciation. This account should be credited each month with the amount of depreciation charged to expenses. The amount of the reserve is usually shown as a deduction from the cost of property and plant account in rendering balance sheet.

415 - Pay Roll Clearing Account. This account is kept to control pay roll transactions and it is credited each month with the total amount of the pay roll and charged with wages paid.

416 - School Collections and Payments - Clearing Account. This account is credited with amounts deducted from wages of employees to cover expenses of the school. When such expenses are paid this account is charged.

417 - Dividends. Created to take care of dividends declared and paid, this account is credited with amount of dividend declared and charged as payments are made.

500 - Graphite Merchandise. This account is charged with the inventory of finished graphite on hand at the beginning of the period. At the end of each month the account is charged with the graphite manufactured account 501 and credited with the cost of graphite sales account 524. The balance in the account should be representative of the finished graphite on hand. If there is any difference an adjustment entry should be made transferring the difference to Profit and Loss.

501 - Graphite Manufacturing. Under this account is assembled all expenses of producing the finished

graphite, the accounts 502 to 510 being summarized herein at the end of each month. The total of the charges in the account will be transferred to account 500 - Graphite Merchandise at the end of each month.

502 - Mine Expense - Explosives. Represents cost of explosives used and labor charge in applying. This account will be closed by transferring the balance to account 501 - Graphite Manufacturing.

503 - Mine Expense - Drilling. Represents cost of drills used and labor charge in drilling operations. This account will be closed by transferring the balance to account 501 - Graphite Manufacturing.

504 - Mine Expense - Loading. Represents cost of shovels, picks and other supplies used, and labor in loading ore into cars. This account will be closed by transferring balance to account 501 - Graphite Manufacturing.

505 - Mine Expense - Conveying. In this account is included labor cost of conveying ore from mine to crusher, and in the unloading of the ore into the belts. All repairs to trestle, cars and cable and a proportion of electric current consumed should be charged to this account, which will be closed by transferring the balance to account 501 - Graphite Manufacturing.

506 - Mine Expense - Miscellaneous. Labor charges and cost of shovels and picks used in banking the ore to loaders and stripping deposits of dirt from veins should be charged to this account as well as any other mine expenses of a miscellaneous nature. This account will be closed into

account 501 - Graphite Manufacturing.

507 - Mill Expense - Crushing. Represents cost of material used, oil consumed, and labor required in crushing the ore. A proportion of electric current consumed and cost of repairs to crushing machinery should be charged to this account which will be closed into account 501 - Graphite Manufacturing.

508 - Mill Expenses - Concentrating. This account should be charged with labor required in separating flakes from dirt and a proportion of cost of electric current consumed. Cost of all repairs to concentrating tables and concentrating machinery should be charged to this account. This account will be closed into account 501 - Graphite Manufacturing.

509 - Mill Expense - Pumping. This account should be charged with the major proportion of cost of material, supplies and labor in operating pump and maintaining water system as practically all of the water pumped is used in the mill concentrating process. A proportion of electric current consumed should also be charged. This account will be closed into account 501 - Graphite Manufacturing.

510 - Mill Expenses - Finishing. Represents cost of fuel and labor in drying and polishing the flakes, cost of sacks and sacking operations, cost of repairs to furnace and machinery, and a proportion of cost of electric current consumed should also be charged. This account will be closed into account 501 - Graphite Manufacturing.

511 - Administration Expenses - Officers

Salaries. Includes salaries and expenses of officers of the company.

512 - Administration Expenses - Office

Salaries. Includes salaries of employees of mine office.

513 - Administration Expenses - Office

Supplies and Expenses. Includes cost of stationery, printing, stamps and sundry supplies and expenses.

514 - Miscellaneous Administrative Expenses.

This account includes all expenses of a general nature not applicable to other accounts.

515 - General Expenses - Automobiles.

Includes cost of repairs, gasoline and oil furnished and depreciation on automobiles.

516 - General Expenses - Road Maintenance.

Represents labor cost in scraping and other maintenance charges of road on mine property.

517 - Taxes Accrued.

This account represents monthly proportion of charges for State and County Taxes, Capital Stock Tax and Income Taxes. This account is charged and Unexpired Taxes Account credited.

518 - Insurance.

This account is charged with monthly proportion of charges for Insurance, the amount thereof being credited to Unexpired Insurance Account.

519 -

520 - Cash Discount on Sales. This

account includes cash discount given on sales of graphite.

521 - Depletion of Ore. This account represents amount charged off for depletion of ore lands owned, Land Account 200 being credited. The available tonnage of ore owned should be ascertained and monthly charges should be made to this account to cover depletion of the property by ore which is taken out of mine.

522 - Depreciation. This account represents monthly charges of depreciation of property and plant, the resulting credits are set up in Reserves for Depreciation Account 410.

523 - Sales of Graphite. This account should be credited with the total amount of sales of graphite each month. Returns and allowances should be charged, the balance being the net sales for the month.

524 - Cost of Graphite Sales. This account is charged with cost of Graphite sales for the month. The cost of sales should be the balance of the Graphite Merchandise account 500 after deducting the inventory of graphite on hand at end of month. The inventory should be valued at average cost per ton and selling cost should not be used.

525 - Delivery of Graphite - Cartage. Represents cost of hauling graphite from mill to railroad cars. Cartage charges on material and supplies should not be charged to this account but to cost of material and supplies.

526 - Delivery of Graphite - Freight Out.

Represents freight charges on graphite sold F. O. B. destination. Freight charges on material and supplies should be charged to cost thereof and net to this account.

527 - Interest on Investments. This account includes interest earned on loans and bills receivable, and bonds owned.

528 - Cash Discount on Purchases. Includes amount of cash discount on purchases.

529 - Rents and Expenses - Cottages. Represents rents received from cottages and expenses of maintaining such cottages. A proportion of expense of taxes, insurance and electric current consumed should be charged to this account.

Statements

PROFIT AND LOSS STATEMENT

		<u>Per Ton</u>
Graphite Sales	\$	
Less: Cartage, Freight, Etc.	<u>.....</u>	
Net Sales	
Cost of Graphite Sold - Schedule "1"	<u>.....</u>	
Gross Profit on Sales	
Deduct:		
General and Administrative Expenses		
Schedule "2"	\$	
Taxes Accrued	
Depreciation	
Insurance	<u>.....</u>	
Addition to Income:		
Net Income from Cottates	
Cash Discount on Purchases	
Interest Earned	<u>.....</u>	
Deductions from Income:		
Interest Accrued	
Cash Discount on Sales	<u>.....</u>	
Income from Operations	
Less: Federal Tax Reserve	<u>.....</u>	
Net Income from Operations	\$	

Schedule "1"

COST OF GRAPHITE SOLD

		<u>Per Ton</u>
Mine Expenses:		
Explosives	\$	
Drilling	
Loading	
Conveying	
Miscellaneous	<u>.....</u>	
Cost of Ore to Mill	
Mill Expenses:		
Crushing	
Concentrating	
Pumping	
Finishing	<u>.....</u>	
Total Mill Expenses	
Depletion		<u>.....</u>
Total Graphite Manufacturing Cost	
Add Decrease or Deduct Increase in Inventory of Finished Graphite:		
Inventory at beginning of period	
" " end " "	<u>.....</u>
Cost of Graphite Sold (\$___ per ton)		\$ <u>.....</u>

ADMINISTRATIVE AND GENERAL EXPENSES

Administrative:		
Office Salaries and Expenses	\$
Office Salaries	
Office Supplies and Expenses	
Miscellaneous		<u>.....</u>
Total Administrative Expenses	
General:		
Automobile Expenses	
Road Maintenance		<u>.....</u>
Total General Expenses		<u>.....</u>
Total Administrative and General Expenses	\$	<u>.....</u>

DAILY MILL REPORT

Greisemer Graphite Company.

Ashland, Alabama.

Date -- Dec. 15, 1919

	Hr.	Min.	
Start Feed	_____	_____	
Delays	_____	_____	Total _____
Stop Feed	_____	_____	

<u>ORE</u>	Begin shift	End shift	
No. 1 bin	_____	_____	
No. 2 bin	_____	_____	
Cars Milled	_____	_____	_____

CONCENTRATES
 Grade _____
 Bags (approx) _____

<u>TAILS</u>	<u>9:00</u>	<u>11:00</u>	<u>1:00</u>	<u>3:00</u>	<u>5:00</u>
Classifiers	_____	_____	_____	_____	_____
Coarse Sand F. M.	_____	_____	_____	_____	_____
Coarse Sand T.	_____	_____	_____	_____	_____
Fine Sand F. M.	_____	_____	_____	_____	_____
Fine Sand T.	_____	_____	_____	_____	_____
Brown F. M.	_____	_____	_____	_____	_____
Middling Washer	_____	_____	_____	_____	_____
Bin Overflow	_____	_____	_____	_____	_____
Finishing T.	_____	_____	_____	_____	_____
Average Tails	_____	_____	_____	_____	_____

<u>Delays</u>	<u>Hours</u>
Classifying	_____
Concentrating	_____
Water Supply	_____
Crushing	_____
Mining	_____
Power	_____
Miscellaneous	_____
Total	_____

<u>SUPPLIES</u>	<u>Gal.</u>
Pine Oil	_____
Kerosene	_____

<u>MEN EMPLOYED</u>	
Crushing	_____
Classifying	_____
Concentrating	_____
Finishing	_____
Miscellaneous	_____
Total	_____

Miscellaneous

MILL FOREMAN

DAILY MINE REPORT

Greisemer Graphite Company,

Ashland, Alabama.

Date _____

	No.1 Cut	No.2 Cut	No.3 Cut	Remarks	Tot
<u>SHOVELERS</u>					
Company Time	_____	_____	_____	_____	_____
Contract	_____	_____	_____	_____	_____
Muckers	_____	_____	_____	_____	_____
<u>DRILLERS</u>					
_____	_____	_____	_____	_____	_____
<u>HOISTMEN</u>					
_____	_____	_____	_____	_____	_____
<u>TRACKMEN</u>					
_____	_____	_____	_____	_____	_____
<u>MISCELLANEOUS</u>					
_____	_____	_____	_____	_____	_____
<u>TOTAL</u>					
_____	_____	_____	_____	_____	_____
<u>BREAKING GROUND</u>					
Cars broke	_____	_____	_____	_____	_____
Holes	_____	_____	_____	_____	_____
Depth	_____	_____	_____	_____	_____
Powder	_____	_____	_____	_____	_____
Fuse	_____	_____	_____	_____	_____
Caps	_____	_____	_____	_____	_____
Time	_____	_____	_____	_____	_____
<u>CARS LOADED</u>					
Company time	_____	_____	_____	_____	_____
Contract	_____	_____	_____	_____	_____
Waste	_____	_____	_____	_____	_____
<u>SUPPLIES</u>					
Picks	_____	_____	_____	_____	_____
Shovels	_____	_____	_____	_____	_____
Hammers	_____	_____	_____	_____	_____
Track	_____	_____	_____	_____	_____
Miscellaneous	_____	_____	_____	_____	_____
<u>ORE VEIN</u>					
Height	_____	_____	_____	_____	_____
Width	_____	_____	_____	_____	_____
Condition	_____	_____	_____	_____	_____
Grade Ore	_____	_____	_____	_____	_____
<u>DELAYS</u>					
_____	_____	_____	_____	_____	_____
<u>MISCELLANEOUS</u>					
_____	_____	_____	_____	_____	_____

SHOVELERS

CARS

SHOVELERS

CARS

MINE FOREMAN

DAILY FINISHING MILL REPORT

Greisemer Graphite Company,

Ashland, Alabama.

Date _____

<u>Graphite Refined</u>	<u>Grade</u>	<u>Month to date</u>
No. 1 Flake	Bags:	Bags.
No. 2 Flake	Bags:	Bags.
No. 1 Dust	Bags:	Bags.
No. 2 Dust	Bags:	Bags.

Graphite to Warehouse.

No. 1 Flake	Bags:	Bags.
No. 2 Flake	Bags:	Bags.
No. 1 Dust	Bags:	Bags.
No. 2 Dust	Bags:	Bags.

Graphite Concentrates.

Made today	Bags:	Bags.
Dried	Bags:	Bags.

<u>Delays</u>	<u>Hours</u>	<u>Cause.</u>
---------------	--------------	---------------

<u>Dryer</u>	Hr.	Min.
--------------	-----	------

Start feed

Stop feed

Delays

Fuel Used

Miscellaneous Work.

Miller.

	Week Ending	Week Ending	Week Ending
Weather			
Running Mine (hrs.)			
Running Mill (hrs.)			
Running Finishing Mill (hrs.)			
Tons Ore No. 1 Cut			
Tons Ore N. 3 Cut			
Tons Ore No. 5 Cut			
Total -- Grade			
Tons Ore -- Total			
Co. Time Shovelers			
Contract Shovelers			
Muckers			

Tract Men

Hoist Men

Misc. Men Mine

Total Men Mine

Crushing man

Class. & Conc. Men

Misc. Men

Total Men Mill

Fin. mill Men

General Men

Grand Total Men

Bags Concentrates

Grade Concentrates

Bags Concentrates Dried

Bags No. 1 Flake

Grade No. 1 Flake

Bags No. 2 Flake

Grade No. 2 Flake

Bags No. 1 Dust

Grade No. 1 Dust

Bags No. 2 Dust

Grade No. 2 Dust

Graphite to Warehouse

Supplies - mine

Supplies - mill

Supplies - Fin. mill

Supplies - general

Total supplies

Payroll - mine

Payroll - mill

Payroll - Fin. mill

Total - payroll

Delays - mine

Delays - mill

Delays - fin. mill

Delays - pump

Total Delays

Oil used flotation

Tons per man - mine

Tons per man - gen.

Bags #1 F per man

Bags No. 1 F per
100 tons ore

Cost per ton - man

Cost per ton - mill

Cost per ton - total

Cost per bag #1 - mine

Cost per bag #1 - mill

Cost per bag #1 - general

Grand total cost No. 1
per bag

Dash pots & boxes S.R.

Two motors
crushing

Conc. room
roll motor

Lower M.
concentrating room

Upper M
concentrating room

Pump M and box

Hoist M and starter

Finishing mill motor

Clean Brown C

Bebbles to bebble M

Screens Inspection

Powder Turn

Power readings

Trestle inspection

Supplies - mine

Supplies - mill

Supplies - fin. mill

Supplies - shops

Supplies - gen.

Fuel

Clean settling tank
