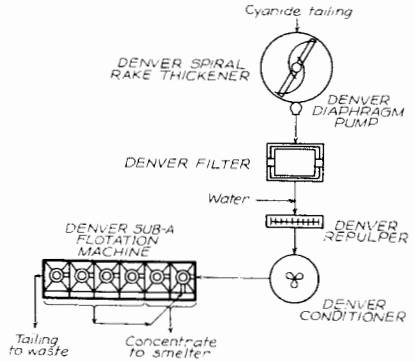
FLOWSHEET No. F-8



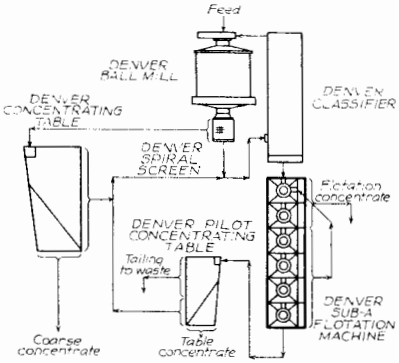
DESCRIPTION Flotation of cyanide tailing.

ORE TREATED Where ore bodies at depth have become more refractory and flotation ahead of cyanidation would call for major and expensive mill alterations, the sulphide minerals containing the undissolved precious metals can be recovered by flotation and shipped to the smelter. In some cases it is possible to make a selective separation of the auriferous sulphides wherein this is impossible if using flotation ahead of cyanidation.

COMMENTS Success depends on an effective and thorough wash of the cyanide tailing to minimize residual cyanide and lime in the flotation circuit. This flowsheet is not recommended unless other more simple methods fail.

Successful milling plants use proved methods

FLOWSHEET No. F-9



DESCRIPTION Coarse concentration followed by flotation.

ORE TREATED On ores wherein base metals or gold bearing pyrite free at a coarse size.

ADVANTAGES This flowsheet illustrates the application of a concentrating table in the ball mill-classifier circuit, followed by flotation of the classifier overflow at a finer mesh. Where base metal minerals free at a coarse size, it may be desirable to remove as high a percentage as possible by gravity concentration.

COMMENTS In the great majority of cases, the use of the Denver Unit Flotation Cell or Denver Mineral Jig has given better results and should be considered in preference to this flowsheet.

All of these flowsheets proved in the field

FLOWSHEET No. F-10

DESCRIPTION Straight flotation flowsheet of one product showing flotation machine treating ground and classified pulp.

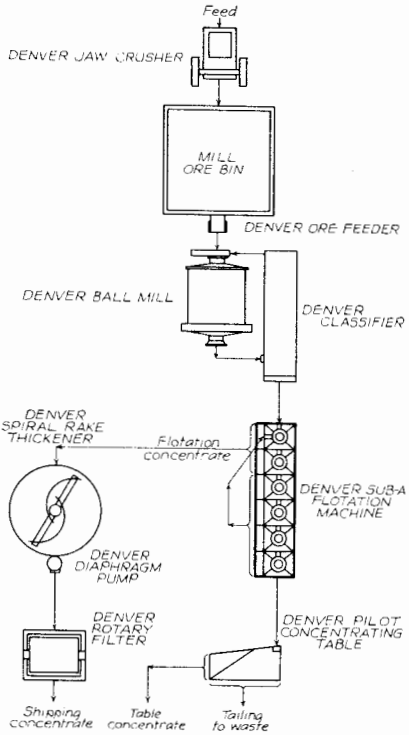
ORE TREATED Base metal ores containing a single valuable mineral such as a copper or lead sulphide, and complex gold and silver ores, are economically handled with this simple flowsheet. It is commonly used where fine grinding is required and where the values can be concentrated into one marketable product.

ADVANTAGES Where adaptable, a plant using this flowsheet can be built at a minimum expenditure. Flotation offers the cheapest and most effective method of concentration and its simplicity is leading to its use on many minerals other than sulphides, and particularly for the cleaning and concentration of such nonmetallics as coal (both bituminous and anthracite), limestone, fluorspar, graphite, potash, phosphate, feldspar, diatomite, and talc.

COMMENTS While a large number of ores can be most economically treated with this flowsheet, the presence of more than one valuable mineral may make it advantageous to use selective flotation so that each valuable constituent can be marketed where the highest net return will be realized. Partially oxidized ores, or those containing friable and easily slimed minerals or metallics, may require the addition of a Denver Unit Flotation Cell or Denver Mineral Jig to make the highest possible recovery. Any change necessary to fit this basic flowsheet to other specific conditions can be easily made by the addition of Denver "Sub-A" or Unit Flotation Cells.

Successful milling plants use proved methods

FLOWSHEET, FLOTATION



All of these flowsheets proved in the field

FLOWSHEET No. U-1

DESCRIPTION Denver Unit Flotation Cell in selective flotation circuit.

ORE TREATED The widest application of this flowsheet is on lead-zinc ores, although it also can be applied to some gold ores as well as molybdenum ores containing other sulphides.

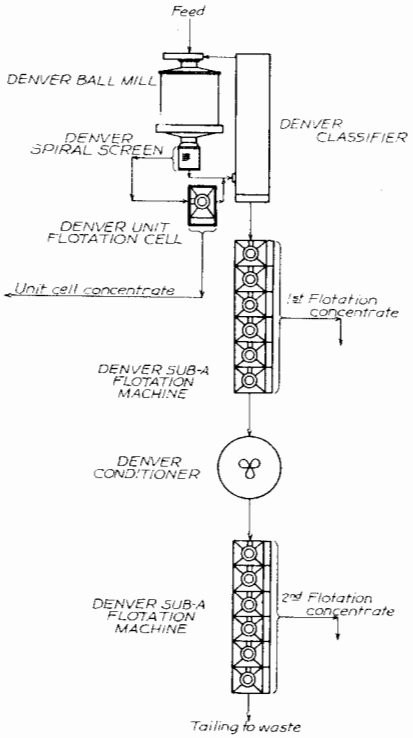
ADVANTAGES In a selective flowsheet, the Denver Unit Flotation Cell installed in the ball mill-classifier circuit recovers a coarse, high-grade lead-silver or molybdenum concentrate. By placing the Denver Unit Flotation Cell at this point in the circuit it prevents excessive grinding of the mineral and thus increases extraction by reducing losses from the sliming of the material which results from overgrinding. The high specific gravity of these minerals keeps them in the grinding circuit where they are badly overground before overflowing the classifier. In addition to increasing recovery, the Denver Unit Flotation Cell greatly reduces the moisture in the shipping concentrate due to the granular nature of the concentrate which aids filtering and drying.

By recovering any of these mineral values as soon as they are freed, better recovery and often increased capacity have resulted.

COMMENTS In many installations of the Denver Unit Flotation Cell in selective flotation plants, increased recovery of lead or other sulphide has been obtained and usually a higher grade product has been secured from this machine.

Successful milling plants use proved methods

FLOWSHEET, SELECTIVE FLOTATION WITH UNIT CELL



All of these flowsheets proved in the field

FLOWSHEET No. U-2

DESCRIPTION Denver Unit Flotation Cell in coarse concentration flotation circuit. This flowsheet is similar to FLOWSHEET No. F-9.

ORE TREATED This flowsheet can be used on ores wherein the base metal minerals are freed at a coarse size.

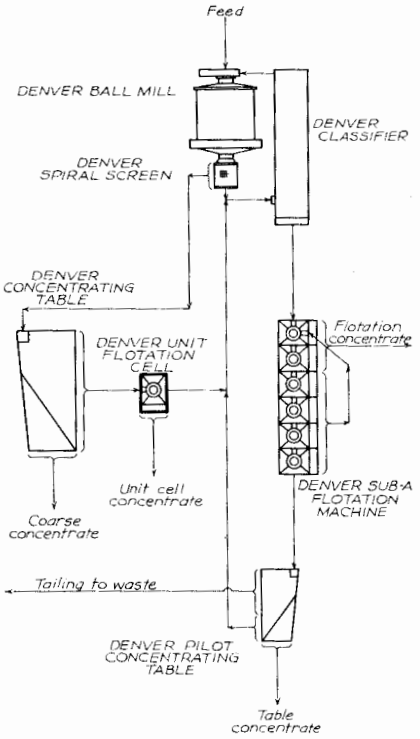
ADVANTAGES The operation of the concentrating table is inefficient due to the high tonnage of unclassified feed. The Denver Unit Flotation Cell recovers the fines lost by the table as well as the coarse mineral.

The improved recoveries are particularly noticeable on gold or silver ores that are partially oxidized and decomposed. The minerals break finer in the grinding mill and are not recovered on the table. Flaky metallic gold is carried across the table with the tailing but may be floated in the Denver Unit Flotation Cell because of the large mineral surface exposed and the high specific gravity pulp which promotes coarse flotation. The value of the classifier overflow is reduced to a uniformly low grade as surges from higher grade ore are smoothed out by the high recovery being made in the fine grinding circuit.

COMMENTS In gold and silver ores the concentrates produced by the Denver Unit Flotation Cell and by the table are generally high in grade and account for a major portion of the recovery of these metals. The concentrating tables used in these circuits are rapidly being replaced by the more efficient and economical Denver Mineral Jig.

All of these flowsheets proved in the field

FLOWSHEET, FLOTATION WITH UNIT CELL



All of these flowsheets proved in the field

FLOWSHEET No. U-3

DESCRIPTION Denver Unit Flotation Cell in cyanide circuit for the removal of concentrate for finer grinding or roasting, or for the removal of sulphides that are cyanicides, or for the removal of other interfering constituents.

ORE TREATED On ores where gold and silver are closely associated with sulphides or tellurides, or where cyanicides or colloidal matter interferes with cyanidation.

ADVANTAGES The Denver Unit Flotation Cell can be used to remove a high percentage of the sulphides or tellurides for regrinding or roasting before returning to the circuit, thereby improving conditions for cyanidation and increasing recovery.

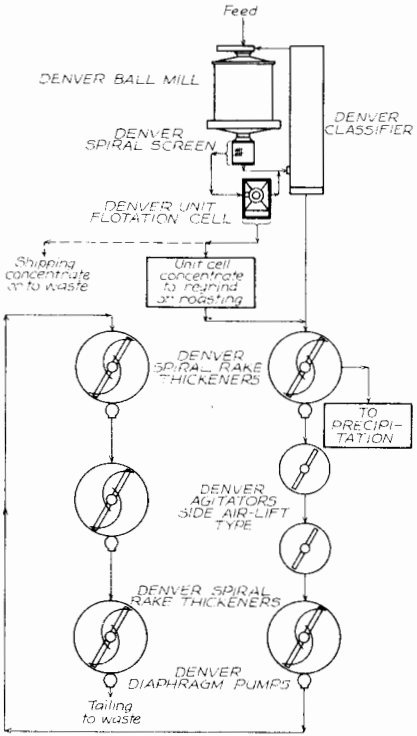
The Denver Unit Flotation Cell is capable of removing cyanicides or colloidal material which interfere with the cyanidation process; thus operating conditions are simplified.

In addition to acting as a concentrating and recovery unit, the violent agitation and aeration in the cell increases the oxygen content of the pulp and improves the cyanide extraction ahead of the primary thickener.

COMMENTS This flowsheet will come into more common usage as additional reagents are developed which can be effectively applied in high lime and cyanide solutions. It has the advantages illustrated in FLOWSHEET No. J-7 of removing gold or silver bearing sulphides for finer grinding and subsequent cyanidation with the coarser gangue fraction of the ore.

Successful milling plants use proved methods

FLOWSHEET, UNIT CELL, FLOTATION AND CYANIDATION



All of these flowsheets proved in the field

FLOWSHEET No. U-4

DESCRIPTION Denver Unit Flotation Cell in gravity concentration plant. This flowsheet shows the use of the Denver Unit Flotation Cell in the ball mill-classifier circuit in a plant where subsequent treatment consists of the usual gravity concentration methods.

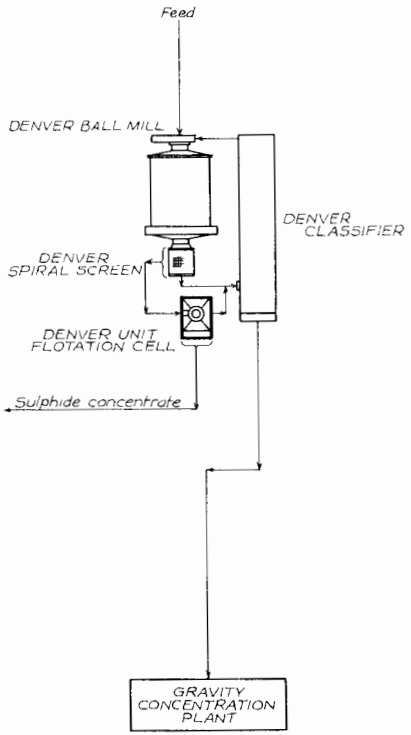
ORE TREATED The ores treated in this manner are those having the valuable mineral non-floatable, and concentration must be made primarily by gravity methods, but where there is a sulphide mineral content which may of itself be valuable for marketing or may be detrimental if left with the gravity concentrates for the marketing of these concentrates.

ADVANTAGES This installation is relatively simple, requiring merely the installation of a Denver Unit Flotation Cell in the grinding circuit.

COMMENTS The Denver Unit Flotation Cell is the only machine which can be applied for the coarse flotation required in this flowsheet. The ability to handle coarse material in the flotation unit is necessary for this application as it is desirable to keep the feed material as coarse as possible in gravity concentration plants. The Denver Unit Flotation Cell, of course, is designed for operation on high pulp densities and also has the ability to circulate material up to ¼" in size, and in some few instances, the material circulated by this machine has even been considerably coarser than this.

Successful milling plants use proved methods

FLOWSHEET, UNIT CELL FLOTATION AND GRAVITY CONCENTRATION



All of these flowsheets proved in the field

FLOWSHEET No. J-1

DESCRIPTION Modern, inexpensive amalgamation circuit with the Denver Mineral Jig as the major recovery unit.

ORE TREATED Practically any gold ore containing native or free gold.

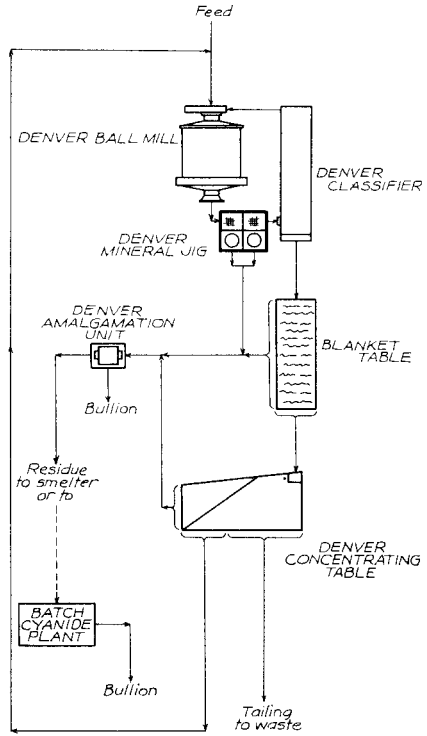
ADVANTAGES From sixty to ninety-five percent recovery can be made with this simple flowsheet on many ores, and the gold produced in bullion form. The Denver Mineral Jig is used between the grinding mill and classifier and recovers not only the free gold but auriferous sulphides and high gravity oxides and carbonates. The gold is recovered in highly concentrated form for subsequent batch treatment by forced amalgamation.

Amalgamation can now be applied to practically any gold ore whereas formerly this process was limited to the few rare ores where the gold was coarse, free and bright. By segregating the gold values into a small bulk of high grade concentrates, the gold can be amalgamated after finer grinding, polishing, and through the use of common reagents to overcome the effect of any deleterious minerals or compounds present.

COMMENTS The Denver Amalgamation Unit is a vital part of this flowsheet and has so simplified this step that the services of an experienced amalgamation operator are not necessary. This flowsheet is being widely used for bulk sampling and for treating development ore. In many cases, the recovery from these plants is carrying the expenses of the development work.

Successful milling plants use proved methods

FLOWSHEET, JIGGING AND AMALGAMATION



All of these flowsheets proved in the field

FLOWSHEET No. J-2

DESCRIPTION Denver Mineral Jig in the flotation circuit with or without amalgamation of the Jig concentrates.

ORE. TREATED Most gold ores where flotation is used for final recovery. Lead or lead-silver ores containing coarse lead sulphides or lead oxide minerals, also pyritic ores containing gold and silver.

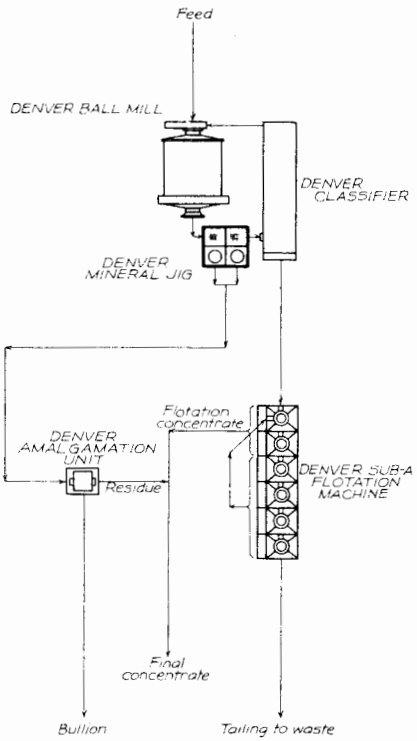
ADVANTAGES Although most gold ores are not classed as "free milling", it is found in many cases that a reasonable percentage of the gold is freed in fine grinding for flotation. This gold may be recovered by the Denver Jig in the ball mill-classifier circuit, preventing its recirculation and overgrinding which results in tailing losses. A small bulk of high grade concentrate is obtained which can be put in bullion form by "forced" amalgamation. The overall net recovery for the plant is improved through lower tailing losses, lower freight and treatment charges on the lower grade flotation concentrates, and through higher returns on bullion sold to the mint.

When treating lead or other sulphide ores where the minerals are coarse, the Denver Mineral Jig recovers a coarse concentrate and removes it from the ball mill-classifier circuit before sliming and subsequent probable tailing loss.

COMMENTS In addition to the direct savings outlined, the uncertainty of sampling and assaying the flotation concentrates is avoided as "metallics" have been removed in the Jig. In producing a coarse sulphide concentrate for shipment, the Denver Mineral Jig is replacing tables in the ball mill-classifier circuit.

Successful milling plants use proved methods

FLOWSHEET, JIGGING, AMALGAMATION AND FLOTATION



All of these flowsheets proved in the field

FLOWSHEET No. J-3

DESCRIPTION Denver Mineral Jig in flotation concentrate regrinding circuit followed by selective flotation with amalgamation of Jig concentrates.

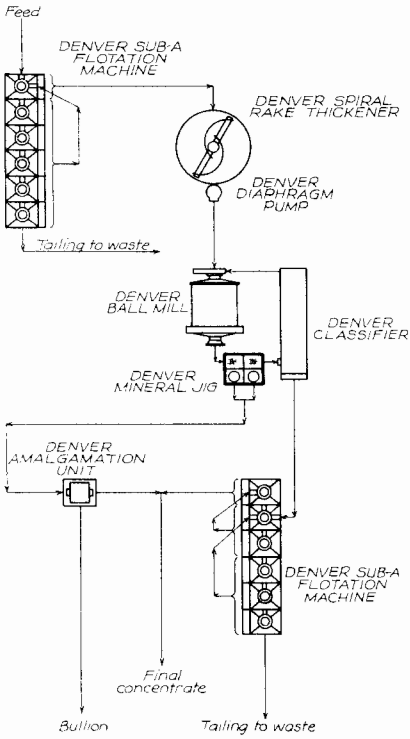
ORE TREATED Sulphide gold ores, principally those containing some values in copper or lead in addition to precious metals. This flowsheet is applied to ores containing large amounts of pyrite which contains intimately associated copper or lead sulphides as well as gold, and requires fine grinding to liberate the copper or lead minerals and gold from the pyrite. Fine grinding of gangue and sulphides is too costly and is not required for a low tailing.

ADVANTAGES This flowsheet greatly improves gold bullion recovery and allows the production of a high-grade copper or lead concentrate and rejection of a barren pyrite. A bulk rougher concentrate is made with a coarse grind and a low rougher tailing is discarded. The coarse bulk flotation concentrate is reground with a Denver Mineral Jig in the regrind circuit and the fine free gold is recovered by the Jig for amalgamation and production of bullion. The classifier overflow passes to a selective flotation circuit where depressants are used to prevent the barren pyrite from floating, and a high-grade copper or lead concentrate is produced and the barren pyrite rejected as tailing.

COMMENTS In treating ores of this type a fraction of the gold is freed in the primary grinding circuit and may be removed by a Denver Mineral Jig and amalgamated with production of bullion.

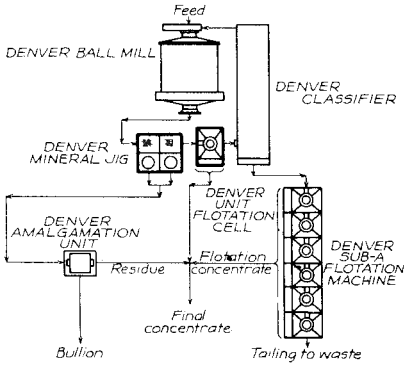
Successful milling plants use proved methods

FLOWSHEET, JIGGING, FLOTATION AND AMALGAMATION



All of these flowsheets proved in the field

FLOWSHEET No. J-4



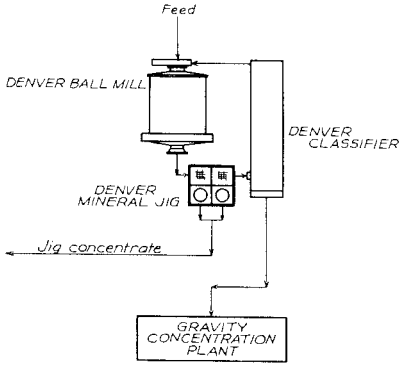
DESCRIPTION Denver Mineral Jig and Denver Unit Cell in a flotation circuit.

ORE TREATED Partially oxidized or mixed oxide and sulphide ores.

ADVANTAGES In several cases this flowsheet has been used with outstanding success on dump ore and stope fills. Non-floating oxide minerals and tarnished gold are recovered in Denver Mineral Jig ahead of the Denver Unit Flotation Cell. The ratio of concentration is held at a high figure to produce a small bulk of very high-grade gold concentrates that may be treated in a Denver Amalgamation Unit. The Denver Unit Flotation Cell recovers a coarse bulk concentrate, preventing slime losses and promoting settling and filtering of the flotation concentrates, usually difficult on this type of ore feed.

Successful milling plants use proved methods

FLOWSHEET No. J-5



DESCRIPTION Denver Mineral Jig in grinding circuit of gravity concentration plant.

ORE TREATED Various oxide and nonmetallic minerals not now recoverable by flotation.

ADVANTAGES Where fine grinding is necessary before gravity concentration, high tailing losses are unavoidable as slimed mineral is not efficiently concentrated and recovered by gravity methods. The flowsheet shown, with the Denver Mineral Jig in the closed grinding circuit, has greatly increased recoveries where used.

A high percentage of the minerals is recovered when freed and at a coarse mesh. Sliming of this fraction, with its resulting losses, is avoided.

COMMENTS Marketing of concentrates is often simplified through the production of a coarser and more granular concentrate product.

All of these flowsheets proved in the field

FLOWSHEET No. J-6

DESCRIPTION Denver Mineral Jig in cyanide circuit with amalgamation of the Jig concentrates.

ORE TREATED Practically all ores treated by cyanidation and especially all ores containing coarse gold.

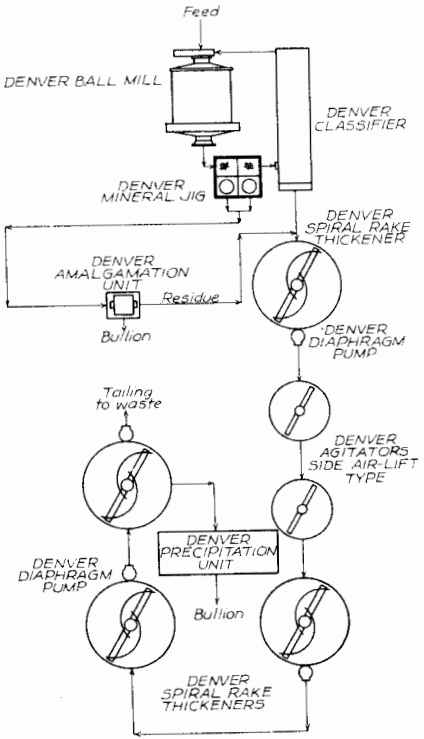
ADVANTAGES The Denver Mineral Jig and Denver Amalgamation Unit have a definite place in cyanide plants, as it has been found that the gold recovered by the Jig includes coarse or granular gold which does not completely dissolve in the cyanide solution during the treatment time given the pulp. The removal of this gold by the Jig tends to provide an overflow from the classifier which is consistently low in gold value and due to this feature erratic high tailings are eliminated and recoveries improved.

Economies in both plant construction and operation have been realized in the many cases where the Jigs are used as shown. The removal of this very small fraction of the ore for grinding and amalgamation eliminates the necessity on many ores for fine grinding and long time of agitation with the cyanide solution.

COMMENTS In some plants where the Denver Mineral Jig has been installed, Jig recoveries are so high that subsequent cyanide treatment of classifier overflow has become unprofitable and has been replaced by Denver "Sub-A" Flotation or by gravity methods with equal or better results. See FLOWSHEET No. J-1.

Successful milling plants use proved methods

FLOWSHEET, JIGGING, AMALGAMATION AND CYANIDATION



All of these flowsheets proved in the field

FLOWSHEET No. J-7

DESCRIPTION Jig concentrates reground and cyanided. Denver Mineral Jig in ball mill-classifier circuit for removing sulphides for fine grinding and subsequent cyanidation.

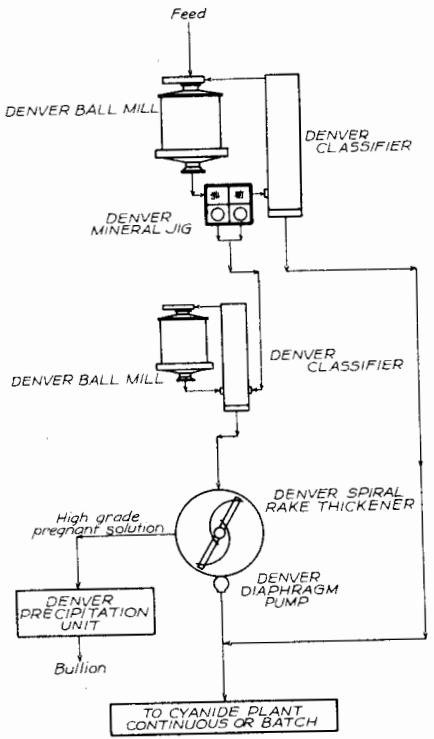
ORE TREATED Sulphide gold or silver ores where fine grinding of the sulphides is necessary to expose the gold or silver to the cyanide solution and where it is not necessary to grind the gangue to the same degree of fineness.

ADVANTAGES The Jig in this flowsheet recovers a bulk concentrate containing practically all of the sulphides as well as the free gold. This fraction of the ore may be ground to any fine mesh necessary for maximum recovery and strong solution if necessary can be used in this circuit. Both classifier overflows from primary and regrinding circuits go to the cyanide treatment plant. This only necessitates grinding the bulk tonnage to free the minerals from the gangue, and the fine grinding needed for gold extraction from sulphides is confined to the small tonnage of gold bearing minerals contained in the Jig concentrate.

COMMENTS This circuit has been used to increase extraction without costly additions to the plant and in other cases has made worthwhile sayings in new plant construction and in plant additions where more tonnage has been required. The installation of a Jig and concentrate grinding circuit has allowed as high as fifty percent increased capacity without sacrifice in recovery.

Successful milling plants use proved methods

FLOWSHEET, JIGGING AND CYANIDATION



All of these flowsheets proved in the field

FLOWSHEET No. C-1

DESCRIPTION Continuous counter-current decantation cyanidation flowsheet.

ORE TREATED Gold and silver ores amenable to the cyanidation process and where economics justify plant outlay.

ADVANTAGES By producing the precious metals in bullion form, the highest net return is realized on many gold and silver ores. Where the tonnage available for treatment justifies the capital outlay, and where this process gives high recovery with satisfactory chemical consumption, this flowsheet is recommended.

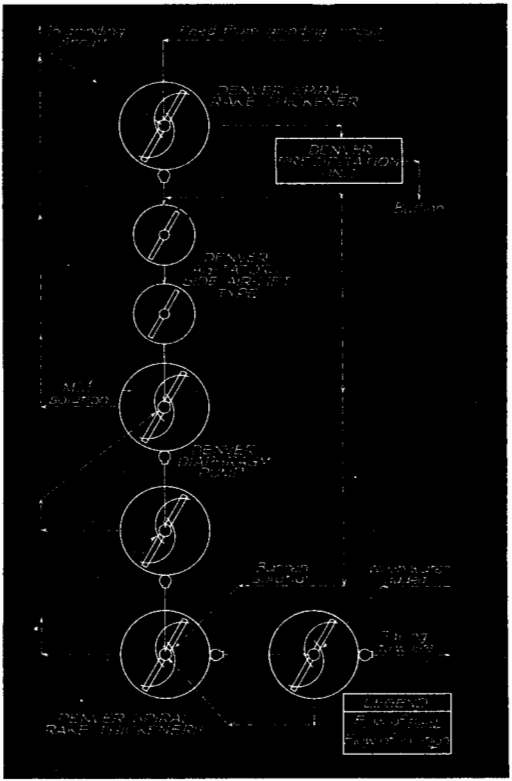
COMMENTS The counter-current decantation washing circuit for removing the solutions carrying the dissolved precious metals is rapidly supplanting other methods. In this circuit, wash water and barren solution are added in the last thickener units and flow toward the head of the plant, becoming enriched and are finally passed to the clarification and precipitation units where the precious metals are precipitated and recovered. The ore pulp (carrying the dissolved gold and silver) flows in the opposite direction, or counter-current, and becomes depleted in soluble value until finally discharged as a tailing with little or no contained soluble values.

Compared with the use of filters, lower capital cost, lower power cost, and lower labor cost more than offset the slightly higher loss in dissolved values, and improve net operating profits.

The Denver (Positive Type) Washing Tray Thickener, requiring a small fraction of former floor and building space, is now replacing individual thickeners and allows the use of this attractive circuit in colder sections where previously building and heating costs prevented this circuit from being considered.

Successful milling plants use proved methods.

FLOWSHEET.
CONTINUOUS CYANIDE PLANT



All of these flowsheets proved in the field

FLOWSHEET No. C-2

DESCRIPTION Denver Batch Cyanidation Plant.

ORE TREATED Small tonnages of high-grade gold-silver ores and flotation or Jig concentrates amenable to cyanide treatment, used for treating as low as one ton of concentrates per day.

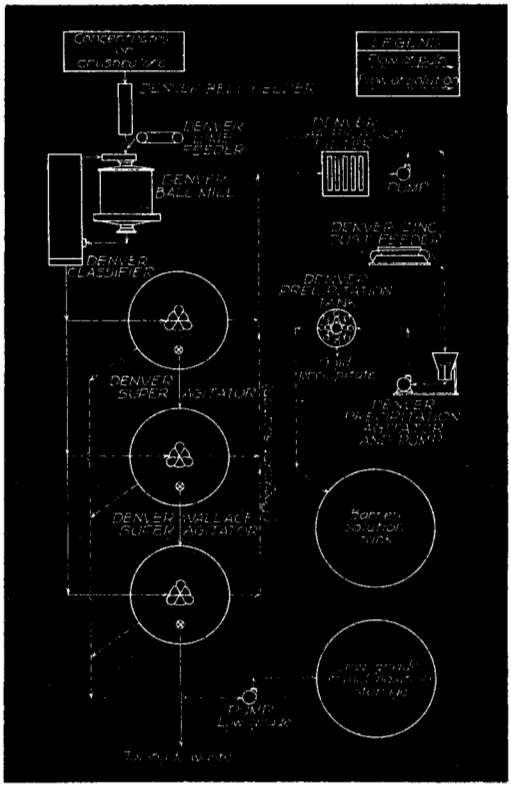
ADVANTAGES Where the tonnage of ore or concentrates is too low for standard continuous cyanidation plants (usually less than ten tons per day) these simple and inexpensive batch plants allow the production of precious metal values in bullion form with low operating costs.

COMMENTS The feed from the fine grinding circuit (some concentrates can be treated without finer grinding) is fed to a group of Denver Patented Super-Agitators, one of which is filling all the time. When an agitator has its predetermined charge, the feed is sent to the next agitator which has previously been emptied at the completion of its treatment cycle and is ready for refilling. The filled agitator is placed in operation and low-grade or mill solution added to bring the pulp to the proper operating level, then agitation is started and continued for a definite period. When agitation is completed, the unit is stopped, solids allowed to settle, and the solution decanted, clarified, and precipitated.

This agitator is again filled with low-grade solution, or barren solution available from the previous precipitation step, and agitated. The solution available after this step may be precipitated if high enough in value or it may be stored and used for dilution in the grinding circuit. Again, this agitator is filled with barren solution and operated, stopped, decanted, and refilled with water for a washing step; after which the tailing is discharged. Clarification and precipitation is intermittent.

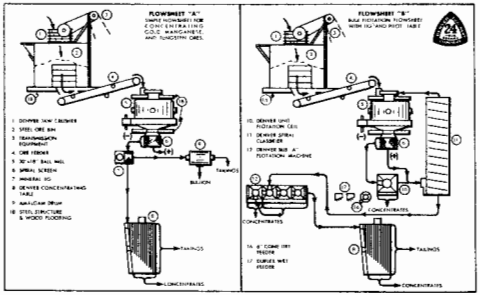
Successful milling plants use proved methods

FLOWSHEET,
BATCH CYANIDE PLANT

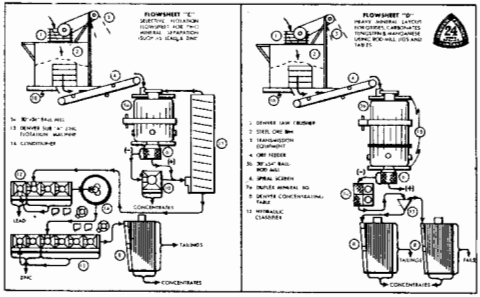


All of these flowsheets proved in the field

FLOWSHEETS FOR PORTABLE MILLS



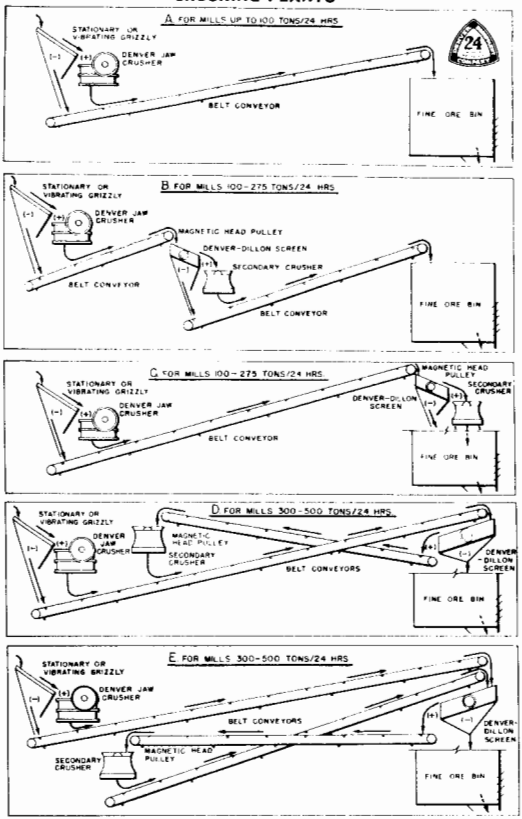
Flowsheet "A" Flowsheet "B"



Flowsheet "C" Flowsheet "D"

Equipment and accompanying specifications has been designed to give continuous "24 Hour Service" because the age-old saying "one hour's delay means no profit today" is more important now with increased operating costs than ever before.

CRUSHING PLANTS



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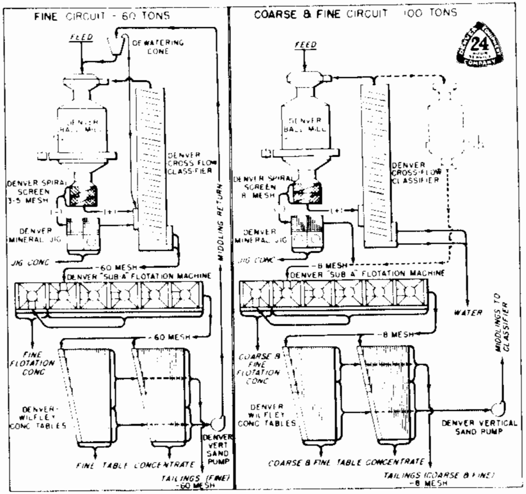
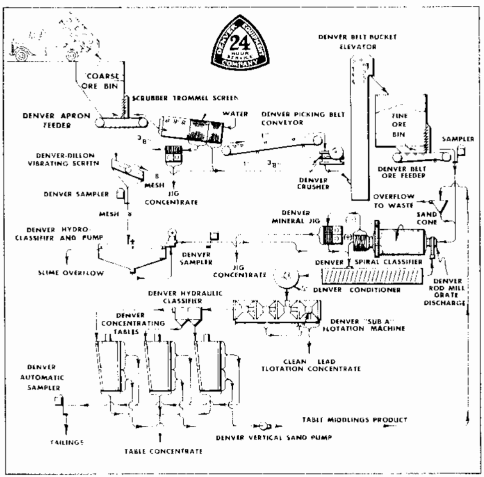
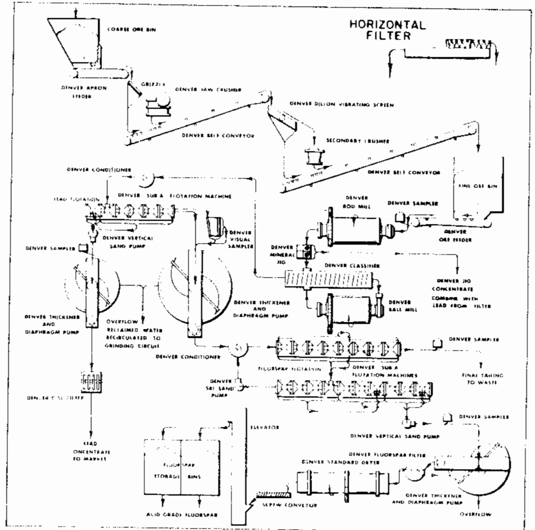


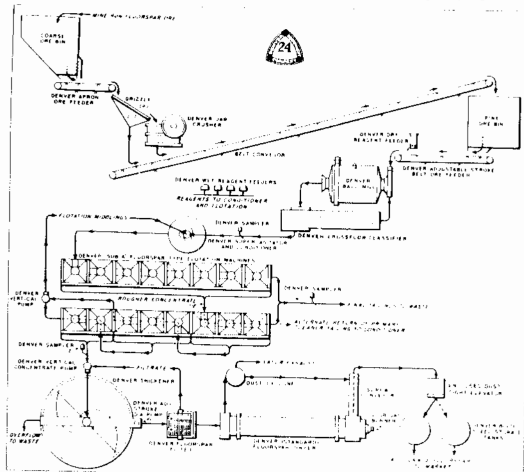
FLOWSHEETS FOR COARSE AND FINE FLOTATION



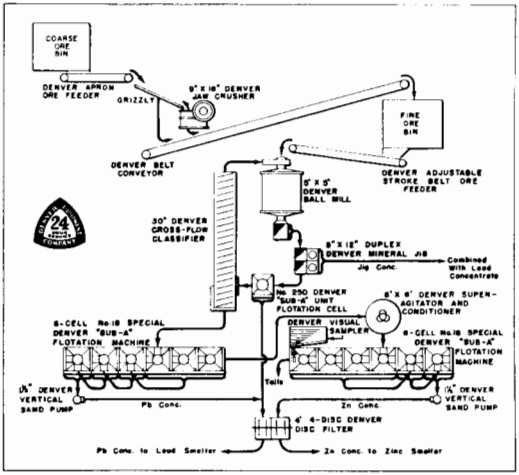
FLOWSHEET FOR OXIDE LEAD ORE



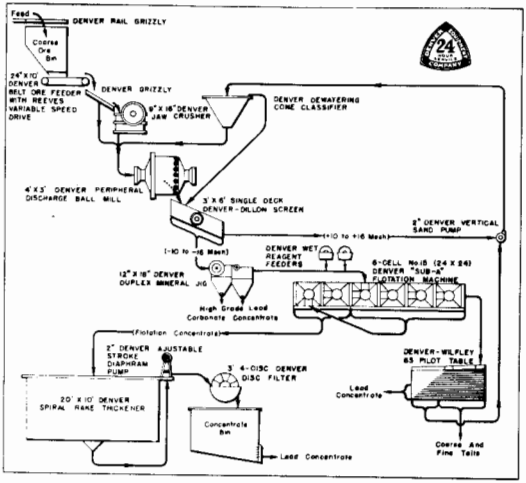
FLOWSHEET FOR FLUORSPAR RECOVERY



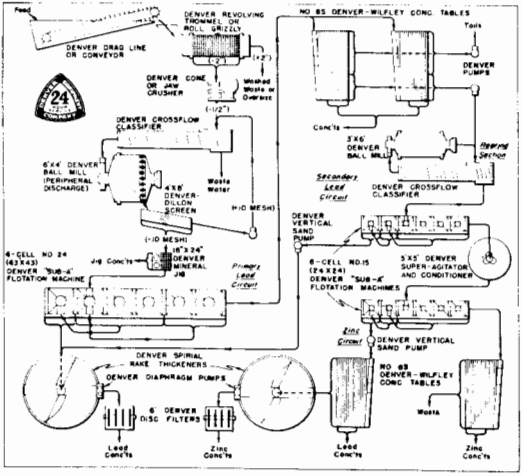
FLOWSHEET FOR FLUORSPAR RECOVERY



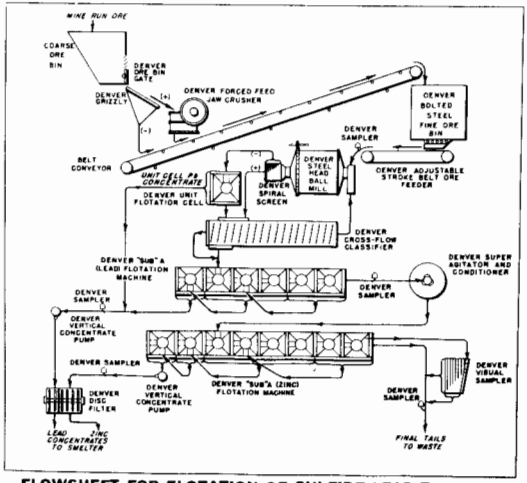
FLOWSHEET FOR LEAD-SILVER, ZINC ORE



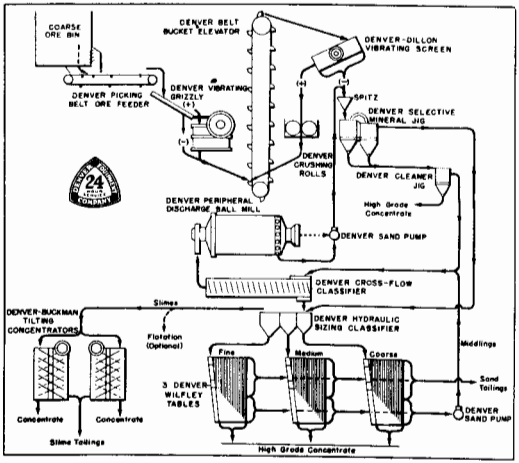
FLOWSHEET FOR LEAD CARBONATE ORE



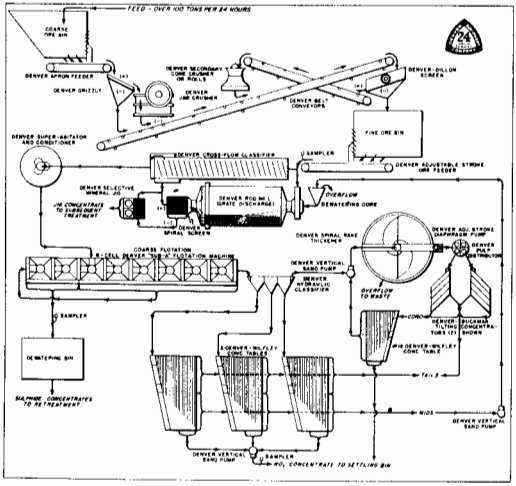
FLOWSHEET FOR LOW-GRADE LEAD-ZINC DUMP ORES



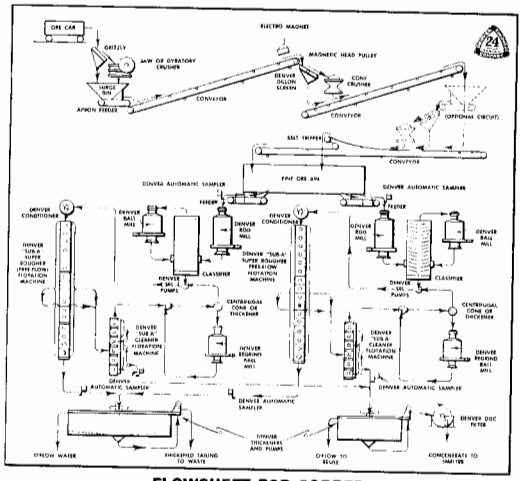
FLOWSHEET FOR FLOTATION OF SULFIDE LEAD-ZINC ORE



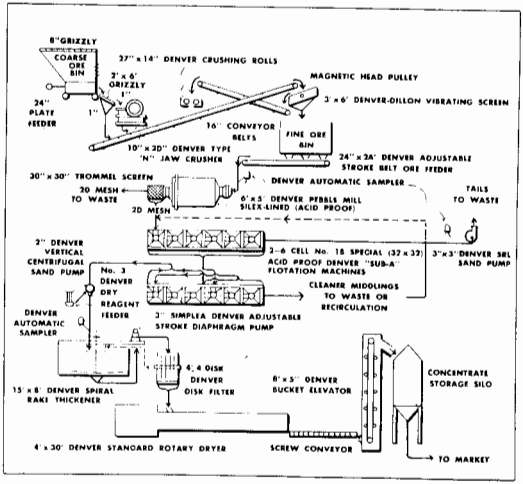
FLOWSHEET FOR TUNGSTEN ORE



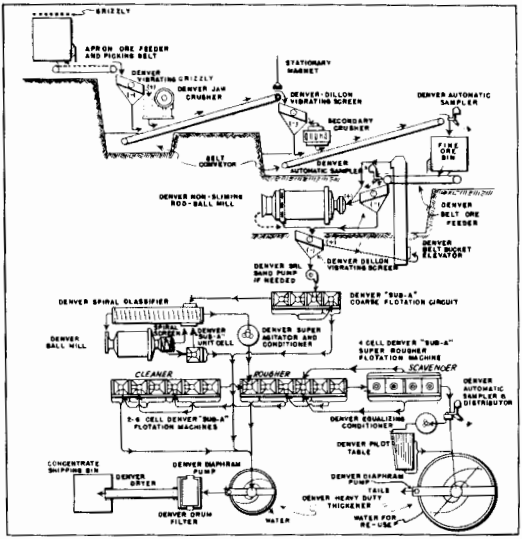
FLOWSHEET FOR A TUNGSTEN-GOLD ORE



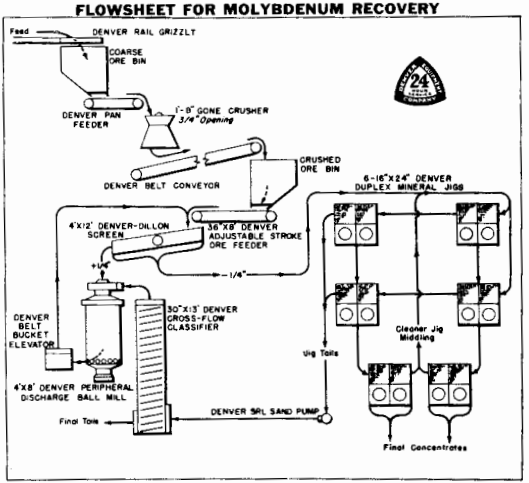
FLOWSHEET FOR COPPER



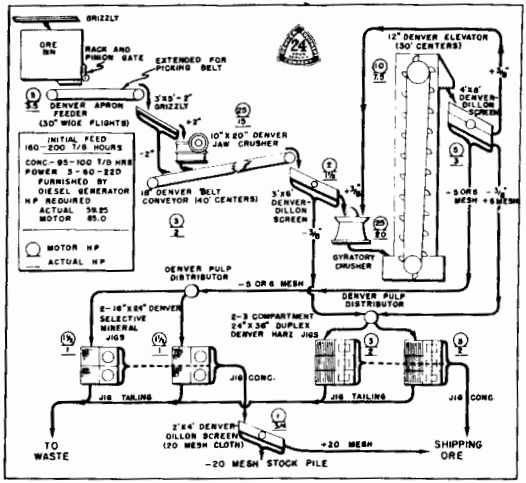
FLOWSHEET FOR SULPHUR RECOVERY



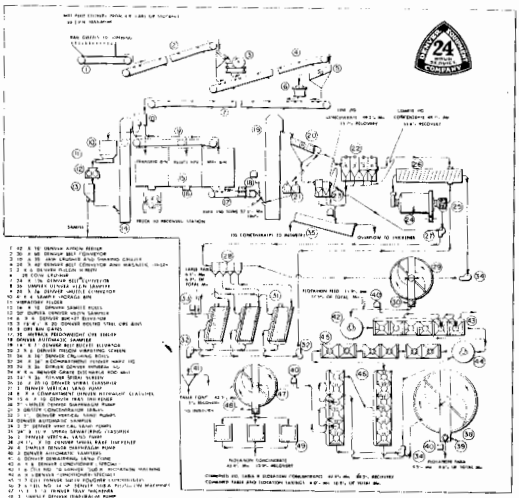
FLOWSHEET FOR MOLYBDENUM RECOVERY



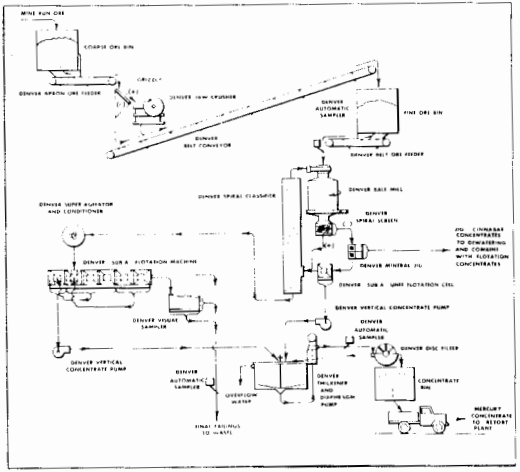
FLOWSHEET FOR CHROME ORE



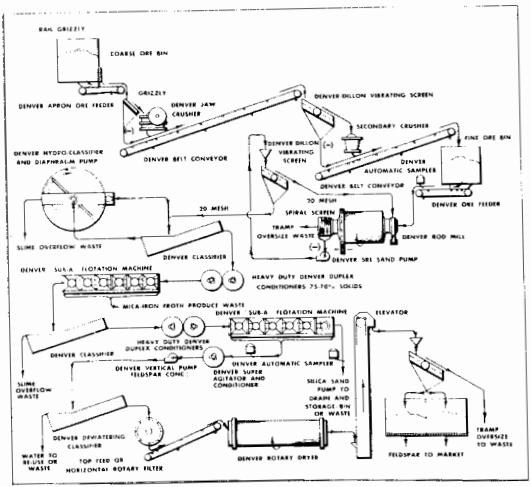
FLOWSHEET FOR MANGANESE ORE



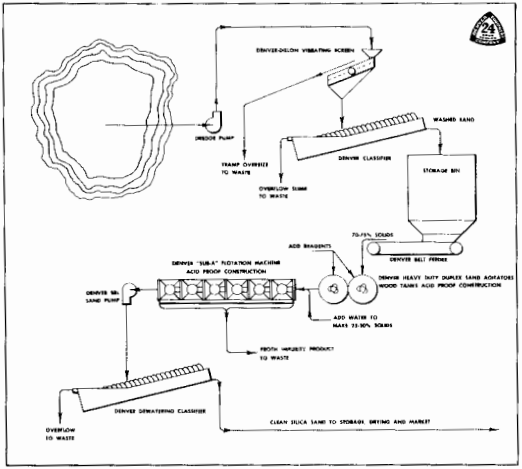
FLOWSHEET FOR MANGANESE



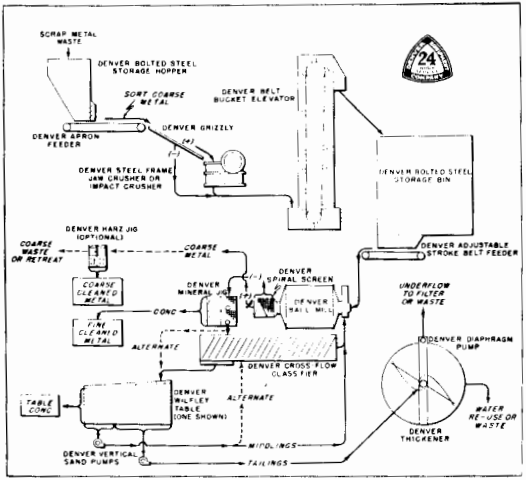
FLOWSHEET FOR MERCURY RECOVERY



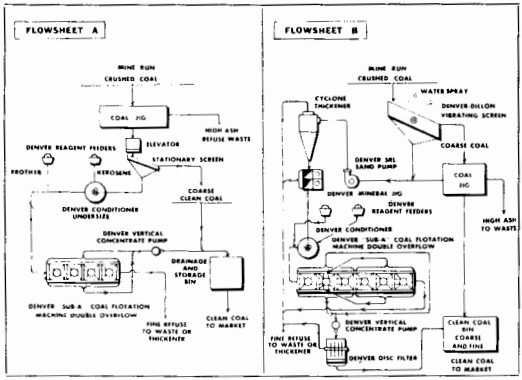
FLOWSHEET FOR FELDSPAR RECOVERY



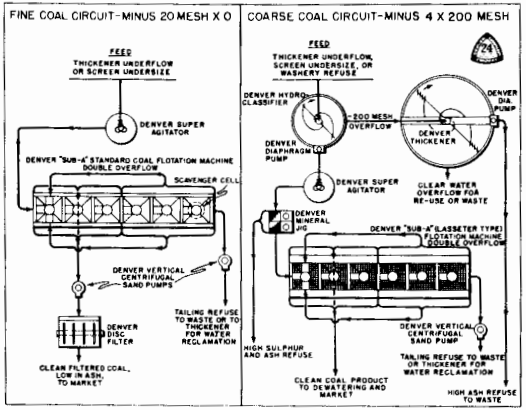
SILICA SAND



FLOWSHEET FOR SCRAP METAL RECLAMATION



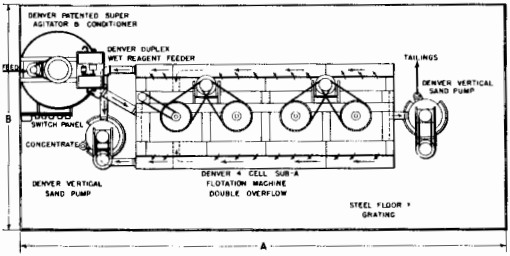
FLOWSHEET FOR COAL RECOVERY

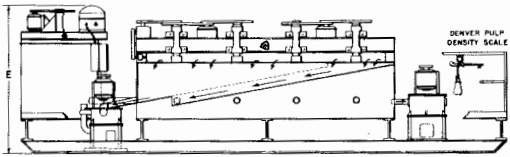


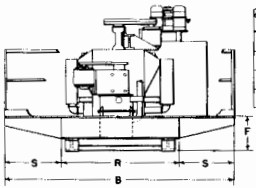
FLOWSHEETS FOR COARSE AND FINE COAL FLOTATION

DENVER "SUB-A"

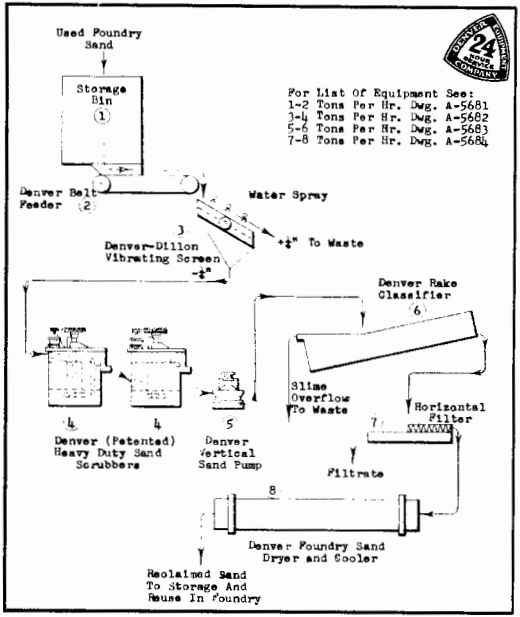
STANDARD COAL FLOTATION



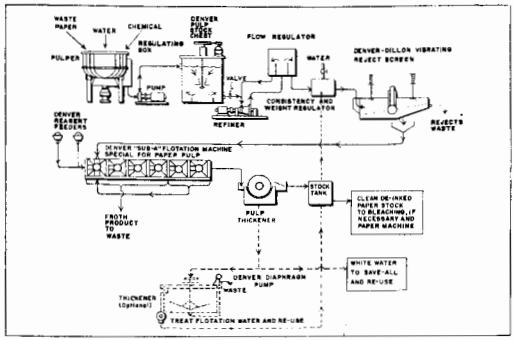




CAPACITY TONS	DIMENSIONS A	B	E	F	R	S	H.P. REQ'D	APPROX WEIGHT	PRICE
2½	22'-0"	12'-0"	7'-0"	24"	6'-0"	3'-0"	12	13,500	
5	25'-3"	12'-0"	8'-0"	22"	6'-0"	3'-0"	18	17,000	
10	33'-6"	13'-0"	9'-6"	30"	7'-0"	3'-0"	38	36,000	
20	40'-6"	14'-0"	11'-8"	28"	8'-0"	3'-0"	65	55,000	



FLOWSHEET FOR FOUNDRY SAND RECLAMATION



De-inking Paper Pulp by Flotation

DENVER CYANIDE PLANT EQUIPMENT

HIGHER RECOVERIES

LOWER INSTALLED COST

LOWER OPERATING COSTS

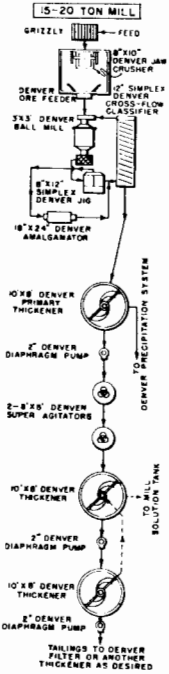
With Standard Denver Equipment Company Products

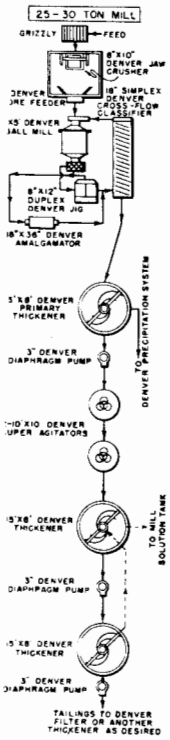
GENERAL NOTES

Agitation capacity based on 36 to 48 hours of agitation time. Thickener area based on 6 to 7 square feet per ton of dry solids per 24 hours. Pregnant cyanide solution (Primary Thickener Overflow) is treated in a Denver Precipitation System which includes: Clarifier, Vacuum Tank, Vacuum Pump, Clarifier Pump, Zinc Dust Feeder, Zinc Mixing Tank with Pump, and Precipitation Tank, Motors and Drives are included with all pumps and the Zinc Dust Feeder.

Secondary Crusher is recommended for efficient crushing in the 250 to 265 ton per 24 hour mill.

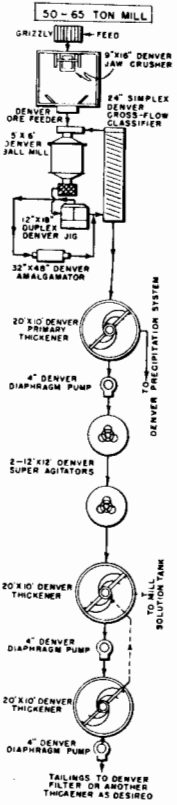
Shown are flowsheets indicating equipment necessary for cyanide mills of five different tonnages. Size of equipment is based upon characteristics of average ore.

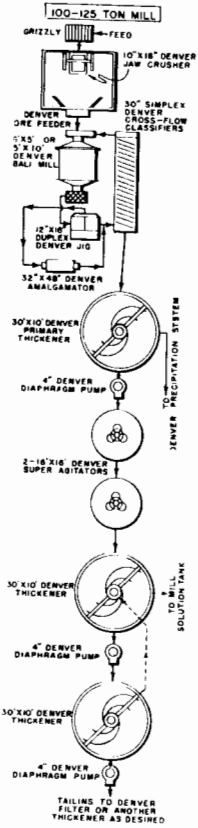




15-20 Ton Mill
Approximate Costs
Primary Equipt.
$19,500
Precipitation Equipt.
$3,225
Total $22,725

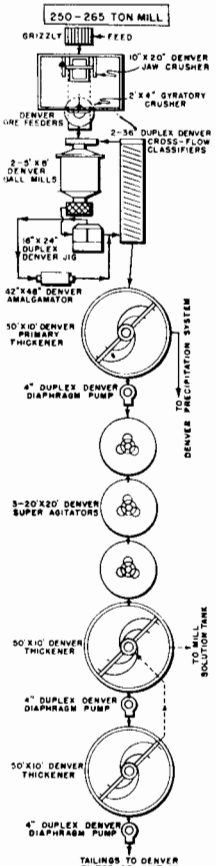
25-30 Ton Mill
Approximate Costs
Primary Equipt.
$23,200
Precipitation Equipt.
$3,825
Total $27,025





50-65 Ton Mill
Approximate Costs
Primary Equipt.
$33,550
Precipitation Equipt.
$5,425
Total $38,975

100-125 Ton Mill
Approximate Costs
Primary Equipt.
$47,400
Precipitation Equipt.
$8,100
Total $55,500



250-265 Ton Mill

Approximate Costs

Primary Equipt.
$96,200

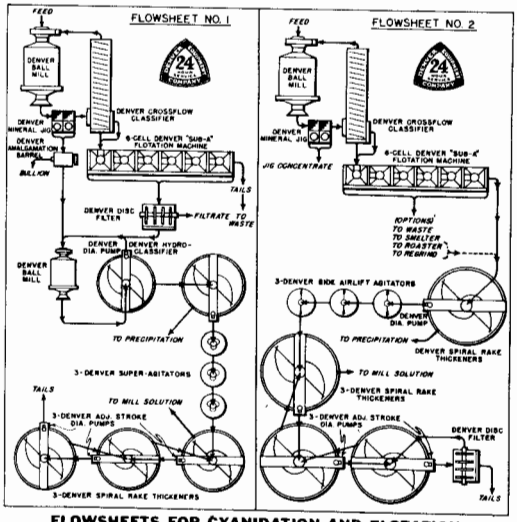
Precipitation Equipt.
$12,300

Total $108,500

Modern Cyanide Practice

THE PRINCIPLE of dissolving gold and silver values in solutions of potassium or sodium cyanide is old and has been thoroughly carried out in practice for many years. There have been only a few changes in the chemical procedure and also few changes in the type of equipment used.

The gold and silver are dissolved by the chemical solution, usually with varying amounts of oxygen or air added to complete the chemical reaction. The



FLOWSHEETS FOR CYANIDATION AND FLOTATION

amount of air or oxygen required for a particular ore varies and depends not only upon the size of the particles of the mineral to be dissolved, but also upon the chemical composition of the ore. In most instances the value of the ore and the size of the mineral particles are the deciding factors.

In the past the usual practice to secure complete dissolution of the gold and silver values was to reduce *all* of the ore to a very finely divided state, practically all through 200 mesh. Recently, however, through the introduction of novel concentrating devices, such as the Denver Mineral Jig and the Denver Unit Flotation Cell, it becomes possible to take out a very large percentage of the values by recovering the valuable metallic minerals (as well as most of the sulphide minerals), which are treated separately, and their removal often eliminates the necessity of fine grinding the remaining relatively barren coarse particles of the ore. This also results in materially reducing the time and equipment required for the dissolution of the remaining gold and silver values, if their recovery warrants the treatment, and a material saving in equipment cost for this purpose can thereby be effected.

The basic principle of adding certain chemicals to counteract unfavorable chemical constituents in the ore is still necessary on each particular ore and, therefore, complete test work is essential to determine the mesh of grind; the time required for agitation; the settling ratio of the ore and the amounts of chemicals required, together with the correct flowsheet.

The basic method of treatment used for many years in cyaniding gold and silver ores is still fundamentally sound. The four flowsheets shown here are distinct, and show the advancements made in cyanide equipment and methods, described below:

FLOWSHEET NO. CY-1 shows the continuous counter-current decantation system, in which *all* the ore is first reduced to a very fine state in the grinding mill-classifier circuit, in a cyanide solution. The slime overflow of the classifier, usually 70%—200 mesh, or finer, is sent to the first thickener, known as the primary thickener.

Here the pregnant solution, containing a large part of the dissolved gold and silver values, overflows

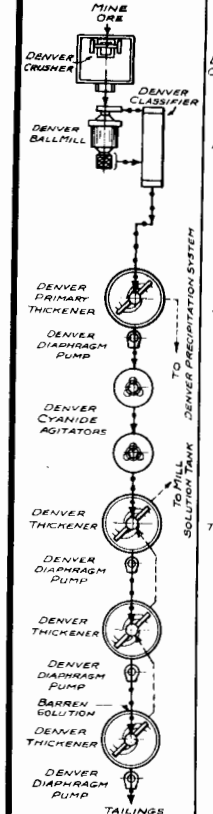
from the top of the thickener and is sent to a clarifier, then to the precipitating system where the gold and silver values are precipitated, the precipitate periodically being reduced to bullion in a furnace.

The underflow pulp of the primary thickener, containing the remaining values and usually at a pulp ratic of 1:1, is elevated by a diaphragm pump into a series of agitators. The agitators are used to aid in the dissolution of the remaining values, augmented by the introduction of air. The time of treatment required depends upon the values still remaining in the slimes or fine sands in the mill pulps.

From the agitators, the pulp at a density of approximately 1:1 overflows directly into the first of a series of secondary thickeners. This feed pulp is diluted with the overflow solution from the second of the secondary thickeners, which solution has been enriched by the removal of values from the second and third secondary thickeners. After the solution is intimately mixed with the pulp it enters the thickener feed well, rises to the top of the thickener, is overflowed and is pumped to either the mill solution tank or introduced into the precipitation system. The thickened pulp from the first of the secondary thickeners settles to the bottom, is raked to the center discharge, and is then pumped to the second secondary thickener where it is mixed with the overflow solution from the third of the secondary thickeners. Thus the pulp flows in one direction with gradually decreasing values, while the solution is pumped in the opposite direction with gradually increasing values, from a barren wash water to a sufficiently enriched solution suitable for precipitation or mill solution storage.

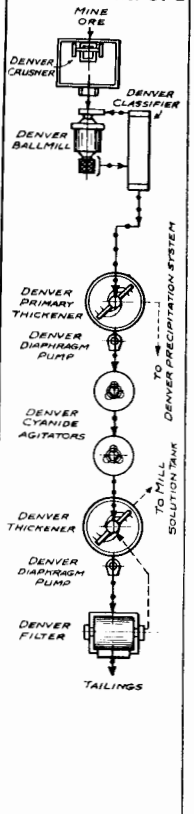
In this way the pulp is gradually lowered in value and the solution is gradually increased. The solution from the first of the series of secondary thickeners is either partly precipitated or sent to the mill solution tank to be used in the head of the mill circuit. This counter-current decantation system, as shown on *Flowsheet No. CY-1* is ideal for a large number of ores. This flowsheet is the ultimate in simplicity.

FLOWSHEET No. CY-1



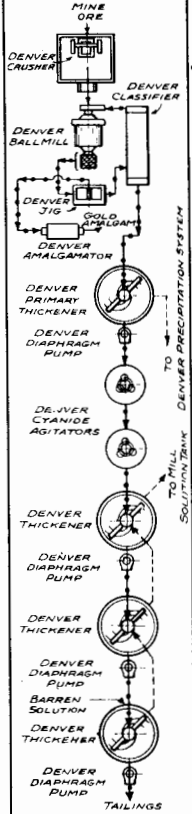
Typical cyanide flowsheet using decantation. Dash lines show direction of solution flow. Full lines with dots show direction of pulp flow.

FLOWSHEET No. CY-2



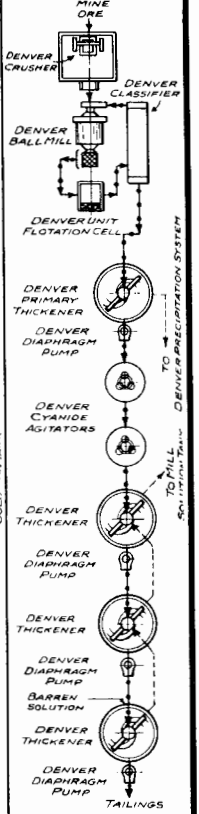
Cyanide flowsheet with filter following one or more secondary thickeners. Filter filter cake can be repulped and refiltered in a second filter.

FLOWSHEET No. CY-3



Cyanide flowsheet using a Denver Jig to remove coarse free gold minerals and metallics. Concentrates are treated in Denver Amalgamator.

FLOWSHEET No. CY-4



Cyanide flowsheet showing use of Denver Unit Flotation Cell to remove cyanicides. This method saves chemicals and increases recoveries.

FLOWSHEET NO. CY-2 is practically the same as *Flowsheet No. CY-1,* only in place of the last two secondary thickeners a rotary filter is used. On some ores two or more thickeners are used between the agitators and the filter. There is no question about the lower soluble loss when using a filter but the cost of the filter operation, amounting to from 8c to 10c per ton, is an important item as compared to the low cost of operating thickeners. Therefore, the question as to whether a filter or a thickener is to be used at the tail end of the cyanide mill is a matter of economics, depending upon the housing facilities, initial investment in the plant, and operating cost. A tailing filter is necessary where water for milling is scarce, or where pollution of streams is prohibited.

IN FLOWSHEET NO. CY-3 is shown one of the outstanding improvements made in cyanidation whereby the coarse metallic minerals are removed from the grinding circuit by means of the Denver Mineral Jig. The hutch product from this jig is amalgamated with a Denver Amalgamator or Clean-Up Pan and thus the coarse mineral values, such as metallic gold, are removed from the circuit before complete fine grinding takes place. This jig hutch product containing most of the fine as well as the coarse metallics, can also be treated by a separate grinding and cyanide treatment plant. This Denver Jig, due to its synchronized valve action, requires the minimum amount of water. Its feed and discharge elevations are sloped as a launder, so that pumps or elevators are not required.

By the early removal of the coarse gold and other minerals, it is possible to materially reduce the chemical consumption in the cyanide plant and also the time required for agitation, as well as offering the possibility of grinding at a coarser mesh. In other words, the removal of a certain portion of the minerals at a coarse mesh, and their separate treatment, either by amalgamation or by a small cyanide plant, eliminates the necessity of fine grinding the entire tonnage to recover the values from this small portion of the ore that often contains the majority of values.

The balance of the circuit is then similar to that shown on *Flowsheet No. CY-1,* with the advantages, however, of lower chemical consumption and a

lower agitating time, with less equipment needed for final thickening and filtering. This is due to the high efficiency of the Denver Mineral Jig in removing not only the coarse values that are free and that would require additional time and equipment, but also in removing most of the middling values that would require finer grinding of the entire ore with the resulting higher equipment and operating costs.

FLOWSHEET NO. CY-4 is similar to *Flowsheet No. CY-3,* excepting that a Denver Unit Flotation Cell is used between the ball mill and the classifier to remove cyanicides or harmful elements from the cyanide circuit, thus preventing an excessive chemical consumption. This concentrate produced on the Unit Flotation Cell can be sent to a smelter or treated separately from the balance of the cyanide circuit. This method of treatment has been proved distinctly advantageous and should have an important application on ores where copper and other cyanicides are present. Flotation chemicals or reagents used in the Denver Unit Flotation Cell do not affect the subsequent treatment by cyanidation.

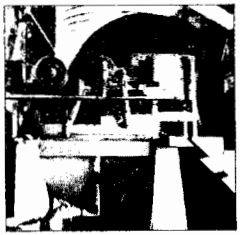
In many instances this Denver Unit Flotation Cell, due to the additional aeration secured, plays an important part in the chemical reaction between the cyanide and the gold and silver values. In the cyaniding of silver ores it is essential to have ample air and therefore the air that is introduced in the Denver Unit Flotation Cell and in the Denver Super-Agitators, is very important.

These flowsheets are widely used for the treatment of average ore by the cyanide process and indicate the improvements which can be made.

MODERN CYANIDE EQUIPMENT

The Denver Mineral Jig, placed between the ball mill and classifier, is one of the most valuable improvements in cyanidation in recent years and was developed by the engineering and research staff of the Denver Equipment Company.

This Mineral Jig has the marked advantage of removing a large portion of the metallic values without excessive dilution, and water or solution is added to the discharge of the jig. This jig handles the grinding mill discharge before it enters the classifier for final separation of the coarse material to be reground and the fine material for subsequent treatment by cyanidation. No elevators or pumps are needed in this jig circuit.



Denver Mineral Jig Installation

The hutch product secured from the Denver Mineral Jig can be treated in a Denver Amalgamator, or by other similar practical means.

Another important unit in these modern flowsheets is the Denver Unit Flotation Cell. This removes the cyanicides and other coarse floatable mineral and is an efficient unit in the grinding circuit due to the use of rubber wearing parts and the distinct gravity flow principle of the Unit Cell.

The discharge from the Unit Cell is higher than the feed inlet, thus making it possible to place the Unit Cell in the ball mill-classifier circuit without an elevator or pump.

Still another important unit in these cyanide circuits is the Denver "Spiral Rake" Thickener with the beam type, lowhead superstructure. With this type of thickener one requires only a minimum building height because a very small distance above the beam superstructure is necessary for its operation. This lower head room permits a more economical building and less fuel is required for heating the mill.

Lowhead Superstructure

Denver Double Spiral Rakes

The Denver "Spiral Rake," which moves the settled material from the bottom of the thickener to the center, in one revolution, is an important improvement . . . avoiding overload conditions and also giving greater capacity in the thickener with a clearer overflow product, due to less disturbance. The use of steel gears and ball bearings on the thickener mechanism also tends to lower the operating and maintenance expense.

Flotation and Cyanidation versus All Cyanidation

A thorough study of this subject is contained in an interesting article by J. P. Dick entitled "Mining and Metallurgy at Moneta Porcupine" in the March 1941 issue of the Canadian Mining and Metallurgical Bulletin. The following comparison is given:

MILL OPERATING COSTS PER TON OF MILL FEED

Operation	Straight Cyaniding	Flot. Cyaniding
Crushing	$0.136	0.200
Grinding	0.414	0.426
Flotation	— —	0.237
Solutions	0.448	0.302
Agitating and thickening	0.102	0.077
Filtering	0.158	0.109
Clarification precipitation	0.161	0.075
Refining	0.017	0.043
Tailing disposal	0.036	0.067
Experimental	0.104	0.025
General mill expense	0.091	0.066
Proportion of general charges	0.063	0.060
Total Cost per ton	$1.736	$1.687
Average tons of ore per day	152.5	180.7
Recovery	83.4%	91.4%

Increase in cost of crushing and grinding is due to finer ball mill feed and regrinding flotation concentrate before cyaniding to 64%—10 microns.

To supplement these figures it should be considered that where metallurgically possible, lower cost per ton will be produced from a combination circuit. However this should not be accepted blindly, as the author believes that below 100 tons a day straight cyanide circuit will be cheaper to operate.

A further point to consider is that frequently the ore at the surface of a property is comparatively easy to treat, and a straight cyanide circuit is naturally installed, usually with a mineral jig in the grinding circuit to remove free gold. As further development is done in depth the character of the

ore frequently changes to include primary gold-bearing sulfides. Sufficient tonnage has also been blocked out to warrant mill expansion. Then the logical action is to install flotation cells to remove the sulfides, which are reground and cyanided in the original cyanide mill. Only a new grinding circuit, in addition to the flotation machine, is needed to increase the mill capacity. The ultimate increase will depend on the ratio of concentration obtainable by flotation with a flotation tailing that can be economically discarded. This ratio and consequent increase may range from 2:1 up to 35:1.

Even if the flotation tailing cannot be economically discarded, as such, these are certain additional considerations. For example: one concentrator with a very low record of cost feeds the flotation tailing to a hydroclassifier. The slime overflow is discarded. The sand fraction is given an agitation of about four hours, resulting in small agitators, and on account of the fast settling characteristics of the sand, thickeners with a capacity of about 0.3 sq. ft. per ton are successfully operated. Accordingly a very small, compact, cyanide mill was installed.

Batch Cyanidation

The batch process of cyanidation is usually applied in two different types of mills:

1. Where the amount of material to be treated is quite small.

At some properties the type of material being handled is quite erratic and so to obtain the maximum extraction the batch method is used. The material is agitated, with perhaps several solution changes, until final assay of residue is satisfactory. Then the material is discharged from the tanks.

Denver super agitators with float decantation devices and bottom discharges are ideal for this type of work.

2. Where the material to be treated is quite erratic in nature.

Cyanidation—Sand Leaching

In practice, efficient classification is absolutely essential for the successful operation of a leaching plant. Even a small percentage of slimes will seriously reduce or even destroy the porosity of the sand bed. Size of particle in the feed is of little concern as long as granular.

Accordingly the discharge from the grinding circuit is classified, the overflow being either treated separately in a slime circuit or discarded, according to its value. The sand is pumped to one of a series of large diameter shallow tanks with porous false bottoms. The sand is evenly distributed in the tank by means of a mechanical distributor. Cyanide solutions may be introduced from the bottom and allowed to percolate upwards, or fed from the top and allowed to seep downwards. Usually the strongest cyanide solution, with the required dissolved lime, is added first, followed by weaker solutions and then one or more water washes. Between each percolation the sands should be allowed to drain so that air will reach the gold particles being dissolved.

After the percolation has been completed, the sand is usually discharged through doors in the bottom of the tank onto a conveyor belt that removes it to the tailing pile. Some operators prefer final washing in a series of washing classifiers after cyanidation in the tanks has been completed.

The number of percolation tanks required depends on the tonnage capacity of each tank, the daily tonnage, and the total time required for a cycle of operations. Leaching and washing may require from two to ten days depending on the ore.

Small Gold Plants

"There is often a tendency to overlook or minimize the importance of the small mine. The small mine of today may develop into the large mine of tomorrow. Under proper management and financing it has as good a chance of yielding a profit as the larger property. Unfortunately large capital is seldom interested in them and they are left to the small groups who are not in a position to obtain the best engineering service. Mills are often erected without proper metallurgical tests and expensive cyanide plants are installed at a time when such large

expenditures of capital on the surface is not justified by the underground developments. Careful metallurgical testing on the ore might have disclosed the fact that a simple method of amalgamation or concentration could have been employed and the mill built for a third the cost of a cyanide plant."*

By taking advantage of the fact that gold is one of the heaviest metals known and readily forms an amalgam with mercury, an effective but simple and inexpensive plant can be built for most small gold mines. Usually the major percentage of the gold values are in the "native" or metallic state and are free at commercial fineness of grinding and can be recovered by some combination of amalgamation and concentration.

Plate amalgamation, where the gold values are caught and held in the quicksilver film on a copper plate is the only step required for a commercial recovery on some few ores. In most cases a portion of the gold is filmed so that it does not amalgamate readily or is contained in ores with other minerals that also amalgamate or "foul" the quicksilver sufficiently to destroy its effectiveness for gold recovery. Here a form of selective concentration such as the Denver Mineral Jigs and blanket tables, is used to concentrate the gold values in a small bulk of high grade concentrates for treatment in an amalgamation barrel or other amalgamator, where the gold is amalgamated and recovered as bullion.

The advantages of these simple plants are many and are not only attractive to the proved small mine but also to those under development. Within recent years many of our well known mines have been developed and brought into large scale production from revenue secured from a small milling plant operating on development ore.

A study of a large number of mills using amalgamation and concentration has disclosed bullion recoveries ranging from 60 per cent to 90 per cent and total recoveries, including concentrates, from 85 per cent to 97 per cent. The average bullion recovery will be about 70 per cent and very often this is of utmost importance as geographic location makes the shipping of the concentrate to a smelting plant undesirable.

*Extracted from Memorandum Series No. 47, by C. S. Parsons, Engineer, Ore Dressing and Metallurgical Division, Mines Branch, Department of Mines, Ottawa. Published by permission of the Director, Mines Branch.

While cyanidation is usually favored for treating gold ores to get maximum recovery of the values in bullion form, nevertheless, the fact that an amalgamation plant can be built for approximately one-third of a complete cyanide mill, together with the lower operating costs of the simpler plant, partially offsets the lower recovery. It is customary to impound the tailings from the amalgamation plant and these are cheaply treated when mine developments have justified the erection of the more complete cyanide plant. An amalgamation and concentration plant can be operating intermittently without sacrificing efficiency, and this allows the operation of the plant for only one or two shifts per day to keep the peak power requirements at a minimum as mine compressors can be operated or the hoisting done while the mill is not in operation. The fact that 60 to 80 per cent of the values can be recovered by amalgamation will usually supply sufficient revenue from the mill to pay for development charges and build a reserve for the construction of the complete cyanide plant.

With reasonable care in the design and construction of the original amalgamation and concentration plant all of the equipment can be utilized in the later complete cyanide mill. By using standard equipment it is possible to add the cyanide equipment following the already installed amalgamation and concentration units as these are an essential part of the completed plant.

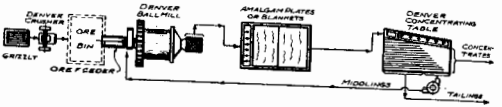
Other advantages of these simple and inexpensive amalgamation and concentration plants are that they can be successfully operated with unskilled labor as no chemical knowledge or previous experience is necessary. Gold ore bodies can be accurately sam-

pled by milling all of the ore from mine development work and the errors resulting from ordinary sampling methods can be entirely eliminated.

It is interesting to note the numerous dividend paying gold properties, particularly those in Eastern Canada, which have followed the treatment methods shown in the following flowsheets during the development stage and they have gradually added to the equipment as the profits and ore developments warranted. The use of standard proved equipment eliminates the biggest element of chance, and from this nucleus a more efficient and complete plant can be acquired as the flexibility of the equipment permits the change from one flowsheet to another.

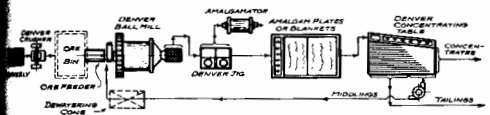
We are giving four typical flowsheets used in treating gold ores and are describing the possible applications of these flowsheets, together with their fields of usefulness, and while in each case there is a similarity in equipment, you will note the changes necessary for various type ores. In each case we have endeavored to show the simplest possible plant for best results on each type of ore and to show the improvements that can be made to further increase recoveries at slight additional cost.

FLOWSHEET AA



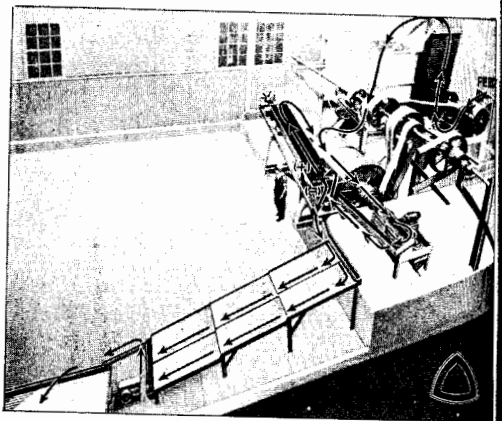
This flowsheet is the lowest in price, and can be used on what are commonly termed as "free milling" gold ores where a high percentage of the values are free and where these values are unlocked at reasonably coarse grinding. This flowsheet is often used for treating high grade pockets. The ball mill is in open circuit and the size of the product to amalgamation plates is controlled by a Denver Spiral Screen on the ball mill discharge. The concentrating table also functions as a classifier and the middling is returned as oversize product for further grinding.

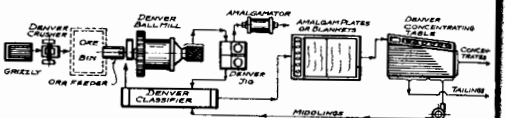
FLOWSHEET BB



Flowsheet BB has a Denver Mineral Jig and amalgamator in addition to the equipment shown for *Flowsheet AA*, and is used for an inexpensive plant where values are coarse but minerals are coated or filmed, and will not amalgamate readily on plates. The jig recovers the "rusty" values in a high grade concentrate for "forced" amalgamation treatment in the Denver Amalgamator. On the ores where this flowsheet is applicable, blankets, corduroy, or Denver Gold Matting are usually substituted for amalgamation plates and their concentrate also is treated in the amalgamator with the jig product.

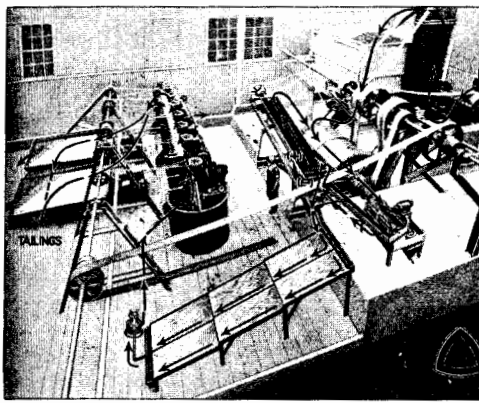
FLOWSHEET CC

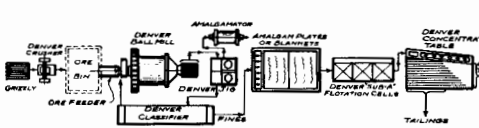




This flowsheet with the ball mill in closed circuit with a classifier, and with the jig in this circuit, will give the highest recovery possible for amalgamation and gravity concentration. The addition of the classifier allows finer grinding and the efficiency of the jig is greatly increased by using it in the closed grinding circuit. This flowsheet not only improves recoveries on ores as described in the previous flowsheets, but is also useful where the minerals are fine and where metallic values are in auriferous sulphides as well as in the free state in the gangue.

FLOWSHEET DD





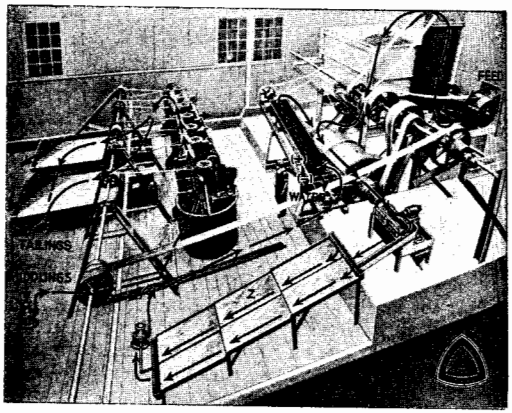
There are many gold ores containing oxidi free gold and also values in the sulphides or te rides; for the latter, flotation must be used on fine sizes.

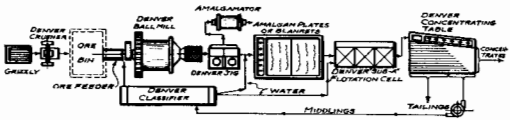
The addition of flotation to *Flowsheet CC* bri recovery to the highest point in *Flowsheet DD* flotation recovers the slime values that are norma lost where gravity concentration only is us The values that can be amalgamated are secured bullion form from the high grade jig and table c centrates, and the remaining values are recove in the flotation concentrate. This flowsheet is necessary where a minor percentage of the g values are present as metallics at commercial fi ness of grinding or where the minerals are fria and easily slimed in fine grinding such as galena the various telluride minerals.

The addition of flotation does not increase greatly the first cost of the plant, nor does it increase the operating expenses more than a few cents per ton. In a great many cases the additional recovery made by flotation means the difference between operating at a profit and at a loss. Flotation is responsible for the success of many small mining properties today.

Where the isolated location of the mill makes shipping of concentrates prohibitive, many properties store their product until they are justified in installing a complete treatment plant on the ground; current expenses are thus paid through bullion recovered by amalgamation ahead of flotation.

FLOWSHEET EE





The equipment in this flowsheet is identical to that of *DD*. Here the ability of the Denver "Sub-A"

Flotation Machine to handle a feed is capitalized on to allow the handling of ly increased tonnages. The ball mill discharge in open circuit over the jig, amalgamation pl blanket tables and the flotation machine. A m product is returned from the concentrating and is dewatered in the classifier and retur regrinding. On tailings, dumps, or low gra where it is necessary to handle a larger tonna flowsheet is very effective, and while the rec would not be as high as in *Flowsheet DD*, t in recovery is more than offset by the grea creased tonnage handled and the resultant milling cost. With this flowsheet a coarse tail be discarded, but slime losses are entirely eli as these, together with the granular miner recovered in the flotation machine.

This flexibility of flowsheet is possible only the standard Denver "Sub-A" Flotati chine is used. The Denver Mineral Jig is a v addition here as the excessive dilution woul it impossible to use any other type of gravi centration device ahead of flotation. The from *Flowsheet DD* to *Flowsheet EE* can b easily made to accommodate changes in ore allow greater profits from the treatment of a gold ore encountered.

EQUIPMENT ESTIMATES

In this section you will find prices on basic items of milling equipment and also some of the essential items for mining such as compressors, drills, hoists, mine cars, etc. These prices are necessarily only approximate. They are provided for your use in estimating only. We invite you to phone, wire or write Denver Equipment Company for up-to-date quotations on all items.

Much time and inconvenience can be saved by having one centralized responsibility and source of supply for all items. Denver Equipment Company can supply standard, reliable equipment designed to operate efficiently and give you continuous 24 Hour Service.

Approximate prices shown here are F.O.B. Factory and for shipment to destinations in the U.S.A., Canada or Mexico only. For foreign operations other than Canada and Mexico, please add 15% for heavy-duty export boxing, crating and special handling, plus $5.50 per hundred weight (Cwt.) for transporting the equipment to any U.S. Port. Ocean freight rates are also given for a few representative ports to help you in estimating the cost of transporting the items to your port.

Please contact Denver Equipment for current process for any and all of your mill requirements. All we ask is the opportunity to work with you and we will gladly supply current prices and delivery information upon request. The prices shown here are those generally in effect during 1953.

gitators and Conditioners,

AGITATORS, OPEN TYPE

(With steel tank, motor and drive)

Also, See CONDITIONERS (See Page 7)

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
3′ x 3′	1	660	$ 395
4′ x 4′	1½	1100	560
5′ x 5′	2	1450	750
6′ x 6′	3	1925	930
7′ x 7′	3	3825	1160
8′ x 8′	5	3180	1300
10′ x 10′	5	5475	2040

AGITATORS, RAKE TYPE WITH CENTER AIRLIFT

(Less tank, but including motor and drive) (See Page 8)

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
5′ x 5′	¾	1200	$1025
6′ x 6′	¾	1250	1075
7′ x 7′	¾	1290	1110
8′ x 8′	¾	2390	1150
9′ x 9′	¾	2510	1200
10′ x 10′	1	2675	1250
12′ x 12′	1	3675	1330
14′ x 14′	1	3825	1450
18′ x 16′	1½	6050	1800
22′ x 16′	1½	6275	2125
28′ x 20′	3	8125	2775
35′ x 20′	3	8975	3525

NOTE: Prices are approximate and are for estimating purposes only. Please phone, write or wire—

DENVER EQUIPMENT COMPANY

Box 5268 •• Denver 17, Colorado

Denver Telephone: CHerry 4466 **Cable: Deco Denver**

AGITATORS, RAKE TYPE WITH SIDE AIRLIFTS

(Less tanks, but including two side air lifts, motor and drive)

Size	Motor HP	Approx. Shipping Wt. (lbs.) (See Page 7)	Approx. Price F.O.B. Factory
5′ x 5′	1	1370	$1085
6′ x 6′	1	1440	1125
7′ x 7′	1	1500	1180
8′ x 8′	1½	2630	1250
9′ x 9′	1½	2770	1300
10′ x 10′	1½	2910	1350
12′ x 12′	3	4130	1505
14′ x 14′	3	4315	1620
18′ x 16′	5	7335	2150
22′ x 16′	5	7610	2450
26′ x 20′	7½	10000	3150
30′ x 20′	7½	10240	3375
35′ x 20′	7½	11400	4025

AMALGAMATION UNITS (See Page 13)

(Includes motor and drive but not grinding charge)

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
18″ x 36″	1	1400	$ 850
24″ x 36″	2	3000	1300
32″ x 48″	5	4800	1950
42″ x 48″	7½	8200	2700

AMALGAMATION DRUM

(Includes motor and drive) (See Page 11)

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
12″	½	300	$ 240
24″	1	1300	630

Bulletins or other descriptive material giving details and specifications as well as up-to-date prices will be sent on request.

BALLS, GRINDING

(Forged steel, heat treated) (See Page 24)

Ball Dia.	Approx. Price Per Ton F.O.B. Factory	Ball Dia.	Approx. Price Per Ton F.O.B. Factory
1″	$235	3″	205
1½″	225	3½″	205
2″	210	4″	205
2½″	210	5″	205

RODS, GRINDING (See Page 181)

(Approximate price, f.o.b. Factory—$165 per ton)

Rod Dia.	Weight Per Ft. Length	Rod Dia.	Weight Per Ft. Length
1½″	6 lbs.	2½″	16.7 lbs.
2″	10.7 lbs.	3″	24 lbs.

BALL MILLS (See Page 20)

(Includes liners, motor and drive but not ball charge)

Size	Approx. Motor HP	Approx Ball Load in Pounds	Approx. Shipping Wt. (lbs.) (less balls)	Approx. Price F.O.B. Factory
3′ x 3′	15	2,700	8,400	$ 3,140
4′ x 4′	25	6,400	17,800	6,280
5′ x 5′	50	12,600	27,600	9,460
6′ x 6′	125	21,700	48,260	22,500
7′ x 6′	150	29,500	79,550	29,175
8′ x 8′	350	51,500	127,800	51,280
9′ x 7′	400	57,000	149,900	53,360
10′ x 10′	800	100,000	229,700	98,215

BINS, ORE

(Bolted steel tank type)

Size	Approx. Shipping Weight	Approx. Volume Cu. Ft. Capacity	Approx. F.O.B. Factory Price
7′-8″ x 8′	1,050	370	$ 225
9′-2⅝″ x 10′	1,500	672	325
12′-3″ x 10′	2,875	1,179	550
15′-4⅝″ x 16′-1″	9,080	2,957	1,675
21′-6″ x 24′-1½″	22,000	8,770	4,155
26′-1″ x 24′-1½″	28,800	12,973	4,750

BITS, DRILL—DETACHABLE CROSS BITS

(For 7/8, 1", 1 1/8 Hollow drill steel)

Bit Gage	Approximate Price each 1000 or less	Bit Gage	Approximate Price each 1000 or less
1 1/2"	$0.43	2 1/8"	0.47
1 5/8"	0.43	2 1/4"	0.50
1 3/4"	0.44	2 3/8"	0.53
1 7/8"	0.45	2 1/2"	0.54
2"	0.46		

DRILL BITS—DETACHABLE CROSS BITS

(With tungsten-carbide inserts
For 7/8, 1", 1 1/8 Hollow drill steel)

Bit Gage	Approximate Price each	Bit Gage	Approximate Price each
1 1/2"	$11.55	1 7/8"	13.65
1 5/8"	12.60	2"	14.70
1 3/4"	13.15	2 1/4"	19.95

CARS, ORE

18" Track Gauge **(See Page 31)**

Capacity Cu. Ft. (level)	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
12	660	$215
16	700	248
20	925	269
24" Track Gauge		
12	685	228
16	730	238
20	955	289

CLASSIFIERS, HYDRAULIC

(For sizing table feed) **(See Page 37)**

Compartment Size	Number of Compartments	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
4" x 4"	2	125	$ 325
	4	200	500
	6	275	675
8" x 8"	2	650	610
	4	850	1125
	6	1050	1425
	8	1250	1750

CLASSIFIERS, HYDRO **(See Page 38)**

(Including tank, superstructure and supports, motor and drive)

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
** 4'	1/2	990	$ 700
8'	3/4	3,200	1,850
12'	1	5,200	2,600
16'	1 1/2	10,400	4,170
20'	2	17,300	6,450
*30'	5	31,400	10,400
*40'	7 1/2	50,400	16,000
†*50'	7 1/2	93,000	22,000
†*75'	7 1/2	131,000	28,000

*Flat-bottomed tank.
**Includes 3/4" suction-pressure diaphragm pump and drive
†Motorized rake lifting device.

CLASSIFIERS, RAKE

(Includes motor and drive) **(See Page 40)**

Size		Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
1'-6" x 18'-0"	Simplex	1 1/2	2,400	$1,475
2' x 18'-0"	Simplex	2	3,000	1,650
3' x 18'-0"	Simplex	2	3,400	2,100
4' x 18'-0"	Duplex	3	4,200	2,800
4' x 26'-8"	Duplex	5	9,100	4,400
5' x 26'-8"	Duplex	5	13,000	5,900
6' x 26'-8"	Duplex	7 1/2	14,000	6,450
7' x 26'-8"	Duplex	7 1/2	15,000	6,800
8' x 26'-8"	Duplex	10	16,000	7,350

NOTE: Prices are approximate and are for estimating purposes only. Please phone, write or wire—

DENVER EQUIPMENT COMPANY
Box 5268 · Denver 17, Colorado
Denver Telephone: CHerry 4466 **Cable: Deco Denver**

CLASSIFIERS, SPIRAL

(Includes tank, spiral and drive) **(See Page 33)**

Size		Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
12″ x 9′-6″	Simplex	½	1,050	$1,150
18″ x 15′	Simplex	1	3,200	2,200
24″ x 16′	Simplex	2	4,250	2,550
30″ x 18′	Simplex	3	6,500	3,350
36″ x 21′-8″	Simplex	5	10,000	4,850
42″ x 21′-8″	Simplex	7½	12,900	5,900
48″ x 28′-9″	Simplex	7½	16,300	7,150
54″ x 28′-9″	Simplex	7½	20,500	8,700
60″ x 33′	Simplex	10	24,300	10,100
24″ x 16′	Duplex	3	9,100	4,600
30″ x 18′	Duplex	5	13,150	5,900
36″ x 21′-8″	Duplex	7½	19,250	8,550
42″ x 21′-8″	Duplex	7½	23,825	9,800
48″ x 28′-9″	Duplex	10	31,100	12,550
54″ x 28′-9″	Duplex	10	37,300	14,850
60″ x 33′	Duplex	15	45,400	17,850

COMPRESSORS, AIR, WATER COOLED

(With electric motors and drives)

Size Cu. Ft./Min.	Motor HP For 100# Working Pressure	Weight	Approximate Price F.O.B. Factory
32	5	910	$ 815
64	10	1,640	1,195
80	15	1,785	1,350
130	25	2,450	1,750
184	30	3,350	2,175
284	50	3,700	3,625
387	75	4,600	4,615
445	75	4,750	4,730
570	100	7,950	6,210
686	125	8,350	7,235

Bulletins or other descriptive material giving details and specifications as well as up-to-date prices will be sent on request.

COMPRESSORS, PORTABLE AIR

(Portable air compressors mounted on rubber tired wheels—gasoline engine driven)

Size Cu. Ft. /Min.	Working Pressure #/Sq. In.	Engine HP Gasoline	Weight Pounds	Approximate Price F.O.B. Factory
30	125	12.5	800	$1,150
60	125	22.5	1,600	2,230
105	125	38.0	3,500	3,650
160	125	55.5	4,100	4,950
210	125	72.5	4,500	6,275
315	125	10.5	5,550	8,195

(Portable air compressors mounted on rubber tired wheels—diesel engine driven)

Size Cu. Ft. /Min.	Working Pressure #/Sq. In.	Engine HP Diesel	Weight Pounds	Approximate Price F.O.B. Factory
105	125	37	4,100	$ 4,650
160	125	52	4,800	6,275
210	125	79	6,000	7,550
315	125	117	7,250	9,750
600	125	125	11,950	14,575

CONCENTRATOR, DENVER-BUCKMAN

(Units include 5 only 6′x6′ decks per units with pulp distributor, launders, gearmotor and drive) **(See Page 45)**

Number of Units	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
1	1	4,150	$ 3,900
2	1	8,300	7,775
4	1	16,600	15,510

CONCENTRATORS, SPIRAL

(Includes cast iron feed box, concentrate collecting pipe, splitters, water scoops and discharge box)

Size	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
5 Turn	850	$550

Bulletins or other descriptive material giving details and specifications as well as up-to-date prices will be sent on request.

CONDITIONERS (See Page 46)

(With steel tanks, stand pipe and wearing plate, motor and drive)

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
3′ x 3′	1½	760	$ 550
4′ x 4′	2	1,300	775
5′ x 5′	3	1,745	1,000
6′ x 6′	3	2,175	1,225
7′ x 7′	5	2,725	1,450
8′ x 8′	5	3,280	1,650
10′ x 10′	7½	4,480	2,350

CONVEYORS, BELT (See Page 47)

(For speed of 200 feet per minute. Includes rubber covered conveyor belts, idlers, pulleys, bearings, take-ups, motor and drive)

Size	Motor HP Up to 100′ Long	Approx. Shipping Wt. (lbs.)	Add per ft. of Additional Length-lb.	Approx. Price F.O.B. Factory	Add per ft. Additional Length
14″ x 15′	3	1,150	12	$ 835	$12
16″ x 15′	5	1,325	14	965	13
18″ x 15′	5	1,500	15	1,035	14
20″ x 15′	7½	1,750	17	1,175	15
24″ x 15′	10	2,525	21	1,595	17
30″ x 15′	15	2,800	27	1,800	22
36″ x 15′	20	3,500	31	2,225	25
42″ x 15′	25	4,700	55	3,000	46
48″ x 15′	30	5,800	65	3,675	53

CRUSHERS, CONE

(Includes motor and drive)

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
2′	30	12,000	$ 9,420
3′	75	25,000	16,550
4′	150	56,600	29,160
5′6″	200	90,000	41,590
7′	300	175,000	66,980

Bulletins or other descriptive material giving details and specifications as well as up-to-date prices will be sent on request.

CRUSHERS, GYRATORY

(Includes motor and drive)

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
2′4″	75	17,000	$11,850
3′	125	30,500	18,000
4′	200	64,000	30,000

CRUSHERS, JAW (Steel Frame)

(Includes motor, motor base and drive) **(See Page 49)**

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
5″ x 6″	3	650	$ 725
8″ x 10″	10	2,700	1,625
10″ x 16″	20	6,100	2,750
10″ x 20″	25	6,300	3,975
10″ x 36″	50	13,000	7,100
15″ x 24″	50	14,500	8,225
18″ x 24″	50	14,500	8,725
18″ x 36″	60	21,000	10,650
21″ x 36″	75	25,000	12,375
25″ x 40″	100	36,500	17,050
32″ x 40″	125	47,000	23,600
48″ x 42″	150	144,100	71,300
48″ x 66″	250	270,000	114,500

CRUSHING ROLLS

(Belt driven—Less belts, less motors) **(See Page 63)**

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
24″ x 14″	20-25	8,500	$ 4,790
24″ x 20″	25-30	9,100	5,310
30″ x 14″	25-30	14,000	5,840
30″ x 18″	30-40	15,000	6,390
36″ x 16″	35-40	18,800	7,960
36″ x 20″	35-45	19,800	9,555
42″ x 16″	35-45	30,000	12,740
42″ x 24″	40-50	38,000	14,390
55″ x 24″	50-65	67,500	20,430
62″ x 24″	60-65	88,000	26,575
72″ x 24″	75-100	112,100	38,650

CRUSHING ROLLS, SAMPLE

(Includes motor, motor base and drive) **(See Page 239)**

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
10" x 6"	2	1,500	$ 885
12" x 8"	3	2,300	1,365
16" x 10"	5	3,850	2,245
20" x 12"	10	5,700	3,040

DISTRIBUTOR, REAGENT

(Lewers type. Includes motor and drive) **(See Page 66)**

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
No. 20	¼	350	$365

DISTRIBUTORS, PULP

(Self rotating) **(See Page 65)**

Size (diameter)	Number of Compartments	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
2′	4	560	$290
2′	8	640	330
3′	4	700	340
3′	8	780	380
4′	4	855	400
4′	8	935	435
5′	4	1,065	475
5′	8	1,240	550
6′	4	1,660	705
6′	8	1,850	785

NOTE: Prices are approximate and are for estimating purposes only. Please phone, write or wire—

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DRILLS, AIR

Drifter Type—Hand Feed

Bore Size	Weight (lbs.)	Approx. Price F.O.B. Factory
3	130	$730
3½	149	825
4	194	950

Drifter Type—Motor Feed

Bore Size	Weight (lbs.)	Approx. Price F.O.B. Factory
3	160	$ 925
3½	190	1,010
4	230	1,130

Jack Hammers or Sinker Drills

Bore Size	Weight (lbs.)	Approx. Price F.O.B. Factory
2¼	29	$305
2⅝	44	350
2⅝	55	370
3	85	420

Stopers—Self Rotating

Cylinder Bore	Weight (lbs.)	Approx. Price F.O.B. Factory
2¼	95	$670
2⅜	140	710
2½	165	735

DRYERS, ROTARY

(Direct Heat Type) **(See Page 71)**

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
18" x 10′	5	8,200	$ 5,650
24" x 15′	7½	12,900	7,450
36" x 20′	10	15,500	8,850
36" x 30′	10	18,100	10,100
48" x 30′	15	21,400	11,700
48" x 40′	15	24,700	13,300
54" x 30′	15	22,500	12,250
60" x 40′	15	31,100	16,300

DRYERS

ESTIMATING DRYER SIZE, CAPACITY AND PRICE

MATERIAL	Dia. x L.	Feed Rate Tons/24 Hrs.	Initial Moisture	Final Moisture	Type Burner	Shell H. P.	Fan H. P.	Type Dryer	Weight Pounds	Estimated Price $
Fluorspar Flot. Conc.	6′ 50′	236	15%	0.1%	Oil	15	10	Counter Current	63,200	29,400.00
Fluorspar Flot. Conc.	4′ 30′	119	12%	0%	Oil	5	5	Counter Current	16,000	8,300.00
Fluorspar Flot. Conc.	4′ 40′	105	10.8%	0%	Oil	7½	5	Counter Current	20,500	11,420.00
Fluorspar Flot. Conc.	5′ 40′	150	14%	0%	Oil	15	7½	Counter Current	32,000	19,010.00
Fluorspar Flot. Conc.	5′ 36′	50	10%	0%	Oil	7½	3	Counter Current	29,000	14,900.00
Feldspar Flot. Conc.	5′ 40′	240	12%	½%	Oil	15	10	Cen. Tube Counter Current	43,000	20,200.00
Spodumene Flot. Conc.	2½′ 20′	56	10%	3%	Oil	3	2	Con-current	7,400	7,180.00
Mica Flot. Conc.	2′ 16′	12½	20%	2%	Oil	3	2	Con-current	5,600	6,570.00
Fluorspar Flot. Conc.	5′ 48′	136	12%	0%	Oil	20	10	Counter Current	54,000	25,300.00
Lime Residue	6′ 40′	190	40%	5%	Oil	10	30	Con-current	41,000	21,800.00
Foundry Sand	3′ 25′	130	17%	0%	Gas	7½	10	Con-current	15,400	12,790.00
Foundry Sand	3′ 19′	48	10%	0%	Gas Oil	10	5	Con-current	12,500	11,100.00
Quartz—Feldspar	4′ 16′	325	10%	½%	Gas	7½	15	Counter Current	17,000	11,000.00
Perlite	4′ 40′	600	3½%	1%	Oil	15	15	Con-current	24,000	13,600.00
Dicalcium Phosphate	6′ 30′	56	17.4%	0%	Gas	7½	15	Counter Current	31,000	13,800.00
Lead Flot. Conc.	4′ 28′	240	10%	5%	Oil	10	5	Con-current	18,000	11,800.00
Bentonite	8′ 60′	384	20%	10%	Gas	60	30	Con-current	130,000	44,100.00
Foundry Sand	3½′ 24′	72	10%	½%	Oil	5	5	Counter Current	17,000	17,468.00
Coke	4′ 40′	138	13%	1%	Gas	20	10	Con-current	35,000	12,050.00
Glass Sand	2′ 12′	24	12%	0%	Oil	1½	1	Counter Current	6,650	8,035.00
Sulphur Flot. Conc.	4′ 30′	45	21%	1½%	Gas	7½	3	Con-current	15,100	10,970.00
Sulphur Flot. Conc.	5′ 30′	150	14%	1½%	Coal	7½	3	Con-current	29,500	19,500.00
Barite Flot. Conc.	3½′ 30′	220	10%	1%	Oil	5	7½	Con-current	14,000	10,150.00
Titanium and Zirconium Ore	5′ 40′	265	20%	.02%	Oil	7½	5	Counter Current	28,000	18,080.00
Pumice	5′ 50′	180	40%	5%	Oil	7½	5	Con-current	24,000	15,000.00
Pyrite Flot. Conc.	5′ 30′	240	10%	4%	Oil	10	7½	Con-current	26,000	16,350.00
Pyrite Flot. Conc.	7′ 35′	480	10%	4%	Oil	20	15	Con-current	47,000	23,600.00
Phosphate Flot. Conc.	5′ 80′	96	25%	0%	Oil	40	20	Con-current	84,000	31,800.00
Zirconium Hydroxide Filter Conc.	3½′ 26′	12	85%	1%	Gas	3	5	Con-current	10,500	12,450.00
Flake Elemental Iron	2′ 12′	8	25%	0%	Gas	½	.....	Counter Current	4,200	5,790.00
Silica Sand	2½′ 8′	60	7%	2%	Oil	2	.....	Con-current	6,087	3,945.00
Foundry Sand	4′ 20′	212	15%	1%	Oil	5	7½	Con-current	19,900	11,875.00
Basnasite Flot. Conc.	2′ 12′	33.4	12%	2%	Oil	2	1½	Indirect Heat	7,792	10,810.00

ELECTRIC GENERATOR SETS, DIESEL

(Includes base, speed control, radiator, fan and fuel tank)

Size in KW (Continuous Duty)	Approx. Shipping Weight (lbs.)	Approx. Price F.O.B. Factory
19	3,500	$ 4,500
27	4,700	5,200
40	6,000	6,800
50	7,500	8,200
75	9,500	10,500
100	12,500	14,000
145	15,000	16,500
200	17,500	23,500
260	20,000	25,500

GENERATOR SETS, see Electric Generators

DIESEL ELECTRIC SETS, see Electric Generators

ENGINES, DIESEL

(With radiator, fan, sub base, clutch and fuel tank)

Size in Brake HP (Continuous Duty)	Approx. Shipping Weight (lbs.)	Approx. Price F.O.B. Factory
30	3,000	$ 2,750
40	3,900	3,500
75	4,800	4,200
110	8,000	7,100
140	11,300	10,400
200	13,000	14,000
300	16,000	19,000
380	18,000	22,000

FEEDERS, DRY REAGENT (Belt Type)

(Includes motor and drive) **(See Page 86)**

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
6″ x 6′	¼	470	$400
9″ x 9′	¼	625	450
12″ x 12′	½	1000	650
15″ x 15′	½	1265	775
18″ x 18′	½	1415	850

FEEDERS, DRY REAGENT (Cone Type)

(Includes motor and drive) **(See Page 86)**

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
6″	¼	140	$160
12″	¼	185	220
18″	½	380	350
24″	½	685	425
36″	½	1615	900

(Note: These feeders can all be equipped with electric vibrator for special application)

FEEDERS, ORE, ADJUSTABLE STROKE BELT

(Includes motor and drive) **(See Page 77)**

Size	Motor HP	Add Extra Per Foot Length Lbs.	Add Extra Per Foot Length Price	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
12″ x 10′	½	80	$51	1,200	$ 675
16″ x 10′	1	85	53	1,600	765
20″ x 10′	1½	90	57	1,775	910
24″ x 10′	1½	95	59	1,800	1,050
30″ x 10′	2	100	62	2,125	1,400
36″ x 10′	2	115	70	2,225	1,510

FEEDERS, ORE (Apron Type)

(Includes motor and drive) **(See Page 78)**

Size	Motor HP	Add Extra Per Foot Length Lbs.	Add Extra Per Foot Length Price	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
18″ x 10′	2	415	$170	6,700	$ 2,625
24″ x 10′	2	475	195	7,700	3,050
30″ x 10′	5	550	220	8,700	3,950
36″ x 10′	5	620	245	10,100	4,600
42″ x 10′	5	720	270	11,200	5,250
48″ x 20′	7½	840	320	21,400	9,500
54″ x 30′	10	1,250	425	50,500	19,650

Bulletins or other descriptive material giving details and specifications as well as up-to-date prices will be sent on request.

FEEDERS, ORE (Continuous Weighing Belt Type)

(Includes motor and drive)

Belt Width	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
16″	3,000	$3,200
24″	3,000	3,300
30″	3,000	3,400

FEEDERS, WET REAGENT

(Includes motor and drive) **(See Page 89)**

Size	Number of Compartments	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
No. 12	1	1/20	135	$ 140
No. 12	2	1/20	230	225
No. 12	3	¼	535	480
No. 12	6	¼	995	875
No. 24	1	¼	385	340
No. 24	3	½	1,000	1,110
No. 24	6	¾	1,865	2,125
No. 36	1	¼	610	455
No. 36	3	½	1,855	1,480

FILTERS, DISC (See Page 92)

(Includes motor and drive but not vacuum equipment)

Diam.	Number of Discs	Motor HP	Approx. Filter Area sq. ft.	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
2′	1	¼	4.5	430	$ 1,360
2′	3	½	13.5	750	2,160
4′	2	¾	44	1,950	2,240
4′	4	1	88	2,800	3,025
6′	2	1	100	4,500	3,510
6′	4	1½	200	5,500	4,640
6′	8	3	400	9,550	8,430
6′	10	3	500	11,050	10,150
9′	8	3	3,200	28,000	10,990
12½′	6	3	11,100	40,300	21,750

NOTE: Prices are approximate and are for estimating purposes only. Please phone, write or wire—

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FILTERS, DRUM

(Does not include motor, drive, oscillating agitator mechanism or vacuum equipment) **(See Page 94)**

Size	Motor HP	Approx. Filter Area sq. ft.	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
1½′ x 1′	½	4.66	750	$ 1,010
3′ x 2′	¾	18	2,600	1,400
4′ x 2′	1	25	3,100	2,140
4′ x 4′	1½	50	4,700	2,725
4′ x 6′	1½	75	6,300	3,120
6′ x 4′	2	75	9,500	5,980
6′ x 6′	3	110	10,900	7,740
8′ x 8′	3	200	20,000	9,950
8′ x 10′	3	250	22,000	10,230
10′ x 12′	4	375	29,000	18,550
10′ x 14′	5	435	30,100	19,400
12′ x 12′	7½	450	34,000	20,200

(Note: Fluorspar filters are special and cost approximately 10% higher. Use next larger size vacuum equipment for fluorspar filtering.)

FILTERS, PAN

(Vacuum equipment is not included) **(See Page 95)**

Size		Approx. Filter Area, sq. ft.	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
3′ x 3′	Simplex	9	300	$200
3′ x 3′	Duplex	18	650	350
4′ x 4′	Simplex	16	500	260
4′ x 4′	Duplex	32	950	460
5′ x 5′	Simplex	25	750	350
5′ x 5′	Duplex	50	1,350	630

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FILTER VACUUM EQUIPMENT (See Page 212)

(Includes vacuum pump, blower, filtrate receiver, moisture trap, filtrate pump and motors, motor bases and drives)

Size C.F.M. Range	Total Motor H.P.	Approx. Shipping Weight (lbs.)	Approx. Price F.O.B. Factory
26-35	2¾	825	$ 825
36-95	6	1,525	1,400
96-125	6	1,600	1,450
126-145	9	1,750	1,575
146-185	11½	3,150	2,400
186-320	18	4,900	3,575
321-450	24½	5,550	3,900
451-750	32	6,950	4,700
751-1200	48	10,000	6,250

FLOTATION MACHINES, DENVER "SUB-A"

(Includes rubber wearing parts, motors and drives) **(See Page 97)**

Size	Number of Cells	Total Motor H.P.	Approx. Shipping Wt. (lbs.)*	Approx. Price F.O.B. Factory
No. 8 (16x16)	2	1½	1,100	$ 900
No. 8 (16x16)	4	3	1,950	1,650
No. 8 (16x16)	8	6	3,650	3,100
No. 12 (22x22)	2	2	1,900	1,100
No. 12 (22x22)	4	4	3,700	2,000
No. 12 (22x22)	8	8	7,200	3,800
No. 15 (24x24)	2	3	2,300	1,150
No. 15 (24x24)	4	6	4,250	2,100
No. 15 (24x24)	8	12	8,250	4,050
No. 18 (28x28)	2	5	3,950	1,350
No. 18 (28x28)	4	10	5,450	2,450
No. 18 (28x28)	8	20	10,950	4,700
No. 18 Sp. (32x32)	2	5	3,650	1,500
No. 18 Sp. (32x32)	4	10	6,900	2,800
No. 18 Sp. (32x32)	8	20	17,700	5,400
No. 21 (38x38)	2	7½	4,850	1,900
No. 21 (38x38)	4	15	9,850	3,500
No. 21 (38x38)	8	30	20,100	6,800
No. 24 (43x43)	2	10	6,150	2,150
No. 24 (43x43)	4	20	24,850	7,700
No. 24 (43x43)	8	40	31,200	9,600
No. 30 (56x56)	2	20	14,200	4,550
No. 30 (56x56)	4	40	27,000	8,400
No. 30 (56x56)	8	80	53,000	16,100

*Note heavy construction

FLOTATION, UNIT CELLS (Denver "Sub-A")

(Includes motor drive, rubber wearing parts and heavy-duty mechanism for coarse flotation) **(See Page 96)**

Size	Motor HP	Approx. Shipping Wt. (lbs.)*	Approx. Price F.O.B. Factory
No. 25 (16x16)	1	725	$ 700
No. 50 (22x22)	1½	800	750
No. 100 (24x24)	2	1,300	800
No. 250 (32x32)	5	1,900	1,025
No. 500 (38x38)	7½	2,800	1,300
No. 750 (43x43)	10	3,400	1,575
No. 1500 (56x56)	15	8,000	2,550

*Note heavy construction

GATES, BIN (For Ore Bins) (See Page 109)

Size	Approx. Shipping Wt.	Approx. Price F.O.B. Factory
18"x24" Single Rack & Pinion	160 lbs.	$ 70
20"x30" Single Rack & Pinion	190 lbs.	75
24"x30" Single Rack & Pinion	220 lbs.	80
30"x36" Single Rack & Pinion	250 lbs.	90
18"x24" Double Rack & Pinion	180 lbs.	80
20"x30" Double Rack & Pinion	220 lbs.	85
24"x30" Double Rack & Pinion	250 lbs.	90
30"x36" Double Rack & Pinion	300 lbs.	100

NOTE: Prices are approximate and are for estimating purposes only. Please phone, write or wire—

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GRIZZLIES (See Page 12)

Size	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
1′ x 4′	100	$ 95
2′ x 6′	420	120
3′ x 6′	630	325
4′ x 8′	2,200	480

GRINDER, DETACHABLE BIT, Motor Driven

(Grinder with two grinding wheels, one for bit gaging and the other for face grinding)

Size	Weight	Approx. Price F.O.B. Factory
No. 1	1,450	$1,530

HOISTS

(Single drum with gasoline engine)

Line Pull	Line Speed	HP	Weight	Approx. Price F.O.B. Factory
1500#	125′	8	750	$ 625
2000#	150′	14	1,100	960
2500#	180′	18	1,300	1,050
3050#	200′	27	1,950	1,265
4200#	200′	45	2,100	1,610

HOISTS

(Double Drum with electric motor—differential load is approximately line pull of lifting drum.)

Line Pull Lifting Drum	Line Speed	H.P.	Weight	Approx. Price F.O.B. Factory
2750#	310	20	5500	$ 4,800
3600#	340	30	8000	6,500
4500#	370	40	12000	9,200
6500#	400	60	27000	19,100
8500#	400	75	36000	27,500
12500#	450	125	55000	32,800

HOISTS, HAND OPERATED

2 Ton Lightweight Hoists

(2 ton load requires ½" cable)

Drum Sizes Diam.	Width	Flange	Drum Capacities, Ft. ¼"	⅜"	½"	⅝"	¾"	Approximate Shipping Weight	Approximate Price F.O.B. Factory
4"	6"	2¼"	300′	200′	150′	100′	75′	70#	$ 80
4"	10"	2¼"	575′	360′	250′	175′	135′	85#	90

5 Ton General Utility Hoist Hoist can be driven with electric motor, air motor, gasoline engine or oil engine drive.

(5 ton load requires ¾" cable)

Drum Sizes Diam.	Width	Flange	Drum Capacities, Ft. ⅜"	½"	⅝"	¾"	Approximate Shipping Weight	Approximate Price F.O.B. Factory
5"	8"	3⅝"	445′	325′	250′	160′	125#	$100
5"	12"	3⅝"	675′	500′	385′	240′	145#	110
5"	16"	3⅝"	890′	650′	500′	320′	170#	125
5"	24"	3⅝"	1335′	975′	750′	480′	200#	135

HOSE, AIR

(Heavy duty for mine service)

Size	Wt./Ft.	Approximate Price/Ft.	Size	Wt./Ft.	Approximate Price/Ft.
½"	.55	$0.60			
1"	.91	0.89	¾"	.70	0.78

JIGS, DENVER MINERAL (See Page 121)

(Includes motor, drive and initial bedding charge)

Size		Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
8" x 12"	Simplex	½	550	$ 600
8" x 12"	Duplex	¾	800	1,025
12" x 18"	Duplex	1	1,600	1,200
16" x 24"	Duplex	1½	2,000	1,550
24" x 36"	Duplex	2	3,900	2,450
36" x 48"	Simplex	3	3,200	2,375
36" x 48"	Duplex	5	6,200	4,625

JIGS, HARZ TYPE (See Page 120)

(Includes steel tanks and special heavy-duty mechanism and plunger as well as motor and drive)

Size		Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
18"x32"	(2 Comp.)	1½	2,600	$1,280
18"x32"	(4 Comp.)	3	4,600	2,100
24"x36"	(2 Comp.)	2	3,900	1,790
24"x36"	(4 Comp.)	5	7,000	2,880
30"x36"	(2 Comp.)	3	5,300	2,170
30"x36"	(4 Comp.)	5	9,600	3,560

LOCOMOTIVES, MINE

Size	Type	Approximate Shipping Weight	Approximate Price F.O.B. Factory
9 Ton	Battery Type	19,000 lbs.	$21,000
12 Ton	Battery Type	26,000 lbs.	24,000

DIESEL LOCOMOTIVES

1½ Ton	2 Cyl.	3,000	$6,500
3 Ton	4 Cyl.	7,000	8,000

MAGNETIC HEAD PULLEYS

(Electro Magnetic)

(Does not include generator or rectifier)

Dia.	Belt Width	Watts	Weight	Approx. Price F.O.B. Factory
12"	12"	400	325	$ 550
12"	18"	500	400	725
18"	18"	950	900	1,025
18"	30"	1,400	1,200	1,650
24"	24"	1,500	1,800	1,875
24"	42"	2,850	2,800	3,025
36"	36"	3,000	5,560	5,050
36"	60"	5,200	8,000	7,250
48"	48"	4,950	12,600	11,200
48"	60"	6,600	17,650	12,150

MAGNETIC HEAD PULLEYS

(Permanent Magnet Type)

Pulley Diameter	Belt Width	Approx. Shipping Weight lbs.	Approx. Price F.O.B. Factory
12"	12"	225	$ 525
12"	18"	280	725
18"	18"	500	1,225
18"	30"	850	2,025
24"	24"	1,250	2,300
24"	42"	2,000	3,750
36"	36"	4,560	7,150
36"	60"	6,120	11,900
42"	42"	6,050	11,150
42"	60"	6,825	15,950

MAGNETS, PERMANENT

(Suspended Type)

Magnetic Width	Approx. Price F.O.B. Factory	Magnetic Width	Approx. Price F.O.B. Factory
6"	$ 70	36"	370
12"	130	48"	500
18"	190	60"	620
24"	250		

MOTORS, ELECTRIC, AND MOTOR BASES

Horse power	Approx. Full Load Speed		Phase	Cycles	Volts	Approx. Shipping Wt. Lbs.	Approx. Price F.O.B. Factory
½	1725		1	60	115	15	$ 25
1/6	1725		1	60	115	25	25
¼	2500-500		1	60	115	32	55
¼	1725		1	60	115	36	27
¼	1140		1	60	115	47	54
½	1725		1	60	115	70	50
½	1140		1	60	115	85	75
¾	1725		1	60	115	75	65
SQUIRREL CAGE, Open Frame							
½	1725		3	60	220/440	53	55
½	1140		2	60	220/440	57	75
¾	1725		"	"	"	57	70
¾	1140		"	"	"	77	95
Including motor base							
		Frame No.					
1	1750	203	3	60	220/440	99	100
1	1165	204	"	"	"	108	115
1½	1750	204	"	"	"	108	115
1½	1165	224	"	"	"	131	130
2	1750	224	"	"	"	131	130
2	1165	225	"	"	"	147	140
3	1750	225	"	"	"	147	140
3	1165	254	"	"	"	194	170
5	1750	254	"	"	"	194	170
5	1165	284	"	"	"	259	225
7½	1750	284	"	"	"	250	225
7½	1165	324	"	"	"	346	280
		Motor Frame					
10	1750	324	3	60	220/440	346	280
10	1165	326	"	"	"	392	330
15	1750	326	"	"	"	392	330
15	1165	364	"	"	"	522	435
20	1750	364	"	"	"	522	435
20	1165	365	"	"	"	595	525
25	1750	364	"	"	"	522	525
25	1165	404	"	"	"	831	650
30	1750	365	"	"	"	595	575
30	1165	405	"	"	"	887	740
40	1750	404	"	"	"	831	710
40	1165	444	"	"	"	1150	920

MOTORS, ELECTRIC, AND MOTOR BASES

Horse power	Approx. Full Load Speed		Phase	Cycles	Volts	Approx. Shipping Wt. Lbs.	Approx. Price F.O.B. Factory
		Motor Frame					
50	1750	405-5	3	60	220/440	887	845
50	1165	445	"	"	"	1313	995
60	1750	444-5	"	"	"	1150	1,050
60	1165	504-U	"	"	"	1664	1,455
75	1750	445-S	"	"	"	1310	1,275
75	1165	505	"	"	"	1830	1,460
100	1750	504-S	"	"	"	1478	1,535
100	1165	6323-S	"	"	"	1783	2,065
WOUND ROTOR, Open Frame							
		Open Frame					
30	1740	404	3	60	220/440	992	1,200
30	1160	444	"	"	"	1246	1,310
30	865	445	"	"	"	1494	1,525
40	1740	405	"	"	"	1042	1,410
40	1160	445	"	"	"	1493	1,525
40	865	504-U	"	"	"	1865	1,795
		Frame No.					
50	1740	444-S	3	60	220/440	1344	1,560
50	1160	504-U	"	"	"	1865	1,795
50	865	505	"	"	"	2031	1,830
60	1740	445-S	"	"	"	1494	1,820
60	1160	505	"	"	"	2031	2,015
60	865	6323	"	"	"	2127	2,180
75	1740	504-S	"	"	"	1679	2,075
75	1160	6323	"	"	"	2127	2,265
75	865	6324	"	"	"	2421	2,525
100	1740	505-S	"	"	"	1840	2,430
100	1160	6324-S	"	"	"	2421	2,735
100	865	6325	"	"	"	2714	3,035
125	1740	6324-S	"	"	"	2243	2,780
125	1160	6325-S	"	"	"	2530	3,105
125	865	6333	"	"	"	3082	3,145
150	1740	6325-S	"	"	"	2530	3,145
150	1160	6333-S	"	"	"	2875	3,570
150	865	6334-S	"	"	"	3577	3,955
200	1740	6334-S	"	"	"	3335	3,850
200	1160	6334-S	"	"	"	3335	4,150
200	865	6335-S	"	"	"	4226	4,830

RATING				PRICES—BARE MOTOR ONLY								PRICE	DATA	
A. C.—60 AND ●50 CYCLES 3 OR 2 PHASE CONTINUOUS DUTY				Open 40° C.				Splash Proof 50° C.		Totally Enclosed Fan Cooled 55° C. Type SC Ball Bearing		Addition For Base or Rail	Approx. F. L. Amps. 220 V. SC 3 Phase	Approx. Weight Lbs. Shipping Open SC
				TYPE SC		TYPE SCH								
FRAME	HP	F. L. RPM Appx.	VOLTS	Sleeve Bearing	Ball Bearing	Sleeve Bearing	Ball Bearing	Type SC Ball Bearing	Type SCH Ball Bearing	Standard	Explosion Proof			
63L	1/4	1740	220	$55.15	$60.10					$68.35			0.9	28
63L	1/3	1730	220	62.05	67.00					76.30			1.2	32
81	1/2	1735	220 440	78.35	83.30					95.05			1.8	51
81	3/4	1735	220 440	100.30	105.25					120.30			2.4	51
203	1	1735		117.	117.			$129.		150.	$198.	$18.	3.2	64
204		1150		138.	138.			150.		176.	228.	18.	3.1	71
225		855		187.	187.			201.		203.	255.	18.	3.8	146
203	1½	3500			124.			136.		192.	244.	♣ 18.	4.2	64
204		1740		138.	138.			150.		176.	228.	18.	4.4	71
224		1150		160.	160.			174.		194.	246.	18.	4.4	121
254		870		223.	223.			241.		245.	313.	24.	5.2	200
204	2	3500			152.			164.		204.	252.	♣ 18.	5.4	71
224		1740		160.	160.			174.		212.	264.	18.	5.6	121
225		1155		178.	178.			192.		234.	300.	18.	5.6	146
254		870		258.	258.			276.		324.	396.	24.	6.8	200
224	3	3460			176.			190.		246.	298.	♣ 18.	8.	121
225		1740		178.	178.			192.		248.	300.	18.	8.	146
254		1160		212.	212.	$223.	$223.	230.	$241.	296.	364.	24.	8.2	200
284		855		292.	292.	307.	307.	316.	331.	410.	482.	30.	9.4	299
225	5	3440	●208; 220 440 550		196.			210.		266.	318.	♣ 24.	12.6	146
254		1740		212.	212.	223.	223.	230.	241.	296.	364.	24.	12.8	200
284		1150		278.	278.	292.	292.	302.	316.	396.	468.	30.	13.6	299
324		860		370.	370.	389.	389.	402.	421.	532.	624.	40.	13.	403
254	7½	3470			233.			251.		317.	385.	♣ 18.	18.	200
284		1730		278.	278.	292.	292.	302.	316.	396.	468.	30.	18.6	299
324		1160		352.	352.	370.	370.	384.	402.	514.	606.	40.	20.	403
326		860		443.	443.	465.	465.	475.	497.	605.	697.	40.	22.	466
284	10	3470			306.			330.		424.	496.	♣ 24.	24.	299
324		1735		352.	352.	370.	370.	384.	402.	514.	606.	40.	26.	403
326		1160		422.	422.	443.	443.	454.	475.	584.	676.	40.	26.	466
364		870		556.	556.	598.	598.	608.	650.	790.	926.	50.	28.	644
324	15	3500			405.			437.		567.	659.	♣ 40.	36.	403
326		1735		422.	422.	443.	443.	454.	475.	584.	676.	40.	36.	466
364		1160		556.	556.	598.	598.	608.	650.	790.	926.	50.	39.	644
365		875		682.	682.	733.	733.	734.	785.	966.	1102.	50.	40.	698

♣326	20	3500			485.			517.		647.	739.	♣	47.	466
364		1740		556.	556.	598.	598.	608.	650.	790.	926.	50.	50.	644
365		1150		682.	682.	733.	733.	734.	785.	966.	1102.	50.	50.	698
484		860		848.	848.	912.	912.	932.	996.	1184.	1384.	60.	50.	840
+364S	25	3500			667.			719.		1018.	1154.	+	61.	621
364		1740		653.	653.	702.	702.	705.	754.	937.	1073.	50.	60.	644
404		1165		848.	848.	912.	912.	932.	996.	1184.	1384.	60.	64.	840
405		865		972.	972.	1045.	1045.	1056.	1129.	1388.	1588.	60.	62.	932
+364S	30	3500			743.			795.		1156.	1356.	+	72.	621
365		1750		750.	750.	806.	806.	802.	858.	1086.	1286.	50.	72.	698
405		1165		972.	972.	1045.	1045.	1056.	1129.	1388.	1588.	60.	76.	932
444		865		1214.	1214.	1396.	1396.	1336.	1518.			72.	74.	1035
+365S	40	3500			818.			870.		1316.	1516.	+	96.	675
404		1760		933.	933.	1003.	1003.	1017.	1087.	1349.	1549.	60.	94.	840
444		1165		1214.	1214.	1396.	1396.	1336.	1518.			72.	96.	1035
445		865		1456.	1456.	1674.	1674.	1578.	1796.			72.	98.	1162
+404S	50	3500			1102.			1186.		1750.	2024.	+	117.	799
♣405S		1760		1118.	1118.	1202.	1202.	1202.	1286.			♣ 60.	114.	891
445		1165		1456.	1456.	1674.	1674.	1578.	1796.			72.	120.	1162
504U		870		1788.	1788.	2056.	2056.	1974.	2242.			96.	126.	1564
+405S	60	3500			1264.			1348.				+	140.	891
♣445S		1760		1396.	1396.	1605.	1605.	1518.	1727.			♣ 72.	138.	989
504U		1170		1788.	1788.	2056.	2056.	1974.	2242.			96.	142.	1564
585		870		2150.	2150.	2473.	2473.	2336.	2659.			96.	146.	1783
+445S	75	3500	●208; 220; 440; 550		1700.			1822.				+	172.	989
♣455S		1760		1674.	1674.	1925.	1925.	1796.	2047.			♣ 72.	170.	1116
585		1170		2150.	2150.	2473.	2473.	2336.	2659.			96.	174.	1564
584		870		2552.	2580.	2935.	3082.	2935.	3375.			102.	177.	2475
+445S	100	3500			2184.			2306.				+	230.	1116
+504S		1760		2146.	2146.	2468.	2468.	2332.	2654.			+	220	1495
♣584S		1170		2752.	2890.	3165.	3323.	3165.	3640.			♣102	238	2475
585		870		3190.	3350.	3569.	3852.	3669.	4219.			136.	240.	2750
+504S	125	3500			2861.			3047.				+	276.	1495
+505S		1760		2580.	2580.	2967.	2967.	2766.	3153.			+	274.	1714
♣585S		1170		3354.	3522.	3857.	4059.	3857.	4436.			♣186	280.	2750
586		870		3758.	3946.	4322.	4538.	4322.	4970.			186.	300.	3025
+505S	150	3500			3655.			3841.				+	332.	1714
+585S		1760		3110.	3266.	3577.	3756.	3577.	4114.			+	336	2750
+586S		1170		3922.	4118.	4510.	4736.	4510.	5187.			+	332	3025
♣682S		880		4312.	4528.	4959.	5207.	4959.	5703.			♣186	355.	3630
+586S	200	1775		3922.	4171.	4568.	4796.	4568.	5253.			+	446.	3025
+682S		1180		4854.	5097.	5582.	5861.	5582.	6419.			+	452	3630
♣684S		880		5376.	5645.	6182.	6491.	6182.	7109.			♣254	470	4235

RATING				PRICES—BARE MOTOR ONLY								PRICE	DATA	
A. C.—60 AND 850 CYCLES 3 OR 2 PHASE CONTINUOUS DUTY				Open 40° C.				Splash Proof 50° C.		Totally Enclosed Fan Cooled 55° C. Type SC Ball Bearing		Addition for Base or Rails [1]	Approx. F. L. Amps. 220 V. SC 3 Phase	Approx. Weight Lbs. Shipping Open SC
				TYPE SC		TYPE SCH								
FRAME	HP	F. L. RPM Appx.	VOLTS	Sleeve Bearing	Ball Bearing	Sleeve Bearing	Ball Bearing	Type SCH Ball Bearing	Type SCHH Ball Bearing	Standard	Explosion Proof [1]			
♦♣4825	250	1775	440	4560	4788	5244	5506	5244	6031			+++	560	3630
♦♣4845		1180	550	5136	5393	5906	6201	5906	6792				550	4235
♦♣4865		880	2300	5632	5914	6477	6801	6477	7449				590	4840
♦♣4845	300	1775	440	5248	5510	6035	6337	6035	6940			+++	670	4235
♦♣4865		1180	550	5824	6115	6698	7033	6698	7703				760	4840
♦♣4865	350	1775	2300	5858	6151	6737	7074	6737	7748			+++	780	4840
♦♣4865	400	1775		6528	6854	7507	7882	7507	8633				890	

REFERENCE NOTES

- All open Type 40 deg. C. general purpose squirrel cage, 60 cycle polyphase motors will operate without injurious heating on 50 cycle circuits of the same voltage at 5/6 of 60 cycle speed.
- Listed with standard short shaft for direct connection; may be supplied with standard long shaft for use, with base, for Multi-V-Belt drive.
- Recommended for direct connection only. Prices are for motors with standard short shaft.
- Recommended for direct connection only. Prices are for motors with standard long shaft.
- These motors are compound wound.

1. These prices are for motors with Underwriters' Label for Class I, Group D or Class II, Groups E, F and G installations.
2. 505 (516 for DC) and smaller, use base. Larger use rails.
3. Totally enclosed, not fan cooled.
4. Requires next larger frame size.
5. Requires second larger frame.
6. For 230 volts add $3.75.
7. For 230 volts add $5.00.
8. 220 volt Type SC motors will operate successfully on 208 volt circuits.

PRICES AND DATA SUBJECT TO CHANGE WITHOUT NOTICE

Century

TYPE SR—WOUND ROTOR INDUCTION MOTOR

A. C.—60 CYCLE—3 OR 2 PHASE—CONTINUOUS DUTY

RATING				PRICES				DATA	
				BARE MOTOR ONLY					
				OPEN 40° C.		Splash Proof 50° C. Ball Bearing	Add for Base or Rails [1]	Approx. F. L. Amps.	Approx. Weight Lbs. Shipping Open Sleeve Bearing
FRAME	HP	F. L. RPM Appx.	VOLTS	Sleeve Bearing	Ball Bearing			220 V. 1 HP and Larger	
224	2	1730	208 220 440 550	$435.	$435.	$449.	$18.	6.2	170
225		1125		482.	482.	496.	18.	8.6	196
254		845		642.	642.	660.	24.	9.6	261
225	3	1735		482.	482.	496.	18.	8.6	196
254		1140		552.	552.	570.	24.	9.6	261
284		875		704.	704.	728.	30.	13.	352
254	5	1725		552.	552.	570.	24.	12.8	261
284		1140		670.	670.	694.	30.	15.6	352
324		850		846.	846.	878.	40.	18.4	458
284	7½	1730		670.	670.	694.	30.	20.	352
324		1140		806.	806.	838.	40.	23.	458
326		860		968.	968.	1000.	40.	25.4	573
324	10	1725		806.	806.	838.	40.	27.	458
326		1150		922.	922.	954.	40.	28.	573
365		860		1158.	1158.	1210.	50.	33.	845
326	15	1730		1014.	1014.	1046.	40.	38.	573
365		1150		1158.	1158.	1210.	50.	42.	845
404		860		1404.	1404.	1488.	60.	43.5	1242
364	20	1745		1173.	1173.	1225.	50.	50.	710
404		1160		1404.	1404.	1488.	60.	53.	1242
405		870		1592.	1592.	1676.	60.	55.	1277
365	25	1740		1332.	1332.	1384.	50.	63.	845
405		1165		1592.	1592.	1676.	60.	64.	1277
444		870		1756.	1756.	1878.	72.	68.	1477
404	30	1745		1615.	1615.	1699.	60.	74.	1242
444		1160		1756.	1756.	1878.	72.	76.	1477
445		870		2060.	2060.	2182.	72.	80.	1505
405	40	1760		1910.	1910.	1994.	60.	98.	1277
445		1150		2060.	2060.	2182.	72.	100.	1505
504U		875		2416.	2416.	2602.	96.	104.	1993
♣4445	50	1765		2107.	2107.	2229.	♣ 72.	118.	1505
504U		1170		2416.	2416.	2602.	96.	120.	1993
505		870		2718.	2718.	2904.	96.	126.	2093
♣4455	60	1755		2472.	2472.	2594.	♣ 72.	146.	1993
505		1170		2718.	2718.	2904.	96.	142.	2093
584		880		2954.	3012.	3397.	96.	150.	2530
♣5045	75	1760	208 220 440 550	2899.	2899.	3085.	♣ 96.	174.	2093
584		1165		3072.	3226.	3533.	102.	180.	2530
584		875		3426.	3597	3940.	102.	194.	2530
+505S	100	1750		3398.	3398.	3584.	+	230.	2530
♣5845		1170		3718.	3904.	4276.	♣102.	238.	2530
585		880		4110.	4316.	4727.	136.	250.	2805
+5845	125	1765		3888.	4082.	4471.	+	294.	2530
♣5855		1170		4338.	4555.	4989.	♣136.	292.	2805
586		880		4750.	4988.	5463.	186.	304.	3080
+5855	150	1760		4398.	4618.	5058.	+	350.	2805
+5865		1170		4988.	5237.	5736.	+	354.	3080
♣6825		880		5340.	5607.	6141.	♣186.	360.	3795
+5865	200	1760		5380.	5649.	6187.	+	440.	3080
+6825		1170		5802.	6092.	6672.	+	462.	3795
♣6845		880		6498.	6823.	7473.	♣254.	480.	4400
+6825	250	1750		5700.	5985.	6555.	+	560.	3795
+6845		1170		6420.	6741.	7383.	+	554.	4400
+6865		880		7040.	7392.	8096.	+	600.	5005
+6845	300	1750	440 550 or 2300	6560.	6888.	7544.	+	660.	4400
+6865		1170		7280.	7644.	8372.	+	660.	5005
+6865	350	1750		7323.	7689.	8421.	+	770.	5005
+6865	400	1750		8160.	8568.	9384.	+	900.	5005

200 HP & SMALLER C-7
250 HP & LARGER C-9

DIRECT CURRENT MOTORS

D. C.—CONTINUOUS DUTY

RATING				PRICES					DATA	
				BARE MOTOR ONLY — Shunt Wound			ADD FOR			
				OPEN 40° C.		Splash Proof 50° C. Ball Bearing				
FRAME	HP	F. L. RPM Appx.	VOLTS	Sleeve Bearing	Ball Bearing		Compound Winding	Base or Rails	Approx. F. L. Amps. 230 V. 1 H.P. and Larger	Approx. Weight Lbs. Shipping Open Sleeve Bearing
65L	1/4	1750	115	▲$93.35					2.45	31
67L	1/3	1750	115	▲103.15					3.2	37
81	1/2	1750	115	▲121.50					4.4	60
82	3/4	1750	115	▲173.45					6.2	67
203	1	1750	↑	286.	$286.	$322.	$6.	$18.	4.1	92
204		1150		338.	338.	374.	6.	18.	4.2	104
204	1½	1750		326.	326.	362.	6.	18.	6.2	104
224		1150		388.	388.	442.	12.	18.	6.2	155
224	2	1750		364.	364.	400.	6.	18.	8.	155
225		1150		454.	454.	508.	12.	18.	8.2	175
225	3	1750		448.	448.	502.	12.	18.	11.8	175
254		1150		686.	686.	764.	20.	24.	11.6	276
254	5	1750		712.	712.	790.	20.	24.	19.	276
284		1150	115	870.	870.	992.	34.	30.	19.	366
284	7½	1750	or	860.	860.	982.	34.	30.	28.5	366
334		1150	230	1056.	1056.	1178.	34.	48.	29.	536
334	10	1750		990.	990.	1112.	34.	48.	38.	536
336		1150		1210.	1210.	1332.	34.	48.	39.	580
336	15	1750		1206.	1206.	1328.	34.	48.	55.	580
374		1150		1482.	1482.	1638.	54.	56.	57.	805
374	20	1750		1394.	1394.	1516.	34	48.	76.	805
375		1150		1728.	1728.	1884.	54.	56.	77.	955
374	25	1750		1570.	1570.	1726.	54.	56.	92.	805
454		1150	↓	1964.	1964.	2228.	102.	82.	91.	1380
375	30	1750	↑	1736.	1736.	1892.	54.	56.	112.	955
454		1150		2180.	2180.	2444.	102.	82.	108.	1380
454	40	1750		2026.	2026.	2290.	102.	82.	142.	1380
455		1150	230	2610.	2610.	2874.	102.	82.	142.	1495
♦455S	50	1750		2464.	2464.	2728.	102.	♦ 82.	176.	1495
514		1150	↓	3022.	3022.	3286.	102.	82.	179.	2070

C-7

GEAR MOTORS

TYPE 1R Single Reduction, Right Angle Shaft.

The following Type 1R single reduction, right angle gear motors are most commonly required. ⅛ to ¾ H. P. are available in speeds of 25, 30, 37, 45, 56, 68, 84, 100, 125, 155, 190, 230 and 280 RPM in ratings 1 to 3 H. P. speeds are as shown.

HP	RPM	With Single Phase Motor 60 Cycle 115/230 Volts — Open	Enclosed	With Three Phase* Motor 60 Cycle 220 or 440 Volts — Open	Enclosed
1/8	Any Speed Shown	$123.05	$130.55		
1/6	Any Speed Shown	137.00	144.50	$151.10	$158.60
1/4	25 and Higher	149.30	156.80	159.20	166.70
1/3	25 and Higher	167.90	177.90	170.85	180.85
1/2	25 and Higher	202.20	217.15	204.40	219.35
3/4	37 and Higher	226.25	243.70	229.60	247.05
1	45 through 280	271.00		264.00	
1	125 through 280		326.00		297.00
1	25, 30, 37	438.00		342.00	
1	25 through 100		512.00		380.00
1½	45 through 280	314.00	369.00	290.00	328.00
1½	25, 30, 37	507.00	580.00	350.00	384.00
2	45 through 280	409.00		350.00	
2	230, 280		483.00		402.00
3	125 through 280	481.00		382.00	

TYPE 1P Single Reduction, Parallel Shaft.

TYPE 2P Double Reduction, Parallel Shaft.

TYPE 2R Double Reduction, Right Angle Shaft.

Century

SINGLE PHASE MOTORS

RATING A. C.—60 CYCLE SINGLE PHASE CONTINUOUS DUTY — HP	F. L. RPM Appx.	VOLTS	OPEN 40° C. MOTORS / SPLASH PROOF 50° C. MOTORS — FRAME	PRICES BARE MOTOR ONLY — OPEN 40° C. Sleeve Bearing — Rigid Base	Sleeve Bearing — Cushion Base	Ball Bearing Rigid Base	Splash Proof 50° C. Ball Bearing	Add for Base	Approx. Weight Lbs. Shipping Open Motor	TOTALLY ENCLOSED FAN COOLED 55° C. BALL BEARING MOTORS — FRAME TEFC Std. Motor	PRICES BARE MOTOR ONLY — Standard	Explosion Proof (1) Class I, Group D Class II, Group E Class II, Group F Class II, Group G	Add for Base	Approx. Weight Lbs. Shipping TEFC Motor
TYPE SP-SPLIT PHASE INDUCTION MOTORS — GENERAL PURPOSE														
1/6	1750	115	63L	$31.25	$33.25				26	63L	$40.90			27
1/4	1750	115	65L	33.00	35.00				29	65L	42.90			30
1/3	1750	115	65L	38.45	40.45				29	67L	49.15			30
SPECIAL SERVICE														
1/4	1750	115	62G	$28.65	$30.65				26					27
1/3	1750	115	63G	29.85	31.85				29					30
TYPE CS-CAPACITOR START INDUCTION MOTORS														
1/6	1750	115	63L	$37.30	39.30	$42.25			29	63L	$47.85			30
1/4	1750	115	65L	41.45	43.45	46.40			35	65L	52.60			36
1/4	1750	↑	65L	45.05	47.05	50.00			35	65L	56.75			36
1/3	1750		65L	59.35	61.35	64.30			44	67L	73.20			45
1/2	1750		81	76.25	80.55	81.20			52	83	92.65			54
	1165		83	112.75	117.05				61	92	134.60			63
3/4	1750		83	97.65	101.95	102.60			61	92	117.25			63
	1165		204	223.	228.	223.	$236.	$21.	87	204	286.	$371.	$21.	142
1	1750		203	144.	149.	144.	157.	21.	74	204	207.	261.	21.	142
	1165		224	288.	310.	288.	304.	21.	138	225	373.	436.	21.	171
1½	1750		204	188.	193.	188.	201.	21.	90	204	251.	330.	21.	171
	1165		225	364.	386.	364.	380.	21.	161	225	449.	512.	21.	179
2	1750		224	253.	275.	253.	269.	21.	165	225	338.	401.	21.	171
	1165	115/230	254	533.		533.	555.	29.	258	254	634.	717.	29.	179
3	1750		225	320.	342.	320.	336.	21.	202	254	405.	468.	29.	280
	1165		284	646.		646.	668.	29.	291	284	747.	830.	36.	385
5	1750		254	533.		533.	555.	29.	258	284	634.	717.	36.	385
	1165	↓	324	754.		754.	790.	48.	258	324	952.	1062.	48.	520

SINGLE PHASE MOTORS

Century

TYPE RS-REPULSION START INDUCTION MOTORS
BRUSH-LIFTING

RATING A. C.—60 CYCLE SINGLE PHASE CONTINUOUS DUTY HP	F.L. RPM Appx.	VOLTS	FRAME	OPEN 40° C. MOTORS SPLASH PROOF 50° C. MOTORS — PRICES BARE MOTOR ONLY — OPEN 40° C. Sleeve Bearing Rigid Base	Sleeve Bearing Cushion Base	Ball Bearing Rigid Base	Splash Proof 50° C. Ball Bearing	Add for Base	Approx. Weight Lbs. Shipping Open Motor
1/2	1750	115 230	81	$84.70 ①		$89.65 ①			56
	1165		83	112.75 ①		117.70 ①			82
3/4	1750		83	108.50 ①		113.45 ①			67
	1165		204	223.		223.	$236.	$21.	84
1	1750		203	144.		160.	173.	21.	74
	1165		224	288.		288.	304.	21.	157
1½	1750		204	188.		209.	222.	21.	84
	1165		225	364.		364.	380.	21.	171
2	1750		224	253.		281.	297.	21.	155
	1165		254			533.	555.	29.	253
3	1750		225	320.		356.	372.	21.	175
	1165		284			646.	668.	29.	400
5	1750		254			533.	555.	29.	248
	1165		284			754.	790.	48.	400
7½	1750		284			754.	790.	48.	388
	1165		365			1069.		48.	690
10	1750		364			995.		48.	620
	1165		365			1321.		60.	690
15	1750		364			1321.		60.	620
20	1750		365			1651.		60.	690

REFERENCE NOTES

① These motors are with Underwriters' Label for Class I, Group D or Class II Groups E, F and G installations Capacitor unit is not explosion proof and must be mounted outside the hazardous area.

② Add $2.75 for automatic thermal overload protection.

③ Add $3.60 for automatic thermal overload protection.

④ 50° C.

⑤ Totally enclosed non-ventilated.

⑥ The high starting currents of these motors limit them for use only on domestic laundry machine and similar intermittent applications.

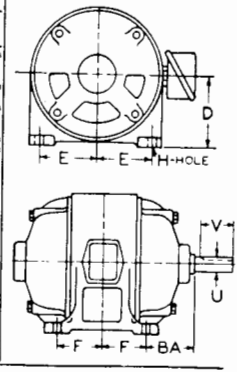
⑦ Requires next larger frame.

C-7A

DIMENSIONS

FRAME	DIMENSIONS IN INCHES Keyway	BA	D	E	F	H	U	V
62G, 63G 63L, 65L, 67L	3/64 R x 1/16 x 3/32	2 13/16	3 1/2	2 7/16	1 1/2	2 11/32 Slot	1/2	1 1/32
81, 82, 83 91, 92, 93	1/16 x 3/32	3 1/8	4 1/8	2 13/16	2 1/2	3 13/32 x 3 29/32 Slot	3/4	2 1/4
203 204	1/16 x 3/32	3 1/4	5	4	2 3/4	3 13/32	3/4	2
224 225	1/4 x 1/4	3 1/2	5 1/2	4 1/2	3 3/4	3 13/32	1	2 3/4
254 284	1/4 x 1/4	4 1/4	6 1/4	5	4 1/4	3 13/32	1 1/4	3 1/4
324, 334 326, 336	3/16 x 3/16	5 1/4	8	6 1/4	5 1/4	3 13/32	1 5/8	4 1/2
364, 374 3645, 3745 365, 375 3655, 3755	1/4 x 1/4 3/16 x 3/16 1/4 x 1/4 3/16 x 3/16	5 1/4	9	7	5 1/4 6 1/4	3 13/32	1 7/8 2 1/8	5 3/8 6 3/8
404 4045 405 4055	1/4 x 1/4	6 1/4	10	8	6 1/4 6 1/4 6 1/4 6 1/4	4 11/16	2 1/8 2 1/8 2 1/8 2 1/8	6 1/4 6 1/4 6 1/4 6 1/4
444, 454 4445, 4545	5/16 x 5/16 1/4 x 1/4	7 1/2	11	9	7 1/4	4 11/16	2 3/8 2 3/8	6 7/8 6 7/8

FRAME	DIMENSIONS IN INCHES Keyway	BA	D	E	F	H	U	V
445, 455 4455, 4555	5/16 x 5/16 1/4 x 1/4	7 1/2	11	9	8 1/4	4 11/16	2 3/8 2 3/8	6 7/8 6 7/8
504U 5045 505, 515 5055, 5155	3/16 x 3/16 1/4 x 1/4 3/16 x 3/16 1/4 x 1/4	8 1/2	12 1/2	10	8 9 9	4 11/16	2 1/8 2 1/8 2 1/8 2 1/8	8 3/8 8 3/8 8 3/8 8 3/8
514 516	5/16 x 5/16 3/16 x 3/16	8 1/2	12 1/2	10	8 10	4 11/16	2 5/8 2 5/8	7 5/8 8 3/8
584 5845 585 5855 586 5865	3/16 x 3/16 3/16 x 3/16 3/16 x 3/16 1/4 x 1/4 3/16 x 3/16 1/4 x 1/4	10	14 1/2	11 1/2	9 9 10 10 11 11	4 11/16	3 3/8 3 3/8 3 3/8 2 1/8 3 3/8 2 1/8	9 3/8 9 3/8 9 3/8 6 9 3/8 6
6825 6845 6865	3/16 x 3/16 1/4 x 1/4	11 1/2	17	13 1/2	8 10 12 1/2	4 11/16	3 3/8	6 1/2
R915 R92 R925 R93	3/16 x 3/16 1/4 x 1/4 3/16 x 3/16 1/4 x 1/4	10 1/8	17 1/2	13 1/8	9 1/2 11 11 12	4 11/16	2 1/8 3 3/8 2 1/8 3 3/8	6 9 3/8 6 9 3/8



CONTROL FOR MOTORS

Motor HP	POLYPHASE																SINGLE PHASE				DIRECT CURRENT	
	SQUIRREL CAGE						WOUND ROTOR										ALL TYPES				ALL TYPES	
	PRICES						PRICES										PRICES				PRICES	
	Manual Compensator Auto Transformer Type		Magnetic Across-The-Line Type with Push Button Station		Magnetic Reversing Type		Starters For Constant Speed Service with Primary Switch		Starters For Adjustable Varying Speed Service with Primary Switch		Motor HP	Magnetic Starter Across-The-Line Type with Push Button Station			Motor HP	Manual Starter with Thermal Cutout Rheostat		Magnetic Starter with Push Button Station	
	220	440 550	220	440 550	220	440 550	220	440 550	220	440 550		115 V	230 V	115 V 230 V		115 V	230 V	115 V	230 V
1½ and smaller			$44.00	$44.00			$40.50	$40.50	$90.50	$90.50	1/6				¼ to 1	$43.10	$43.10	$33.50	$33.50
2			44.00	44.00			40.50	40.50	90.50	90.50	⅓				1½ to 3	62.00	62.00	133.50	133.50
3			44.00	44.00			40.50	40.50	90.50	90.50	½				5	78.00	78.00	237.50	149.50
5	$310.00		49.50	49.50			154.00	154.00	272.00	272.00	¾								
7½	310.00		89.50	49.50	324.00	143.50	278.00	238.00	352.00	312.00	1	$38.50	$38.50	$44.00 $44.00	7½	126.00	80.00	473.50	173.50
10	310.00		89.50	89.50	324.00	143.50	278.00	278.00	376.00	376.00	1½	44.00	38.50	49.50 44.00	10	156.00	140.00	487.50	237.50
15	310.00		89.50	89.50	336.00	143.50	362.00	362.00	440.00	440.00	2	55.00	44.00	89.50 49.50	15	170.00	162.00	831.50	459.50
20	324.00		143.50	89.50	354.00	143.50	416.00	362.00	546.00	492.00	3	55.00	44.00	89.50 49.50	20	222.00	162.00	870.50	473.50
25	324.00		143.50	89.50	354.00	143.50	502.00	448.00	630.00	576.00	5		55.00	143.50 89.50	25	270.00	178.00	1310.50	487.50
30	336.00		143.50	143.50	354.00	143.50	602.00	602.00	832.00	832.00	7½			143.50 89.50	30	290.00	222.00	1338.50	831.50
40	570.00	354.00	313.50	143.50	588.00	313.50	808.00	638.00	1094.00	894.00	10			143.50 89.50	40	290.00		1378.50	870.50
50	588.00	354.00	313.50	143.50	610.00	313.50	822.00	652.00	1150.00	980.00	15			143.50 89.50	50	306.00		1942.50	1310.50
60	610.00	588.00	638.50	313.50	632.00	638.50	1146.00	832.00	1556.00	1242.00	20			143.50 89.50					
75	632.00	610.00	638.50	313.50	860.00	638.50	1152.00	838.00	1562.00	1248.00				313.50					
100	860.00	632.00	638.50	638.50	902.00	638.50	1612.00	1188.00	1978.00	1612.00	15			143.50					
125	902.00	686.00	1850.50	638.50		1850.50	2698.00	1486.00	3518.00	2306.00									
150				1850.50			2770.00	1558.00	3778.00	2566.00	20			313.50					
200									4242.00	3030.00									
250				1850.50			2878.00		4594.00										
300				1850.50			2984.00		5012.00										
350				1850.50			3546.00		5546.00										
400				1850.50			3616.00		6392.00										

C—Secondary Starter 25 H.P. and below is a non-reversing faceplate with self contained resistors. 30 H.P. and larger are non-reversing drums with radial operating lever with separately mounted resistors.

Secondary Regulator 10 H.P. and below is a non-reversing faceplate with self contained resistors. 50 H.P. and larger are non-reversing drums with radial operating lever with separately mounted resistors.

C-10

PRECIPITATION EQUIPMENT

(Includes motors and drives but does not include piping between units) **(See Page 153)**

Capacity of Plant Tons of Solution Per 24 Hours	Mill Feed Dry Tons per 24 Hours	Total Connected HP	Approx. Shipping Wt. Lbs.	Approx. Price F.O.B. Factory
25-30	3-10	3¾	3,175	$ 3,195
75-100	25-35	3¾	4,775	4,525
300-400	100-135	6¼	12,390	9,303
900-1000	300-335	13¼	23,781	15,377

PUMPS, DIAPHRAGM (Adjustable Stroke)

(Includes motors and drives) **(See Page 156)**

Size		Motor HP	Approx. Ship. Wt. Lbs.	Approx. Price F.O.B. Factory
2"	Simplex	1	900	$ 750
2"	Simplex	2	1,450	1,100
3"	Simplex	2	1,600	900
3"	Duplex	3	2,375	1,350
4"	Simplex	2	1,600	900
4"	Duplex	3	2,375	1,350
5"	Simplex	2	2,600	1,450
5"	Duplex	5	4,700	2,100
6"	Simplex	3	2,500	1,550
6"	Duplex	7½	5,050	2,300

(See Page 161)

PUMPS, DIAPHRAGM, SUCTION-PRESSURE

Size		Motor HP	Approx. Ship. Wt. Lbs.	Approx. Price F.O.B. Factory
¾"	Simplex	¼	135	$ 260
1½"	Simplex	1	200	300
1½"	Duplex	2	385	600
2"	Simplex	1½	380	450
2"	Duplex	3	720	875
4"	Simplex	2	750	800
4"	Duplex	5	1,450	1,575

NOTE: Prices are approximate and are for estimating purposes only. Please phone, write or wire—

PUMPS, SAND

(SRL—Rubber Lined) **(See Page 166)**

Size	Approx. Motor HP for 30' Head	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
Open Runner			
2" x 2"	2	575	$ 850
3" x 3"	3	850	1,050
Closed Runner			
3" x 3"—C	5	1,240	1,370
5" x 5"	5	1,550	1,625
6" x 6"	7½	2,300	2,050
8" x 6"—C	10	4,375	3,350
10" x 8"—C	15	5,100	4,125
(SRL—Vertical Pump*)			
2" x 2"—Vertical	2	1,025	1,220
5" x 5"—Vertical	5	1,590	1,925

*Includes V-belt drive, motor and floor-plate mounting)

PUMPS, VERTICAL SAND (For 30' Total Head)

(Includes motor and drive) **(See Page 164)**

Size	Motor HP	Approx. Ship. Wt. Lbs.	Factory Price Approx. F.O.B.
¾"	1	395	$ 400
1"	1½	450	450
1½"	3	830	525
2"	5	1,025	575
3"	7½	2,490	900
4"	15	2,615	1,150

PUMPS, VACUUM

(Includes motors, motor bases and drives)

Approx. Cubic Feet per minute	Size Pump	Motor	Approx. Shipping Wt. Lbs.	Approx. Price F.O.B. Factory
40	3½"x3½" Duplex Air Cooled	2	395	$ 400
125	6½"x4" Duplex Air Cooled	5	870	775
320	12"x7" Single Cyl. Water Cooled	15	3,580	2,580
720	18"x7" Single Cyl. Water Cooled	25	4,645	3,350
1185	22"x9" Single Cyl. Water Cooled	40	7,600	4,950

RAIL, MINE

Weight per Yard Pounds	Height	Approximate Price per Cwt. F.O.B. Factory
12	1¾"	$8.15
16	2"	8.05
20	2¼"	7.98
30	2⅜"	7.85

RECEIVERS, AIR

(Complete with safety valves and pressure gauges—125 pound working pressure. A.S.M.E. code made for mining service)

Size	Weight	Approx. Price F.O.B. Factory
30" x 7'	975	$305
36" x 8'	1,490	400
42" x 10'	2,460	580
48" x 12'	4,285	780

PUMPS, WATER

(Includes motor and drive)

Size	Motor HP	GPM	Total Dynamic Head	Approx. Shipping Wt. Lbs.	Approx. Price F.O.B. Factory
1"	1	50	30	154	$180
2"	2	150	30	266	260
4"	10	600	40	605	560
8"	15	1,800	20	1,010	790
		Closed Runner			
1"	2.0	25	90	282	270
2"	10	250	100	560	530
4"	20	600	90	940	810

ROD, DRILL

(Hollow-shanked and threaded)

Length in Feet Size	Approximate Price Each 1'	2'	4'	6'	8'	10'	12'
⅞" Hex	$3.35	$4.00	$5.35	$6.65	$ 8.15	$ 9.70	$11.20
1" Hex	3.80	4.55	6.10	7.65	9.40	11.15	12.90
1⅛" Round	4.20	5.25	7.50	9.70	12.10	14.50	16.95

Bulletins or other descriptive material giving details and specifications as well as up-to-date prices will be sent on request.

ROD, DRILL

(Hollow—superior quality)

Size	Weight/Ft.	Feet/100 Lbs.	Approximate Price/100 Lbs. F.O.B. Factory
⅞" Hex	2.05	48.7	$21.40
1" Hex	2.55	39.2	21.40
1⅛" Round	3.07	32.5	21.40
1¼" Round	3.85	26.0	21.40

ROD MILLS

(Large Trunnion) **(See Page 180)**

(Includes motor, V-belt drive but does not include rod charge or switches)

Size	Approx. Motor HP	Approx. Rod Charge Lbs.	Approx. Shipping Wt. (lbs.)*	Approx. Price F.O.B. Factory
3' x 6'	20	6,600	11,350	$ 4,760
4' x 8'	50	15,700	25,400	9,550
5' x 10'	100	30,700	43,000	15,650
6' x 12'	200	35,300	68,400	29,550
7' x 12'	250	73,000	100,000	37,690
8' x 12'	350	94,000	127,200	56,650
9' x 10'	600	99,000	175,400	70,650
10½' x 14'	800	189,000	232,000	85,600

NOTE: Rod charge is based on 40% of mill volume and rods weighing 390 lbs. per cu. ft.

*Does not include rods.

SAMPLERS, DECO Heavy-Duty Automatic

(Horizontal Traveling Cutter Type)

(Includes motor, limit switches and cutter) **(See Page 185)**

Size	Horsepower	Approx. Shipping Weight	Approx. Price F.O.B. Factory
21"	¼	330	$525
30"	¼	400	575
48"	¼	550	675

SAMPLERS, DENVER VISUAL (See Page 186)

(Complete with concentrating table, suction-pressure diaphragm pump, fluorescent light, motor, drive and supporting frame)

Size	HP	Approx. Ship. Wt. -Lbs.	Approx. Price F.O.B. Factory
With 13A Table	½	750	$675
With 13B Table	½	850	700

SAMPLERS (Snyder Type)

(Includes motor and drive) **(See Page 184)**

Size	Motor HP	Approx. Ship. Wt. Lbs.	Approx. F.O.B. Factory Price
24" Simplex	½	525	$ 675
36" Simplex	½	850	925
48" Simplex	½	1,150	1,150
60" Simplex	¾	1,750	1,525
24" Tandem	1½	1,200	1,275
36" Tandem	1½	1,875	1,700
48" Tandem	1½	2,600	1,950

SAMPLERS (Vezin Type)

(Includes motor and drive) **(See Page 183)**

Size	% Cut	Horsepower	Approx. Ship. Wt. Lbs.	Approx. F.O.B. Factory Price
20"	5	½	625	$ 900
20"	10	½	700	980
28"	5	½	850	1,025
28"	10	½	950	1,125
36"	5	½	1,050	1,075
36"	10	½	1,150	1,200
48"	5	½	1,475	1,325
48"	10	½	1,600	1,450
60"	5	¾	1,850	1,575
60"	10	¾	2,000	1,725

SCREENS, TROMMEL (For Ball Mill Discharge)

(Includes steel spiral, steel screen cloth and flanges for attaching to ball mill discharge lip) **(See Page 191)**

Size (Dia. x length)	Screen Mesh	Approx. Shipping Wt. Lbs.	Approx. Price F.O.B. Factory
12" x 18"	6	100	$ 120
18" x 24"	6	180	185
24" x 24"	6	300	220
36" x 36"	6	500	385

NOTE: Prices are approximate and are for estimating purposes only. Please phone, write or wire—

DENVER EQUIPMENT COMPANY
Box 5268 • Denver 17, Colorado
Denver Telephone: CHerry 4466 **Cable: Deco Denver**

SCREENS, REVOLVING (Trommel Type)

(Includes structural steel frame, bevel gear drive and counter shaft, motor and drive)

Size	HP	Approx. Shipping Wt.—Lbs.	Approx. Price F.O.B. Factory
24" x 12'	5	2,800	$1,750
36" x 12'	10	4,200	2,550
48" x 12'	15	5,250	3,450

SCREENS, VIBRATING (Denver-Dillon)

(Includes motor, motor base and drive)

Size	No. of Decks	Motor HP	Approx. Shipping Weight	Approx. F.O.B. Factory Price
1' x 3'	1	½	400	$ 450
	2	½	525	400
1½' x 3'	1	½	575	525
	2	¾	675	575
2' x 4'	1	¾	775	650
	2	1	1,050	725
3' x 6'	1	2	1,300	1,225
	2	3	1,800	1,350
4' x 8'	1	3	2,400	1,900
	2	5	3,350	2,100
5' x 10'	1	5	3,550	2,750
	2	7½	5,150	3,100
6' x 14'	1	7½	5,050	4,075
	2	10	7,150	4,500

Prices shown do not include screen cloth.

SHARPENERS, DRILL STEEL

(Sharpeners for drill steel of latest design in sharpening practice equipped for upsetting tread end on detachable bit drill rods and for shanking. Floor mounted)

Size	Weight (lbs.)	Approx. Price F.O.B. Factory
#1	1,510	$1,095
#2	1,950	1,790
#3	2,200	2,910

Bulletins or other descriptive material giving details and specifications as well as up-to-date prices will be sent on request.

ANGLES STRUCTURAL—Also see page 503

Size	Weight/Ft.	Approximate Prices Warehouse	Mill
6x4x3/8	12.3	U. S. $8.10 per 100 lbs.	4.60
6x4x7/16	14.3	8.10	4.60
6x4x1/2	16.2	8.10	4.60
6x4x9/16	18.1	8.10	4.60
6x4x5/8	20.0	8.10	4.60
6x4x3/4	23.6	8.10	4.60
6x6x3/8	14.9	8.05	4.55
6x6x7/16	17.2	8.05	4.55
6x6x1/2	19.6	8.05	4.55
6x6x5/8	24.2	8.05	4.55
6x6x3/4	28.7	8.05	4.55
7x3½x3/8	13.0	8.10	4.60
7x3½x1/2	17.0	8.10	4.60
8x3½x1/2	18.7	8.10	4.60
8x6x1/2	23.0	8.10	4.60
8x6x3/4	33.8	8.10	4.60
8x8x1/2	26.4	8.05	4.55

ANGLES BAR SIZE

Size	Weight/Ft.	Approximate Prices Warehouse	Mill
¾x¾x1/8	.59	U. S. $8.91 per 100 lbs.	5.60
1x1x1/8	.80	8.51	5.20
1x1x3/16	1.16	8.46	5.15
1¼x1¼x1/8	1.01	8.51	5.20
1¼x1¼x3/16	1.48	8.46	5.15
1¼x1¼x¼	1.92	8.46	5.15
1½x1½x1/8	1.23	8.46	5.15
1½x1½x3/16	1.80	8.21	4.90
1½x1½x¼	2.34	8.21	4.90
1¾x1¾x3/16	2.12	8.21	4.90
1¾x1¾x¼	2.77	8.21	4.90
2x1½x3/8	1.44	8.36	5.05
2x1½x3/16	2.12	8.26	4.95
2x1½x¼	2.77	8.26	4.95
2x2x1/8	1.65	8.26	4.95
2x2x3/16	2.44	8.21	4.90
2x2x¼	3.19	8.21	4.90
2x2x5/16	3.92	8.21	4.90
2x2x3/8	4.70	8.21	4.90
2½x2½x¼	3.62	8.21	4.90
2½x2x5/16	2.75	8.21	4.90
2½x2x¼	3.62	8.21	4.90
2½x2x5/16	4.50	8.21	4.90
2½x2x3/8	5.30	8.21	4.90
2½x2½x5/16	3.07	8.21	4.90
2½x2½x¼	4.10	8.21	4.90
2½x2½x5/16	5.00	8.21	4.90
2½x2½x3/8	5.90	8.21	4.90

CHANNELS — STRUCTURAL

Size	Weight/Ft.	Approximate Warehouse Prices	Mill
2″	1.76	U. S. $8.55 per 100 lbs.	5.05
2″	2.32	8.55	5.05
3″	4.10	8.60	5.10
3″	5.00	8.60	5.10
4″	5.40	8.40	4.90
4″	6.25	8.40	4.90
4″	7.25	8.40	4.90
5″	6.70	8.25	4.75
5″	9.00	8.25	4.75
6″	8.20	8.20	4.70
6″	10.50	8.20	4.70
6″	13.00	8.20	4.70
7″	9.80	8.30	4.80
7″	12.25	8.30	4.80
7″	14.75	8.30	4.80
8″	11.50	8.25	4.75
8″	13.75	8.25	4.75
8″	16.25	8.25	4.75
8″	21.25	8.25	4.75
9″	13.40	8.20	4.70
9″	15.00	8.20	4.70
9″	20.00	8.20	4.70
9″	25.0	8.20	4.70
10″	15.3	8.15	4.65
10″	20.0	8.15	4.65
10″	25.0	8.15	4.65
10″	30.0	8.15	4.65
12″	20.7	8.10	4.60
12″	25.0	8.10	4.60
12″	30.0	8.10	4.60
13″	31.8	8.15	4.65
15″	33.9	8.15	4.65
15″	40.0	8.15	4.65

STRUCTURAL H BEAMS

Size	Weight/Ft.	Approximate Warehouse Prices	Mill
4″	13.8	U. S. $8.60 per 100 lbs.	5.10
5″	18.9	8.40	4.90
6″	20.0	8.45	4.95
6″	23.0	8.45	4.95
8″x6½″	24.0 CB	8.20	4.70
8″	32.6	8.15	4.65
8″	34.3	8.15	4.65

STRUCTURAL I BEAM

Size	Weight/Ft.	Approximate Warehouse Prices	Mill
3″	@ 5.7	U. S. $8.60 per 100 lbs.	5.10
3″	@ 6.5	8.60	5.10
4″	@ 7.7	8.35	4.85
4″	@ 9.5	8.35	4.85
5″	@ 10.0	8.20	4.70
5″	@ 12.3	8.20	4.70
5″	@ 14.8	8.20	4.70
6″	@ 12.5	8.30	4.80
6″	@ 14.8	8.30	4.80
7″	@ 15.3	8.25	4.75
7″	@ 17.5	8.25	4.75
8″	@ 18.4	8.20	4.70
8″	@ 20.5	8.20	4.70
8″	@ 23.0	8.20	4.70
9″	@ 21.8	.....	.....
9″	@ 25.0	.....	.....
9″	@ 30.0	.....	.....
10″	@ 21.0	8.10	4.60
10″	@ 25.4	8.10	4.60
10″	@ 30.0	8.10	4.60
12″	@ 25.0	8.10	4.60
12″	@ 31.8	8.10	4.60
12″	@ 40.8	8.10	4.60
12″	@ 50.0	8.10	4.60
15″	@ 35.0	8.05	4.55
15″	@ 42.9	8.05	4.55
15″	@ 50.0	8.05	4.55
15″	@ 60.8	8.05	4.55
18″	@ 46.0	8.05	4.55
18″	@ 54.7	8.10	4.60
18″	@ 65.0	8.10	4.60
20″	@ 65.4	8.10	4.60
20″	@ 81.4	8.10	4.60
24″	@ 71.0	8.15	4.65
24″	@ 79.9	8.15	4.65
24″	@ 100.0	8.15	4.65

TEES — BAR SIZE AND STRUCTURAL

Size	Weight/Ft.	Approximate Prices Warehouse	Mill
¾x¾x⅛	.60	U. S. $9.86 per 100 lbs.	6.55
1x1x⅛	.90	9.36	6.05
1¼x1¼x$\frac{3}{16}$	1.55	8.86	5.55
1½x1½x$\frac{3}{16}$	1.88	8.71	5.30
1½x1½x¼	2.43	8.71	5.30
1¾x1¾x¼	2.90	8.71	5.30
2x2x¼	3.60	8.71	5.30
2¼x2¼x¼	4.10	8.71	5.30
2½x2½x$\frac{5}{16}$	5.50	8.71	5.30

TEES STRUCTURAL

Size	Weight/Ft.	Approximate Prices Warehouse	Mill
3x3x$\frac{5}{16}$	6.7	U. S. $9.85 per 100 lbs.	5.35
3x3x⅜	7.8	9.80	5.30
3½x3½x⅜	9.2	.....	.....
4x4x⅜	10.5	8.55	5.05

STEEL PLATE

Size	Weight/Sq. Ft.	Approximate Prices Warehouse	Mill
12 Ga.	4.90	U. S. $7.89 per 100 lbs.	4.65
⅛"	5.10	7.94	4.70
10 Ga.	5.75	7.94	4.70
8 Ga.	6.37	7.89	4.65
$\frac{3}{16}$"	7.65	7.89	4.65
¼"	10.20	7.81	4.25
$\frac{5}{16}$"	12.75	7.66	4.10
⅜"	15.30	7.56	3.95

SHAFTING

Size	Weight/Ft.	Approximate Prices Warehouse	Mill
⅝"	1.04	U. S. $8.76 per 100 lbs.	7.98
¾"	1.50	8.61	5.83
⅞"	2.05	8.61	5.83
1"	2.67	8.51	5.73
1$\frac{3}{16}$"	3.77	8.51	5.73
1$\frac{7}{16}$"	5.52	8.41	5.63
1$\frac{11}{16}$"	7.60	8.41	5.63
1$\frac{15}{16}$"	10.02	8.51	5.73
2$\frac{3}{16}$"	12.78	8.51	5.73
2$\frac{7}{16}$"	15.87	8.51	5.73

SHAFTING—Continued

Size	Weight/Ft.	Approximate Prices Warehouse	Mill
2$\frac{11}{16}$"	19.29	U. S. $8.51 per 100 lbs.	5.73
2$\frac{15}{16}$"	23.04	9.11	6.33
3$\frac{3}{16}$"	27.13	9.21	6.43
3$\frac{7}{16}$"	31.55	9.31	6.53
3$\frac{11}{16}$"	36.21	9.31	6.53
3$\frac{15}{16}$"	41.40	9.46	6.68
4$\frac{3}{16}$"	52.58	9.66	6.88
4$\frac{15}{16}$"	65.10	9.76	6.98
5$\frac{7}{16}$"	78.95	10.26	6.48
5$\frac{15}{16}$"	94.14	10.71	6.93

COMMON NAILS

Size	Price Per 100# Keg	Size	Price Per 100# Keg
3d	$11.11	20d	$9.43
4d	10.49	30d	9.43
6d	9.99	40d	9.43
8d	9.80	50d	9.43
10d	9.49	60d	9.36
16d	9.43		

RAIL SPIKES ..... $6.50 per 100 lbs.

CONVENTIONAL CORRUGATED ROOFING AND SIDING

Gauge	Size	No. Shts. Per Sq. (100 Sq. Feet)	Wt. Per Sq.	Price Per Sq.
29	26x 72	7.692	77 lbs.	$11.53
29	26x 84	6.593	77 lbs.	11.53
29	26x 96	5.769	77 lbs.	11.41
29	26x144	3.846	77 lbs.	11.41

COMPOSITION, ROOFING

Grade	Ply	Length of Roll	Width of Roll	Sq. Ft. Roll Per Roll	Weight Per Roll	Price Per Roll
Light	2	36'	36"	108	45	$1.96
Medium	3	36'	36"	108	55	2.47
Heavy	4	36'	36"	108	65	2.81
Extra Heavy	5	36'	36"	108	75	4.75

MACHINE BOLTS

Size	Per 1,000 Weight	No. Per Case	Price Per 100 Pc.
¼"x 1"	27.0	3,200	$ 1.15
¼"x 2"	40.4	3,000	1.50
¼"x 4"	67.0	2,000	2.50
¼"x 8"	121.0	1,000	4.35
¼"x12"	175.0	600	5.75
½"x 1"	156.0	1,200	4.60
½"x 2"	205	1,000	5.35
½"x 4"	313	600	6.85
½"x 8"	527	350	11.50
½"x12"	743	200	15.60
¾"x 1"	434	600	10.95
¾"x 2"	543	425	11.60
¾"x 4"	779	275	14.20
¾"x 8"	1,260	125	19.40
¾"x12"	1,740	100	24.60

TABLES, CONCENTRATING

(Includes motor and drive) **(See Page 199)**

	Motor HP	Approx. Ship. Wt.—Lbs.	Approx. Price F.O.B. Factory
No. 12 (Half size)			
3'6"x7'6"			
Concrete Piers	1	1,375	$ 775
Steel Structure	1	1,675	875
No. 6 (5'11"x14'9")			
Concrete Piers	1½	2,200	1,150
Steel Structure	1½	3,100	1,275
No. 6 Diagonal Deck, Linoleum Cover with Steel Understructure	2	3,160	1,600

TANK, Denver Bolted Steel —See page 818

TANKS, WELDED STEEL (See Page 203)

Size	Gals. Cap.	Cu. Ft.	Approx. Ship. Wt.—Lbs.	Approx. Price F.O.B. Factory
3' x 3'	159	21	180	$ 75
4' x 4'	376	50	425	175
5' x 5'	734	98	675	275
6' x 6'	1,269	170	950	375
7' x 7'	2,015	269	1,350	525
8' x 8'	3,008	402	1,800	675
9' x 9'	4,283	573	2,350	800
10' x 10'	5,875	785	3,600	1,100

TANKS, STANDARD WOOD (See Page 204)

Outside Diam. Feet	Outside Height Feet	Approx. Solution Cap. Tons	Capacity Cubic Feet	Approx. Capacity Gallons	—2-in. Lumber— Approx. Weight	—2-in. Lumber— List Price	—3-in. Lumber— Approx. Weight	—3-in. Lumber— List Price
3	2	.27	8.7	65	144	$27.50	.....	.....
	3	.45	14.4	107	186	33.75	.....	.....
	4	.63	20.1	150	236	42.50	.....	.....
	5	.81	25.8	193	286	50.00	.....	.....
4	2	.47	16.6	124	206	37.50	.....	.....
	3	.85	27.3	204	262	47.25	.....	.....
	4	1.2	38.1	285	328	56.25	.....	.....
	5	1.5	48.8	365	394	67.50	.....	.....
	6	1.8	59.5	445	470	80.00	.....	.....
5	2	.81	26.7	200	282	50.00	.....	.....
	3	1.4	44.1	330	352	60.00	.....	.....
	4	1.9	61.4	459	436	75.00	.....	.....
	5	2.4	78.8	589	520	87.50	.....	.....
	6	3.0	96.1	718	618	105.00	.....	.....
	7	3.6	113.4	847	702	117.50	.....	.....
	9	4.7	148.0	1106	870	147.50	.....	.....
6	2	1.2	39.3	294	360	62.50	.....	.....
	3	2.0	64.8	485	444	75.00	.....	.....
	4	2.8	90.3	675	544	90.00	874	$127.50
	5	3.6	115.8	866	644	107.50	1032	150.00
	6	4.4	141.4	1058	760	127.50	1206	175.00
	7	5.2	166.9	1248	860	142.50	1363	197.50
	8	6.0	192.4	1439	960	160.50	1521	222.50
	9	6.8	217.9	1630	1060	175.00	1679	245.00
	10	7.6	243.4	1820	1160	192.50	1837	267.50
7	3	2.8	89.6	670	562	92.50	.....	.....
	4	3.9	124.8	933	678	112.50	1082	155.00
	5	5.0	160.1	1196	794	132.50	1267	182.50
	6	6.1	195.3	1460	910	150.00	1449	210.00
	7	7.2	230.6	1725	1026	170.00	1634	235.00
	8	8.3	265.8	1987	1142	187.50	1816	262.50
	9	9.4	301.1	2251	1258	207.50	2000	290.00
	10	10.3	336.3	2515	1374	225.00	2183	315.00
8	3	3.7	118.3	884	672	100.00	.....	.....
	4	5.1	164.8	1233	804	132.50	1288	185.00
	5	6.6	211.4	1580	936	152.50	1497	215.00
	6	8.1	258.8	1935	1068	175.00	1706	245.00
	7	9.5	304.5	2278	1200	195.00	1915	275.00
	8	11.0	351.1	2625	1332	217.50	2124	305.00
	9	12.4	397.7	2975	1464	240.00	2333	337.50
	10	13.9	444.2	3320	1596	260.00	2542	367.50
	12	16.8	537.4	4015	1860	302.50	2960	427.50
	14	19.7	630.5	4760	2124	347.50	3378	487.50
	16	22.3	713.6	5360	2388	390.00	3796	547.50
9	3	4.7	151.0	1130	758	125.00	1220	175.00
	4	6.6	210.4	1575	906	147.50	1453	207.50
	5	8.4	269.9	2018	1054	172.50	1689	242.50
	6	10.3	329.3	2462	1202	195.00	1923	275.00
	7	12.2	389.	2910	1350	220.00	2158	310.00
	8	14.0	448.	3350	1498	245.00	2392	342.50
	9	15.9	508.	3800	1646	267.50	2628	377.50
	10	17.7	567.	4240	1794	292.50	2932	412.50
	12	21.4	686.	5130	2090	350.00	3330	480.00
	14	25.1	805.	6020	2386	390.00	3799	547.50
	16	28.8	924.	6900	2678	437.50	4494	645.00
10	4	8.2	262.	1960	1040	167.50	1673	237.50
	5	10.5	336.	2510	1204	195.00	1933	275.00
	6	12.7	408.	3050	1368	220.00	2193	312.50
	7	15.1	482.	3600	1532	247.50	2453	352.50
	8	17.4	556.	4160	1696	437.50	2714	390.00
	9	19.7	630.	4710	1860	302.50	2974	427.50
	10	22.0	704.	5260	2024	327.50	3234	465.00

TANKS, STANDARD WOOD

Outside Diam. Feet	Outside Height Feet	Approx. Solution Cap. Tons	Capacity Cubic Feet	Approx. Capacity Gallons	—2-in. Lumber— Approx. Weight	List Price	—3-in. Lumber— Approx. Weight	List Price
10	12	26.6	852.	6370	2352	$382.50	3755	$540.00
	14	31.2	1000.	7480	2680	435.00	4275	615.00
	16	35.8	1147.	8570	.....	.....	4795	690.00
	18	40.5	1295.	9670	.....	.....	5330	767.50
	20	45.1	1443.	10760	.....	.....	5921	857.50
11	4	9.9	317.	2370	1182	190.00	1905	270.00
	5	12.7	407.	3040	1362	220.00	2192	312.50
	6	15.5	497.	3710	1542	247.50	2477	352.50
	7	18.4	587.	4390	1722	277.50	2764	395.00
	8	21.2	677.	5030	1902	307.50	3049	435.00
	9	23.9	767.	5740	2082	337.50	3334	480.00
	10	26.7	857.	6410	2262	365.00	3636	517.50
	12	32.4	1037.	7760	2622	425.00	4192	600.00
	14	38.1	1217.	9100	2982	482.50	4989	712.50
	16	43.7	1396.	10430	.....	.....	5336	765.00
	18	49.3	1576.	11780	.....	.....	5998	867.50
	20	54.9	1756.	13130	.....	.....	6659	967.50
12	4	11.9	381.	2850	1340	217.50	2159	308.50
	5	15.2	488.	3650	1538	250.00	2473	352.50
	6	18.6	596.	4450	1736	482.50	2785	400.00
	7	22.1	703.	5260	1934	315.00	3100	445.00
	8	25.4	811.	6060	2132	347.50	3413	490.00
	9	28.8	918.	6850	2330	380.00	3727	535.00
	10	32.4	1026.	7680	2528	412.50	4040	580.00
	12	38.7	1241.	9280	2914	447.50	4667	672.50
	14	45.5	1456.	10890	3320	542.50	5294	762.50
	16	52.2	1671.	12500	.....	.....	5970	867.50
	18	58.9	1886.	14100	.....	.....	6713	980.00
	20	65.6	2101.	15700	.....	.....	7439	1092.50
13	4	14.0	448.	3350	1496	240.00	2415	345.00
	5	18.0	575.	4300	1710	275.00	2753	392.50
	6	22.0	702.	5260	1924	310.00	3093	442.50
	7	25.9	828.	6190	2138	347.50	3433	492.50
	8	29.8	955.	7140	2352	380.00	3771	540.00
	9	33.8	1082.	8090	2566	417.50	4111	590.00
	10	37.7	1208.	9040	2780	452.50	4449	637.50
	12	45.6	1462.	10930	3208	522.50	5128	735.00
	14	53.6	1715.	12820	.....	.....	5875	850.00
	16	61.5	1969.	14700	.....	.....	6595	962.50
	18	69.4	2223.	16600	.....	.....	7421	1087.50
	20	77.4	2475.	18500	.....	.....	8229	1215.00
14	4	16.3	522.	3900	1681	270.00	2702	385.00
	5	20.9	669.	5000	1911	307.50	3069	437.50
	6	25.5	816.	6100	2141	347.50	3434	490.00
	7	30.1	964.	7200	2371	385.00	3798	542.50
	8	34.7	1011.	8300	2601	422.50	4263	597.50
	9	39.3	1259.	9400	2831	460.00	4526	647.50
	10	43.9	1406.	10500	3061	497.50	4891	702.50
	12	53.2	1701.	12700	3521	552.50	5621	807.50
	14	62.4	1996.	14900	.....	.....	6451	935.00
	16	71.6	2291.	17100	.....	.....	7260	1057.50
	18	80.8	2585.	19300	.....	.....	8171	1202.50
	20	90.0	2880.	21500	.....	.....	9047	1340.00
15	4	17.5	561.	4200	1852	297.50	3199	452.50
	5	22.7	726.	5400	2088	337.50	3361	477.50
	6	28.	892.	6600	2333	375.00	3748	535.00
	7	33.	1057.	7900	2576	415.00	4135	590.00
	8	38.	1222.	9100	2820	455.00	4522	647.50
	9	43.	1387.	10400	3064	495.00	4909	702.50
	10	49.	1552.	11600	3308	535.00	5296	454.50
	12	59.	1882.	14100	.....	.....	6070	870.00
	14	69.	2213.	16500	.....	.....	6970	1007.50
	16	79.	2543.	19000	.....	.....	7962	1167.50

TANKS, STANDARD WOOD

Outside Diam. Feet	Outside Height Feet	Approx. Solution Cap. Tons	Capacity Cubic Feet	Approx. Capacity Gallons	—2-in. Lumber— Approx. Weight	List Price	—3-in. Lumber— Approx. Weight	List Price
15	18	90.	2873.	21500	.....	.....	9051	$1330.00
	20	100.	3203.	24000	.....	.....	9756	1445.00
16	4	20.	642.	4800	2023	$325.00	3266	462.50
	5	26.	820.	6100	2284	367.50	3680	522.50
	6	32.	1009.	7500	2533	410.00	4092	582.50
	7	37.	1198.	9000	2803	452.50	4505	642.50
	8	43.	1386.	10400	3063	495.00	4917	702.50
	9	49.	1575.	11800	3323	537.50	5328	760.00
	10	55.	1764.	13200	3604	528.50	5763	825.00
	12	67.	2151.	16000	4124	667.50	6588	945.00
	14	79.	2528.	18500	.....	.....	7590	1100.00
	16	91.	2906.	21900	.....	.....	8570	1252.50
	18	102.	3283.	24500	.....	.....	9559	1407.50
	20	114.	3660.	27300	.....	.....	10607	1575.00
17	4	23.	736.	5500	2216	357.50	3582	510.00
	5	30.	952.	7100	2496	402.50	4022	572.50
	6	37.	1169.	8700	2774	447.50	4463	637.50
	7	43.	1385.	10300	3052	492.50	4903	700.00
	8	50.	1601.	12000	3330	540.00	5343	765.00
	9	56.	1818.	13600	.....	.....	5783	830.00
	10	64.	2034.	15200	.....	.....	6248	897.50
	12	75.	2467.	18400	.....	.....	7200	1040.00
	14	91.	2900.	21700	.....	.....	8249	1205.00
	16	105.	3333.	24900	.....	.....	9315	1372.50
	18	121.	3766.	27900	.....	.....	10442	1555.00
	20	136.	4200.	31200	.....	.....	11568	1737.50
18	4	26.	827.	6200	2412	387.50	3903	555.00
	5	33.	1071.	8000	2706	435.00	4369	622.50
	6	41.	1314.	9800	3000	482.50	4834	687.50
	7	49.	1558.	11600	3294	532.50	5299	755.00
	8	56.	1801.	13500	3588	580.00	5772	887.50
	9	64.	2044.	15300	.....	.....	6231	890.00
	10	72.	2288.	17100	.....	.....	6724	962.50
	12	87.	2773.	20700	.....	.....	7811	1132.50
	14	103.	3260.	24400	.....	.....	8925	1307.50
	16	118.	3747.	28000	.....	.....	10049	1472.50
	18	134.	4233.	32300	.....	.....	11243	1777.50
	20	150.	4720.	36600	.....	.....	12436	1870.00
19	4	29.	924.	6900	2615	420.00	4233	600.00
	5	37.	1196.	8900	2925	470.00	4724	670.00
	6	46.	1467.	11000	3235	520.00	5216	742.50
	7	54.	1739.	13000	3545	570.00	5707	812.50
	8	63.	2011.	15000	3854	670.00	6199	882.50
	9	71.	2282.	17000	.....	.....	6717	960.00
	10	80.	2554.	19100	.....	.....	7236	1032.50
	12	97.	3098.	23100	.....	.....	8358	1210.00
	14	114.	3641.	27200	.....	.....	9526	1392.50
	16	131.	4184.	31300	.....	.....	10782	1595.00
	18	148.	4728.	35300	.....	.....	12038	1795.00
	20	165.	5272.	39300	.....	.....	13377	2015.00
20	4	32	1026	7700	2820	450.00	4575	647.50
	5	41	1328	10000	3146	505.00	5093	722.50
	6	51	1629	12100	3472	558.50	5609	797.50
	7	60	1931	14400	3798	610.00	6125	870.00
	8	70	2233	16700	.....	.....	6643	945.00
	9	79	2534	18900	.....	.....	7187	1025.00
	10	88	2836	21200	.....	.....	7733	1107.50
	12	107	3440	25700	.....	.....	8964	1297.50
	14	128	4043	33200	.....	.....	10214	1495.00
	16	146	4646	34700	.....	.....	11532	1715.00
	18	164	5250	39200	.....	.....	12850	1917.50
	20	182	5853	43700	.....	.....	14245	2147.50

TANKS, STANDARD WOOD

Outside Diam. Feet	Outside Height Feet	Approx. Solution Cap. Tons	Capacity Cubic Feet	Approx. Capacity Gallons	—2 in. Lumber— Approx. Weight	List Price	—3-in. Lumber— Approx. Weight	List Price
21	4	35	1133	8500	3035	$485.00	4930	$ 695.00
	5	46	1466	11000	3377	540.00	5473	775.00
	6	56	1800	13500	3719	595.00	6016	852.50
	7	67	2133	16000	4051	650.50	6558	930.00
	8	77	2466	18400	.....	.....	7101	1010.00
	9	87	2800	20900	.....	.....	7673	1092.50
	10	98	3133	23400	.....	.....	8331	1097.50
	12	119	3800	28400	.....	.....	9620	1397.50
	14	139	4466	33400	.....	.....	10921	1600.00
	16	160	5133	38400	.....	.....	12302	1822.50
	18	181	5800	43400	.....	.....	13761	2060.00
	20	202	6466	48300	.....	.....	15215	2295.00
22	4	39	1246	9300	3256	517.50	5296	747.50
	5	50	1612	12000	3614	577.50	5866	830.00
	6	62	1979	14800	3972	635.00	6433	910.00
	7	73	2345	17500	.....	.....	7003	992.50
	8	84	2712	20300	.....	.....	7622	1090.00
	9	95	3078	23000	.....	.....	8229	1175.00
	10	107	3444	25800	.....	.....	8827	1265.00
	12	130	4177	31200	.....	.....	10203	1480.00
	14	153	4910	36700	.....	.....	11482	1705.00
	16	176	5643	42200	.....	.....	13089	1840.00
	18	199	6376	47700	.....	.....	14659	2195.00
	20	222	7109	52200	.....	.....	16223	2455.00
23	4	42	1364	10200	.....	.....	5687	802.50
	5	55	1765	13200	.....	.....	6283	890.00
	6	68	2166	16200	.....	.....	6879	975.00
	7	80	2567	19200	.....	.....	7475	1062.50
	8	93	2969	22200	.....	.....	8071	1147.50
	9	105	3370	25200	.....	.....	8733	1247.50
	10	118	3771	28200	.....	.....	9495	1370.00
	12	143	4573	34200	.....	.....	10939	1597.50
	14	168	5375	40200	.....	.....	12375	1825.00
	16	193	6178	46200	.....	.....	13989	2090.00
	18	218	6980	52200	.....	.....	15603	2355.00
	20	243	7782	58200	.....	.....	17307	2640.00
24	4	46	1487	11100	.....	.....	6078	857.50
	5	60	1924	14400	.....	.....	6701	947.50
	6	74	2361	17600	.....	.....	7322	1037.50
	7	87	2799	20900	.....	.....	7944	1127.50
	8	101	3236	24200	.....	.....	8733	1227.50
	9	114	3673	27570	.....	.....	9299	1327.50
	10	128	4111	31400	.....	.....	10045	1455.00
	12	156	4986	37300	.....	.....	11550	1685.00
	14	183	5861	43900	.....	.....	13139	1840.00
	16	210	6736	50200	.....	.....	14818	2215.00
	18	238	7611	56900	.....	.....	16568	2510.00
	20	265	8485	63400	.....	.....	18360	2807.50
25	4	50	1616	12100	.....	.....	6483	912.50
	5	65	2091	15600	.....	.....	7130	1005.00
	6	80	2567	19100	.....	.....	7778	1100.00
	7	95	3042	22700	.....	.....	8425	1192.50
	8	110	3517	26300	.....	.....	9142	1302.50
	9	125	3992	29900	.....	.....	9828	1402.50
	10	139	4468	33400	.....	.....	10611	1525.00
	12	169	5418	40500	.....	.....	12371	1790.00
	14	199	6369	47600	.....	.....	13920	2057.50
	16	229	7319	54700	.....	.....	15664	2342.50
	18	258	8270	61800	.....	.....	17504	2647.50
	20	288	9221	69000	.....	.....	19343	2957.50
26	4	55	1750	13100	.....	.....	6897	975.00
	5	71	2265	16900	.....	.....	7571	1067.50
	6	87	2779	20800	.....	.....	8242	1165.00

TANKS, STANDARD WOOD

Outside Diam. Feet	Outside Height Feet	Approx. Solution Cap. Tons	Capacity Cubic Feet	Approx. Capacity Gallons	—2 in. Lumber— Approx. Weight	List Price	—3-in. Lumber— Approx. Weight	List Price
26	7	103	3294	24600	.....	.....	8917	$1262.50
	8	120	3809	28500	.....	.....	9560	1357.50
	9	134	4324	32300	.....	.....	10478	1502.50
	10	151	4838	36200	.....	.....	11293	1630.00
	12	182	5868	43900	.....	.....	12907	1882.50
	14	215	6898	51600	.....	.....	14718	2180.00
	16	248	7927	59200	.....	.....	16527	2475.00
	18	280	8957	67000	.....	.....	18434	2790.00
	20	312	9986	74700	.....	.....	20440	3130.00
27	4	59	1889	14100	.....	.....	7324	1027.50
	5	76	2445	18300	.....	.....	8023	1130.00
	6	94	3001	22400	.....	.....	8721	1230.00
	7	111	3557	26600	.....	.....	9420	1330.00
	8	128	4112	30700	.....	.....	10202	1450.00
	9	146	4668	34900	.....	.....	11139	1580.00
	10	163	5224	39200	.....	.....	11885	1712.50
	12	198	6335	47400	.....	.....	13658	1995.00
	14	233	7447	55700	.....	.....	15553	2302.50
	16	267	8558	64000	.....	.....	17408	2607.50
	18	302	9670	72300	.....	.....	19385	2955.00
	20	337	10781	80600	.....	.....	21562	3307.50
28	4	63	2034	15200	.....	.....	7776	1092.50
	5	82	2632	19700	.....	.....	8501	1197.50
	6	101	3231	24200	.....	.....	9228	1302.50
	7	119	3829	28600	.....	.....	9995	1417.50
	8	138	4427	33200	.....	.....	10880	1557.50
	9	157	5026	37800	.....	.....	11768	1697.50
	10	176	5624	42400	.....	.....	12641	1832.50
	12	213	6820	51000	.....	.....	14497	2132.50
	14	251	8017	60000	.....	.....	16353	2432.50
	16	288	9214	69000	.....	.....	18429	2775.00
	18	325	10410	78000	.....	.....	20606	3122.50
	20	362	11607	87000	.....	.....	22786	3517.50
29	4	68	2184	16300	.....	.....	8214	1155.00
	5	88	2827	21100	.....	.....	8964	1272.50
	6	108	3469	25900	.....	.....	9711	1370.00
	7	128	4111	30700	.....	.....	10540	1495.00
	8	149	4754	35500	.....	.....	11413	1630.00
	9	169	5396	41100	.....	.....	12326	1775.00
	10	189	6039	45200	.....	.....	13326	1915.00
	12	229	7324	54800	.....	.....	15137	2222.50
	14	269	8608	64200	.....	.....	17160	2553.00
	16	309	9893	73800	.....	.....	19294	2912.50
	18	346	11178	83500	.....	.....	21539	3292.50
	20	389	12463	93100	.....	.....	23894	3697.50
30	4	73	2340	17500	.....	.....	8677	1217.50
	5	95	3028	21600	.....	.....	9452	1327.50
	6	116	3716	78800	.....	.....	10226	1440.00
	7	138	4404	32900	.....	.....	11044	1562.50
	8	159	5092	38000	.....	.....	12110	1737.50
	9	181	5780	43200	.....	.....	12927	1851.50
	10	202	6468	48300	.....	.....	13838	2002.50
	12	245	7845	58600	.....	.....	15944	2345.00
	14	288	9221	69000	.....	.....	18032	2687.50
	16	331	10597	79200	.....	.....	20234	3055.00
	18	374	11974	89600	.....	.....	22550	3447.50
	20	417	13350	100000	.....	.....	24980	3865.00
31	4	78	2500	18700	.....	.....	9154	1282.50
	5	101	3236	24100	.....	.....	9953	1396.50
	6	124	3971	29700	.....	.....	10754	1515.00
	7	147	4707	35600	.....	.....	11726	1667.50
	8	170	5442	40700	.....	.....	12568	1790.00
	9	193	6178	46100	.....	.....	13658	1970.00

TANKS, STANDARD WOOD

Outside Diam. Feet	Outside Height Feet	Approx. Solution Cap. Tons	Capacity Cubic Feet	Approx. Capacity Gallons	—2-in. Lumber— Approx. Weight	List Price	—3-in. Lumber— Approx. Weight	List Price
31	10	216	6913	51600	.....	.....	14616	$2120.00
	12	264	8384	62600	.....	.....	16652	2445.00
	14	308	9855	73600	.....	.....	18900	2825.00
	16	353	11325	84700	.....	.....	21193	3202.50
	18	400	12796	95700	.....	.....	23697	3632.50
	20	444	14267	106700	.....	.....	26201	4060.00
32	4	83	2667	19900	.....	.....	9642	1350.00
	5	108	3451	25800	.....	.....	10446	1472.50
	6	132	4235	31600	.....	.....	11293	1587.50
	7	157	5019	37500	.....	.....	12294	1745.00
	8	181	5804	43400	.....	.....	13295	1902.50
	9	205	6588	49300	.....	.....	14285	2057.50
	10	230	7372	55100	.....	.....	15274	2212.50
	12	279	8941	65900	.....	.....	17492	1575.00
	14	325	10409	77800	.....	.....	19833	2962.50
	16	378	12078	90100	.....	.....	22160	3347.50
	18	426	13646	101800	.....	.....	24747	3792.50
	20	475	15215	113700	.....	.....	27446	4260.00
33	4	89	2838	21200	.....	.....	10142	1420.00
	5	114	3673	27400	.....	.....	10994	1542.50
	6	141	4507	33600	.....	.....	11888	1675.00
	7	167	5342	40000	.....	.....	12875	1825.00
	8	193	6177	46200	.....	.....	13905	1987.50
	9	219	7011	52400	.....	.....	14925	2147.50
	10	245	7846	57600	.....	.....	16066	2332.50
	12	297	9515	71200	.....	.....	18277	2677.50
	14	350	11185	83600	.....	.....	20633	3077.50
	16	402	12854	96000	.....	.....	23163	3502.50
	18	454	14524	107500	.....	.....	25816	3957.50
	20	506	16193	121200	.....	.....	28592	4437.50
34	4	94	3015	22500	.....	.....	10672	1495.00
	5	122	3901	29200	.....	.....	11550	1620.00
	6	150	4788	35800	.....	.....	12476	1757.50
	7	177	5675	42400	.....	.....	13499	1917.50
	8	205	6561	49000	.....	.....	14570	2085.00
	9	233	7448	55700	.....	.....	15715	2280.00
	10	260	8335	62300	.....	.....	16834	2447.50
	12	316	10108	75600	.....	.....	19185	2835.00
	14	372	11882	88400	.....	.....	21689	3252.50
	16	427	13655	102200	.....	.....	24322	3700.00
	18	482	15428	115400	.....	.....	27084	4175.00
	20	538	17202	128600	.....	.....	30108	4707.50
35	4	100	3197	23900	.....	.....	11194	1565.00
	5	129	4137	30900	.....	.....	12099	1697.50
	6	158	5077	38000	.....	.....	13198	1770.00
	7	188	6017	45000	.....	.....	14103	2000.00
	8	217	6958	52000	.....	.....	15202	2172.50
	9	243	7898	59000	.....	.....	16421	2372.50
	10	276	8838	66000	.....	.....	17506	2542.50
	12	335	10719	73000	.....	.....	20078	2977.50
	14	393	12599	81600	.....	.....	22649	3400.00
	16	452	14480	108200	.....	.....	25353	3857.50
	18	510	16360	122400	.....	.....	28323	4375.00
	20	571	18241	136500	.....	.....	31294	4890.00
36	4	106	3384	25300	.....	.....	11709	1637.50
	5	137	4380	32800	.....	.....	12643	1770.00
	6	168	5375	40200	.....	.....	13717	1937.50
	7	199	6370	47700	.....	.....	14847	2115.00
	8	230	7366	55100	.....	.....	15963	2267.50
	9	261	8361	62500	.....	.....	17078	2465.00
	10	292	9356	70100	.....	.....	18331	2670.00
	12	354	11347	85000	.....	.....	20835	3080.00
	14	416	13338	99900	.....	.....	23610	3547.50

TANKS, STANDARD WOOD

Outside Diam. Feet	Outside Height Feet	Approx. Solution Cap. Tons	Capacity Cubic Feet	Approx. Capacity Gallons	— 2-in. Lumber— Approx. Weight	List Price	—3-in. Lumber— Approx. Weight	List Price
36	16	478	15329	114800	.....	.....	26386	$4017.50
	18	541	17320	129700	.....	.....	29433	4550.00
	20	603	19310	144500	.....	.....	32616	5102.50
37	4	111	3577	26700	.....	.....	12278	1715.00
	5	144	4629	34600	.....	.....	13232	1852.50
	6	177	5681	42500	.....	.....	14340	2025.00
	7	210	6733	50400	.....	.....	15499	2205.00
	8	234	7785	57300	.....	.....	16645	2385.00
	9	276	8838	65100	.....	.....	17787	2562.50
	10	308	9890	72900	.....	.....	19075	2775.00
	12	374	11994	89800	.....	.....	21783	3225.00
	14	440	14097	105500	.....	.....	24491	3675.00
	16	506	16201	122000	.....	.....	27476	4185.00
	18	572	18305	136800	.....	.....	30596	4727.50
	20	638	20410	153300	.....	.....	34004	5330.00
38	4	118	3775	28200	.....	.....	12840	1792.50
	5	153	4886	36600	.....	.....	13820	1935.00
	6	187	5996	44800	.....	.....	14957	2110.00
	7	222	7106	53100	.....	.....	16146	2295.00
	8	257	8217	61400	.....	.....	17321	2480.00
	9	292	9327	69700	.....	.....	18777	2725.00
	10	325	10437	78000	.....	.....	19955	2910.00
	12	395	12658	89800	.....	.....	22585	3337.50
	14	465	14879	111400	.....	.....	25507	3830.00
	16	534	17100	127800	.....	.....	28568	4352.50
	18	604	19320	144500	.....	.....	31911	4937.50
	20	674	21541	161000	.....	.....	35256	5525.50
39	4	124	3979	29700	.....	.....	13424	1875.00
	5	161	5149	38600	.....	.....	14434	2022.50
	6	197	6319	47300	.....	.....	15607	2202.50
	7	231	7489	56000	.....	.....	16821	2390.00
	8	270	8660	64900	.....	.....	18048	2585.00
	9	310	9830	73700	.....	.....	19408	2810.00
	10	349	11000	82100	.....	.....	20771	3032.50
	12	427	13440	100500	.....	.....	23639	3512.50
	14	493	15781	117800	.....	.....	26665	4025.00
	16	563	18121	135400	.....	.....	29837	4570.00
	18	639	20462	153000	.....	.....	33303	5182.50
	20	714	22802	170500	.....	.....	36920	5825.00
40	4	131	4188	31300	.....	.....	14009	1955.00
	5	169	5419	40500	.....	.....	15043	2105.00
	6	204	6651	49600	.....	.....	16246	2290.00
	7	246	7882	58900	.....	.....	17504	2487.50
	8	285	9114	68200	.....	.....	18896	2717.50
	9	323	10346	77100	.....	.....	20140	2912.50
	10	362	11577	86800	.....	.....	21535	3135.00
	12	439	14041	105000	.....	.....	24475	3630.00
	14	518	16504	123400	.....	.....	27719	4187.50
	16	591	18967	141700	.....	.....	30964	4745.00
	18	669	21430	160300	.....	.....	34513	5357.50
	20	746	23894	178500	.....	.....	38213	6027.50
41	4	136	4402	32900	.....	.....	14607	2037.50
	5	177	5696	42600	.....	.....	15782	2215.00
	6	218	6991	52300	.....	.....	16898	2380.00
	7	259	8286	62000	.....	.....	18187	2582.50
	8	299	9580	71600	.....	.....	19612	2817.50
	9	339	10875	81200	.....	.....	21041	3050.00
	10	380	12169	91000	.....	.....	22467	3282.50
	12	461	14759	110400	.....	.....	25480	3785.00
	14	542	17348	129600	.....	.....	28794	4352.50
	16	623	19937	149000	.....	.....	32113	4922.50
	18	703	22526	168500	.....	.....	35897	5595.00
	20	784	25116	188000	.....	.....	39680	6265.00

Outside Diam. Feet	Outside Height Feet	Approx. Solution Cap. Tons	Capacity Cubic Feet	Approx. Capacity Gallons	—2 in. Lumber— Approx. Weight	List Price	—3-in. Lumber— Approx. Weight	List Price
42	4	144	4621	34600	.....	.....	15203	$1997.50
	5	187	5980	44700	.....	.....	16403	2177.50
	6	230	7340	54900	.....	.....	17716	2385.00
	7	272	8699	65100	.....	.....	19015	2707.50
	8	314	10058	75200	.....	.....	20312	2792.50
	9	357	11417	85400	.....	.....	21769	3030.00
	10	398	12776	95600	.....	.....	23224	3267.50
	12	484	15495	115800	.....	.....	26452	3812.50
	14	569	18213	136100	.....	.....	29681	4357.50
	16	654	20931	156500	.....	.....	33225	4972.50
	18	739	23649	176900	.....	.....	37085	5657.50
	20	823	26368	197200	.....	.....	41103	6372.50
43	4	151	4846	36200	.....	.....	15821	2205.00
	5	196	6271	46800	.....	.....	17050	2390.00
	6	243	7797	58200	.....	.....	18387	2602.50
	7	289	9222	68900	.....	.....	19704	2807.50
	8	333	10647	79600	.....	.....	21051	3017.50
	9	378	12073	90100	.....	.....	22538	3260.00
	10	422	13498	100800	.....	.....	24188	3537.50
	12	511	16348	122200	.....	.....	27325	4060.00
	14	600	19199	143500	.....	.....	30791	4650.00
	16	689	22050	165400	.....	.....	34410	5272.50
	18	778	24900	186200	.....	.....	38371	5975.00
	20	867	27751	207400	.....	.....	42451	6707.50
44	4	158	5076	37900	.....	.....	16458	2292.50
	5	205	6569	49100	.....	.....	17713	2482.50
	6	252	8062	60300	.....	.....	19085	2697.50
	7	298	9555	71400	.....	.....	20441	2910.00
	8	345	11048	82600	.....	.....	21964	3157.50
	9	392	12541	93700	.....	.....	23486	3405.00
	10	438	14034	104800	.....	.....	25007	3552.50
	12	531	17020	127200	.....	.....	28377	4220.00
	14	625	20006	149500	.....	.....	31912	4825.00
	16	719	22992	171800	.....	.....	35621	5465.00
	18	811	25978	194200	.....	.....	39637	6175.00
	20	903	28964	216800	.....	.....	43992	6960.00
45	4	166	5312	39700	.....	.....	17117	2385.00
	5	215	6874	51400	.....	.....	18404	2580.00
	6	264	8437	63100	.....	.....	19817	2802.50
	7	313	9999	74800	.....	.....	21212	3020.00
	8	362	11561	86400	.....	.....	22775	3277.50
	9	411	13123	98200	.....	.....	24344	3535.00
	10	460	14686	109800	.....	.....	25909	3790.00
	12	556	17810	133200	.....	.....	29383	4377.50
	14	654	20935	156500	.....	.....	33199	5042.50
	16	752	24059	179800	.....	.....	37010	5707.50
	18	849	27184	202300	.....	.....	41344	6485.00
	20	948	30309	226500	.....	.....	45773	7260.00
46	4	173	5553	41500	.....	.....	17777	2475.00
	5	224	7186	53700	.....	.....	19092	2675.00
	6	275	8819	65900	.....	.....	20533	2900.00
	7	326	10452	78200	.....	.....	21959	3125.00
	8	378	12085	90400	.....	.....	23555	3385.00
	9	432	13718	102600	.....	.....	25156	3647.50
	10	479	15351	114700	.....	.....	26928	3947.50
	12	582	18618	139100	.....	.....	30473	4547.50
	14	684	21884	162500	.....	.....	34291	5205.00
	16	786	25150	188000	.....	.....	38432	5937.50
	18	888	28416	212400	.....	.....	42673	6690.00
	20	990	31683	236800	.....	.....	47263	7520.00

Outside Diam. Feet	Outside Height Feet	Approx. Solution Cap. Tons	Capacity Cubic Feet	Approx. Capacity Gallons	—2 in. Lumber— Approx. Weight	List Price	—3 in. Lumber— Approx. Weight	List Price
47	4	181	5799	43600	.....	.....	18446	$2567.50
	5	234	7504	56200	.....	.....	19788	2770.00
	6	288	9210	68800	.....	.....	21261	3002.50
	7	341	10915	81700	.....	.....	22891	3267.50
	8	394	12621	94400	.....	.....	24345	3495.00
	9	448	14327	107000	.....	.....	26376	3832.50
	10	501	16032	119500	.....	.....	27786	4067.50
	12	607	19443	145100	.....	.....	31402	4680.00
	14	714	22854	170800	.....	.....	35373	5362.50
	16	820	26265	196100	.....	.....	39697	6135.00
	18	926	29676	221800	.....	.....	44026	6900.00
	20	1030	33087	247200	.....	.....	48867	7777.50
48	4	189	6050	45200	.....	.....	19195	2675.00
	5	244	7830	73500	.....	.....	20501	2892.50
	6	300	9609	71800	.....	.....	22002	3105.00
	7	356	11389	85200	.....	.....	23665	3375.00
	8	412	13168	98500	.....	.....	25329	3647.50
	9	467	14948	111600	.....	.....	26993	3920.00
	10	522	16727	124900	.....	.....	28836	4230.00
	12	634	20287	151500	.....	.....	32524	4852.50
	14	745	23846	178200	.....	.....	36372	5552.50
	16	856	27405	204800	.....	.....	40979	6332.50
	18	967	30964	231200	.....	.....	45573	7152.50
	20	1078	34523	256000	.....	.....	50336	8012.50
49	4	197	6307	47100	.....	.....	19891	2772.50
	5	255	8162	61000	.....	.....	21222	2967.50
	6	312	10017	74800	.....	.....	22936	3247.50
	7	369	11873	88700	.....	.....	24449	3485.00
	8	427	13728	102600	.....	.....	26147	3760.00
	9	484	15583	116500	.....	.....	27842	4037.50
	10	531	17438	130400	.....	.....	29722	4355.00
	12	646	21148	158100	.....	.....	33665	5027.50
	14	759	24858	185800	.....	.....	37790	5742.50
	16	872	28568	213500	.....	.....	42281	6537.50
	18	1005	32278	241300	.....	.....	46955	7370.00
	20	1125	35989	269000	.....	.....	51995	8285.00

EQUIPMENT PRICES

These prices are as of 1953. They are only approximate figures. The price is for a motor driven unit, with drive, unless it is specifically stated otherwise.

PRICES AND DATA SUBJECT TO CHANGE WITHOUT NOTICE

THICKENERS, SPIRAL RAKE

(Includes motor and drive but does not include thickener tank)

Size	Motor HP	Approx. Shipping Wt. (lbs.)	Approx. Price F.O.B. Factory
6′ x 6′	½	1,170	$ 1,040
8′ x 7′	¾	1,715	1,265
10′ x 7′	¾	1,850	1,445
12′ x 8′	1	2,355	1,560
14′ x 8′	1	2,500	1,675
16′ x 8′	1	3,935	1,770
18′ x 8′	1	4,235	1,835
20′ x 10′	1	4,420	1,900
24′ x 10′	1½	5,000	2,060
28′ x 10′	2	7,365	2,455
32′ x 10′	2	9,650	2,730
36′ x 10′	2	9,950	3,440
40′ x 10′	2	10,500	3,545
50′ x 10′	3	20,000	6,460
55′ x 10′	3	21,900	7,125
60′ x 10′	3	23,800	7,855
65′ x 10′	3	25,600	8,855
70′ x 10′	5	27,500	9,850
75′ x 10′	5	29,500	10,915
80′ x 10′	5	31,500	12,115
100′ x 14′	5	43,000	18,000
150′ x 15′	5	54,000	22,500
200′ x 17′	7½	83,000	38,500

AIR TRAMMERS

Airmotor H. P.	Size Air Receiver	Approx. Weight, Lbs.	Approx. Price F.O.B. Factory
6	36″x84″	3,000	$2,200
10	48″x120″	3,700	3,200

PHONE, WIRE, OR WRITE YOUR ORDER TODAY

Bulletins or other descriptive material giving details and specifications as well as up-to-date prices will be sent on request.

DENVER EQUIPMENT 24 HOUR SERVICE COMPANY

 Also see page 487.

ANGLES STRUCTURAL

Size	Weight /Ft.	Approximate Prices Warehouse	Mill
3x2x3/16	3.1	U. S. $ 8.20 per 100 lbs.	4.60
3x2x¼	4.1	7.80	4.30
3x2x5/16	5.0	7.80	4.30
3x2x⅜	5.9	7.80	4.30
3x2½x¼	4.5	7.80	4.30
3x2½x5/16	5.6	7.80	4.30
3x2½x⅜	6.6	7.80	4.30
3x3x3/16	3.7	7.80	4.30
3x3x¼	4.9	7.80	4.30
3x3x5/16	6.1	7.80	4.30
3x3x⅜	7.2	7.80	4.30
3x3x½	9.4	7.80	4.30
3½x3½x¼	4.9	7.95	4.45
3½x3½x5/16	6.1	7.95	4.45
3½x3½x⅜	7.2	7.95	4.45
3½x3x¼	5.4	8.00	4.50
3½x3x5/16	6.6	8.00	4.50
3½x3x⅜	7.9	8.00	4.50
3½x3½x¼	5.4	7.95	4.45
3½x3½x5/16	7.2	7.95	4.45
3½x3½x⅜	8.5	7.95	4.45
3½x3½x½	11.1	7.95	4.45
3½x3½x⅝	13.6	7.95	4.45
4x3½x¼	6.3	8.00	4.50
4x3½x5/16	7.7	8.00	4.50
4x3½x⅜	9.1	8.00	4.50
4x4x¼	6.6	8.25	4.65
4x4x5/16	8.2	8.00	4.50
4x4x⅜	9.8	8.00	4.50
4x4x7/16	11.3	8.00	4.50
4x4x½	12.8	8.00	4.50
4x4x⅝	15.7	8.00	4.50
5x3x5/16	8.2	8.20	4.70
5x3x⅜	9.8	8.00	4.50
5x3x½	12.8	8.00	4.50
5x3½x5/16	8.7	8.05	4.55
5x3½x⅜	10.4	8.05	4.55
5x3½x7/16	12.0	8.05	4.55
5x3½x½	13.6	8.05	4.55
5x4x⅜	11.0	8.05	4.55
5x4x½	14.5	8.05	4.55
5x5x⅜	12.3	8.15	4.65
5x5x½	16.2	8.15	4.65
6x3½x⅜	11.7	8.15	4.65
6x3½x½	15.3	8.15	4.65
6x4x5/16	10.3	8.15	4.65

MILL DESIGN AND CONSTRUCTION ESTIMATES

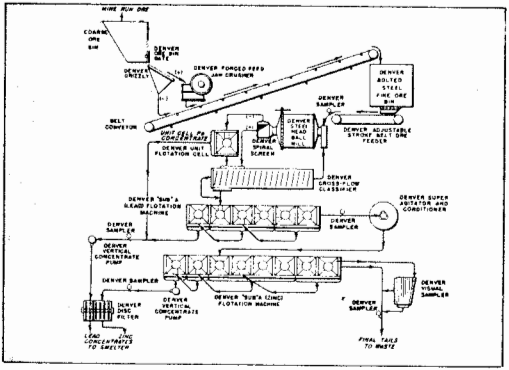
Denver Equipment Company's experience in mill design, based on over 25 years' experience, is available to you to insure success and maximum profit of both new and existing mills. DECO Mill Design Service is just another part of a complete service that starts with the ore test and continues through the supplying of equipment to a follow-up field service which includes distribution of latest technical and operating information to our customers.

Mills all over the world are in close contact with DECO engineers. These mills treat both metallics and non-metallics as well as industrial products and this vast reservoir of experience is available to you through Denver Equipment Company. It has been said of mining that "experience is the cheapest thing in the world as long as you buy it from someone else."

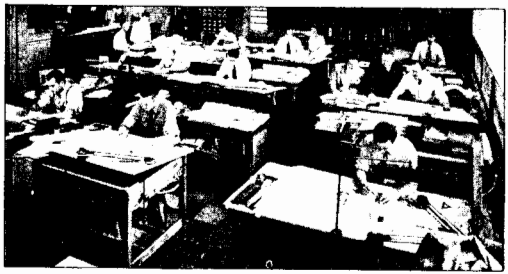
You will find that emphasis is on practical solutions to milling problems and you receive the advantages of experience by many leading mill operators instead of just a few.

Estimated charges for design service and mill construction are given in this section along with typical plant layouts and examples of actual construction projects. These will, we believe, be useful as a guide in your plans.

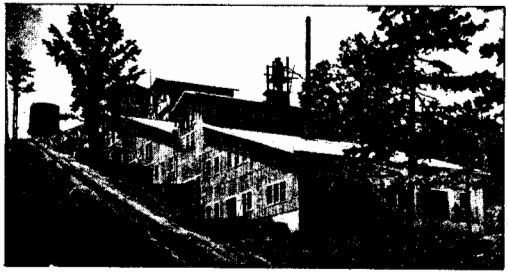
• FLOW SHEETS



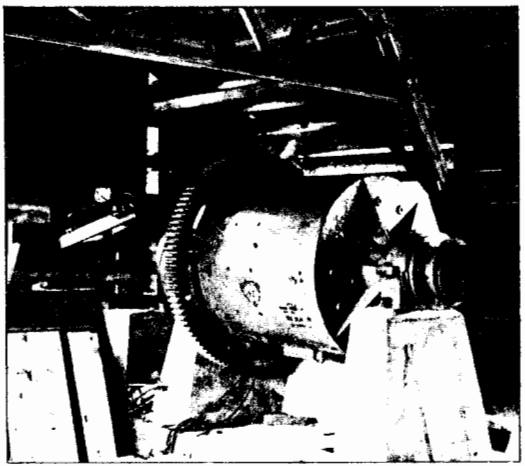
• MILL DESIGN & LAYOUT



• FOLLOW-UP FIELD SERVICE



We welcome the opportunity to help you with your mill design and construction and invite you to consult with us without charge or obligation at any time.



MILL CRUSHING PLANT NOW ALMOST COMPLETED

DECO MILL DESIGN SERVICE

After completion of the ore test and establishing the daily tonnage your mine will produce on a continuous basis the mill flowsheet with equipment sizes is determined.

From this flowsheet the cost of equipment F.O.B. factory is established. Denver Equipment Company supplies you with a complete equipment proposal along with the laboratory test report.

For estimating purposes the machinery costs given in this handbook may be used in establishing the approximate cost for the plant equipment. With this information on mill machinery costs you can estimate the engineering fees for the mill design.

Estimated Engineering Fees for Mill Design

Mill Machinery Cost	Service "A" includes(1)* (2) (3) (4) and (5)	Service "B" includes (1)* (2) (3) and (4)	Service "C" includes(1)* (3) and (4)	Service "D" includes (1)* only
$ 10000	$1100	$ 880	$ 550	$ 330
20000	1600	1260	785	475
30000	2000	1640	1025	620
40000	2500	2025	1265	760
50000	2900	2325	1460	875
60000	3300	2640	1650	990
70000	3700	2950	1845	1100
80000	4100	3255	2035	1220
90000	4400	3520	2200	1320
100000	4800	3785	2365	1420
110000	5100	4050	2520	1520
120000	5400	4315	2695	1620
130000	5700	4575	2860	1715
140000	6100	4840	3025	1815
150000	6400	5105	3190	1915

*Figures in parentheses indicate type of service as described below.

Mill design and specifications to include.

(1) General arrangement of the equipment in plan and elevation as necessary to show location of equipment and flowsheet.

(2) Details of foundations, building, platforms, walkways, stairways as required for construction. Details of elevators and conveyors as necessary for construction and installation.

(3) Details showing the arrangement and sizes of water piping and launders.

MILL BUILDING ROOF TRUSSES UP AND ROOF PARTIALLY COMPLETED.

(4) Details showing the arrangement and sizes of electric wiring and electrical equipment.

(5) Specifications shall accompany these drawings and shall fully explain the construction, type and quality of material used, duties and responsibilities of the contractor and all features relative.

The customer is to select the mill site and furnish topographic maps and other information relative to building conditions.

Machinery cost is used as the basis for arriving at the estimated engineering fee for the various services available. Even though we show estimated machinery costs and estimates, Denver Equipment Company will gladly help you in providing this engineering service for your specific project.

Machinery cost is taken as the total and current F.O.B. factory selling prices of all equipment included in the mill design. If used equipment is to be utilized in the mill design, the current new price should be used as a basis for determining the proper engineering fee.

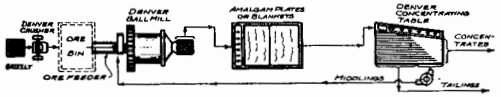
The estimated engineering fee for the various services is based on the drafting board expense of the engineer doing the design work at the rate of $5.00 an hour.

Estimated engineering fees include drafting, labor and expenses such as the cost of tracing cloth, tracing paper, supervision by the Chief Engineer, and cost of blueprints of mill plans. Any other expenses such as traveling expenses (transportation, hotel, meals, etc.) and minimum engineering labor charge of $40.00 for the first day plus $40.00 for each additional day based on the time the engineer leaves his office and returns is extra. Estimated engineering fees do not include outside surveys or outside consulting engineering fees nor any contracting or construction work.

Costs of Small Gold Plants

These five illustrated flowsheets fully described in the article "Small Gold Milling Plants" follow a natural sequence. These start with a very simple *Flowsheet AA*, and then by the addition of the more extensive equipment, it is possible to take care of slight changes in the ore as well as improve recovery. The following tables include the tonnage handled per day in each mill, the total amount of power required for operation, tons of water needed for milling, weight of machinery and approximate machinery cost for each mill according to the flowsheet utilized. These estimates are based on belt driven machines and are f.o.b. factory. Motor driven equipment costs approximately ten per cent more than belt driven.

COST DATA FOR FLOWSHEET AA

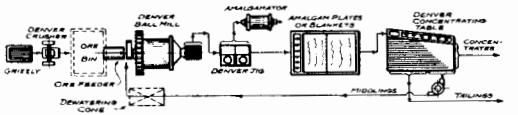


FLOWSHEET AA, AMALGAMATION AND GRAVITY CONCENTRATION

This flowsheet is the lowest priced possible and can be used on an ore with a high percentage of free gold values and where the values are unlocked at reasonably coarse grinding.

Tons per 24 Hrs.	Tons Water per 24 hours	H. P.	Weight Lbs.	Approximate Price
5-10	25-40	12.50	6500	$5210.00
11-15	50-75	17.25	8500	6295.00
16-20	80-100	27.75	13000	8630.00
25-35	126-165	39.50	23000	12745.00
50-65	250-300	66.00	37000	16720.00

COST DATA FOR FLOWSHEET BB

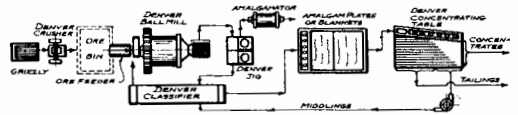


FLOWSHEET BB, DENVER MINERAL JIG AHEAD OF AMALGAMATION

Flowsheet BB has a Denver Mineral Jig and Amalgamator in addition to equipment required for *Flowsheet AA*, and is used for an inexpensive plant where values are coarse but minerals are coated or filmed and will not amalgamate readily on plates. Jig recovers "rusty" values in a high grade concentrate for forced amalgamation treatment in Denver Amalgamator. On these ores, blankets, corduroy or Denver Gold Matting usually are substituted for amalgamation plates and their concentrate also treated in Amalgamator.

Tons per 24 Hrs.	Tons Water per 24 hours	H. P.	Weight Lbs.	Approximate Price
5-10	25-40	13.25	9500	$5900.00
11-15	50-75	18.25	11500	7135.00
16-20	80-100	28.75	16000	8570.00
25-35	125-165	40.50	26000	13585.00
50-65	250-300	68.00	42000	18550.00

COST DATA FOR FLOWSHEET CC

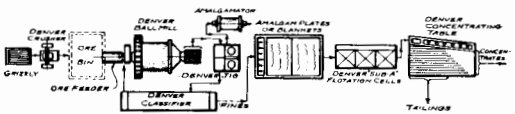


FLOWSHEET CC, DENVER JIG IN BALL MILL-CLASSIFIER CIRCUIT

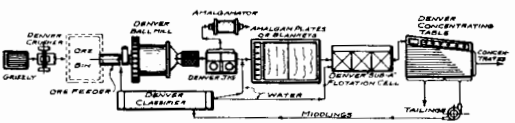
This flowsheet with the addition of the classifier allows finer grinding and the jig used in the closed grinding circuit has increased efficiency. It will give the highest recovery possible for amalgamation and gravity concentration.

Tons per 24 Hrs.	Tons Water per 24 hours	H. P.	Weight Lbs.	Approximate Price
5-10	20-35	13.75	10200	$7050.00
11-15	45-60	18.75	12500	8285.00
16-20	65-80	29.50	18000	10770.00
25-35	100-140	41.50	30000	15785.00
50-65	200-260	70.00	47000	21100.00

COST DATA FOR FLOWSHEETS DD-EE



FLOWSHEET DD, JIG, AMALGAMATION, FLOTATION, CONCENTRATION



FLOWSHEET EE, RETREATING MIDDLINGS FROM CONCENTRATING TABLE

The addition of flotation brings recovery to the highest point as slime values are recovered as well as more granular minerals. Values that can be amalgamated are secured in bullion form and remainder are recovered in flotation concentrate. This flowsheet necessary where minor percentage of values are present as metallics, at commercial fineness of grinding, and where the minerals are friable and easily slimed in fine grinding such as galena or the various telluride minerals.

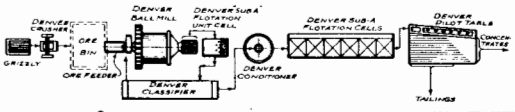
Tons per 24 Hrs.	Tons Water per 24 hours	H. P.	Weight Lbs.	Approximate Price
5-10	20-35	16.75	14400	$8700.00
11-15	40-55	23.25	17500	10735.00
16-20	60-80	33.50	23500	12910.00
25-30	90-125	47.50	36000	18775.00
50-65	175-250	77.00	60000	24260.00

From the above you will note that the additional cost of the classifier, flotation cells, and reagent feeder, which means so much in these simple plants, is very small.

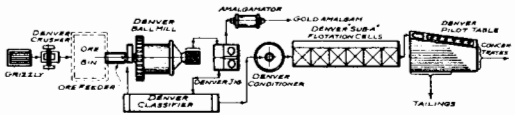
Cost of Flotation Mills

The following estimates on flotation mills cover standard practice as used on base metal and non-metallic ores where the majority of values are recoverable by flotation, and where there is sufficient freed mineral in the ball mill discharge to warrant recovery by means of either a Denver Unit Flotation Cell, a concentrating table, or a jig, in the ball mill-classifier circuit. Many gold and silver ores come under this same classification as not enough of the precious metals are present as free metallics to warrant the use of amalgamation. On lead copper ores, the unit flotation cell is recommended, whereas with free gold ores containing coarse metallic gold values, along with sulphides, we recommend the Denver Mineral Jig. No elevator or pump is necessary in this circuit when using the unit cell or jig, such as is the case when the table is placed between the ball mill and classifier. Care must be taken when using a table in not permitting the use of too much water in the circuit to interfere with subsequent treatment, therefore the Denver Unit Flotation Cell or Denver Mineral Jig is economical to install and more efficient.

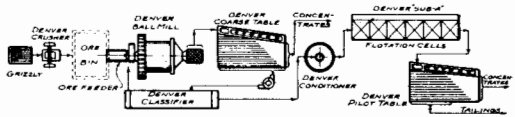
Flowsheets 2B (unit cell), *2J* (jig) and *1* (table), with either the unit flotation cell, the jig, or the table between the ball mill and classifier, makes the standard flotation mill. The data below is for all equipment necessary and with either unit flotation cell, jig or coarse table, but with no amalgamator.



FLOWSHEET 2B, DENVER UNIT FLOTATION CELL IN GRINDING CIRCUIT



FLOWSHEET, 2J, DENVER MINERAL JIG PLACED IN GRINDING CIRCUIT

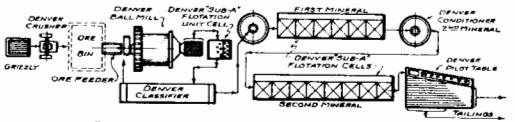


FLOWSHEET 1, DENVER CONCENTRATING TABLE IN GRINDING CIRCUIT

COST DATA FOR FLOWSHEET 2B, 2J OR 1

Tons per 24 Hrs.	Tons Water per 24 hours	H. P.	Weight Lbs.	Approximate Price
16-20	60-80	36.5	25000	$13655.00
25-35	90-125	50.0	40000	17990.00
50-65	175-250	80.5	70000	20775.00
100-125	350-500	125.5	95000	31832.00

Selective Flotation Plants



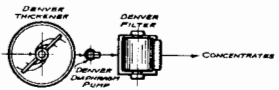
FLOWSHEET 3B, RECOVERING TWO MINERALS BY SELECTIVE FLOTATION

Below are prices and data for a selective flotation plant where two minerals are to be recovered as separate concentrates. This includes all necessary equipment as shown on *Flowsheet 3B*.

COST DATA FOR FLOWSHEET 3B

Tons per 24 Hrs.	Tons Water per 24 hours	H. P.	Weight Lbs.	Approximate Price
16-20	70-90	41.25	30000	$16500.00
25-35	100-140	58.00	45000	21815.00
60-75	200-300	122.50	80000	28925.00
100-125	400-600	154.00	115000	37507.00

Thickener and Filter Equipment



FLOWSHEET FF, FILTERING EQUIPMENT FOR FLOTATION CONCENTRATES

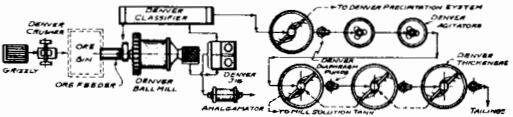
If thickener (including mechanism superstructure, and wood tank) diaphragm pump and filter are required in *Flowsheet 1*, *2B*, or *2J*, add the following prices to those already given. For selective Flotation Plants, *Flowsheet 3B*, add 75-80% to the weights and prices shown below to cover the extra thickener, diaphragm pump, and filter for the second concentrate.

COST DATA FOR FLOWSHEET FF

Size of Mill Tons per 24 Hrs.	Tons Filtered	H. P.	Weight Lbs.	Approximate Price
16-20	1½ to 2	5	6000	$5000.00
25-35	2½ to 3½	6	7500	5600.00
50-65	5 to 6½	7½	9000	6000.00
100-125	10 to 12½	10	12000	7000.00

The above figures are based on ratio of concentration of 10:1 or 12:1.

Cyanide Mills



FLOWSHEET CY3, COUNTER-CURRENT DECANTATION CYANIDE PLANT

The following estimates are for counter-current decantation cyanide circuits and are based on average grade ore requiring average treatment time. These include precipitation and accessory equipment. The equipment required for a cyanide plant will vary considerably with the value of the ore, the settling rate, the chemical composition of the ore, the hardness, and the degree of grinding required, as well as other important factors. It is very difficult to give accurate estimates on a cyanide mill until the exact flowsheet has been determined. There are so many factors that enter into the cost of a cyanide mill that the following figures must be carefully checked so that ample consideration is given to all these variable factors.

COST DATA FOR FLOWSHEET Cy3

Size of Mill Tons per 24 Hrs.	Minimum Tons Water per 24 Hrs.	H. P.	Weight, Lbs.	Approximate Mach. Prices
16-20	50	20	50000	$23000.00
25-35	70	35	85000	27000.00
50-65	115	65	125000	39000.00
100-125	185	125	220000	56000.00

Estimating Mill Building

THE FOLLOWING COSTS and items on mill estimating have been compiled from actual mill costs covering approximately twenty different mills built in various locations in the United States. Frequently, in mill estimating, small items are omitted and unforeseen expenses arise that rapidly increase the cost of a mill above the estimated price. The following percentages and costs can be used with safety in estimating the cost of building a mill.

(R) Roads and Clearings—$0.75-$1.25 per Yard — Minimum $750.00

This item covers the expense of building a road to the upper part of the mill site and around the lower part of the mill to enable trucks and teams to reach the various mill levels. For the road work a figure of 75 cents to $1.25 per yard depending on amount of rock work can be used. Never estimate less than $750.00. This item also covers the cost of repairing bridges to permit the haulage of heavy machinery. Even though the railroad siding is at the bottom of the mill site, it is still necessary to figure on a road to other parts of the mill.

(E) Excavation — $0.75 per Yard for Soft Dirt up to $5.00 per Yard for Rock

Excavation cost depends upon the nature of the ground. Estimate the actual number of cu. yds. of material to be excavated, using a cost of 75 cents for soft dirt, in which a bulldozer can be used, and $2.00 per yard for rock. A good average cost per yard for excavation is $1.50. This assumes that the material excavated can either be used in fills or close to the mill site. If the material is to be hauled any distance, estimate 50 cents extra per yard mile for loading and hauling.

(F) Foundations—$40.00 to $75.00 per Yard of Concrete (includes forms)

This covers all of the concrete foundations for the building and machinery. The foundations should be carefully calculated to be sure that ample footing is placed under each machine and under the mill walls. Even though the machines do not require a very strong foundation, figure at least a thickness of 12″ over the entire plan area of the machines. The average thickness of the floors should be 6″ even though a 4″ or 5″ floor is desired. The excavation for the foundations is covered by item "E" and should not be confused with "F". A cost of from $40.00 to $75.00 per yard for the cement work is about correct. This cost covers a concrete mixer, water lines to the mixture, forms, raw material, and labor. An average of six sacks of cement per yard of concrete is required. Piers for heavy crushers, ball mills and engines should be tied together with a solid block of concrete strongly reinforced.

(BL) Lumber for Building — $70.00 to $95.00 per Thousand Board Feet for Labor, Plus Actual Cost of Lumber

Make a complete lumber list of the framing lumber and the sheeting and after securing the exact number of board feet add 20% for wastage. To the cost f.o.b. the lumber mills, on the lumber, (a thousand board feet of lumber weighs approximately 3000 lbs.) add the freight and a haulage and handling charge at the rate of 50 cents per ton mile from the railroad station to the mill site with a minimum charge of 50 cents per ton. This gives the cost of the lumber f.o.b. mill site. The labor for putting the lumber in place will cost from $70.00 to $95.00 per thousand board feet.

(BS) Structural Steel for Building — $175.00 to $275.00 per Ton Installed

An installed cost of $175 to $275 per ton of steel frames and steel-work for building is about right. This item, however, depends upon the design and shape of the steel-work as well as the distance from the steel mills.

(BR) Roofing – Corrugated Iron — $15.00 to $20.00 per Square (100 square ft.) —Composition Roofing $7.50 to $9.00 per square

Cost of roofing varies, depending upon the grade. For corrugated iron roofing, an installed cost, including the cost of the roofing plus the labor of putting it in place, of $15.00 to $20.00 per square (100 square feet) is approximately correct. For composition roofing use an installed cost of from $7.50 to $9.00 per square. A 3-ply roofing for the roof and a 2-ply for the sides is usually used, although in cold climates 4-ply for the roof and 3-ply for the sides should be used.

(BD) Doors and Windows

Obtain the cost of the doors and windows f.o.b. mill site and then add 100% to cover the cost of installation.

(BP) Launders, Stairways and Platforms — 10% to 20% of Building Cost

Estimate a cost of 10% to 20% of the total cost of the items "BL," "BD," "BR" and "BS" to cover the above construction.

(BH) Hardware, Nails, Rods, and Bolts—7½% to 10% of Building Cost

Hardware, etc., installed usually amounts to 7½% to 10% of the total installed cost of "BL," "BD," "BR," and "BS."

(M) Machinery—Cost of Machinery f.o.b. Factory

This is the largest item and should be calculated very carefully. It includes all of the machinery from the crusher to, and including, the final filter and drier equipment and motors. The transmission equipment, piping and electric wiring are figured separately.

(MFH) Freight and Haulage of Machinery

As much equipment as possible covered under the heading (M) should be consolidated in carload shipments. A figure based on carload rate, plus 25% should be used to estimate freight charges. The 25% additional to the carload rate is to compensate for the large amount of machinery that must be shipped either "LCL", or by express. To this freight charge, add the haulage and handling charge, which amounts to approximately 50 cents per ton mile. A minimum amount of 50 cents per ton should be allowed for handling charge even though the mill is adjacent to the railroad.

(ML) Installation of Machinery — Cost Installed from 2½c to 5c per pound

Installation cost of the machinery should be figured on the total weight of the machinery, using the manufacturer's shipping weights, multiplying this weight in pounds by 2½c to 5c. Under favorable conditions, a cost of 2½c per lb. is sufficient and in unfavorable cases, a figure of 4c to 5c per lb. should be used.

(MT) Transmission Equipment—8% to 10% of the Factory Cost of the Machinery (M)

This includes all of the shafting, bearings, safety set collars, pulleys, belting, and in the case of motor rope drives, includes the motor ropes and sheaves.

(MP) Piping—

3% to 6% of factory machinery cost "M" and includes mill water tank.

(MW) Electric Wiring and Switch Board 4% to 8% of Factory Cost (M)

This includes all of the wiring, switchboards, and conduit, but does not include the motors or motor generator sets.

(T) Tools—2% to 3% of Machinery Cost f.o.b. Factory

Pipe cutters, dies, carrying hooks, large wrenches, chains, blocks, etc., cost 2% to 3% of the machinery cost f.o.b. factory (no large tools included).

(D) Drafting and Engineering

The cost of drafting and engineering depends a great deal upon the size of the mill. For small mills of 50-ton capacity, a total cost of $1250.00 for drafting and engineering can be used. The designing cost will be lowered considerably if a standardized mill is built. An average cost of from $1000.00 to $2500.00 per month for large mills should be allowed for drafting during construction, and a draftsman or designer should be kept on the ground while the mill is being constructed to make changes in design as required. The standard scale used for mill designing is ¼" to the foot, but on large general arrangement mill

drawings ⅛" to the foot may be used. Templates of various machines of ¼" scale to the foot should be made of all machines in the three views, plan, front elevation, and side elevation. These templates can be changed about until the proper arrangement is secured to fit the mill site. The templates of the various machines handled by the Denver Equipment Company will be very gladly sent to designing engineers. A good designing engineer is indispensable, for money spent on general arrangement and detail drawing brings good dividends in mill construction. Base engineering and draftsman time on rate of from $4 to $6 per hour.

(C) Commissary

The charge for board and room for the workmen is usually short about 85 cents per day per man, particularly if the mine is not located near a town, and it is well to figure accordingly.

(G) General Expense—12½% of the above items

Superintendent, timekeeper, fire insurance, liability insurance, field office, stationery, telephone, telegraph, and traveling expenses are included in general expense. Under no circumstance should this 12½% charge be reduced, for it will be found that this item will amount to a considerable sum before the mill is finished.

(EX) Emergency Expense—10% of all expenses

A contingent charge of ten per cent to cover all emergencies, such as strikes, delays in shipment, extremely bad weather, fires, floods, railroad accidents, etc., is very essential. This item is extremely important, particularly if cold weather is encountered.

PROBLEM: Cost of 500-Ton Flotation Mill located five miles from railroad, with electric power and water available at mill site, and with building made of standard wood construction.

R—	Roads			$ 2,500
E—	Excavation—2,000 yds. @ $1.87½ (½ rock, ½ dirt), tree trunks			3,750
F—	Concrete Work—500 yds @ $40.00			20,000
BL—	Building Lumber—			
	250,000 bd. ft. @ $60.00 f.o.b. R.R.	$15,000		
	Haulage	1,500		
	Installation @ $75.00/M	18,750	$35,250	
BR—	Corrugated Roofing—175 @ $15.00	2,625		
	Composition Roofing—250 @ $9.00	2,250	4,875	
BS—	Building Steel—11 tons @ $250.00/ton		2,750	
BD—	Doors and Windows, f.o.b. mill site—			
	12 Light 12"x14"	700		
	Labor of installing	700	1,400	
PB—	Launders, Stairways, Platforms (15% of $44,275)		6,641	
BH—	Hardware, Nails, Rods and Bolts (8% of $44,275)		3,542	54,458
M—	Machinery f.o.b. Factory			175,000

CONTINUED ON NEXT PAGE

PROBLEM: Cost of 500-Ton Flotation Mill located five miles from railroad, with electric power and water available at mill site, and with building made of standard wood construction.

MFH—	Machinery—Freight and Haulage			
	Freight—700,000 lbs. @ $3.00/100 lbs.	21,000		
	Haulage—700,000 lbs. @ $3.50/ton	1,225	22,225	
ML—	Labor, Installing Machines @ 3c/lb.		21,000	
MT—	Transmission Installed		6,000	
MP—	Pipe and Fittings Installed		7,000	
MW—	Electrical Wiring Installed		4,000	
T—	Tools—2% of Machinery ($75,000)		3,500	238,725
D—	Drafting and Engineering			9,500
C—	Commissary—Boarding House Deficit			1,000
	Total Cost Building and Machinery			**329,933**
G—	General Expenses—12½% of all above items $322,433)		40,304	
EX—	Emergency Expenses—10% of all above items ($362,737)		36,273	76,577
	GRAND TOTAL COST OF 500-TON MILL			**$406,510**

PRESENT COST – 50 TON DENVER FLOTATION MILL – COLORADO

MACHINERY WITH MOTORS AND DRIVES

	Motor H. P.	Weight	Price
Grizzley	.....	300	$ 150
Crusher 10x16	20	6,650	2,675
Fine Ore Bin	.....	5,050	800
Belt Ore Feeder 20″x10′	1½	1,800	825
Ball Mill 5′x5′	50	27,000	7,100
Duplex Mineral Jig 8″x12″	¾	800	930
Spiral Classifier 30″x16′-9″	2	6,100	2,890
8 Cell No. 18 Sp. Denver Flotation Cells	20	14,200	4,670
Reagent Feeders	½	650	550
Visual Sampler	½	750	600
Disc Filter—Denver 4′x3′ Disc	¾	2,450	2,575
Vacuum Equipment	9	1,750	1,430
Mill Water Tank (8′x12′)	.....	1,800	460
Sand and Water Pumps	5	1,750	970
	110	71,050	$26,625

*Actual H. P. consumed will be 15 to 25% less, or 83-95 H. P.

MILL OPERATING COST—1,350 tons per month

Power (1.50¢ per K.W. Hour)	$ .72
Supplies	1.20
Labor and Supervision	1.80
	$3.72 Per Ton

The above does not include taxes and plant amortization.

CONSTRUCTION ITEMS

	Cost
Roads and Clearing Site	$ 750
Excavation 250 Cu. Yards Rock and Dirt	475
Foundations—45 Cu. Yards Concrete—Materials Only	585
Buildings and Foundations	
Laborers—2,750 Hours	4,250
Carpenters and Millwrights—1,350 Hours	3,160
Lumber and Hardware	3,540
Glass Windows	230
Roofing—Mill Sides and Roof	415
Machinery F.O.B. Factory	26,625
Freight and Haulage	950
Electrical Switches and Wiring—Materials	1,385
Machinery Installation and Wiring Labor—1,450 Hours	2,865
Designing, Testing and Supervision—680 Hours	2,775
TOTAL COST	$48,005

We welcome the opportunity to help you with your mill design and construction and invite you to consult with us without charge or obligation at any time.

Estimated charges for design service and mill construction are given in this section along with typical plant layouts and examples of actual construction projects. These will, we believe, be useful as a guide in your plans.

50-65 TON DENVER MILLING PLANT

Machine	H.P.	Domestic Wt. Lbs.	Export Wt. Lbs.
10"x16" Denver Jaw Crusher	12	4650	5100
15"x6' Denver Belt Ore Feeder	½	1350	1485
5'x5' Denver Ball Mill (Steel Head)	40	27500	29000
No. 100 Denver Unit Flotation Cell	1½	1300	1500
Denver Spiral Screen		300	375
30" Denver Cross-Flow Classifier	2	4800	5600
5'x5' Denver Conditioner and Tank	1½	1750	2190
4 Cell No. 15 Denver "Sub-A"	4	5600	6150
6" Denver Cone Reagent Feeder	¼	110	125
Denver Triplex Wet Reagent Feeder	¼	600	700
No. 6 Wilfley Concentrating Table	1¼	2900	3400
1¼" Denver Vertical Sand Pump	2	840	920
TOTAL	65¼	51700	56545
10'x8' Denver Thickener and Tank	¾	4120	4365
2" Denver Diaphragm Pump	½	800	880
4'x2-disc Denver Disc Filter	¾	1950	2350
Vacuum Equipment for Filter	4	1000	1100
TOTAL	6	7870	8695
COMPLETE MILL TOTAL	71¼	59570	65240

All we ask is a chance to help you and the opportunity to work with you on your equipment needs.

100-125 TON DENVER MILLING PLANT

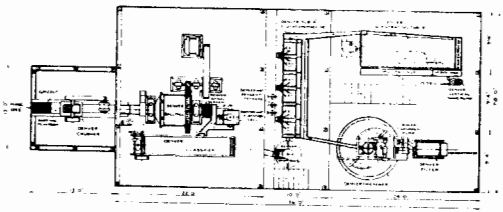
Machine	H.P.	Domestic Wt. Lbs.	Export Wt. Lbs.
10"x20" Denver Jaw Crusher	17	8100	8600
24"x8' Denver Belt Ore Feeder	1	1600	1760
5'x8' Denver Ball Mill (Steel Head)	75	41500	44000
No. 250 Denver Unit Flotation Cell	3	1950	2150
Denver Spiral Screen		400	500
42" Denver Cross-Flow Classifier	4	9600	11000
6'x6' Denver Conditioner and Tank	2	2050	2550
6 Cell No. 18 Denver "Sub-A"	10	10800	11900
6" Denver Cone Reagent Feeder	¼	110	125
Denver Triplex Wet Reagent Feeder	¼	600	700
No. 6 Wilfley Concentrating Table	1¼	2900	3400
2" Denver Vertical Sand Pump	4	900	990
TOTAL	117¾	80510	87675
14'x8' Denver Thickener and Tank	1	5500	6300
2" Denver Diaphragm Pump	½	800	880
4'x3-disc Denver Disc Filter	¾	2400	2900
Vacuum Equipment for Filter	5	1100	1200
TOTAL	7¼	9800	11280
COMPLETE MILL TOTAL	125	90310	98955

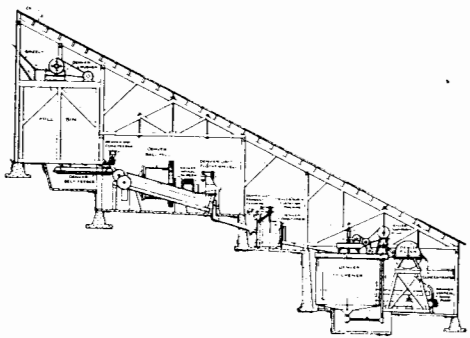
50-65 TON DENVER MILLING PLANT

The 50 to 65 Ton Denver Mill is the most practical size for the average milling plant. The 9"x16" Denver Jaw Crusher (forced feed) produces enough crushed ore for the ball mill on one eight hour shift to run the balance of the mill for twenty-four hours. Oversize primary crushers are recommended for most economical results. Note the flexibility of the flowsheet and the gravity flow through the mill which eliminates elevators, conveyors and pumps (except for middling products).

Advantages include motor "V" Rope drives and ample room. On gold ores a Denver Selective Mineral Jig in the grinding circuit may be advisable.

The simplicity of the flowsheet makes it easy to operate and eliminates difficulties.

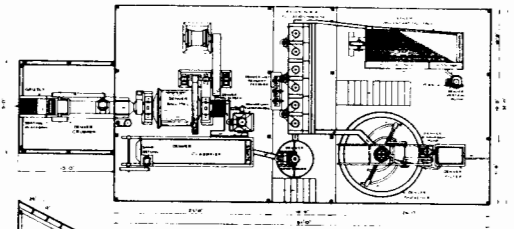


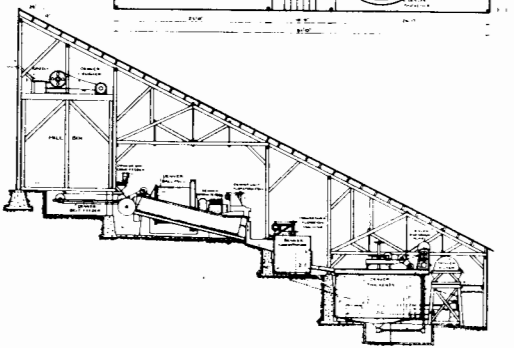


100-125 TON DENVER MILLING PLANT

The 100 to 125 Ton Denver Mill is arranged along the same standard lines as the smaller mills, and a large oversize forced feed crusher is recommended for primary crushing. An intermediate crusher can be installed later if necessary. Changes can be easily made according to your local conditions. Here too, a Denver Selective Mineral Jig may be advisable on gold ores.

All machines have motor "V" Rope drive, but with slight changes belt drives can be furnished. Drives and flowsheet can be changed to meet your conditions, and by means of the sand pump, products can be returned to any part of the flowsheet. Standard Denver Machines, flexible in design, insure successful and profitable operation.





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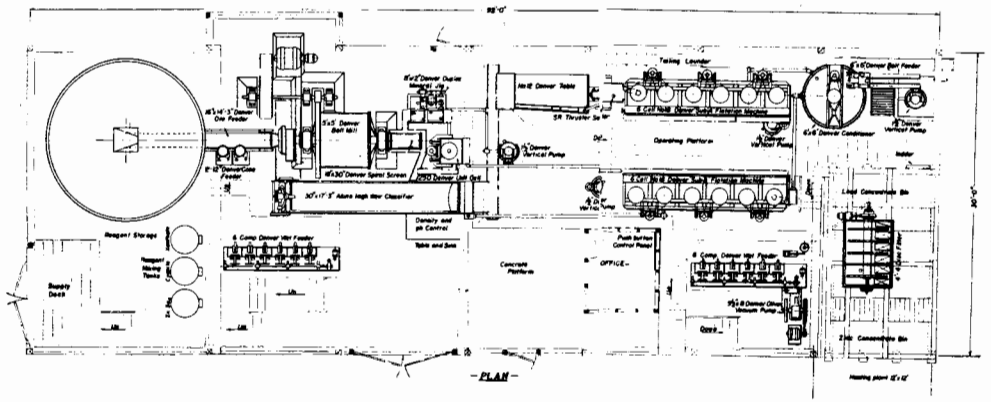

— PLAN —

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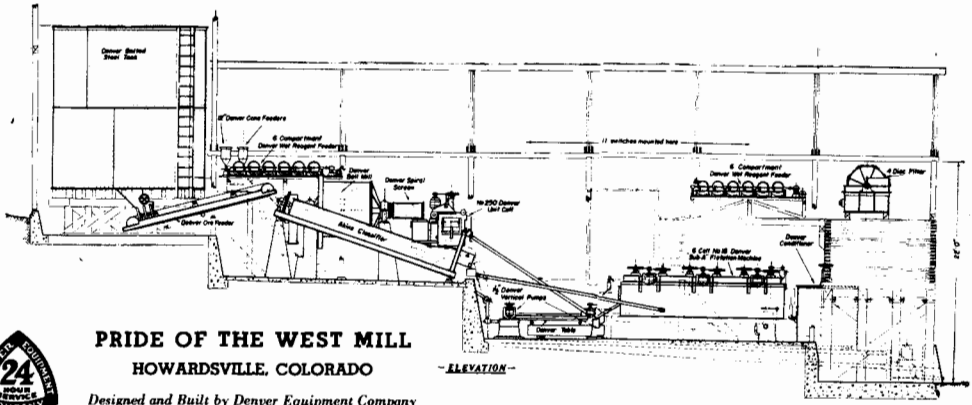


— ELEVATION —

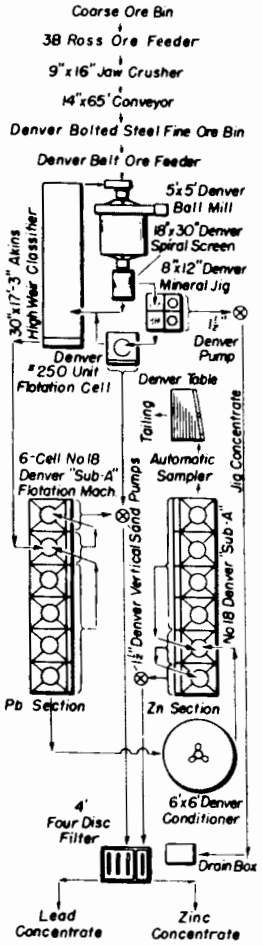
PRIDE OF THE WEST MILL

HOWARDSVILLE, COLORADO

Designed and Built by Denver Equipment Company

DENVER EQUIPMENT COMPANY 24 HOUR SERVICE

FLOWSHEET—PRIDE OF WEST MILL

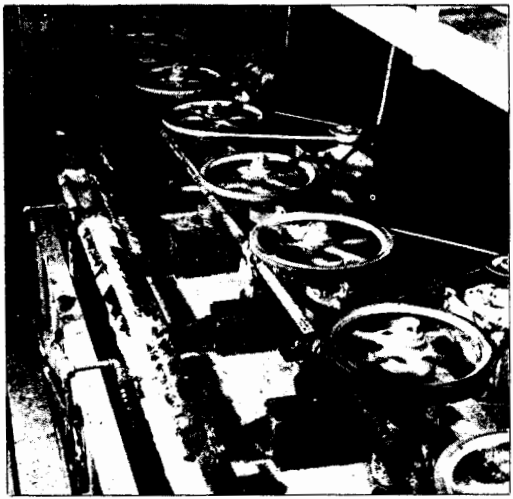


MILL OPERATION

Mill operation and costs vary so widely that it is possible, in this section, to give you only a limited amount of information which is intended for rough approximations.

Plant location, local labor conditions, distance from sources of supply and markets are all factors which must be taken into account in predicting and establishing milling costs.

General information presented in this and the foregoing sections represents a composite of many actual operations. We hope it will be able to serve you by furnishing a basis for rough estimates so essential for planning long-range profitable milling.



FLOTATION OF NON-METALLICS . . . DENVER "SUB-A" FLOTATION MACHINES RECOVERING TALC IN NEW ENGLAND PLANT

ESTIMATING MILL COSTS

Mill—Type	Gravity Plus Magnetic Separation	Cyanide, Continuous Decantation	Selective Flotation	Flotation	Selective Flotation
Products	Tungsten	Gold	Lead-Zinc	Silver	Cu-Pb-Fe.
Size—Tons 24 Hours	100	100	100	500	250
Roads and Clearing	850	950	860	1,750	1,200
Excavation	650	2,850	1,650	5,500	2,400
Foundations	4,000	8,900	12,200	27,000	21,000
*Mill Building Wood	12,000	19,000	14,000	49,000	27,500
*Mill Building Steel	1,500	1,800	1,150	5,200	3,100
Roofing—Doors—Windows	2,750	3,600	2,950	7,800	5,200
Launders—Platforms and Hardware	1,700	2,250	2,600	10,200	4,200
Machinery	29,000	43,000	33,000	178,000	122,000
Machinery—Freight and Haulage	4,000	6,800	3,680	24,500	14,000
Machinery—Installation	6,600	12,000	5,460	27,500	16,800
Transmission Equipment	2,350	3,850	2,690	12,450	9,480
Piping	1,850	3,750	2,900	10,500	6,500
Electrical Wiring and Switch Board	1,250	1,880	1,575	8,900	6,100
Tools	850	1,250	975	4,800	3,400
Drafting and Engineering	2,150	2,780	2,350	9,500	6,100
Commissary Expense	1,950	2,950	2,850	8,500	4,200
General Expense	9,190	14,750	11,300	48,900	31,650
Emergency Expense	8,300	13,240	10,160	44,000	28,500
TOTAL	$90,940	$145,700	$112,350	$484,000	$313,330
WEIGHT MACHINERY	220,000#	400,000#	182,000#	850,000#	500,000#

*Includes Ore Bin.

Denver Portable Mills

One of the most serious problems confronting the mining industry today is how to profitably begin the small scale milling of ores from mines where insufficient ore has been developed to warrant an expensive mill installation, but where a large plant might be needed later. The same question arises in connection with the economical working of numerous small but relatively high grade ore deposits.

Denver Portable Mills, and in particular, Denver Truck Mills, are a most practical solution to this problem. For a relatively small investment a complete and efficient mill can be brought to the mine and speedily put into operation.

Some of the advantages obtained with Denver Portable Mills are summed up as follows:

1. Low initial cost for a complete mill which is ready to operate;

2. Mill can be easily transported from one place to another;

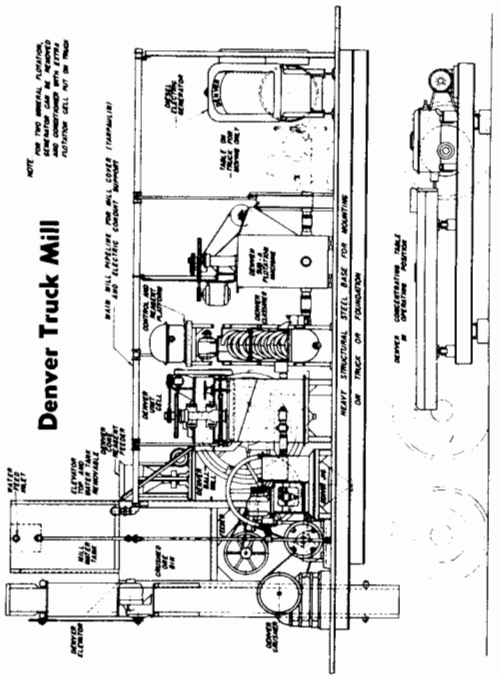
3. Small isolated ore deposits can be worked that would not justify a permanent mill installation;

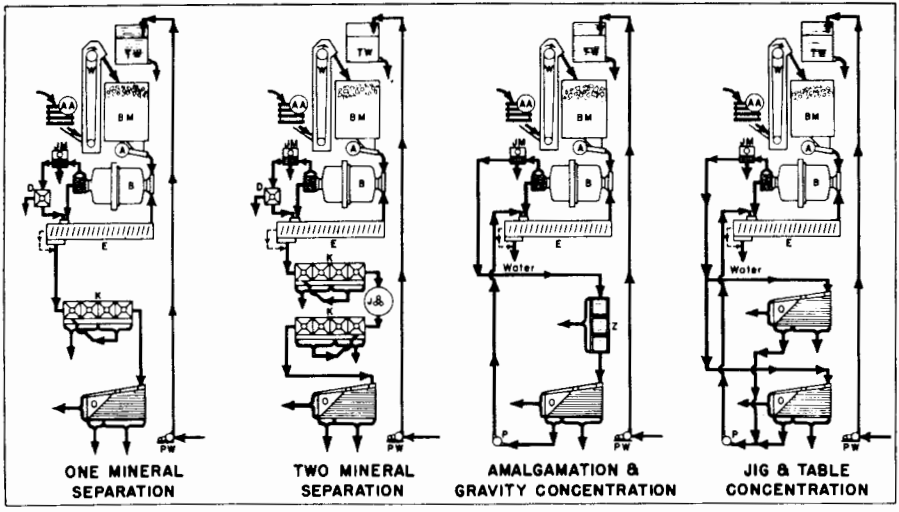
4. Flexibility of the equipment furnished, and in particular the flexibility of the Denver "Sub-A" Flotation Machine, enables the operator to easily and rapidly work out the most efficient flowsheet for the ore to be treated.

5. Provides a plant to mill ore produced during the development period of prospective large producers. This gives an income during development.

6. Eliminates the "monuments" of abandoned mills by providing for common sense investments through testing before building. Denver Portable Mills or Denver Truck Mills can be used as efficient test units or as pilot plants, assuring the success of future large scale installations.

7. Utilizes standard and proved equipment which is low in cost and insures greatest likelihood of a successful operation.





Denver Truck Mill Equipment Shown in Flowsheets

Code Letter	Size	Machine	Weight	Motor H.P.	Motor Weight	Total
AA	5"x6"	Denver Jaw Crusher	1010 lbs.	5 Hp	175 lbs.	1185 lbs.
W	4"x3"x2½"	Bucket Elevator	1000 lbs.	1 Hp	60 lbs.	1060 lbs.
A	3"x6"	Plunger Ore Feeder	285 lbs.	.....	.....	285 lbs.
B	30"x36"	Ball Mill (Includes balls)	3800 lbs.	7½ Hp	153 lbs.	3953 lbs.
	12"x18"	Spiral Screen	85 lbs.	.....	.....	85 lbs.
JM	8"x12"	Simplex Denver Mineral Jig	430 lbs.	½ Hp	75 lbs.	505 lbs.
D	No. 5C	Denver "Sub-A" Unit Cell	820 lbs.	1½ Hp	105 lbs.	925 lbs.
E	12"x0'10"	Crosa-Flow Classifier	950 lbs.	½ Hp	50 lbs.	1000 lbs.
K	4 cell No. 12	Denver "Sub-A" Flotation Machine	3800 lbs.	1 Hp (4)	240 lbs.	4040 lbs.
O	No. 12-S	Concentrating Table	1540 lbs.	1 Hp	60 lbs.	1600 lbs.
	6"	Cone Reagent Feeder	130 lbs.	¼ Hp	25 lbs.	155 lbs.
	No. 12	Wet Reagent Feeder	2 @ 225 lbs.	1/20 Hp	2 @ 10 lbs.	470 lbs.
	25 K.W.	Diesel Electric Set	3082 lbs.	.....	.....	3082 lbs.
BM	2.0 ton	Steel Ore Bin	450 lbs.	.....	.....	450 lbs.
TW	280 gal.	Steel Water Tank	200 lbs.	.....	.....	200 lbs.
		Steel Framework	3500 lbs.	.....	.....	3500 lbs.
		Piping and Launders	1100 lbs.	.....	.....	1100 lbs.
		Electrical Equipment	250 lbs.	.....	.....	250 lbs.
P	¾"	Vertical Sand Pump	355 lbs.	½ Hp	.....	355 lbs.
Z		Amalgam Plates	.....	.....	.....	.....
					TOTAL WEIGHT	24,200 lbs.

Design and Construction of Small Concentrators in British Columbia

By H. M. WRIGHT, B.S., M.A., M.S., P. ENG., M.C.I.M.

THE following material is reprinted from a paper presented before the Institution of Mining and Metallurgy in London, (September 1952) by H. M. Wright, President of Wright Engineers* Ltd., Vancouver, B. C., and gives detailed information deemed of interest to mineral dressing engineers on six typical concentrating plants.

In British Columbia mines are almost invariably adit rather than shaft mines, and in most instances ore is trammed directly from mine to coarse ore bin at the mill for crushing. Accordingly, most mills are situated adjacent to the portal of the main haulage level. In a few cases, location of the mill at the mine is impractical due to water shortage, adverse snow conditions, inaccessibility, etc., and therefore a wide choice of mill sites may not be available. Careful consideration of all the economic factors is a prerequisite.

Summary—Requirements for Mill Design

Preliminary to mill design the mine must be developed to the point where a decision may be made on daily mill tonnage, and representative samples can be obtained for metallurgical test work. From the metallurgical test work a flow-sheet is worked out and the mill site is then selected.

When the mill site is selected, and cleared, a detailed contour map of a reasonably broad area around the mill location is required so that full consideration may be given to access roads, tailing disposal, water supply, and service facilities. Test pits for foundation information must be dug in most cases. The next step is completion of a preliminary layout based on the selected flow-sheet and mill site contour. This is followed by determination of all machinery sizes so that manufacturers' drawings can be obtained as quickly as possible.

With the above information final elevations can be determined and mill foundations designed. Following this, the building and installation programme is quite straightforward.

Constructon of Small Concentrating Plants

Construction

The following remarks are generally applicable to the six plants referred to in the present article. These plants are of standard frame construction on concrete foundations. Lumber, other than truss lumber, is obtained from the nearest available sawmill, cut to size and length as instructed. To obtain added strength for the building wall frame, the exterior shiplap is placed diagonally. This is found particularly necessary for the ore bin tower framework.

The trusses frequently are prefabricated from B.C. Coast fir at Vancouver and shipped to the site knocked down in crates and marked for assembly. Depending on the spacing of the trusses or roofing frame, the sub-roof is shiplap or in 2-in. material. Roofing is generally ready-made roll-roofing or aluminum sheeting. In heavy snow country, where most of the mills are located, the pitch of the roof is made 8 in 12, with the aluminum roofing preferred, as the heavy snow load slides off the roof with the added warmth of the building interior. The overhanging eaves are completely housed on the outside with the heated air allowed to circulate to this space. This prevents ice forming above the eaves and minimizes formation of icicles.

The exterior finish to the walls will vary, with about three types to choose from, these being ordinary building paper, 'ready-roofing,' or 'asbestoside.' All sash and doors are usually primed at the factory and the desired finish colour added when in place.

A feature of each mill is the octagonal laminated construction of the coarse ore bin, which is totally enclosed to protect the ore in the bin from freezing. The fine ore bin is usually a wood stave tank, again with a building frame totally enclosing it. The twin concentrate bins are raised high enough to afford clearance for a truck and are emptied through the bottom by means of removable floor sections.

All heavy mill equipment is set on reinforced concrete foundations carried down to solid bearing. Lighter machinery is supported on wood frame substructure. Concrete floor slabs are sloped to desired points, particularly the subfloor below the flotation cells to a collecting trough and in turn to sump and pump.

Changes in floor levels are made with easy stairs to the various levels. The reagent platform is sufficiently high to provide adequate man clearance beneath and to provide gravity feed from the reagent feeders to any position. Guard rails 3 ft. 6 in. in height are always placed between changes in levels.

Power Supply

Owing to the remote situation of most of the small mines in British Columbia, very few are within economic distance of the transmission lines of any existing power company. Accordingly, most mines must provide their own power supply. Because of the mountainous terrain in British Columbia, the choice is frequently available between hydro-electric and diesel-electric installations. At small mines with limited ore reserves, however, the choice is almost invariably in favour of diesel-electric, because of the much lower capital cost. In addition, the salvage value on a hydro-electric installation is limited, whereas a diesel-electric installation can be readily transported for re-use.

Of the six plants discussed in the present article, five are powered by diesel-electric and the other has a hydro-electric installation. There are many economic factors involved in this hydro-electric installation and while the capital cost is undoubtedly higher than for equivalent diesel-electric, the hydro-electric installation is relatively straightforward. In addition, the mine is difficult of access and therefore transmission of power to the mine from the centrally-located hydro-electric station offers advantages.

*Agents for Denver Equipment Company.

The usual diesel-electric installation is housed in a building adjacent to and connected to the mill building proper. The disadvantage of this adjacent location is, of course, the risk of fire and the consequent higher insurance rate, but this disadvantage is more than overbalanced by the following advantages:

(1) Waste heat from the diesel-electric plant is readily available to the mill.

(2) Surplus hot water from the cooling system is of advantage in the mill for increasing the temperature of the flotation pulp.

(3) In a small mill, supervision of the power engines can be handled by the mill crew without increasing the number of employees and this economy, amounting to three man-shifts per day, greatly outweighs the added insurance costs.

Power costs vary from less than 1 cent per kWh for purchased power from utility companies to more than 4 cents per kWh for diesel-electric power.

Electrical Installation

Electrical installations are usually let out for contract bid and since this is one of the last jobs to be done in a mill installation, the time saving advantage of having a contractor with fairly large electrical crew is important. Electrical installations are quite straightforward in most cases, consisting of a diesel-electric plant requiring a synchronizing panel, main disconnect switch, and two main distribution panels, one for the mill proper and one for the crushing plant. Combination magnetic switches with stop-start buttons are usually employed with a remote stop-start button at the machine to fulfill safety requirements.

Lighting

Lighting is standard, with the exception that fluorescent lighting is usually provided over the flotation machines. This lighting is kept at a fairly high level so that the influence of daylight does not affect the operator's judgment on the appearance of the froth.

Features

Several features are incorporated into the plants under discussion. In general, these aim at decreasing costs without sacrificing efficiency, and are also adapted because of local conditions. Briefly, they are as follows:

Flood Feeding—This system, based on feeding from the face of the coarse ore bin only, gives a lower proportion of live capacity in the bin than does bottom feeding, but requires less headroom and results in almost automatic feeding. This system allows the use of a heavy-duty coarse ore belt-feeder instead of the most expensive pan feeder. The feeder is installed under the coarse ore bin. The extension from the bin face is built up with high side boards to prevent spillage. The rack and pinion gate over the opening is kept open except in emergency. Therefore, there is a flood feed on the belt at all times with the gate controlling the angle of repose on the belt to prevent overflow over the discharge. The belt is never empty and thus the ore, and not the belt, absorbs any direct shock when the bin is filled. Rate of feed is controlled with a stop-start push button and/or variable drive.

Vibrating Screen.— It has been found beneficial to use a vibrating screen instead of the conventional stationary grizzly. This is especially applicable in single-stage crushing plants. The main benefit derived is the positive removal of primary fines ahead of the jaw crusher, which allows a closer setting and therefore a better and more uniform feed to the ball-mill, with corresponding tonnage increase. In two-stage crushing plants vibrating screens are invariably used ahead of the secondary crusher.

Grinding Circuit.—Standard single-stage grinding circuits are the general rule, with operators favouring the spiral classifier because it is not necessary to drain after forced shut-downs. In one instance a jig is used in closed circuit with classifier and ball-mill for recovery of coarse native silver. At another plant a unit cell is employed for recovery of coarse silver-lead concentrate to assure a uniform grade of feed to flotation, to increase recovery and to improve filtering.

Flotation Reagents and Concentrate Pumps.—The flotation floor is laid out for compactness and where possible has one operating aisle. The aisle is set at a height to allow easy cell adjustment. The launders are built so that the cleaning stages can be varied as required. Allowance is made for stage-feeding reagents from mechanical feeders whether dry or wet. Concentrate pumps are frequently preceded by small tanks to absorb surges and to take care of filter overflow, especially when direct filtration is employed. The flotation floor is usually set well above the mill floor, with concentrate pumps below and ample drainage to mill sump.

Dewatering.—In small mills there is a definite trend to direct filtration or dewatering without thickeners. As most plants of this type are handling relatively coarse grind ores, direct filtration of concentrates gives a low moisture content. The saving in capital cost for thickeners, diaphragm pumps, and larger buildings is considerable.

Wet Vacuum System.—A wet vacuum system instead of the conventional dry system is occasionally used. This results in an appreciable saving in capital equipment and installation costs, as the customary filtrate pump, filtrate receiver tank, moisture trap, and considerable piping are eliminated. The wet cycloidal vacuum pump is on the gravity discharge of the filter. It requires about 20 per cent more power with approximately equal results.

Concentrate Handling.—The capacity of concentrate storage facilities is in general dependent on distance from the railroad. This storage usually consists of a concentrate bin or bins with filter above. Bins are built so that a truck can pass beneath and loading is usually by hand from removable floor planks in the bin bottom. Louvres on the bin face allow for initial discharge of the bin. One plant loads with a small electrically-driven slusher.

Storage.—Ore storage in the coarse ore bin and the fine ore bin is designed to meet the requirements of the customary 5 days per week mine operation and 7 days mill operation. Fine

ore bin capacity is such that the crushing plant can usually shut down one day each week. General practice is to do all crushing on one shift for three-shift mill operation. Concentrate storage is arranged on the same basis and allows for haulage distance. Because of the distance from sources of supply, storage facilities are usually provided within the mill proper for ample quantities of reagents, grinding ball, spare parts, liners, etc.

Controls, Laboratory, Sampling.—Because of the small size of the plants under discussion, mechanical metallurgical controls are not generally used. Density and pH readings are taken at regular intervals and grind control is by periodic screen analysis, while tonnage determinations are usually by means of a time-sample from the fine ore feeder. Sampling is generally done by hand-cutting methods, but in some mills an automatic sampler is used on the tailing. Assaying is usually on a shift basis. The assay office is in a separate building where fire assaying is employed. When only wet assays are required the facilities are sometimes housed in the mill proper.

Tailing disposal.—Tailing disposal is usually by gravity to a nearby flat site for impounding. Impounding is necessary because of fish and game regulations and/or small power plants on the same water system. In no instance in British Columbia is tailing impounded for water recovery.

Operating Crew.—There are two men employed on each shift in the concentrating section. When the power house is adjacent to the mill, the mill crew operates this portion of the plant with the assistance of overall supervision from the company master mechanic.

Heating.—Heating methods vary from dependence on an adjacent power plant for radiated heat to hot air coal-fired furnaces, to waste heat recovery by water tube boiler on diesel exhaust gases, or to circulating hot water systems with unit heaters, or oil-fired unit heaters.

Safety.—It is standard practice to have a dust exhaust system in the crushing plant. An exhaust fan is connected to the dust concentration points at the crusher, screen, etc. The equipment is housed in as far as is practical. Water sprays are also used and dust counts are taken periodically by a Government inspector.

All walkways, stairs, platforms, etc., are properly guarded with suitable railing and V-belt drives have safety guards. Oil and grease line extensions are used to avoid hazards.

Electric wiring is to Government specifications and all wiring is in rigid metal conduit, switch boxes, motor frames, and electrical panels being grounded. Stop switches are adjacent to all motors where emergency stop or starting supervision is required.

First aid kits are provided and instructions for first aid treatment for injuries are at hand.

In mill design, care is taken to arrange the layout to facilitate good housekeeping, which assures safety.

TABLE I

Name of Mill	Tons*/ 24 hr.	Period of Const.	Location	Stage Crushing	Type of Concentration	Conn. h.p.	Type of power	
Silver Standard	60	May-Oct., 1948	Hazelton	Single	Hand sort unit cell, S.F.	134	Diesel-electric	Ag-Pb-Zn Au-Cd
Highland-Bell	60	April-Sept., 1950	Beaverdell	Single	Jig and S.F.	139	Diesel-electric	Ag-Pb Zn
Giant Mascot	250	May-Dec., 1950	Spillimacheen	2-stage closed	F.	347	Diesel-electric	Pb-Ag
Cork Province	125	Oct., 1950-April, 1951	Zwicky	Single	S.F.	159	Diesel-electric	Pb-Zn-Ag
Kootenay Base Metals	50	June, 1951-Feb., 1952	Fort Steele	Single	S.F.	150	Diesel-electric	Pb-Zn-Ag
Mastodon	150	Sept., 1951-Apr., 1952	Revelstoke	2-stage open	S.F.	297	Hydro-electric	Zn-Pb

S.F. = Selective flotation. F. = Bulk flotation.

* Throughout this paper short tons of 2,000 lb. are used except in Table XXII.

TABLE II

Name of Mill	Ft. above Sea-Level	Miles to Rail Ship-Point	In. Annual Precipitation		Temp., °F.			Railroad Dist. to Smelter, miles	Mine to Mill	
			Rain	Snow	Mean	Max.	Min.		Miles	Transportation
Silver Standard	1,300	6	18.7	43.4	40	90	— 30	940	Adjacent	Mine cars
Highland-Bell	2,580	Adjacent	23.9	24.0	39	95	— 31	161	2	Truck
Giant Mascot	3,200	8	12.0	40.0	39	90	— 40	328	Adjacent	Mine cars
Cork Province	3,250	4½	26.3	79.9	45	100	— 17	107	Adjacent	Mine cars
Kootenay Base Metals	3,000	15	14.4	56.7	41	102	— 41	226	7	Truck
Mastodon	3,300	22	39.3	143.3	43	105	— 30	460	2	Surface and incline tram

MASTODON ZINC MINES LIMITED (150 Ton/24 Hr. Zn Pb)
DETAILS OF MILL CONSTRUCTION AND EQUIPMENT COSTS

		Labour	Material	Contract	Total
Clearing Site and Grading		$ 525.99	$ 352.62		$ 878.61
Crusher Plant:					
Excavating and Foundations		3,282.72	2,742.76		6,025.48
Superstructure		13,771.00	7,562.95		21,333.95
*Installation of Machinery and Piping Installation and Supply	Electrical			$ 1,975.00	1,975.00
Mill:					
Excavating and Foundations		6,784.76	3,591.26		10,376.02
Superstructure		16,392.76	12,082.11		28,474.87
*Installation of Machinery and Piping Installation	Electrical			6,000.00	6,000.00
General:					
Engineering and Supervision				5,000.00	5,000.00
Total		$ 40,757.23	$ 26,331.70	$ 12,975.00	$ 80,063.93
Equipment and Equipment Installation:					
Jaw Crusher		$ 258.02	$ 5,183.42		$ 5,441.44
Conveyors		338.64	5,185.90		5,524.54
Magnet		40.96	1,231.01		1,271.97
Vibrating Screen			1,513.20		1,513.20
Cone Crusher		538.49	9,416.94		9,955.43
Mill:					
Fine Ore Bin and Feeder			1,260.47		1,260.47
Ball Mill		1,031.36	22,655.17		23,686.53
Classifier		299.39	6,084.38		6,383.97
Flotation		1,639.98	19,913.04		21,544.02
Pipe and Fittings		1,187.34	3,673.27		4,860.61
Filtering		640.56	9,938.62		10,579.18
Assay		37.58	1,030.22		1,067.80
Concentrate Loading			2,558.52		2,558.52
Total		$ 6,003.52	$ 89,644.16		$ 95,647.68
Grand Total		$ 46,760.75	$115,975.86	$12,975.00	$175,711.61

* "Installation of Machinery and Piping" charged to "Equipment and Equipment Installation".

TABLE XXI
COST FACTORS DURING CONSTRUCTION IN DOLLARS

Period Built	1948 Silver Standard	1950 Highland-Bell	1950 Giant Mascot	1950-51 Cork Province	1951-52 Kootenay Base	1951-52 Mastodon
Construction Wage Rates, $/Shift						
Labourer	7.12	7.86	8.80	8.24	9.48	11.20
Helper	8.26	.....	..	8.80	9.88	.....
Cat driver	8.26	.....	12.20	10.16	11.08	12.80
Truck driver	7.62		10.00	9.00	10.12	10.50
Carpenter	7.62	10.45	12.60	11.60	15.20	16.00
Carpenter foreman	11.00	..	.....	13.44	16.80	20.00
Millwright	..	..	..	13.44	16.80	16.00
Mechanic	8.80	10.45	9.90	11.60	12.32	12.40
Materials, F.O.B. Site	*					
Lumber, per 1,000 bd. ft.	45.00	60.00	70.00	72.10	86.50	42.00
Cement, per 87½ lb. sack	1.42	1.13	1.25	1.27	1.53	1.27
Diesel fuel, per Imp. gal.	0.243	0.215	0.204	0.236	0.27	Hydro

Milling Costs $ Per Ton Milled	Silver Standard Mines Ltd. 60 Ton Pb-Zn Concentrator July 1951	Highland-Bell Ltd. 60 Ton Ag-Pb-Zn Concentrator 1951	Giant Mascot Mines Ltd. 250 Ton Pb Concentrator 1951	Base Metal Mining Corp. Ltd. 125 Ton Pb-Zn Concentrator Jan. 1952
Crushing and conveying	$0.29	$0.51	$0.325	$0.197
Grinding and classifying	0.75	0.82	0.499	0.393
Flotation and reagents	0.93	1.40	0.399	0.667
Filtering	0.05	0.36*	0.069	0.244*
Assaying and testing	0.25	0.39	0.079	0.072
Power	1.24	1.86	0.903	1.248
Water	0.21	0.24	0.146	0.034
Supervision	0.23			0.121
General	1.25			
Supervision and general		1.43	1.74	
Building maintenance				0.012
Sorting	0.43			
Tailing disposal		0.07	0.036	
Total Costs Milling/Ton	$5.63	$7.08	$2.630	$2.988

*Includes concentrate handling.

TABLE XXII

SUMMARY OF CONSTRUCTION COSTS IN DOLLARS

(Conversion rate: Canadian dollars per £ sterling.)

	Mill Only			
	Total	Per ton*	Per sq. ft.	Per cu. ft.
	$	$	$	$
Silver Standard (Pb-Zn 60 TPD)				
Construction	23,500	392	4.23	0.22
Equipment	55,800	930	10.05	0.53
Total	79,300	1,320	14.28	0.75
Highland-Bell (Ag-Pb-Zn 60 TPD)				
Construction	67,200	1,120	14.64	0.55
Equipment	38,600	643	8.41	0.31
Total	105,800	1,763	23.05	0.86
Giant Mascot (Pb-Zn 250 TPD)				
Construction	105,200	420	14.94	0.57
Equipment	87,200	349	12.39	0.48
Total	192,400	769	27.33	1.05
Cork Province (Pb-Zn 125 TPD)				
Construction	53,100	425	11.85	0.41
Equipment	49,500	396	11.05	0.38
Total	102,600	821	22.90	0.79
Kootenay Base (Pb-Zn 50 TPD)				
Construction	55,600	1,112	15.11	0.72
Equipment	45,500	910	12.36	0.58
Total	101,100	2,022	27.47	1.30
Mastodon (Pb-Zn 150 TPD)				
Construction	80,063	533	11.69	0.49
Equipment	95,647	637	13.96	0.58
Total	175,711	1,171	25.65	1.07

	Mill and Power Plant			
	Total	Per ton*	Per sq. ft.	Per cu. ft.
	$	$	$	$
Silver Standard				
Construction	27,000	450	4.21	0.23
Equipment	78,300	1,305	12.19	0.66
Total	105,300	1,755	16.40	0.89
Highland-Bell				
Construction	76,200	1,269	12.64	0.53
Equipment	55,700	429	9.23	0.39
Total	131,900	2,198	21.87	0.92
Giant Mascot				
Construction				
Equipment	Separate diesel-electric power-house			
Total				
Cork Province				
Construction	61,000	488	11.42	0.43
Equipment	93,800	751	17.56	0.66
Total	154,800	1,239	28.98	1.09
Kootenay Base				
Construction	67,800	1,356	15.13	0.73
Equipment	79,800	1,596	17.81	0.86
Total	147,600	2,952	32.94	1.59
Mastodon				
Construction				
Equipment	Separate hydro-electric power plant			
Total				

* Dollars per short ton, £ sterling per long ton.

TABLE XXIII

Design Data	Silver Standard		Highland-Bell		Giant Mascot	
	Total	Per ton	Total	Per ton	Total	Per ton
Mill area, sq. ft.	5,550	92	4,590	76	7,040	28
Mill volume, cu. ft.	104,460	1,750	122,800	2,040	183,300	730
Mill area and power-house, sq. ft.	6,420	107	6,030	100		
Mill volume and power-house, cu. ft.	118,260	1,970	143,700	2,390	Separate diesel	
Connected h.p.	134	2.0	118	2.0	347	1.4
Storage capacity, tons	400	6.7	230	3.8	500	2.2

Design Data	Cork Province		Kootenay Base		Mastodon	
	Total	Per ton	Total	Per ton	Total	Per ton
Mill area, sq. ft.	4,480	36	3,680	74	6,850	46
Mill volume, cu. ft.	129,300	1,035	77,800	1,550	164,800	1,100
Mill area and power-house, sq. ft.	5,340	43	4,480	89		
Mill volume and power-house, cu. ft.	142,200	1,140	92,900	1,850	Separate hydro	
Connected, h.p.	159	1.3	148	2.9	279	1.9
Storage capacity, tons	400	3.2	380	7.6	750	5.0

In reviewing the summary of capital costs given in Table XXII it is important to note that the term 'cost per ton' is a figure that may vary within wide limits, depending on the plant tonnage figure used. For example, the Cork Province was designed for 100 tons per day but the actual capacity has been established at 125, so the latter figure is the basis for the 'cost per ton' data. The designed capacity for Kootenay Base Metals mill was 50 tons per day and as this plant has just commenced operations the actual capacity has not been established. If it will handle 60 tons then the figures quoted are 20 per cent high. In designing small mills it is not feasible to forecast accurately the actual tonnage the plant is capable of handling and even this figure varies as underground conditions change and wear takes place on mill equipment.

MACHINERY FREIGHT RATES
FROM DENVER

To	LCL SU	LCL KD	CL 18M	CL 24M	CL 30M	CL 40M
ARIZONA						
Clarkdale	265	265	226			222
Douglas	265	265	226			222
Gila	265	265	226			222
Globe	302	302	239			235
Kingman	265	265	226			222
Nogales	265	265	226			222
Prescott	265	265	226			222
Tucson	265	265	226			222
CALIFORNIA						
Grass Valley	359	350	241			236
Los Angeles	265	265	226			222
COLORADO						
Boulder (	71	63				
(5M	52	45				
(10M	32	28				
FLORIDA						
Tampa	434	434		230		
GEORGIA						
Atlanta	435	370		196		
IDAHO						
Kellogg	265	265	226			222
Wallace	265	265	226			222
ILLINOIS						
Chicago	350	298		158		
Rosiclare	360	306		220		
KANSAS						
Baxter Springs	270	230		164		
KENTUCKY						
Mexico	370	315		167		
LOUISIANA						
New Orleans	410	349		257		
Export	272¼					
MICHIGAN						
Houghton	385	327		223		
MINNESOTA						
Duluth	345	293		148		
Hibbing	355	302		202		
St. Paul	315	268		148		
MISSOURI						
Bonne Terre	340	289		194		
Joplin	275	234		164		
St. Louis	325	276		148		
MONTANA						
Anaconda	265	265	226		168	
Butte	265	165	226		168	
Helena	265	265	226		168	
Neihart	265	265	226		168	
NEW MEXICO						
Carlsbad	265	265	226			222
NEW YORK						
Edwards	500	425		225		
New York	525	446		236		
NEVADA						
Ely	265	265	226			222
Pioche	265	265	226			222
Reno	265	265	226			222
Tonopah	311	304	250			246

MACHINERY FREIGHT RATES
FROM DENVER

To	LCL SU	LCL KD	CL 18M	CL 24M	CL 30M	CL 40M
NORTH CAROLINA						
Asheville	460	391		207		
Spruce Pine	460	391		207		
OHIO						
Cincinnati	390	332		176		
Cleveland	415	353		187		
OKLAHOMA						
Miami	275	234		166		
OREGON						
Portland	265	265	226			222
Albany	265	265	226			222
PENNSYLVANIA						
Pittsburgh	440	374		198		
Locust Summit		453		227		
Coopersburg						
TENNESSEE						
Copperhill	435	370		196		
Newmarket	440	374		198		
TEXAS						
El Paso	194	194		174		
UTAH						
Eureka	248	248			119	
(10M)	215	215				
(20M)	180	180				
Park City	248	248			119	
(10M)	215	215				
(20M)	180	180				
Salt Lake	248	248			119	
(10M)	215	215				
(20M)	180	180				
VIRGINIA						
Gossan Junction—No facilities for handling freight.						
WASHINGTON						
Seattle	265	265	226			222
Spokane	265	265	226			222
WISCONSIN						
Platteville	325	276		190		
WYOMING						
Laramie	184	156		83		
Rock Springs	248	248		135	104	
(10M)	215	215				
(20M)	180	180				
CANADA						
Montreal, Que.	653	557		282		
Sheridan, Man.	660	557		340		
Sudbury, Ont.	629	535		272		
The Pas, Man.	675	569		346		
Toronto, Ont.	562	478		247		
Nelson, B. C.	387	367		273		269
Vancouver, B. C.	265	265	226			222

All interstate rates subject to 15% increase.
Colorado intrastate rates subject to 6% increase.
All rates subject to 3% Federal Tax.
Rates for C/L minimum of 24,000 lbs. apply in 40 ft. car.
Other C/L minimums are for size of car used.
SU—Set Up
KD—Knocked Down
M—Minimum
CL—Car Load
LCL—Less than Carload

OCEAN FREIGHT RATES

The following are estimated ocean freight rates on mining machinery.

Current insurance rates on mining machinery are listed for estimating purposes. All rates, unless otherwise specified, are from Atlantic or Gulf ports which carry the same rate.

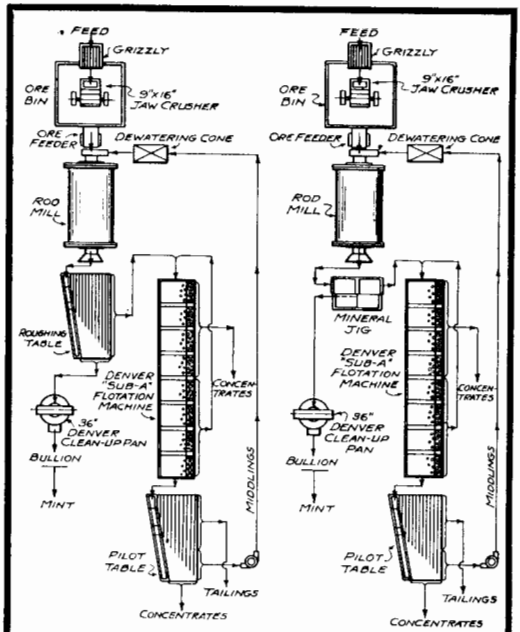
Port	Rate Per 40 cu. Ft.	Ins. Rate Per $100.00
Africa		
Dar-Es-Salam	46.40	.60
East London	43.50	.60
Casablanca	27.50	.55
Tunis	27.50	.55
Algiers	32.25	.55
India and Far East		
Port Swettanham	39.00	.85
Bombay	41.00	.75
Madras	41.25	.75
Malaya	54.00	.85
Siam	37.50	.95
Bankok	44.50	.95
Penang	50.00	.85
Yokohama (Via San Francisco)	37.25	.60
Yokohama (Via New York)	59.50	.60
Melbourne (Via San Francisco)	49.00	.55
Manila (Via San Francisco)	37.25	.75
Jeddah	42.25	.85
Mediterranean		
Piracus	27.50	.75
Haita	45.50	.95
Genoa	27.50	.75
Marseille	24.50	.50
Europe		
LeHarve	34.00	.50
Lisbon	41.75	.40
Bilbao	44.00	.40
London	34.00	.50
Stockholm	46.00	.50
South and Central America		
Santiago	78.00	.75
Valparaiso	45.00	.70
Callao	45.00	.70
Bucaramanga	27.50	.65
Ciudad Bolivar	49.00	.40
Dominican Republic	30.00	.40
Puntarenas	33.00	.50
Nicaragua	22.50	.50
Vera Cruz	20.00	.30

Port handling charges average approximately $35 to $40 per shipment regardless of tonnage involved.

Cost Data on Colorado Gold Mill

A SUCCESSFUL COLORADO gold mine flowsheet is shown below together with cost data which clearly shows the results that can be obtained when handling a low grade ore by a simple process. There are many commendable features in such a set up and no complicated machines or practices are embodied in this plan. In fact, its simplicity is appealing and the results obtained prove the practicability of this flowsheet.

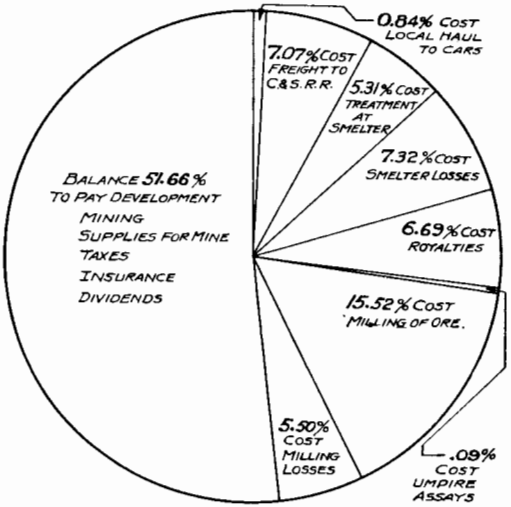
The rod mill product passes over a roughing table where a high grade gold concentrate containing most of the free mineral is sent directly to a Denver Clean-Up Pan. The middlings from the table are sent directly to an 8-cell Denver "Sub-A" Flotation Machine from which a high grade concentrate is obtained. The tailings from the flotation machine are sent over a pilot concentrating table for visual examination. A middling pump and a dewaterer can be installed to take care of the middlings for regrinding, should enough value be found in them to warrant such a treatment. In this concentrating mill, however, it has been found that the middling product is of so little value that it would not be economically profitable to regrind and retreat this product. The cost data above referred to has been compiled from actual operating results and shows the cost of milling both for the old 50-ton plant and the new 100 ton concentrator, as is now in use. Note the reduction in milling costs through the use of the new flowsheet which includes an 8-cell Denver "Sub-A" Flotation Machine. The savings made in lower operation costs and lower maintenance costs are noticeable and this saving was also made in the face of a 12½% increase in wages made when the new plant was started.



Flowsheet, as used in mill described on these two pages, showing also the Denver Clean-Up Pan recently installed.

Identical flowsheet showing the use of Denver Mineral Jig in place of the roughing table.

Many of our so-called small gold mines or low grade deposits could well take this simple and inexpensive flowsheet for an example and be rewarded by a good profit per ton of ore treated, if the owners or operators would adhere to these principles. These are namely a simple crushing, grinding, concentrating, and flotation circuit without frill or fancy theories, but with a constant supply of ore through the mill at a nominal profit per ton, operating continually 24 hours per day. In other words, it may pay to have a lower recovery with a higher net profit than a higher recovery with an actual loss.



You will note from the above chart, the fairly high cost of marketing concentrates, but with the addition of the Denver Clean-Up Pan a large portion of the free gold can be recovered in the form of amalgam and then reduced to bullion for shipment direct to the mint. The treatment of concentrates even of a complex nature is now standardized and should result in additional profits.

Operating Costs Data on Mill

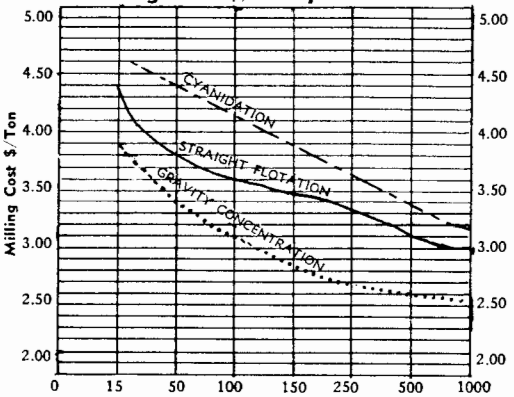
Only rough estimates of milling costs can be made without study of each individual case, as these are determined largely by local conditions that are peculiar to each problem.

To aid in arriving at approximate operating costs, we are giving four charts with curves showing operating costs for the different standard methods of

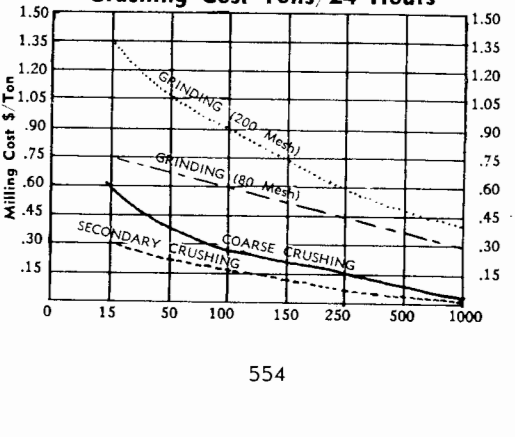
treating ores. These charts show the costs compiled from actual operating figures secured from a number of mills operating under varying conditions. These figures show that operating costs do not increase greatly as one would naturally suppose when smaller tonnages are handled.

In studying the various factors affecting milling costs, the one point that is most noticeable is the effect of operating time on these costs. Plants that have mechanical difficulties show costs greatly in excess of those with full operating time working under comparable conditions, and this demonstrates clearly the importance of having fool proof and ruggedly designed machinery that will run 24 hours per day. Modern milling equipment must be able to take care of overloads and handle oversize material without choke-ups and the resulting shut-downs. One must always keep in mind that after all a machine, a mill, or a process is only as strong as the weakest link.

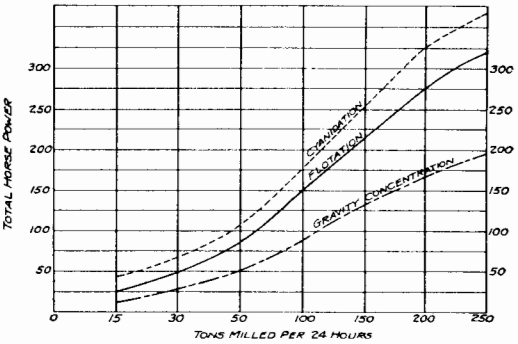
Milling Cost $/Ton per 24 Hours



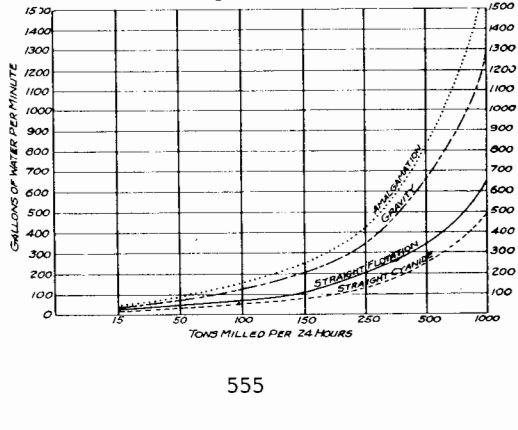
Crushing Cost Tons/24 Hours



Horsepower per Ton per 24 Hours



Water Consumption, Tons per 24 Hrs.



Marketing Concentrates

FOREWORD

The object of this article is to draw attention to the benefits of modern milling practice, thus enabling the miner and mill operator to plan their operations so as to net the highest commercial return. By making such products as will be in demand, they may thus take advantage of conditions existing in the various smelters where the concentrates must be sold.

AS THE SCIENCE OF ORE DRESSING ADVANCES, the flotation process assumes its rightful position as the most important. The progress made during the past decade has been due to intensive research resulting in the development of better reagents and the marked improvement in flotation machinery in which the Denver Equipment Company has played a leading part.

Flotation, though primarily used in the recovery of copper, lead, zinc, gold, and silver minerals, is also being applied to many non-metallics such as coal, sand, potash salts, talc, etc., as well as to ores of the less common metals such as molybdenum, nickel, antimony and mercury. The products of such operations are nearly always used or further processed in the same plant in which they are produced and, therefore, present no problem in the marketing of concentrates as such. When concentrates of the less common ores must be sold, it is necessary to make special contracts with the comparatively few buyers who are in the market for such products.

GOLD AND SILVER

It is well understood that the production of gold and silver in the form of bullion, or as cyanide precipitates, is ordinarily more profitable than the sale of even a rich flotation concentrate. The United States Mint will accept bullion containing 20% or more of gold and silver combined, while in Canada the minimum is 50%. Refining charges are only a few cents per ounce. Similar conditions prevail in other countries. Cyanidation and amalgamation of both crude ore and concentrates have long been used to advantage, and during recent years, the Denver Mineral Jig followed by amalgamation of the concentrates, preferably in an amalgam barrel, has increased the recovery in the form of profitable amalgam in many plants. This modern modification of amalgamating practice can be profitably applied to most gold ores, whether the subsequent treatment be flotation or cyanidation.

On the other hand, some ores are not amenable to these processes alone, and in order to obtain the best commercial return, it is often profitable to market a concentrate containing a portion of the precious metals, which is not directly recoverable as bullion. Moreover, in view of the present value of gold and silver, several important producers of these metals are investigating the possibilities of flotation to recover values not now being extracted by mercury or cyanide and thus improve the overall recovery. Although in a few cases a highly siliceous concentrate containing gold and silver is shipped to a smelter, such a product can usually be further treated in the mill by cyanidation or other methods. Barrel amalgamation preceded by fine grinding in the same unit will usually recover the major part of this gold and silver. Concentrates containing little or no lead, copper, or zinc, sometimes carry sufficient gold and silver to be valuable. Such products usually consist principally of iron sulphides and may be classified as iron concentrates.

BASE METAL CONCENTRATES

In addition to iron, the important concentrates normally shipped to smelting plants are those of lead, copper, and zinc, so these four are the principal ones in which the average producer is interested. In treating ores of these base metals, containing gold and silver, the ore in the mine is the raw material and the refined bars of gold, silver, lead, copper, and zinc are the finished product, as far as the metallurgist is concerned. The process of selection and separation begins underground, continues in the mill, is further carried on in the smelter, and finished in the refinery, so the milling operation is but one step in the whole process.

It may be stated as a general proposition that the smelting process is more efficient than milling and the ores could be smelted without milling, but as smelting is also much more costly, only high grade ores permit direct smelting and to enrich the lower grade ores, milling methods were introduced. This is one of the two important reasons for the establishment of the flotation plants; the other is transportation. Since few mines are located very near the smelter, it is necessary to concentrate the values into as small a bulk as is consistent with good recovery in order to reduce to a minimum the cost of delivery to the market and of the subsequent treatment processes required. Milling not only increases the grade of the products to be marketed, but may be used to separate one type of mineral from another as illustrated by selective flotation applied to lead-zinc ores.

MILLING

In the development of any mine, the metallurgical processes are of prime importance. As soon as sufficient ore is developed to justify even a small mill, the matter should receive careful consideration. Consider a hypothetical case which is typical of many situations. Assume that the gross value of an ore is $20.00 per ton; mining and development cost $5.00; marketing cost including freight, treatment, and smelter deductions $13.00; interest and amortization on plant investment $1.00—therefore, net profit per ton is $1.00. If a mill is built at a cost even double that of the investment in the mining plant, making a 90% recovery and a concentration ratio of ten into one, the picture would be about as follows:

Gross Value		$20.00
Mining and Development	$ 5.00	
Milling	$ 2.00	
Marketing Cost	1.30	
Loss in Mill Tailings	2.00	
Interest and Amortization	3.00	
Total	$13.30	$13.30
Net profit per ton		$ 6.70

Another phase of the question is illustrated by the case of a mine which is shipping about one hundred tons of gold-silver-lead-zinc ore per day to a custom mill. While the milling charges are reasonable, the custom plant cannot rearrange its flowsheet for this particular ore, and does not recover the zinc. At present market prices the net returns from the mill, after paying transportation, treatment charges, and royalty, are about $15.00 per ton.

Recoveries and concentration ratios, based on exhaustive laboratory tests on this ore, indicate that net smelter returns from concentrates produced in a selective flotation mill on the property, especially designed to treat this ore, would amount to $17.25 per ton of heads. This is the net return after allowing the conservative charge of $1.50 per ton for milling cost, and deducting the transportation and smelter charges on the concentrates, and the royalty. This saving or added profit of approximately $2.25 per ton or $225.00 per day is due to three factors:

1. Better all around results in a mill designed and operated for treating a specific ore.
2. The milling profit now being made by the custom plant.
3. The production of a marketable zinc concentrate.

We may conservatively estimate and confidently predict that the saving would pay for the plant in less than one year.

There are many instances of which the above examples are typical; yet it must be realized that the cost of milling will vary greatly, depending upon the tonnage treated. However, even a small mill of ten to fifteen tons per day can be operated profitably as has been proven many times by the DENVER EQUIPMENT COMPANY, when standard methods and machinery are used. The profit per ton from a small mill will naturally be less than that from a large one, but in addition to the profit earned, the small plant will also determine the correct metallurgy for the larger operation.

GROSS VALUE

The term "gross value" refers to the total value of all marketable metals contained in an ore when priced on the basis of refined bars delivered at some standard market. It is perhaps unfortunate that many custom assayers follow the method of translating metallic contents into gross values in dollars and cents. While this custom is not misrepresentation, it is nevertheless misleading to the uninformed. The farmer who raises sugar beets well realizes that his marketable product is not finished and still must be processed before it is salable to the general public. If sugar is five cents a pound and the beets contain 15% sugar, he will not receive $15.00 a ton for them. Yet he endeavors to produce as many tons with as high a sugar content as possible. The manufacturer of any commodity strives not only to keep down costs and keep up production, but to present to his market the kind of commodity which that market will buy at the best price. Likewise, it behooves the mill operator to be familiar with the market upon which he must sell, and to keep himself informed not only of price changes, but of varying local conditions which may affect that market. Frequently, it becomes advisable to alter plant practice and flowsheets. It is for this reason that the DENVER EQUIPMENT COMPANY has always strongly advocated flexibility in mill design and operation, together with the use of standard proven equipment.

SMELTER SCHEDULES

It is not our intention to publish any specific smelter schedules for several reasons; first, these vary in different localities although they are all based on similar principles. In some markets, such as the Joplin district where lead and zinc concentrates contain no precious metals and vary but little in character, the procedure has been greatly simplified. Such cases, however, are the exception, not the rule. Second, schedules at the same plant vary from time to time, not only on account of prices, but with the varying needs of the plant for different classes of material. Third, a steady producer can always secure a better rate than that offered to the spasmodic operator, because the buyer obtains a distinct advantage in being able to plan operations in advance. Nevertheless, the reasons behind the various clauses in the contracts offered by the purchaser are important to the seller.

The following examples illustrate typical provisions of smelter schedules. They do not represent any definite settlement data, but are what might be called synthetic schedules which show approximately the payments and charges usually made. If the shipper is in a position to furnish a definite minimum tonnage, arrangements should always be made with the buyer on that basis, as better rates will be obtained. In order to offer a contract, the smelter must know the complete details with reference to the assay and analysis of the concentrate and it is best to submit a sample.

General Provisions

Delivery: Shipments are paid for f.o.b. smelter. Freight charges must be paid or guaranteed by shipper and if not paid in advance, will be deducted from smelter settlement.

Taxes: Any government taxes are paid by shipper.

Moisture: Actual moisture will be deducted with the understanding that the minimum deduction is 1%.

Weighing and Sampling: To be done by the buyer in presence of seller's representative—standard methods to be used. After sampling, all but the plate reject may be disposed of as buyer sees fit.

Settlement: In the event that buyer's and seller's assays do not check within the limits stipulated in the contract, an assay shall be made by a third party selected from a list of umpire assayers previously agreed upon. If the umpire exactly checks either previous result, the assay not checking will be disregarded. When three different results are obtained, the one between the other two will govern.

Sacks: $1.00 per dry ton will be charged for concentrates delivered in sacks.

Small Lots: A sampling charge of $7.50 will be made for each lot of less than ten tons dry weight.

Weights: All calculations are based on dry weights. A ton is 2,000 avoirdupois pounds. An ounce of gold or silver is a troy ounce. A unit is one percent of a ton or 20 pounds. (In Mexico and other countries using the metric system, a ton is 1000 kilograms, while gold and silver are reported in grams. A unit is then, of course, 1% of 1000 Kgs. or 10 Kgs.)

Weight Units: The grain is the basis of avoirdupois, troy and apothecaries weights, and this unit is the same in all three systems.

1 pound (lb.) Avoirdupois	=	7000 grains (gr.)
1 pound (lb.) Apothecaries	=	5760 grains (gr.)
1 pound (lb.) Troy (12 oz.)	=	5760 grains (gr.)
1 kilogram	=	15432 grains (gr.)
1 grain	=	64.8 milligrams (metric)

Ore and base metals are weighed in Avoirdupois long or short tons or in metric tons. 1 metric ton = 1000 kilograms. 1 long ton = 2240 pounds. 1 short ton = 2000 pounds.

Precious metals are weighed by metric or troy weights. The common weights in the metric system are the following:

1 metric ton	=	1000 kilograms (kgs.)
1 kilogram	=	1000 grams (g.)
1 gram	=	1000 milligrams (mg.)
1 metric ton	=	2204 pounds = 1.102 short tons (Avdp.)
1 kilogram	=	2.204 lbs. (Avdp.) = 32.15 oz. Troy
1 gram	=	.03215 ounce Troy

In the Troy system of weights:

24 grains = 1 pennyweight (dwt.)
20 dwt. = 1 oz. = 1.0971 oz. Avoirdupois = 31.1035 grams
12 oz. = 1 lb. = .8229 lb. Avoirdupois = 373.24 grams

With gold worth $35.00 per Troy ounce:

1 dwt. Troy	=	$1.75
1 gram (metric)	=	1.125

In England, one ounce of gold is worth approximately 12½ pounds.

In Mexico, one gram of gold is worth about $9.60 (Pesos).

U. S. Metal Prices: GOLD PAYMENTS are based on realized mint price of $34.9125 per troy ounce, ($35.00 minus $34.9125 = $.0875 refining charge).

SILVER PAYMENTS are based on realized mint price provided affidavit is furnished to qualify silver for U. S. government purchase, or, if seller elects, prices can be based on Handy & Harmon, N. Y., silver quotations for week during which last car of lot arrives.

ZINC PAYMENTS are based on East St. Louis price for Prime Western Zinc quotations in Engineering and Mining Journal averaged for the week.

LEAD PAYMENTS are based on N. Y. quotation for desilverized lead.

COPPER PAYMENTS are based on Engineering and Mining Journal quotation for electrolytic cathodes averaged for the week.

CONCENTRATES

Before investigating further those provisions of smelter contracts which refer to assays and analyses, let us consider the handling, transportation and sampling of concentrate shipments. A good mill is always a clean mill and this applies especially to the section in which the concentrates are handled, on account of the high grade of the products. Due care should be taken to prevent washing or blowing away of the enriched products. In small plants settling boxes are often employed instead of vacuum filters and the values lost in the overflow are often found upon investigation to be surprisingly high.

Drying

The drying of the concentrates should also receive careful study, and no concentrates should ever be so dry that there is danger of loss in transit from dusting. The finer the concentrate the more water must be left in it to prevent this. It is much better to pay freight on a little water than to lose valuable concentrate in the form of fine dust. On the other hand, if the cost of drying is not too great, a saving can be made by removing unnecessary moisture. Moderate drying also facilitates sampling at the smelter, so that mill and smelter assays are easier to check. Concentrates as discharged from the filter usually contain from 10 to 15% moisture. About half of this water can be removed without danger of dusting, thus making an ideal shipping product. This can be done in any drier, but the rotating type using steam or hot air is best. Unusually wet concentrates may be penalized at the smelter on account of difficulties in handling, especially in freezing weather.

When concentrates are absolutely dry, there is always a dusting loss at the smelter, and for this reason a minimum moisture deduction of 1% is applied. It is, therefore, evident that when concentrates contain less than 1% of water, part of the deduction will be actual values, which is excellent reason for not carrying the drying process too far.

Sacking

If concentrates must be handled by pack animals or airplane, it is necessary to ship in sacks. Rich concentrates should always be packed in double sacks, even though the smelter makes a small additional charge for the extra cost of handling sacked material. The usual method of packing is to put a closely woven canvas sack inside of a heavy gunnysack. Some shippers in order to reduce spillage and dusting to a minimum use an inside sack of heavy paper. Cloth sacks are always returnable to the shipper. If concentrates are shipped in bulk, either in railroad cars or trucks, care must be taken to see that all cracks in floors and sides are tightly sealed by means of suitable lining. Shipments in trucks should also be covered.

Freight Rates

When shipments are made by rail, the freight charges per ton increase with the value, and the rate is based on the value per wet ton, which is determined by dividing the total value of the carload by the wet weight in tons. As railroad calculations are not infallible, it is advisable to check freight charges to see that dry ton values are not applied to freight bills.

Weighing

Shippers to custom plants are entitled to watch the weighing and sampling of shipments, or to appoint a representative for that purpose. It is the duty of such representative to see the weighing of cars and trucks, both gross and tare, to make sure that tare weight is taken within a reasonable time and to insist that cars are properly cleaned.

Sampling

The moisture sample is always taken at the time the car is weighed. Samples for assay pulps may be taken later. Pipe samples are usually satisfactory for carload shipments that are too wet or too tightly packed to be properly mixed by shoveling. The sample is then cut down by standard methods of coning and quartering and splitting. Since the smelter is as vitally interested in obtaining an accurate sample as is the shipper, great care is exercised and methods are constantly studied and checked so that no mistake will be made.

Since smelter charges are based upon tons treated and almost as much work is required to sample a small lot as a large one, a sampling charge for small lots is customary However, there should be no such charge for shipments from the average mill, except in case of special high grade products, when the added cost is insignificant compared to the value.

From one to four samples may be taken from a lot for checking purposes, but in the majority of cases, there will be an original and a duplicate. It is customary to retain the rejects from samples until the lot is liquidated, so that a resample may be taken if required. The final pulp consisting of a few pounds from each sample is carefully dried at a temperature slightly above the boiling point of water, all screened through a fine screen, commonly 100 mesh, and divided into four portions, one for the buyer, one for the seller, one for umpire and the fourth as a reserve to replace possible loss of any of the first three. The shipper's pulp is delivered to his representative for independent assay and analysis. Results are compared with those obtained by the smelter, and if reasonably close, settlement is made according to the contract. If results do not check, the pulp reserved for the purpose is sent to an umpire assayer. When the three results are obtained, it is customary to settle on the result between the other two or on the one the umpire may check exactly. Should there be discrepancies not remedied by repeating the assays or if the original and duplicate samples are far apart, the lot is resampled.

Metallics

Concentrates are obviously more homogeneous mixtures than crude ore and, therefore, easier to sample accurately, provided that they contain no metallics too coarse to pass the screen used in preparing the pulp. The smelters are not at all enthusiastic about receiving lots containing appreciable amounts of metallics on account of the difficulty of obtaining accurate samples and the shipper is at an even greater disadvantage for two reasons: First, it is impossible to split the

MARKETING CONCENTRATES

	SCHEDULE FOR	COPPER SMELTER	LEAD SMELTER	ZINC PLANT
CHARGES	Base treatment Charge per ton.	$5.00 per ton charge up to gross value $20.00. Add 10% of excess value to a maximum of $8.50.	$9.00 per ton on wet assay of 20% lead or under 20%. Add or deduct 10c per unit for lead over or under 20%.	$41.00 when East St. Louis market is 8c per pound. Add or deduct $1.00 per ton for each 1c change in price above or below 8c.
PAYMENTS	Gold.	Pay for 100% at $31.81925 when .02 troy oz. or above.	Pay for 100% at $31.81925 when .03 troy oz. or above. Pay for 100% at $32.3185 when 1.0 troy oz. or over.	Pay for 59.24% at $34.9125 per troy oz. No payment for less than .03 oz. troy.
	Silver.	Pay for 95% at N. Y. quotation less 0.5 oz. No payment if less than 1.0 oz. troy.	Pay for 95% @ N. Y. quotation less 1.0 oz. troy.	Pay for 65% @ N. Y. quotation. No payment for less than 1.0 oz. troy.
	Lead.	Pay for 50% of wet assay at N. Y. market price less 6.5c per pound. No payment if less than 2%.	Pay for 90% of wet assay less 30 lbs. per ton at N. Y. market price less 2.07c per pound.	Pay for 65% of wet assay less 30 lbs. per ton at N. Y. market price.
	Copper	Pay for 100% of wet assay less 15 lbs. per ton at N. Y. market price less 3.0c per lb. No payment if less than 1%.	Pay for 100% of wet assay less 20 lbs. per ton at N. Y. market price less 6.5c per lb. No payment if less than 1%.	Pay for 65% of wet assay at N. Y. market price less 5.0c per lb. No payment if less than 1%.
	Zinc.	.....	.....	Pay for 82% of wet assay if 40% or over. If under 40% deduct 8 units per ton and pay for at market price less 0.45c per lb.
	Lime.	.....	Pay for excess over 10% at 8c per unit.	.....
	Iron.	.....	Pay for excess @ 5c per unit (Excess %— FR—% Insoluble).	.....

	SCHEDULE FOR	COPPER SMELTER	LEAD SMELTER	ZINC PLANT
PENALTIES	Zinc	30c per unit in excess of 6%.	30c per unit in excess of 8%.	
	Iron			50c per unit in excess of 6%.
	Insoluble		8c per unit for excess over iron.	
	Lime			$1.00 per unit in excess of 1%.
	Sulphur		25c per unit in excess of 0.3%.	
	Arsenic and Antimony	50c per unit in excess of 2%.	$1.00 per unit in excess of 0.5%.	
	Bismuth		50c per pound in excess of 0.5%.	
	Moisture	10c per unit in excess of 12%.	5c per unit in excess of 10%.	

metallics equally between the four pulp samples, so there is no opportunity for a check assay; and second, the loss in handling of even a few particles of gold will make an appreciable difference in the liquidation.

In the early days of such camps as Leadville and Cobalt, large amounts of native silver were mined and shipped to smelters, but today gold metallics are more important, so the operator will profit by removing them from the concentrate by amalgamation. This results in not only getting a better sample, but also obtaining a better price for gold. There is the added advantage of being able to market the gold promptly, thus avoiding the tie-up of operating capital in concentrates or in various places in the plant, from which it may or may not be eventually recovered. The Denver Amalgam Barrel and Denver Amalgam Separator are now performing this duty efficiently in many mills. The Denver Mineral Jig, located in the ballmill-classifier circuit, removes the metallics in the form of a high grade hutch product which is subsequently treated by amalgamation.

SMELTING, A BUSINESS

Like any business institution, every smelter is in business to make a profit. It is confronted with the same problems of overhead, insurance, taxes, obsolescence, etc. The item of interest on investment and stock is greater than in the average operation of the same magnitude on account of the high values of the raw material ordinarily in stock. Likewise, the amortization charge is large because the life of the plant is limited by the life of the mines tributary to it. Nevertheless, in order to stay in business, a smelter must give the best service possible to the shippers, and arrange its schedules to attract the maximum quantities of ore and concentrates which can be treated profitably.

The basis of payments is the gross value of the metals which can be extracted and refined, and in addition to a base treatment charge of so much a ton, deductions are made from the gross values to cover the costs. The base treatment charge is the approximate cost of handling and smelting one ton of ore. This charge should theoretically include the smelter's profit, but rarely does include more than a small part of the legitimate profit to which it is entitled. Deduction from gross values take many different forms but may be roughly classified as follows:

1. Percentage deductions, which cover the losses by spillage, dust, slag, and re-treatment of by-products.

2. Deductions per pound or ounce to cover the cost of refining and transportation. These deductions include the cost of separating the gold and silver from the lead bullion or blister copper to produce bars of refined metals, as well as the cost of shipment from the smelter to the market where the metals are priced. Also when a metal such as lead at a copper smelter or copper at a lead smelter is recovered in the form of a by-product, deductions are made to pay for the additional processing required.

3. Minimum deductions, for the purpose of protecting against losses in slag which the ore will form, thus carrying out some values contained in the other ores with which it is smelted, and which otherwise would not be lost.

Most of the smelter's profit is included in the percentage deductions, which places a premium on efficient metallurgy. In other words, if the metallurgy is bad, the profit vanishes; if good, the profit is earned. The success of any smelter depends greatly upon its staff of metallurgists, and most important, upon its honest and diplomatic management. The penalties and premiums for constituents of an ore or concentrate which are not actually finally recovered as metal are calculated according to their beneficial or detrimental effect upon the smelting and refining processes. These are computed as modifications of the base treatment charge.

THE ZINC PLANT

As previously stated, zinc, iron, copper and lead concentrate are the ones in which the mill operator is interested. Consider first zinc which is a special case, in fact technically there is no such thing as a zinc "smelter". Zinc distillery would be a better term, because the zinc is distilled and condensed, and is the only metal recovered in the plant. Other values, if present, remain in the residue and have not been benefited by the treatment except insofar as the removal of most of the zinc makes them more amenable to further treatment. Base charges for zinc concentrates are very high, comparatively speaking, on account of the cost of the process, particularly the item of fuel, which is usually gas. In fact, zinc smelters are ordinarily built near the gas supply, because it is cheaper to transport the ore than the fuel.

Moreover, recovery by this process is not so high as in lead or copper plants, and the percentage deduction is therefore greater. It is also easily understood that on account of the fuel cost and lower percentage of recovery, low grade material cannot be profitably treated. Gold, silver, lead and copper, if present, will be paid for; but the percentage deductions from their market values are greater. Notwithstanding the distillation operation, the percentage of zinc remaining

in the residue is always higher than desirable for subsequent smelting and the residue must be shipped to a lead or copper smelter for treatment, hence the lower payments for gold, silver, lead and copper. The electrolytic process for zinc is quite different, but involves a large capital output, low electric power cost and also a *most* competent metallurgical staff. Costs and other factors which affect schedules are comparable, so detailed discussion of this method would be superfluous.

IRON CONCENTRATES

Iron sulphide concentrates may be shipped to either a copper or lead plant, but the transportation cost is usually the deciding factor. Base treatment charges are approximately the same. At lead plants, the iron present in excess of silica is desirable for mixing with siliceous ores, but the premium for iron is offset by roasting charges, so there is but little difference in net returns from the two classes of smelters.

Whether or not to produce an iron concentrate at all is a question that warrants careful study. In some mills it has been found that the production of iron concentrates following other flotation circuits, such as lead and zinc, is profitable at higher gold prices, while formerly such a product would not pay expenses. On the other hand, at some plants it is better to float a richer concentrate containing copper or iron sulphides or both, and allow a part of the iron to go into the tailings, although it could be floated, thus discarding that part of the sulphide which would not pay its own way to and through the smelter. Both of these profitable alterations in flowsheets have been accomplished using Denver "Sub-A" Flotation Machines with selective flotation methods.

COLLECTORS FOR GOLD AND SILVER

The recovery of precious metals in base metal smelters is accomplished by means of a collector, either lead or copper. In the lead blast furnace the particles of molten lead absorb the gold and silver as they settle through the melting mass, so the precious metals will be found in the base bullion produced, and will later be separated at the refinery. In copper smelting, the furnace product is matte, a chemical combination of sulphur, iron and copper, which although not as heavy as lead bullion, is still heavier than the slag and collects the gold and silver in the same manner. The matte is subsequently treated in convertors by a strong air blast to burn off the sulphur and with the addition of siliceous

flux, to slag the iron. The resultant product is impure metallic copper, containing gold and silver, which is known as blister copper. This is cast into anodes for the electrolytic refinery.

THE COPPER SMELTER

The schedules offered by lead and copper smelters will be more easily understood by first explaining the principal differences between them and then discussing the lead smelter schedules in more detail. Modern copper smelting is performed in reverberatory furnaces, while lead smelting is accomplished in blast furnaces. As the reverberatory is an oxidizing unit, much of the sulphur is eliminated during the operation, so there is normally no roasting charge, although some plants penalize fine material. Production of matte permits the use of much more siliceous slags than the production of lead bullion, that is to say, a highly siliceous slag cannot be as thoroughly cleaned of lead or as easily controlled in the blast furnace; therefore, the copper smelter has a much greater range available in the balance between silica and principal bases which are iron and lime. Hence there are no adjustments made for iron or silica at the average copper smelter, although there are exceptions. Abnormal flux balances may affect the situation; in fact, one smelter assesses a small penalty for iron and another penalizes silica in excess of 35%. The higher gold price has encouraged the production of siliceous ores, thus creating a demand for iron and favoring the concentrate producer. Better copper prices resulting in more concentrates will tend to readjust the flux balance.

Copper plants pay more for copper than lead plants for the simple reason that copper as recovered in the latter is in the form of low-grade matte carrying some lead, a by-product requiring additional roasting, a second smelting step and transportation to the copper smelter before it is ready for the convertor. On the other hand, many copper plants make no payment whatever for lead, as the lead is driven off as fume. Plants having accessory equipment for recovery of the fume, make only small payments because the lead that is saved is in a form that is very expensive to re-treat and also contains large quantities of undesirable impurities such as arsenic. It is, therefore, obvious that when transportation facilities permit, both a lead and a copper concentrate should be produced, if possible, when treating lead-copper ores. Many ores can be so treated to produce more profits, and the flexibility of the Denver "Sub-A" makes it especially valuable in such flowsheets. Except for the points noted, the provisions in copper and lead schedules are for the same reasons quite similar, and differ slightly only in degree.

THE LEAD SMELTER

Some lead smelter schedules are more involved than others. This is partly due to following early customs and partly to the attempt to cover all contingencies. The sampling and handling of shipments and deductions from gross values have already been described. There still remain to be considered the penalties and premiums which respectively increase and decrease the treatment charge. One common provision is the graduated increase in the base charge according to value up to a maximum charge, but this is partially offset by increasing the gold payments within certain limits. The increase in gold payments is logical because the gold is practically all recovered in the smelter. The increase in base charges helps to defray the added interest charges involved. It normally requires about ninety days to process the metals after receipt of the concentrates. When the values exceed those provided for in maximum charges, the smelting company can afford to give the material special routing through the plant.

Penalties and Premiums

The constituents of the concentrates as determined by analysis affect the treatment charge insofar as they influence (1) the preparation of the blast furnace charge; (2) the collector; (3) the formation of the slag; (4) the refining of the base bullion.

SULPHUR

Sulphur is always penalized, although in some schedules applying only to high sulphides the penalty is not shown and is included in the base charge. Direct smelting ores, i. e., ores containing little or no sulphur can be charged directly to the furnace, when not too fine, but sulphides must be roasted so that the furnace will produce bullion instead of matte. A small percentage of sulphur is usually free of penalty and the excess graduated to a maximum of two or three dollars to cover the sintering costs. In many modern plants, the concentrates are sintered twice or even three times to insure maximum sulphur elimination and provide a porous material more suitable for smelting. Formerly it was customary to make a charge for fine material in oxidized ores, but as these fines are now actually beneficial in the sinter charge, the shipper has been relieved of this penalty.

LEAD

Lead is the collector of the precious metals and a minimum of about ten percent is necessary for proper silver recovery. In recent years, the production of lead concentrates increased to the point where the average smelter ceased to be concerned about the percentage of lead on the charge, but greater production of dry ores (ores without lead) due to the higher gold price, altered the situation again. Illustrating the divergent conditions found in the various markets, there is one plant that pays premiums for lead, because the normal ore supply is deficient in that metal, and at the other extreme, another smelter actually penalizes the lead in excess of 50%, because the normal ore supply contains all the lead that can be conveniently treated in the blast furnace.

In the early days of lead smelting, the lead content was determined by fire assay, but the more satisfactory wet method which shows more lead is now used. During the transition period, it became customary to adjust the difference by deducting one to one and a half percent from the wet assay, and although this deduction might be easily absorbed in the other adjustments, the custom is still followed at many plants.

THE SLAG

As already pointed out, the lead smelter must maintain the balance between iron and silica within fairly close limits and as it is necessary to add barren or almost barren iron flux at times in order to maintain this balance, iron commands a premium and silica is penalized. Manganese is considered equivalent to iron, but is rarely present in concentrates. The silica penalty is expressed as insoluble. Since the insoluble determination is less expensive for both the shipper and the smelter, and since the small amount of other elements, principally alumina, which are included in the insoluble are also detrimental, the insoluble is on the whole a perfectly fair basis of settlement. With the increasing production of iron concentrates, there is no assurance that the present situation with respect to iron and silica will last forever, but at present iron, as a rule, still gets a premium and silica a penalty. Lime, being a necessary constituent of the blast furnace charge, also receives a credit at most plants, inasmuch as it replaces a part of the barren limerock that otherwise would be necessary as flux. Lime goes out with the tailings in the production of base metal concentrates and this premium therefore does not apply.

ZINC

Zinc has probably caused the lead metallurgist more grief than any other one element, hence the stiff penalty. When the zinc is completely oxidized, furnace operation can be improved by using more iron, which increases the smelting cost and the slag losses, but zinc in the form of sulphide is much worse. It causes the formation of zinc "mush" of low specific gravity, which cannot be separated from the slag and this mush always absorbs silver. Also zinc sulphide rapidly forms incrustations in the furnace which greatly reduce efficiency. Zinc sulphide is, therefore, the reason for going to extreme in roasting practice in order to convert as much of it as possible to the oxidized form. As zinc in most concentrates is all sulphide, we now find the smelters have reduced the amount of zinc admitted free of penalty to as low as 5% in many instances.

ARSENIC, ANTIMONY, TIN

Arsenic when present in the blast furnace charge is largely volatilized and when condensed contaminates the dust chamber by-products. Retreatment of the flue dust and fume is expensive, but is a source of salable arsenic in most cases and this tends to offset the added cost of recovering the other values in the dust. Arsenic also tends to form speiss, a by-product usually rich in gold and very difficult to re-treat. Some of the arsenic is always found in the base bullion along with the antimony and tin, which metals react similarly to lead in the furnace. The penalty on these three metals is, therefore, based principally on the added burden on the refinery. They must be removed in the softening furnace and the more of these impurities present in the base bullion, the more fuel will be required, the longer the equipment will be tied up and the more lead-bearing by-products will be formed. The arsenic, antimony and tin can also be removed by means of molten caustic soda, but this process is also expensive, and not extensively used.

BISMUTH

Bismuth goes with the lead throughout the standard smelting and refining process and can only be removed by special methods in the refinery. If sufficient bismuth is present in the lead bullion, the refined metallic bismuth recovered will pay the cost of special treatment, but it is not removed by standard processes and a very small amount contaminates the refined lead to a point where it is not marketable at standard prices. For this reason, most smelters reserve the right to reject any shipment containing appreciable quantities of bismuth.

FOUR POSSIBLE METHODS OF HANDLING A COMPLEX SULPHIDE ORE

574

1. NO TREATMENT

CRUDE ORE
1.00 TON

Au - 0.45 oz.
Ag - 9.6 oz.
Cu - 6.7%
Pb - 3.4%
Zn - 5.1%
Fe - 18.5%
Insol - 38.4%

TO LEAD SMELTER

$25.86
NET RETURN PER TON OF ORE

2. NO TREATMENT

CRUDE ORE
1.00 TON

Au - 0.45 oz.
Ag - 9.6 oz.
Cu - 6.7%
Pb - 3.4%
Zn - 5.1%
Fe - 18.5%
Insol - 38.4%

TO COPPER SMELTER

$28.69
NET RETURN PER TON OF ORE

3. BULK FLOTATION

BULK CONCENTRATE
0.589 TONS

Au - 0.75 oz.
Ag - 15.7 oz.
Cu - 11.1%
Pb - 5.4%
Zn - 8.4%
Fe - 29.2%
Insol - 4.0%

TO COPPER SMELTER
$65.21 per ton conc.

$38.41
NET RETURN PER TON OF ORE

CALCULATIONS ARE BASED ON THE FOLLOWING PRICES:
AU—$35.00 PER OZ.; AG—.83 PER OZ.; CU—.24 PER LB.; PB—.14 PER LB.; ZN—.125 PER LB.

4. AMALGAMATION AND SELECTIVE FLOTATION

575

BULLION

Au - 0.24 oz.
Ag - 0.78 oz.
.....
.....
.....
.....
.....

TO MINT
$9.03 per ton ore

COPPER CONC.
0.214 TONS

Au - 0.3 oz.
Ag - 14.4 oz.
Cu - 27.8%
Pb - 1.3%
Zn - 2.5%
Fe - 29.1%
Insol - 2.9%

TO COPPER SMELTER
$115.11 per ton conc.
$24.63 per ton ore

LEAD CONCENTRATE
0.065 TONS

Au - 1.6 oz.
Ag - 61.9 oz.
Cu - 5.0%
Pb - 44.8%
Zn - 3.1%
Fe - 3.0%
Insol - 8.0%

TO LEAD SMELTER
$190.27 per ton conc.
$12.36 per ton ore

ZINC CONCENTRATE
0.054 TONS

Au - 0.12 oz.
Ag - 4.4 oz.
Cu - 0.5%
Pb - 0.2%
Zn - 63.2%
Fe - 1.1%
Insol - 2.0%

TO ZINC SMELTER
$76.41 per ton conc.
$4.13 per ton ore

ERRATA: Figures on page 575, as bound in DENVER HANDBOOK, are in error. Please paste this sheet with correct figures on page 575. Thank you.

TOTAL
$50.15
NET RETURN PER TON OF ORE

FROM THE "NET RETURN" ABOVE, ALL CHARGES FOR FREIGHT, HAULAGE AND MILLING SHOULD BE DEDUCTED.

INCREASING PROFITS

From the above explanation of the effect of the various constituents of ores on smelter practice, one can readily see that the maximum return is obtained when lead, copper or zinc concentrates are shipped to the respective plants which specialize in their treatment. For example, if you ship a lead-copper concentrate to a lead smelter, you will receive about 3.5 cents a pound less for the copper, while if this same lead-copper concentrate is shipped to a typical copper plant, you will be paid for only half the lead and will get about 6 cents a pound less for that lead. If the lead and copper minerals are separated into two products by selective flotation and each shipped to the proper smelter, you will receive the maximum return on both.

This difference in net returns is still more apparent when zinc is considered, for zinc in a bulk concentrate is very undesirable at lead or copper smelters. You usually not only get nothing from these plants for the zinc, but are penalized for it above a certain minimum, and the amount admitted without penalty is as low as 5% in some instances. On the other hand, if the zinc is separated and shipped to a zinc plant, it becomes an asset instead of a liability.

It is, therefore, evident that milling is the solution of the problem of separating the various minerals into concentrates from which the maximum returns will be secured from the various treatment plants. In our general metallurgical and milling practice we have tested many different types of ores and have built mills that have successfully carried out the procedure indicated in the laboratory. The above table clearly shows how a complex ore can be separated into its various constituents to secure the maximum commercial results. It is doubtful whether the ore could be mined at a profit without using these standard modern milling methods.

Also, by the use of the Denver Mineral Jig we are now able to remove the free gold from these complex ores, and even from flotation concentrates, and this gold is then recovered by amalgamation as bullion, whereas formerly it was sent to the smelter in a form difficult to sample and was paid for at a reduced price.

This discussion does not pretend to be a treatise on smelting. We have merely attempted to explain briefly the principal factors which affect the schedules. We hope that our suggestions in regard to the separation of various metals and the amalgamation of metallics, both gold and silver, will give ideas to many of our friends, and that we may be able to render further assistance in the future.

We have attempted to show how every producer of concentrates should study his own individual problem to be able to net the greatest commercial return, how possible changes in processes should be investigated if they indicate an opportunity to produce material for which there is a better market, and how changing conditions in metal prices and in the requirements of smelters affect the problem. Perhaps you can increase your profits by amalgamating the metallics recovered by a Denver Mineral Jig prior to flotation; possibly you can do better by making a cleaner concentrate; it may be that separating the lead from the copper will mean more profits; you may need another flotation circuit to recover zinc now going into the tailings; you might be able to recover more gold by making a separate iron flotation concentrate, or by cyanidation of your flotation tailing. Such changes in mill flowsheets are not visionary, but practical. All these things can be done, have been done, and are being constantly studied. If you lack the equipment, the staff or the time, or desire to check your results, the metallurgical laboratory of the DENVER EQUIPMENT COMPANY is available for such investigations.

ORDERS

Delivery is normally an important item in selecting equipment. Delivery estimates, based on conditions existing at the time quotations are made, are subject to adjustment at the time your order is received.

Considerable time can be saved in processing an order if all necessary information is furnished. Otherwise your order may be delayed as correspondence is carried on to obtain the essential information.

DENVER EQUIPMENT COMPANY
Box 5268, Denver 17, Colorado

Freight Rates on Ores and Concentrates to Copper and Lead Smelters

FROM	TO	VALUE PER TON OF ORE (TON = 2,000 pounds)													
		$5	$10	$15	$20	$25	$30	$35	$40	$50	$60	$70	$75	$80	$90	$100
ARIZONA																
Tombstone	Douglas, Ariz.	.....	.....	.93	1.41	.....	2.50	.....	2.97	3.44	.....	.....	4.37	.....	.....	5.31
Tombstone	El Paso, Texas	.....	2.50	2.97	3.75	.....	4.94	.....	5.47	5.94	.....	.....	7.17	.....	.....	7.81
CALIFORNIA																
Mojave	Humbolt, Ariz.	.....	.....	.....	5.31	.....	6.40	.....	7.50	8.59	9.60	10.78	.....	11.87	12.21	12.96
Paxton	Salt Lake City, Utah④	.....	.....	.....	.....	.....	.....	.....	.....	8.59	9.37	10.47	.....	11.50	12.65	13.75
Rand	Selby, Calif.	.....	.....	.....	4.37	.....	5.47	.....	6.56	7.65	8.75	9.84	.....	10.93	11.56	12.03
COLORADO																
Creede	Leadville, Colo.	.....	.....	3.89	4.47	4.54	4.99	4.99	5.44	6.19	6.93	7.82	.....	7.82	7.82	7.82
Ridgeway	Leadville, Colo.	.....	.....	.....	4.92	.....	5.37	.....	5.81	6.26	7.00	7.82	.....	8.65	9.46	10.28
Silverton	Leadville, Colo.	.....	.....	.....	7.26	7.26	7.26	7.26	7.26	7.26	7.65	8.12	.....	8.50	8.87	9.25
Ridgeway	Salt Lake City, Utah	.....	7.60	.....	.....	.....	7.81	.....	8.29	7.80	9.61	10.43	.....	11.25	12.08	12.16
Leadville	Amarillo, Texas	.....	7.81	8.40	8.99	9.97	13.70	13.70	13.70	13.70	13.70	13.70	.....	13.70	13.70	13.70
IDAHO																
Bayview	Bradley, Idaho	.....	.....	3.52	3.92	4.30	.....	5.08	5.47	5.86	6.25	6.40	.....	6.65	7.03	7.43
Burke	Bradley, Idaho④	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.64
Burke	East Helena, Mont.	.....	.....	.....	.....	.....	4.69	.....	5.08	5.47	5.86	6.25	.....	6.65	7.03	7.42
Rogerson	Salt Lake City, Utah	.....	3.91	4.30	5.47	.....	6.25	.....	7.03	7.81	8.59	9.37	.....	10.15	10.93	11.72
Sagel	East Helena, Mont.	.....	.....	.....	.....	5.27	.....	5.27	.....	6.50	.....	.....	.....	.....	.....	7.55
Sierra, Nev.	Bradley, Idaho⑥	.....	.....	.....	.....	.....	.....	.....	.....	.....	.50	.....	.....	.....	.....	.71
Wallace	East Helena, Mont.	.....	.....	.....	.....	.....	4.69	.....	5.08	5.47	5.86	6.25	.....	6.65	7.03	7.43
MONTANA																
Butte	Anaconda, Mont.⑤④	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43	.43
Butte	Anaconda, Mont.⑦④	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57	.57
Great Falls	Helena, Mont.	.....	.....	2.43	.....	2.43	.....	2.98	.....	3.69	.....	.....	.....	.....	.....	3.88
NEVADA																
Battle Mountain	Salt Lake Smelters⑨	.....	.....	.....	3.55	.....	5.94	.....	6.87	7.43	8.21	9.37	.....	10.55	11.50	11.50
Cherry Creek	Garfield, Utah④	.....	.....	4.69	5.00	.....	6.09	.....	7.19	8.28	9.43	10.46	.....	11.56	.....	.....
Golconda	Salt Lake Smelters④	.....	.....	.....	5.00	.....	5.99	.....	7.19	8.28	9.37	10.47	.....	11.56	12.65	13.75
Goldfield	Salt Lake Smelters⑤	.....	.....	5.86	7.19	.....	8.28	.....	9.37	10.43	11.56	-12.65	.....	13.75	.....	14.06
Hazen	Salt Lake Smelters④	.....	.....	.....	5.00	.....	5.09	.....	7.19	8.28	9.37	10.46	.....	11.56	12.65	13.75
Lovelock	Salt Lake Smelters④	.....	.....	.....	5.00	.....	5.09	.....	7.19	8.28	9.37	10.46	.....	11.56	12.65	13.75
Mina	Salt Lake Smelters	.....	5.00	.....	5.62	.....	5.67	.....	7.67	8.66	10.00	11.09	.....	12.18	13.28	14.06
Palisade	Salt Lake Smelters⑤	.....	.....	.....	3.55	.....	⑤5.94	.....	⑤6.70	⑤7.43	8.21	9.06	.....	9.38	10.62	11.40
Pioche	Humbolt, Ariz.③	.....	.....	10.62	.....	12.08	.....	13.36	.....	14.63	.....	.....	17.58	.....	.....	19.40
Tonopah	Salt Lake Smelters⑤	.....	.....	5.86	7.19	.....	8.18	.....	9.37	10.46	11.56	12.65	.....	13.75	.....	14.06
NEW MEXICO																
Lordsburg	Douglas, Ariz.	.....	1.56	2.97	3.91	.....	4.30	.....	4.37	4.84	.....	.....	5.90	.....	.....	6.70
Lordsburg	El Paso, Texas	.....	1.87	2.34	2.81	.....	3.28	.....	.....	3.43	.....	.....	.....	.....	.....	3.59
UTAH																
Bingham	Salt Lake Smelters⑧	.64	.71	.71	1.28	1.28	1.70	1.70	1.70	1.99	1.99	1.99	2.27	2.27	2.27	2.27
Eureka	Salt Lake Smelters	1.42	1.42	1.56	1.78	2.13	2.13	2.46	2.46	2.84	3.20	3.55	3.91	3.91	4.26	4.62
Park City	Salt Lake Smelters①	1.14	1.42	1.56	1.78	2.13	2.13	2.46	2.46	2.84	3.20	3.20	3.55	3.55	3.55	3.55
St. John	Salt Lake Smelters	1.42	1.42	1.56	1.78	2.13	2.13	2.46	2.45	2.84	3.20	3.55	3.91	3.91	4.26	4.62
Tintic	Salt Lake Smelters	1.42	1.42	1.56	1.78	2.13	2.13	2.46	2.84	2.84	3.20	3.55	3.91	3.91	4.26	4.62
WASHINGTON																
Republic	Grand Forkes, B.C.	.....	1.58	.....	.....	2.29	.....	.....	.....	3.34	.....	.....	.....	.....	.....	4.36
CANADA																
Alamo Conc., B.C.	Tadanac, B.C.	2.13	2.27	2.41	2.56	2.70	3.41	.....	3.55	3.98	4.69	4.97	.....	5.25	5.40	5.54
Rossland, B.C.	Tadanac, B.C.	1.28	1.28	1.42	1.42	1.56	2.13	.....	2.27	2.27	2.27	2.41	.....	2.41	2.41	2.41
Rossland, B.C.	Tadanac, B.C.⑨	.....	.....	.....	.....	.50	.....	.....	.....	.50	.....	.....	.....	.....	.....	.35
Sandon, B.C.	Tadanac, B.C.	2.13	2.27	2.41	2.70	2.84	3.55	.....	3.69	4.12	4.83	4.97	.....	5.25	5.40	5.54

① 30,000 Minimum
② 40,000 Minimum
③ 60,000 Minimum
④ 80,000 Minimum
⑤ 100,000 Minimum
⑥ Applies only on crude ore for concentration
⑦ Applies only on concentrates
⑧ Applies only to Midvale and Murray, Utah
⑨ Applicable only on lots of 5 carloads or more shipped at one time and released to a valuation not exceeding $25.00.

Freight Rates on Concentrates to Zinc Plants

FROM	TO	Any	$20	$100
Miami, Okla.	Amarillo, Tex.	.....	4.84	5.31
Cardin, Okla.	Amarillo, Tex.	.....	.....	5.31
Century, Okla.	Amarillo, Tex.	.....	.....	5.31
Picher, Okla.	Amarillo, Tex.	.....	.....	5.31
So. Hockerville, Okla.	Amarillo, Tex.	.....	.....	5.31
Zincville, Okla.	Amarillo, Tex.	.....	.....	5.31
Sand Springs, Okla.	Amarillo, Tex.	4.69	.....	.....
River Mines, Mo.	Amarillo, Tex.	.....	6.40	.....
Magdalena, N. M.	Amarillo, Tex.	4.69	.....	.....
Silverton, Colo.	Amarillo, Tex.	9.34	.....	.....
Leadville, Colo.	Amarillo, Tex.	6.49	.....	.....

FROM	TO	Any	$20	$100
Altoona, Kan.	Bartlesville, Okla.	3.28	.....	.....
Pittsburg, Kan.	Bartlesville, Okla.	1.70	.....	.....
Galena, Kan.	Bartlesville, Okla.	2.34	.....	.....
Joplin, Mo.	Bartlesville, Okla.	2.34	.....	.....
Iola, Kan.	Bartlesville, Okla.	1.70	.....	.....
Baxter, Kan.	Bartlesville, Okla.	2.34	.....	.....
Miami, Okla.	Bartlesville, Okla.	2.34	.....	.....
Quapaw, Okla.	Bartlesville, Okla.	2.34	.....	.....
Galena, Kan.	Coffeyville, Kan.	1.56	.....	.....
Joplin, Mo.	Coffeyville, Kan.	1.56	.....	.....
N.E.O.R.R. Station	Blackwell, Okla.	1.56	.....	.....

Reagent Tables

The tables on the following pages have been prepared to present in brief form pertinent information on a few of the more common reagents now being used in the flotation of metallic and non-metallic minerals. A brief explanation of the headings in the table is as follows:

Reagent: Reagents are listed alphabetically according to their technical names or manufacturer's trade designation.

Description: Includes chemical composition if known, color, and other physical characteristics useful in identification of the reagent.

Usual Method of Feeding: Whether in dry or liquid form. A large number of reagents are available in liquid form and naturally are best handled in wet reagent feeders, either full strength or diluted for greater accuracy in feeding. Many dry reagents are best handled in solution form and in such cases common solution strengths are specified in percent under this heading. A 10% water solution of a reagent means 10 lbs. of dry reagent dissolved in 90 lbs. of water to make 100 lbs. of solution. Some dry reagents, because of insolubility or other conditions, must be fed dry. This is usually done by belt or cone type feeders designed especially for this service to give accurate and uniform feed rates.

Pasty, viscous, insoluble reagents present a problem in handling and are generally dispersed by intense agitation with water to form emulsions which can then be fed in the usual manner with a wet reagent feeder.

Usual Quantity Fed: Average figures in lbs. of reagents per ton of mill feed are shown and are to be used only as a guide.

Price Per Lb.: Prices shown are approximate and in general apply to drum lots and larger quantities F.O.B. factory. This information is very useful when making tests to determine the lowest cost satisfactory reagent combination for a specific ore. Some ores will not justify reagent expenditures beyond a certain limit, and in this case less expensive reagents must be given first consideration.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Acid Sludge	Oil refinery bi-product high in sulphuric acid.	Undiluted liquid	1.0 -3.0	.03	Frother and promoter for bulk sulphide flotation.
Acid-Thio	Dissolve 5 grams dry thiocarbanilide in cold solution 100 grams concentrated H_2SO_4 diluted with 25 grams water.	Solution	.05-.20 Thio	See Sulphuric Acid & Thiocarbanilide	This combination makes thiocarbanilide water soluble and is useful in selective flotation of lead and zinc.
Aciterge OL	A cationic surface active reagent formulated from Alkaterge C with lactic acid, shellacol, and water.	5-10% solution	.25-1.00	.10	Wetting, frothing, and emulsifying agent for floating non-metallic minerals in an acid circuit. Slime flocculator.
Actinol C	A crude Tall Oil 40-53% Rosin Acids, 40-52% fatty acids.	Undiluted liquid	.5-2.5	.023	Flotation of non-metallic minerals.
Actinol D	A refined Tall Oil 46% Linoleic, 51% oleic.	Undiluted liquid	.5-2.5	.06	Flotation of non-metallic minerals.
Activated Carbon	A finely divided activated carbon product.	Dry	.5-1.5	.21	In some cases when used with xanthate higher grade sulphide concentrates have been produced.
Aerofloat 15	15% phosphorus pentasulphide in cresylic acid.	Undiluted liquid	.05-.20	.295	Frother and promoter for gold and sulphides of silver, copper, lead and zinc.
Aerofloat 25	25% phosphorus pentasulphide in cresylic acid.	Undiluted liquid	.05-.20	.295	In acid or neutral circuit is a strong non-selective promoter and frother for sulphide minerals.
Aerofloat 31	31% phosphorus pentasulphide in creyslic acid.	Undiluted liquid	.05-.20	.305	Excellent frother-promoter for galena and oxidized gold ores, also silver sulphides.
Aerofloat 203	A water soluble dry aerofloat reagent.	5-10% solution	.05-.20	.27	Promoter for gold, silver, copper and zinc sulphide ores. Stronger than sodium aerofloat.
Aerofloat 208	A non-frothing water soluble dry aerofloat.	5-10% solution	.01-.10	.30	Alone or in combination with reagent 301 is widely used for flotation of gold and silver.
Aerofloat 211	A water soluble dry aerofloat. Formerly sodium aerofloat B.	5-10% solution	.05-.20	.24	Same as sodium aerofloat B. A powerful selective zinc reagent.
Aerofloat 213	A water soluble dry aerofloat.	5-10% solution	.01-.10	.44	Promoter for gold, silver, and copper ores. Has some tendency to froth.
Aerofloat 226	A water soluble dry aerofloat.	5-10% solution	.02-.10	.44	Similar to Aerofloat 213.
Aerofloat 238	A water soluble dry aerofloat.	5-10% solution	.02-.15	.30	Strong promoter for gold and silver, copper, and zinc sulphide ores. Very little tendency to float pyrite in alkaline pulps.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Aerofloat 241	Neutralized aerofloat 25. Greenish black liquid.	5-10% solution	.05-.15	.255	Fast acting aerofloat promoter-frother for silver bearing lead ores, also copper and zinc sulphides.
Aerofloat 242	Neutralized aerofloat 31. Black and water soluble.	5-10% solution	.02-.15	.305	Similar to aerofloat 241 but a stronger promoter for copper, lead, and silver sulphides.
Aerofloat 243	A water soluble dry aerofloat.	5-10% solution	.02-.15	.295	Slightly stronger promoter than reagent 203.
Aerofloat 249	Water soluble aerofloat. Brown to black color.	5-10% solution	.02-.15	.335	Strong non-selective promoter for sphalerite, copper sulphides, and gold ores. Also a frother.
Aerosol OT 100%	Sodium salt of di-octyl-sulfo-succinic acid. Resembles paraffin.	1% solution	.01-.20	1.20	Wetting and dispersing agent in treatment of oxides and non-metallic minerals.
Alamac	Acetate of Tallow amine.	5% water solution	.10-.50	.29	Cationic reagent for flotation of non-metallics such as feldspar. potash, and phosphate.
Alamac 26-D	Acetate of distilled tallow amine.	5% water solution	.10-.50	.37	Cationic reagent for flotation of non-metallics such as feldspar, potash, and phosphate.
Alamine 26	A tallow amine.	5% water solution	.10-.50	.32	Flotation of non-metallics.
Alamine 26-D	A distilled tallow amine.	5% water solution	.10-.50	.39	Flotation of non-metallics.
Aliphat 44-A	Double distilled tall oil fatty acids primarily oleic and linoleic.	Undiluted liquid	.5-2.0	.123	Fatty acid collector promoter for flotation of non-metallic minerals.
Aliphat 44-B	Single distilled tall oil fatty acids. Primarily oleic, linoleic and rosin acids.	Undiluted liquid	.5-2.0	.11	Fatty acid collector promoter for flotation of non-metallic minerals.
Aliphat 44-E	Fractionally distilled tall oil fatty acids. Oleic and linoleic acid low in rosin acids.	Undiluted liquid	.5-2.0	.12	Very effective collector-promoter for flotation of fluorspar.
Alkaterges A, E, & T	Cationic oil soluble surface active agents similar to Alkaterge C.	Emulsion	.25-.50	.58	Emulsification agents useful in non-metallic flotation.
Alkaterge C	A non-volatile high molecular weight cationic surface active amine type agent.	Emulsion	.25-.50	.58	Wetting, frothing, and emulsifying agent for non-metallic flotation.
Aluminum Sulphate	Commonly known as alum, white crystalline water soluble solid solution $Al_2(SO_4)_3$. 18 H_2O.	5-10% solution	.1- .5	.02	A good flocculating agent for slimes.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Amijel	A form of corn starch. Granular powder.	1-2% solution	.1- .3	.04	Disperses gangue slimes and in some cases permits production of higher grade sulphide concentrates.
Amine 220	A mixture of high molecular weight amines.	5% solution	.10-.50	.75	Has been used to float silica and iron oxide from barite. Acts as frother and promoter.
Amono-Phos	A crude mono-ammonium phosphate.	Dry	.5-3.0	.085	A modifying agent similar in action to soda ash and sodium silicate.
Annite Reagent A	An amine soap. Water soluble powder.	1-2%	.5-1.5	.17	Promoter for oxidized minerals such as lead carbonate: Effective without sulphidization.
Antifoam HF	Colorless liquid.	Undiluted liquid	.05-.25	.37	Froth modifier for use with cationic reagents.
Armac 12-D	Distilled N-dodecylamine acetate. Laurylamine acetate.	1-5% water solution	.05-1.00	.67	Strong cationic collector. Hematite, magnetite, manganite, ilmenite, wolframite, scheelite, feldspar, monazite, chromite.
Armac 16-D	Distilled N-hexadecylamine acetate. Palmitylamine acetate.	1-5% water solution	.05-1.00	.49	Strong cationic collector. Potash, phosphate, feldspar, mica, spodumene, beryl, silica, clays.
Armac 18-D	Distilled octadecylamine acetate stearylamine acetate.	1-2.5 water solution	.05-1.00	.48	Strong cationic collector. Same minerals as Armac 16D.
Armac CD	Distilled primary amine acetate derived from cocoanut fatty acids.	1-5% water solution	.05-1.00	.54	Strong cationic collector. Same minerals as Armac 12D.
Armac SD	Distilled primary amine acetate derived from soya fatty acids.	1-5% water solution	.05-1.00	.42	Strong cationic collector. Same minerals as Armac 16-D.
Armac T	Technical primary amine acetate derived from tallow fatty acids.	1-5% water solution	.05-1.00	.29	Strong cationic collector. Same minerals as Armac 16-D.
Armac TD	Distilled primary amine acetate derived from tallow fatty acids.	1-5% water solution	.05-1.00	.37	Strong cationic collector. Same minerals as Armac 16-D.
Armac HTD	Distilled primary amine acetate derived from hydrogenated tallow fatty acids.	1-2.5 water solution	.05-1.00	.41	Strong cationic collector. Same minerals as Armac 16-D.
Armeen 12-D	Distilled primary N-dodecylamine. Laurylamine.	In isopropyl alcohol or kerosene solvent	.05-1.00	.81	Strong cationic collector. Hematite, magnetite, ilmenite, wolframite, scheelite, feldspar, monazite, chromite.

High molecular wt. aliphatic amine acetates

Continued on page 588

FLOTATION REAGENT DATA

Reagent		Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Armeen 18-D	High molecular wt. aliphatic amines	Distilled primary N-hexadecyl-amine. Palmitylamine.	In isopropyl alcohol or kerosene solvent	.05-1.00	.53	Strong cationic collector. Potash, phosphate, feldspar, mica, spodumene, beryl, silica, clays.
Armeen CD		Distilled primary amine derived from cocoanut fatty acids.	Liquid or in isopropyl alcohol or kerosene solvent	.05-1.00	.62	Strong cationic collector. Same minerals as Armeen 12-D.
Armeen SD		Distilled primary amine derived from soya fatty acids.	Liquid or in isopropyl alcohol or kerosene solvent	.05-1.00	.44	Strong cationic collector. Same minerals as Armeen 18-D.
Armeen TD		Distilled primary amine derived from tallow fatty acids.	In isopropyl alcohol or kerosene solvent	.05-1.00	.39	Strong cationic collector. Same minerals as Armeen 18-D and Armeen SD.
Armeen HTD		Distilled primary amine derived from hydrogenated tallow fatty acids.	In isopropyl alcohol or kerosene solvent	.05-1.00	.44	Strong cationic collector. Same minerals as Armeen TD.
Arquad C	Quaternary ammonium chlorides	33% active coconut tri-methyl ammonium chloride.	1-5% water solution	.10-1.00	.43	Weak cationic collector. Flotation of silica.
Arquad 2C		50% active di-coconut dimethyl ammonium chloride.	1-5% water solution	.10-1.00	.37	Weak cationic collector for silica. Flocculating agent for slimes.
Arquad S		50% active soya-trimethyl ammonium chloride.	1-5% water solution	.10-1.00	.40	Weak cationic collector. Flotation of paper pulp fiber, waste oils, fats, etc.
Arquad T		50% active tallow tri-methyl ammonium chloride.	1-5% water solution	.10-1.00	.38	Weak cationic collector. Same materials as Arquad S.
Barium Chloride		$BaCl_2$. water soluble crystalline solid.	1-5% water solution	.01-1.00	.06	Modifier for quartz.
Barium Sulphide		A grayish black powder.	Dry	1.0-3.0	.04	Sulphidizing agent for oxidizing minerals. High pH avoided by its use.
Barrett Flotation Oil No. 4		Coal tar creosote oil. Slightly more viscous than cresylic acid. Insoluble in water.	Undiluted liquid	.05-2.0	.07	Has strong frothing and collecting properties. Used on sulphide ores quite extensively.
Barrett No. 410		Coal tar creosote oil.	Undiluted liquid	.05-.20	.07	Froth modifier and promoter similar in action to Barrett No. 4.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Barrett No. 634	A coal tar creosote oil slightly more viscous than Barrett No. 4. Insoluble in water.	Undiluted liquid	.05-.20	.05	Useful if a stiff and more persistent froth is desirable for sulphide flotation.
Calcium Polysulphide	A liquid calcium polysulphide.	Undiluted	.5-2.0	.04	Sulphidizer for lead carbonate and tarnished sulphides.
590 Calcium Sulphite	$CaSO_3 2H_2O$. Insoluble white crystalline solid.	Dry	.1-5.0	.23	Similar in action to sodium sulphite for depressing iron and zinc sulphides.
Calgon	Sodium hexameta - phosphate. Water soluble glassy flakes.	5-10% solution	0.1-1.0	.19	Excellent water softener, useful when floating non-metallics with fatty acids. Good dispersant.
Castor Oil Acids 9-11	Distilled fatty acids of dehydrated castor oil. Clear liquid.	Undiluted or emulsion	.5-2.0	.46	Promoter for oxide and non-metallic minerals, similar to oleic acid in its action.
Castor Oil Acids 135	Clear bright oily liquid. Octadecadienoic acids 9-11 and 9-12.	Undiluted or emulsion	.5-2.0	.42	Promoter for oxide and non-metallic minerals, similar to oleic acid in its action.
Caustic Soda	NaOH, flakes or pellets. Water soluble.	5-10% solution	.5-3.0	.05	Alkalinity regulator and dispersing agent for sulphide and non-sulphide flotation.
Caustic Starch	A water solution of starch and sodium hydroxide.	1-2% solution	.1- .3	.04	Aids production of high-grade sulphide concentrates by depressing slimes, settling aid.
Cellulosics CMC	Sodium carboxymethyl - cellulose, ionic. Dry powder cellulose gum.	Water dispersion	.01-.05	.55	A flocculant and dispersant; also a depressant or gangue slimes in flotation of sulphides.
Cellulosics HEC (Natrosol)	Hydroxyethyl cellulose, non-ionic. Dry powder cellulose.	Water dispersion	.01-.05	.45	A flocculant and dispersant useful in flotation of non-metallic and iron ore along with cationic promoter.
591 Cement	Standard cement with variable lime content.	Dry	.5-2.0	.015	Alkalinity regulator. Has been used to depress pyrite and pyrrhotite.
Coal Tar	A coal distillation by-product.	Undiluted liquid	.1- .5	.04	Frother for sulphide minerals being replaced by more uniform reagents.
Copper Sulphate	A blue crystalline solid commonly known as blue stone or blue vitriol. $CuSO_4 \cdot 5H_2O$.	Saturated solution	.25-1.0	.14	Activator for sphalerite, arsenopyrite, and tarnished gold, the latter when used with caustic soda.
Creosote Coal Tar	A creosote produced as a coal tar distillation bi-product.	Undiluted liquid	.1- .3	.05	Frother and collector for sulphides. Produces a tough froth.
Creosote No. 1 Hardwood	Black, slightly viscous liquid.	Undiluted liquid	.1- .3	.05	Frother and collector for sulphides. Extensively used for gold flotation.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Cresylic Acid	A crude grade of carbolic acid. Straw color to dark brown.	Undiluted liquid	.05-.20	.13	Frother extensively used for lead sulphide flotation.
Cupferron	Ammonium phenylnitroso - hydroxyl-amine.	Solution	.01-.05	.....	A cationic collector for cassiterite (SnO_2) (experimental only).
Cyanide	Sodium cyanide eggs or granular. Very poisonous.	5-10% solution	.03-.75	.23	Depressant for iron and zinc sulphides. Also depresses silica in presence of fatty acids.
Daxad No. 23	Polymerized sodium salts of substituted benzoic alkyl sulfonic acids. Water soluble brown powder.	5-10% solution	.05-.20	.25	Dispersing agent for gangue slimes. Best at Ph 7.0 - 9.5. Aid in classification.
Denver Sulphidizer	A calcium polysulphide in liquid form.	Undiluted liquid	.5-1.5	.04	An inexpensive sulphidizer for lead carbonate. Has slight frothing properties.
Dichromate	$Na_2Cr_2O_7 \cdot 2H_2O$. Sodium dichromate, an orange crystalline powder.	5-10% solution	1.0-5.0	.12	Positive depressor for galena in copper, lead, zinc separations.
Dowfroth 250	Water soluble alcohol type frother.	Undiluted liquid	.01-.05	.27	Excellent frother for selective flotation. Produces brittle froth. Does not attack rubber.
Dresinates X, XX, TX	Sodium salts (soaps) of selected rosin acids.	1-5% water solution	.2-3.0	....	Anionic collector. Non-metallic flotation.
Duomeen T	Light red soft paste. A diamine with 75-80% amine content.	1-5% emulsion	.05-1.0	.38	Strong cationic collector.
Duponal 100	Dry water soluble white flakes. Sodium octyl sulphate.	5-10% solution	.01-.10	1.00	Anionic collector. Flotation of molybdenite similar to Syntex L.
Elastoil LL	A dark-colored liquid bi-product from linseed oil processing.	Undiluted liquid	.3-1.5	.11	A collector for non-metallics and tungsten minerals. Has little or no tendency to froth.
Emcol X-25	Alkanolamine salt of a sulfated complex alcohol.	1-5% solution	.1- .5	.55	A cationic collector; also used as an emulsion with oleic acid or kerosene. See kerosene.
Emcol 4150	A complex fatty acid amite sulfate.	Undiluted liquid	.25-1.5	.20	Manganese flotation.
Emersol 300	A distilled vegetable liquid fatty acid, 95-98% free oleic.	Undiluted liquid	.5-2.0	.17	A fatty acid promoter-collector for flotation of fluorspar.
Ethyl Silicate	$(C_2H_5)_4SiO_4$. Water will hydrolize it to pure SiO_2.	Undiluted liquid	.05-.25	.50	Similar in action to sodium silicate but for acid or neutral circuits where pH is critical.
Eucalyptus Oil	An oil extracted from the eucalyptus tree	Undiluted liquid	.05-.20	.70 U.S.	Frother used in place of pine oil in tropical countries

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Ferric Sulphate	A water soluble iron salt. $Fe_2(SO_4)_3$ plus water.	10-20% solution	.5-1.5	.06	Activates arsenopyrite and tetrahedrite in presence of cyanide and zinc sulphate. Permits floating these minerals from sphalerite.
Fish Oil Fatty Acid	A mixture of saturated and unsaturated fatty acids. Pasty and insoluble in water.	Undiluted or with fuel oil	.5-1.5	.12	Anionic collector. A promoter and frother similar in action to oleic acid.
Flexricin 9	Propelene glycol monoricinoleate. Clear viscous liquid.	Undiluted or emulsion	.5-2.0	.44	Highly polar. Flotation of non-metallics and oxide minerals.
Fluorspar	Finely ground acid grade calcium fluoride. CaF_2.	Dry	1.0-3.0	.03	Used with sulphuric acid to release fluoride ion required in selective flotation of feldspar from quartz.
Fuel Oil	Petroleum oils of various grades.	Undiluted liquid	.5-2.5	.02	Used for froth control and also in flotation of various metallics and non-metallics.
Glue	An organic colloid powder.	5% water solution	.1- .5	.24	Depressant and slime regulator.
Galactasol	A food grade guar gum—dry powder flakes.	1% water solution with Preservative	0.1-0.5	.39	Excellent slime flocculent and settling aid.
Guartex	Industrial grade guar gum—dry powder flakes.	1% water solution with Preservative	0.1-0.5	.36	Excellent slime flocculent and settling aid.
Gum Arabic	A white powder water soluble.	5-10% solution	.1- .3	.17	A good dispersant and depressant for gangue slimes.
Goulac	Calcium ligninsulfonate. Tan powder.	5% water solution	.5-2.0	.035	Depressant for carbonaceous gangues. Used in depressing calcite and barite from fluorspar and rare earths oxide ores.
Hydrochloric Acid	Commercially known as muriatic acid. Approx. 32% HCl.	Undiluted liquid	.5-5.0	.03	To lower pH when necessary to float in acid circuit.
Hydrofluoric Acid	Commercial 60% HF. Very corrosive.	Undiluted 10% solution	.5-4.0	.15	Extensively used in selective flotation of feldspar from quartz. Depresses mica.
Hydrogen Sulphide	H_2S gas or saturated water solution.	Gas or water solution	.25-1.0	...	Sulphidizing agent for oxide minerals. Most effective in nascent forms from Ca or Na-polysulphide and sod-bicarbonate.
Indusoil	Refined tall oil. Mixture of fatty and rosin acids.	Undiluted liquid	0.5-2.0	.08	Substitute for oleic and other fatty acids for floating non-metallic minerals and oxides.
Invadine	Sodium alkylbenzenesulfonate. Light tan powder. Water soluble.	5-10% solution	.2- .5	.53	Wetting agent.
Kerosene	A water white distillate from petroleum.	Undiluted or emulsion	.5-2.5	.02	Promoter for coal and graphite. Best when emulsified with Emcol X-25 or similar reagents. Floats ink from paper pulp.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Lactic Acid	$C_3H_6O_3$. Colorless liquid.	Undiluted liquid	.25-1.0	.10	Depressant for mica.
Lead Nitrate	A white crystalline water soluble salt $Pb(NO_3)_2$.	5-10% solution	.5-1.5	.12	Activator in flotation of sodium chloride from potash salts. Activates stibnite.
Lime	Calcium hydroxide. White powder. Solubility 2.6 lbs. per ton of water.	Slurry or dry	1.0-10.0	.015	An alkalinity modifier regulator and depressor of pyrite. Used extensively in lead-zinc flotation.
Liqro	A crude tall oil, bi-product from paper pulp manufacture.	Water emulsion	.5-2.5	.03	Contains fatty and resin acids and is used as a substitute for oleic acid in flotation of non-metallics.
Lintz Reagent R-52	A surface active agent dry powder. Non-toxic.	4% water solution	1.0-5.0	....	An excellent flocculating agent useful in thickening and filtering.
Manganese Sulfate	$MnSO_4$—Reddish.	5-10% water solution	1.0-5.0	.07	Activator in flotation of manganese dioxide.
Mahogany Sherosope F-445	A dark brown of viscous liquid. Sodium salt of crude or refined petroleum sulfonic acids.	5% solution	.1- .5	.15	Has been used to float metallic and oxide copper ores. Also good to float carbonaceous or graphitic impurities from lead-zinc ores.
Marasperse CB	A water soluble sodium ligno sulfonate.	5-10% solution	.1- .5	0.14	A dispersing agent similar in action to Quebracho. Used in phosphate flotation.
Methyl Amyl Acetate	A water white liquid with a high boiling point.	Undiluted liquid	.05-.10	.16	Produces a very brittle froth. Similar in action to methyl amyl alcohol.
Methyl Amyl Alcohol	A medium high boiling alcohol. Water white liquid.	Undiluted liquid	.05-.10	.16	An excellent frother for selective flotation of metallics and non-metallics. Brittle froth.
Methyl Isobutyl Carbinol	A higher alcohol water white liquid.	Undiluted liquid	.05-.10	.16	An excellent frother for selective flotation of sulphides, also non-metallics. Produces a brittle froth.
Metso	Sodium metasilicate pentahydrate. Approx. 57.5% Na_2SiO_3.	Dry or 10% solution	.5-1.5	.05	A substitute for sodium silicate as a gangue dispersant. Does not raise pH abnormally.
Micate	A dry powder soap made from tall oil. 50.5% sodium oleate, 38% sodium abietate.	5% water solution	.5-1.5	.038	Flotation of non-metallics.
Minerec A	Dixanthogen (diethyl dithiobis thionoformate). Light yellow liquid.	Undiluted to grinding circuit	.05-.25	.48	An effective sulfide promoter in either acid or alkaline circuits. An excellent copper reagent.
Minerec B	Similar to Minerec A.	Undiluted to grinding circuit	.05-.25	.48	Especially adapted to flotation of copper and gold ores in lime circuit. Non-frothing promoter.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Minerec 27	Similar to Minerec A & B.	Undiluted liquid	.05-.25	.48	Powerful and selective collector for flotation of copper ores.
Nacconol NR	White flaky solid. Sodium alkylated aryl sulfonate.	1-5% solution	- .5	.13	A neutral surface active wetting agent possessing frothing and collecting properties for talc and similar non-metallics.
Naphtha Solvent	Commonly known as Stoddard's solvent. Water white liquid.	Undiluted liquid	.5-1.5	.03	Modifying agent when used with Tallso and other fatty acids in flotation of ilmenite and rutile from beach sand.
Naphthenic Acid "D"	A petroleum bi-product.	Undiluted liquid	.5-2.0	.11	A frother and promoter for flotation of potash salts, barite, magnesite and various other non-metallics.
Naphthenic Acid "P"	A petroleum bi-product dark colored liquid.	Undiluted liquid	.5-2.0	.07	Same as Napthenic Acid D.
Neofat 42-12 (formerly S-142)	Tall oil fatty acids single distilled.	Undiluted liquid or emulsion	.20-2.00	.11	Anionic collector for non-metallics such as fluorspar, barite, beryl, magnetite, hemotite, calcite, spodumene, phosphate.
Neofat 42-06 (formerly D-142)	Tall oil fatty acids double distilled.	Undiluted liquid or emulsion	.20-2.00	.13	Anionic collector for non-metallics same as above.
Oleic Acid	A fatty acid commonly known as Red Oil.	Undiluted liquid	.5-2.0	.14	One of the most common promoter-collectors for flotation of non-metallic minerals. Used extensively for fluorspar.
Oronite Wetting Agent	A viscous brown paste. Petroleum bi-product.	Water solution	.1-1.0	.18	Wetting agent in non-metallic flotation.
Orso	A blown neutral soap of vegetable origin containing about 4% moisture.	1-2% solution	.2-1.0	.095	Promoter and collector for scheelite and other tungsten minerals.
Orthotoluidine	A brownish black liquid. Very fluid.	Liquid	See TT mixture	.20	A frother and froth modifying agent. Excellent for mixing with cresylic or pine oil.
Pentasol Frother No. 26	An amyl alcohol of special distillation range.	Undiluted liquid	.05-.20	.16	A frother and froth modifying agent. Excellent for mixing with cresylic acid or pine oil.
Pine Oil-Yarmor "F"	A standard high grade pine oil of uniform consistency, steam distilled.	Undiluted liquid	.05-.20	.13	An extensively used frother for bulk and selective flotation of sulphide minerals.
Potassium Permanganate	$KMnO_4$, crystalline solid.	5% water solution	.1-2.0	.38	A selective sulfide depressant.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Quebracho	A tannic product containing approximately 70% tannic acid. Dry brown powder.	5-10% solution	.05-.30	.17	An excellent depressor for calcite in fluorspar flot. Also depressant for wolframite when floating sulphides.
Reagent 301	An xanthate of a higher petroleum alcohol similar to Z-8. Light yellow powder.	10% solution	.05-.15	.30	Promoter for sulphide and oxidized base metal ores, the latter after sulphidizing.
Reagent 322	A higher xanthate similar to Reagent 343.	10% solution	.05-.15	.23	Strong promoter for all sulphide minerals.
Reagent 325	An xanthate made from a lower alcohol than Reagent 301.	10% solution	.05-.15	.235	Strong promoter for bulk flotation of sulphide minerals.
Reagent 343	A higher xanthate similar to Reagent 301.	10% solution	.05-.15	.215	Strong promoter for all sulphide minerals. Promoter activity between ethyl xanthate and Reagent 301.
Reagent 404	Mercaptobenzthiazole. Greenish yellow water. Soluble pasty solid.	5% solution	.2- .5	.355	Promoter for oxidized base metal ores. Also used for flotation of vanadium and auriferous pyrite ores.
Reagent 425	A yellow to greenish yellow hydroscopic powder.	5% solution	.2- .5	.37	Developed primarily for flotation of oxidized copper ores. Promoter for malachite and azurite without sulphidization.
Reagent 444	A yellow water soluble powder.	5% solution	.2- .5	.35	An effective promoter for copper and zinc sulphide ores.
Reagent 610	A dark colored powder. Slightly hydroscopic.	2-5% solution	.10-1.0	.11	A slime and gangue dispersant; aids production of clean concentrates.
Reagent 645	A dark colored powder. Slightly hydroscopic.	2-5% solution	.10-1.0	.34	A depressant for carbonaceous gangue, also arsenic and antimony sulphides.
Reagent 710	A fatty acid of vegetable origin. Dark brown to brownish black liquid.	Undiluted if kept warm	.5-2.0	.07	Used as a substitute for oleic acid and other fatty acids for flot. of phosphate, fluorspar, and barite. replaces Reagent 708.
Reagent 712	A clear amber to dark brown pasty liquid. Water soluble.	5-10% solution	.05-.50	.18	A secondary promoter and frother for flotation of base metal, precious metal, and non-metallic ores. Floats middlings.
Roccal 50%	A high molecular alkyldimethyl - benzyl - ammonium chloride. Sanitizing agent. Germicide.	10% solution	.01-.02	.90	Useful floating bacteria, and solids from water. Non-toxic. 10 parts per million usually sufficient.
Rosin Amine D-Acetate (RADA 80%)	A primary amine acetate. Water soluble. Also available in 50% and 70% aqueous grades.	1-5% water solution	.05-1.0	.216	A strong cationic collector for flotation of non-metallic minerals. Mica, quartz, and feldspar.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Reagent 801	Dark colored viscous liquid petroleum sulfonic acids. Water soluble up to 30%.	10-30% water solution	.5-3.0	.07	Promoter for flotation of non-metallics, calcite, barite, tungsten, garnet, and iron ores.
Reagent 825	Dark colored viscous liquid or paste. Petroleum sulfonic acids.	5-12% dispersion in water	.5-3.0	.18	Strong promoter similar to 801. More selective on some ores often mixed with 801.
Red Oil	Same as oleic acid. Commercial grade, low titre oleic-linoleic acids.	Undiluted	.5-2.0	.14	Anionic collector. See oleic acid.
Sapamine MS	A cationic reagent. Clear liquid.	Undiluted	.1- .3	.55	Promoter in floating silica from gypsum. Also useful in flotation of iron ores.
Soda Ash	Na_2CO_3. White water soluble powder. "Trona."	Dry or 10-20% solution	1.0-5.0	.03	A widely used alkalinity regulator in selective flot. of lead-zinc ores. Also used in bulk and non-metallic flot.
Sodium Aerofloat B (Now Aerofloat 211)	A water soluble granular gray powder. Sodium diethyl dithiophosphate.	5-10% solution	.05-.20	.24	A powerful selective zinc promoter. also used in flot. of gold, silver and copper from pyrite. Non-frothing.
Sodium Bicarbonate	$NaHCO_3$. Water soluble white powder commonly known as baking soda.	Dry or 10-20% solution	1.0-5.0	.04	Same general use as soda ash. In some cases improved results warrant its use. pH buffer.
Sodium Bisulphite	A white to yellow powder. $Na_2S_2O_5$.	10% solution	.5-2.5	.06	Similar in use to sodium sulphite as a depressant.
Sodium Dichromate	Orange crystalline powder. $Na_2Cr_2O_7.2H_2O$.	5-10% solution	1.0-5.0	.12	See dichromate. Sulfide depressant.
Sodium Ferro-cyanide	$Na_4Fe(CN)_6.10H_2O$. Crystalline powder.	5% solution	.1-2.0		Useful in floating molybdenite from bulk copper concentrates. A selective depressant for sulfides.
Sodium Fluoride	NaF. Insoluble white powder.	Dry	.5-1.5	.12	May be used with sulphuric acid in flotation of non-metallics in place of hydrofluoric acid. Ilmenite and fluorspar flotation.
Sodium Hydrosulphide	Light yellow crystalline solid, approx. 72% NaHS. Sodium sulphydrate.	5-10% solution	.5-1.0	.05	Sulphidizing agent used in place of and at times more effective than sodium sulphide.
Sodium Hydrosulphite	A white powder. $NaHSO_2$.	5-10%	.1-1.5	.25	Similar in action to sodium sulphite as a depressant.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Sodium Metasilicate	Commonly known as "metso."	Dry to 10% solution	.5-1.5	.05	See Metso.
Sodium Oleate	A fatty acid soap. Made from oleic acid and sodium hydroxide.	1-2% solution	.5-2.0	.19	A promoter for oxides and non-metallics. Sometimes more effective than oleic acid.
Sodium Polysulphide	Solid form of sodium polysulphide. Water soluble.	10% solution	.5-2.0	.10	A sulphidizing agent for oxide lead minerals similar in action to calcium polysulphide.
Sodium Silicate	Commonly known as water glass. Usual grade is 41° Baume.	10% solution	.5-3.0	.03	A depressant for gangue slimes and siliceous gangue minerals in sulphide and non-sulphide flotation.
Sodium Palconate	The unrefined soluble product which results when redwood bark is cooked with sodium hydroxide.	Water dispersion	0.1-0.5	.09	Calcite depressant. Similer use to quebracho.
Sodium Palcosulfonate (Palcotan)	The unrefined product which results when redwood bark is cooked with sodium sulfite.	5-10% Water dispersion	0.1-0.5	.09	Calcite depressant. Similar use to quebracho.
Sodium Silicofluoride	Na_2SiF_6. Slightly soluble white granular solid.	Dry	.5-2.5	.09	Depressant for quartz and feldspar in flotation of spodumene.
Sodium Sulphide	A reddish brown flaky water soluble solid. $Na_2S \cdot 9H_2O$.	10% solution	.5-3.0	.06	Used to sulphidize lead and copper ores. Depressant for silver sulphide minerals and metallic gold.
Sodium Sulphite	Na_2SO_3. White granular water soluble solid.	10% solution	.1-5.0	.04	Depressant for zinc and iron sulphides. Used in place of cyanide, particularly in ores containing silver.
Sodium Tetra Pyrophosphate	$Na_4P_2O_7 \cdot 10H_2O$. White granular solid.	5-10% water solution	.5-3.0	.07	Has been used as a depressant for calcite in flotation of magnesite with napthenic acid. Dispersant.
Starch	Usually a white granular solid. Most effective when causticized.	1-5% solution	.05-.30	.04	Flocculating agent and aids in depressing slime gangue when floating sulphides.
Sulphuric Acid	H_2SO_4. Strong acid. Common name of vitriol.	Undiluted or as 10% solution	.5-2.0	.015	Used to reactivate pyrite after being depressed by lime or cyanide. Lowers pH. Depresses quartz.
Sulphurous Acid	H_2SO_3. Available commercially as SO_2 in liquid form.	Gas or saturated sol.	.5-2.0	.17	To acidify flotation pulps and reactivate pyrite. Substitute for sulphuric acid when source of supply permits.
Syntex L	Sulphated mono-glyceride of cocoanut oil derivation. Powder.	5-8% solution	.01-.10	.17	Frother and promoter for molybdenite and its use permits greater selectivity.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Sonneborn Reagents (1-2-3)	Petroleum sulfonates. Dark colored viscous liquids.	Water solution emulsion	0.5-3.0	.05 to .145	Non-metallic collectors for phosphate, barite, feldspar, fluorspar, manganese oxides.
Tannic Acid	Tannin C76H52046. Light brown powder.	5% solution	0.05-.30	1.36	Depressant for calcite. Can be used in place of quebracho but is more expensive.
Tall Oil	See Liqro and Indusoil.	Undiluted or emulsion	.5-2.5	.02	Used as a substitute for oleic acid and other fatty acids in flotation of non-metallics.
Tergitol Dispersant NPX (formerly NPG-101)	Non-ionic surface active dispersant. Mixture of alkyl aryl polyglycol ethers.	Undiluted liquid	.05-.30	.34	A wetting agent used in paper pulp flotation to depress cellulose fibers when de-inking.
Tergitol Penetrant No. 4	Sodium lauryl sulphate: A surface active wetting agent.	5-10% solution	.25-.75	.31	A wetting agent useful as a frother and collector in non-sulphide flotation.
Tergitol Wetting Agent No. 7	A surface active wetting agent.	5-10% solution	.25-.75	.37	A wetting agent useful as a frother and collector in non-sulphide flotation.
Terposol No. 3	Mixture about 60% terpinyl methyl ethers balance tertiary terpene alcohols.	Undiluted liquid	.05-.2	.15	Good frother with very little collecting properties.
Thiocarbanilide	A white fluffy powder insoluble in water. 1,3-Diphenyl 2-thiorea.	Dry to grinding mill	.05-.10	.37	A good promoter for lead, zinc, copper and silver ores. Excellent for selective flotation of sulphides.
Thiocarbanilide 130	A cream to white dry powder. Wettable.	Dry or 5-10% slurry	.05-.10	.43	Same general use as thiocarbanilide but more dispersible.
Tragacine Powdafloc	A starch base powder.	Make paste then dilute to 2-10% solution	1.0-1.5	.07	Flocculating agent settlement of slimes.
Tri-Sodium Phosphate	$Na_3PO_4 \cdot 12H_2O$. Water soluble. White solid.	5-10% solution	.5-3.0	.04	An alkaline detergent and water softener useful in flotation of non-metallics. Slime dispersant and depressant.
Triton K-60	Dimethyl cetyl benzyl ammonium chloride. Aqueous solution.	Undiluted	.10-.30	.50	A cationic collector for non-metallic minerals.
Trostol	A crude tall oil product. Approximately 48% rosin acids and 52% fatty acids.	Undiluted or emulsion	.5-2.5	.02	A substitute for oleic and other fatty acids as a collector for non-metallic minerals.
TT Mixture	Made by dissolving not more than 15% thiocarbanilide in hot orthotoluidine.	Undiluted (hot) mixture	.25-.50	.22	A good promoter of lead, copper and silver ores. Thiocarbanilide solubility increased in this form.

FLOTATION REAGENT DATA

Reagent	Description	Usual Method of Feeding	Usual Quantity Fed Lbs./ton	Approx. Price U. S. Dollars Per Lb.	Uses
Turkey Red Oil	Sulphated and sulfonated castor oil. Viscous.	Undiluted or emulsion	.5-1.5	.12	Promoter and frother similar in action to oleic acid.
Ultrawet DS	Dry powder. Sodium alkyl aryl sulfonate 85% active.	10-20% solution	.05-.30	.31	An anionic wetting and dispersing agent. Also an excellent frother-collector for talc and steatite.
Ultrawet 30-DS	A 30% aqueous solution of ultrawet DS.	10-20% solution	.10-.60	.12	Same as ultrawet DS. Aqueous solution.
Vapor Oil	A pale neutral petroleum hydrocarbon oil low in paraffin wax.	Undiluted liquid	.25-1.0	.03	Flotation of molybdenite used with pine oil and syntex L.
Wattle Bark Extract	A tannin product similar to quebracho.	5-10% solution	.05-.30	.12	Calcite depressant when floating fluorite with fatty acids.
Xanthate Z-3	C_2H_5OCSSK. Potassium ethyl xanthate, yellowish gray pellets.	10% solution	.05-.30	.28	One of the most widely used collectors for bulk flotation of copper and other complex sulphides.
Xanthate Z-4	$C_2H_5OCSSNa$. Sodium ethyl xanthate. Pale yellow pellets.	10% solution	.05-.30	.27	Same as Z-3 but preferred by some on account of its higher xanthate content.
Xanthate Z-5	$C_5H_{11}OCSSK$ Potassium sec amyl xanthate. Yellowish brown pellets.	10% solution	.01-.20	.38	A powerful collector and flocculator for flotation of slow floating and semi-oxidized sulphides.
Xanthate Z-6	$C_5H_{11}OCSSK$. Potassium amyl xanthate. Grayish pellets.	10% solution	.01-.20	.37	Collector power of the same order as Z-5. Excellent for metallic gold arsenopyrite, and slow floating sulphide minerals.
Xanthate Z-8	C_4H_9OCSSK. Potassium sec butyl. Dark yellow pellets.	10% solution	.01-.20	.32	Superior to Z-9 in collecting power. Excellent for tarnished sulphide minerals or metallics.
Xanthate Z-9	C_3H_7OCSSK. Potassium isopropyl xanthate. Slightly yellow gray pellets.	10% solution	.05-.30	.27	Collector for lead-zinc-iron sulphide ores. Superior collecting power and selectivity toward pyrite in cleaner circuits.
Xanthate Z-11	$C_3H_7OCSSNa$. Sodium isopropyl xanthate. Yellowish white pellets.	10% solution	.05-.30	.26	Lead-zinc selective flotation. Improved selectivity.
Yellow Dextrine	A yellow amorphous powder. A starch product.	10% solution	.1- .3	.10	Slime and insoluble depressant in flotation of copper and other metallic sulphides. Add to cleaners.
Zinc Hydrosulphite	A water soluble white powder.	10% solution	.5-1.5	.22	Depressant similar in action to sodium sulphite. Best in acid circuit.
Zinc Sulphate	A white granular, water soluble powder.	5-10% solution	.5-1.5	.11	Depressant for pyrite and sphalerite in selective flotation of lead, zinc, and copper ores.

AERATION, FLOTATION MACHINE CONTROL

A SIMPLE METHOD FOR MEASURING AIR IN CELLS

A very unique and simple way of measuring or comparing the amount of air that is working its way up through the pulp of any flotation cell is as follows:

1. A 500 cc. or 1000 cc. graduated cylinder (smaller size should be used if test is to be made on a laboratory size cell).
2. A stop watch or ordinary watch with a second hand.

PROCEDURE

Fill the graduate completely full of water, seal top with hand, invert into cell being tested, submerging the top of the graduate about 3 or 4 inches.

Check time and remove hand, allowing air to bubble up into the cylinder and displace water.

Be sure to move the cylinder around over the entire surface of the cell to get an average reading.

Use time of ½ minute or 1 minute as desired. (If for ½ minute, double cubic centimeters displaced.)

At end of predetermined time, reclose graduate with hand.

Read actual displacement.

Now measure the inside diameter of the graduate, determine area and convert to square inches.

Divide displaced water in cubic centimeters by the area of the cylinder in square inches and the answer in cc. air per square inch per minute.

EXAMPLE: Actual test on 18 Special Denver Supercharged "Sub-A."

Cylinder, 1000 cc. size.

Cylinder Diameter = $2\frac{3}{16}$" inside.

Cylinder Area = 3.756 square inches $\frac{(d^2\ \Pi)}{4}$

Water displaced in ½ minute = 631 cc.

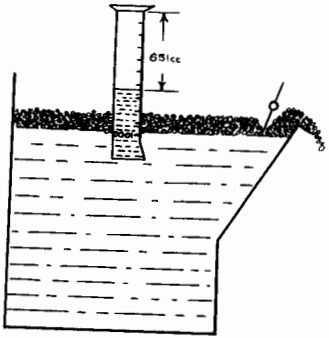
Water displaced in 1 minute = 1262 cc.

$\frac{1262}{3.756}$ = 336 cc. per square inch per minute.

The Denver Equipment Company has always realized the importance of no lost time, and this has prompted our symbol "24 Hour Service," which means equipment that will operate 24 hours per day, and give the greatest profit for the milling operation.

1000 cc. graduated cylinder. For laboratory size flotation machines, a smaller graduate should be used.

Submerge graduate 3 or 4 inches below froth column



Modern Concentration of Minerals

Laboratory Test Results

Presented herein is a brief index of a number of ores which have been tested for the recovery of valuable minerals contained therein, in the laboratory of the Denver Equipment Company.

The data herein has been selected from laboratory notes and incorporates only the usual ore dressing methods in practice for the treatment of common minerals. Necessarily, detailed information regarding location of the mineral deposit, marketing conditions, cost factors and certain specific data concerning the performance of test work in each case is omitted, as such information is held to be confidential between the customer and the company. However, the information contained herein can apply to many ores in many parts of the world and is typical only of general treatment methods, so that there is no question of publicizing trade secrets or guarded patent processes.

A comprehensive ore test includes data on physical characteristics of the ore, the response to various metallurgical processes, the physical characteristics of various products secured, and conclusions on the treatment expected to give the best results. From such a complete study it is possible to determine a flowsheet that is applicable, and also to make a selection of equipment suitable to handle a desired tonnage of mill feed.

It is not the purpose of this article to present data for the determination of treatment methods or flowsheets for the ores listed, but rather to illustrate from such data that these ores can be concentrated simply and effectively. It is hoped that the information given may suggest methods or reagents that will assist in securing better results and increased profits from mining operations.

The mining and ore dressing industry has made much progress by the exchange of information through trade publications, publications of technical societies, and agencies such as the various governmental Bureaus of Mines. This exchange of information has led to greater profits in general for those engaged in mining and beneficiation, and has aided subsequent operations also, through the supply of better or higher grade raw materials.

It is therefore commendable that those engaged in this industry have been liberal and generous in furnishing data and information for the general good. Increased yields, opening to trade of lower grade deposits, and better utilization of natural resources has continually added greatly to the national wealth of many countries.

Because a mineral is not listed in this index does not mean that it cannot be economically concentrated. This list is only partial. Nor does it include data on many industrial products or by-products that are being treated by usual metallurgical processes, such as cleaning of foundry sands, recovery of metals or plastics from scrap or waste materials, and many similar operations.

All ores bearing as the principal value the minerals as listed herein will not respond exactly to the treatment methods as shown. Mineral associations and the chemical and physical characteristics of the particular ore will affect in one way or another the results that can be secured. Each ore presents its own individual problem, but the experience gained from the investigation or treatment of a similar ore will indicate likely methods to follow and a comprehensive ore test will show the results that can be expected.

Reliable Denver Ore Tests insure your mining investment.

MODERN CONCENTRATION OF MINERALS

Mineral or Metal	**ANTIMONY**
Description of Ore	An antimony ore containing stibnite, a small amount of pyrite and arsenic in a siliceous gangue.
Assay of Ore, Approximate	Antimony 6.0% Arsenic 0.1% Iron 2.0% Insoluble 77.0% Sulphur 3.0%
Method or Process	Denver "Sub-A" Unit Cell Denver "Sub-A" Flotation
Concentrates and Recovery	Percent Antimony / Percent Recovery Unit Cell Concentrate 67.0 / 69.0 Flotation Concentrate 69.0 / 26.0
Reagents, Lbs. Per Ton	Lead Nitrate 2.8 Z-5 Xanthate 0.3 Pine Oil 0.1
Miscellaneous Data	pH, 6.5 Grind, Unit Cell feed—35 mesh Grind, Flotation feed—65 mesh

Mineral or Metal	**ANTIMONY**
Description of Ore	An ore containing stibnite and antimony oxides in a siliceous gangue.
Assay of Ore, Approximate	Antimony 26.0% Iron 1.1% Sulphur 8.7% Insoluble 59.5%
Method or Process	Denver "Sub-A" Unit Cell Denver "Sub-A" Flotation
Concentrates and Recovery	Percent Antimony / Percent Recovery Unit Cell Concentrate 65.5 / 29.0 Flotation Concentrate 54.0 / 64.0 (Middlings not included)
Reagents, Lbs. Per Ton	Soda Ash 2.0 Lead Nitrate 1.8 Z-6 Xanthate 0.4 Pine Oil 0.06
Miscellaneous Data	pH, 8.0 Grind, Unit Cell feed—35 mesh Grind, Flotation feed—65 mesh

MODERN CONCENTRATION OF MINERALS

Mineral or Metal	**BARITE**
Description of Ore	A barium ore containing silica, alumina, and iron oxide as the chief impurities. Specific Gravity 4.14
Assay of Ore, Approximate	Barium Sulphate 88.8% Silica 9.2% Alumina 0.5% Iron Oxide (Fe_2O_3) 1.2%
Method or Process	Denver "Sub-A" Flotation (Floating impurities)
Concentrates and Recovery	Percent $BaSO_4$ / Percent Recovery Flotation froth (waste) 60.8 / 6.0 Flotation tailing Sp. gr. 4.34) 94.6 / 85.5 (Middlings not included)
Reagents, Lbs. Per Ton	Amine 220 0.30 (acidified with HCl)
Miscellaneous Data	pH, 7.8 Grind, Flotation feed—325 mesh

Mineral or Metal	**BARITE**
Description of Ore	A barium ore containing silica as the principal gangue, with a small amount of calcite and iron oxide. Specific Gravity 3.8
Assay of Ore, Approximate	Barium Sulphate 80.8% Silica 16.3%
Method or Process	Denver "Sub-A" Flotation
Concentrates and Recovery	Percent $BaSO_4$ / Percent Recovery Concentrate (Sp. Gr. 4.4) 97.0 / 65.0 Middlings 83.0 / 27.0
Reagents, Lbs. Per Ton	Soda Ash 1.5 Sodium Silicate 3.0 Calgon 0.25 Oleic Acid 2.5 Quebracho 0.65 Alcohol 2.5 Fuel Oil 0.25
Miscellaneous Data	pH, 8.6 Grind, Flotation feed—325 mesh

Mineral or Metal **CHALCOPYRITE**

Description of Ore

A copper ore containing chalcopyrite, pyrite, pyrrhotite, and secondary copper sulphides in a mixed siliceous and lime gangue with altered micas.

Assay of Ore, Approximate

Copper	3.3%
Iron	16.6%
Insoluble	54.0%
Sulphur	9.7%

Method or Process

Denver "Sub-A" Unit Cell
Denver "Sub-A" Flotation

Concentrates and Recovery

	Percent Copper	Percent Recovery
Unit Cell concentrate	28.05	46.1
Recleaned Flot. Conc. (Middlings not included)	28.60	43.5

Reagents, Lbs. Per Ton

Lime	2.80
Sodium Cyanide	0.04
Z-5 Xanthate	0.10
Cresylic Acid	0.10
Creosote No. 4	0.04

Miscellaneous Data

pH, 9.6
Grind, Unit Cell feed—20 mesh
Grind, Flotation feed—48 mesh

Mineral or Metal **CHROMITE**

Description of Ore

Chrome—ore with chromite contained as crystals in a siliceous gangue, with some silicates and some mica and iron oxide.

Assay of Ore, Approximate

Chrome oxide	20.6%
Iron	9.8%
Insoluble*	88.0%

(*Includes chromite)

Method or Process

Denver Mineral Jig
Denver-Wilfley Table

Concentrates and Recovery

Recovery, less middlings 75%

Assay Cr_2O_3	48.6%
MgO	3.9%
Fe	23.2%
SiO_2	4.2%

Reagents, Lbs. Per Ton

No reagents used. All gravity concentration process.

Miscellaneous Data

Grind, Jig feed—10 mesh
Grind, Table feed—65 mesh

Mineral or Metal **CINNABAR**

Description of Ore

Low grade mercury ore containing possibly some metacinnabarite, with magnetic iron and a high percentage of silica.

Assay of Ore, Approximate

Mercury	0.55%
Iron	2.6%
Sulphur	0.2%
Insoluble	94.2%

Method or Process

Denver Mineral Jig
Denver "Sub-A" Flotation

Concentrates and Recovery

	Percent Mercury	Percent Recovery
Jig Concentrate	51.6	30.6
Flotation Concentrate	25.8	57.8

Reagents, Lbs. Per Ton

Soda Ash	6.0
Z-8 Xanthate	0.3
Pine Oil	0.04
Copper Sulphate	0.5

Miscellaneous Data

pH, 8.0
Grind, Jig feed—10 mesh
Grind, Flotation feed—48 mesh

Recover Your Mineral As Soon And As Coarse As Possible.

Mineral or Metal **CINNABAR**

Description of Ore

High grade mercury ore carrying cinnabar in a siliceous gangue. Small content of iron sulphide and traces of arsenic and copper.

Assay of Ore, Approximate

Mercury	9.0%
Iron	1.1%
Sulphur	1.5%
Insoluble	83.0%
Arsenic & Copper	Tr.

Method or Process

Denver Mineral Jig
Denver "Sub-A" Unit Cell
Denver "Sub-A" Flotation

Concentrates and Recovery

	Percent Mercury	Percent Recovery
Jig Conc.	78.8	65.0
Unit Cell Concentrate	79.4	19.0
Flotation Concentrate	44.5	15.0

Reagents, Lbs. Per Ton

Soda Ash	1.4
Z-5 Xanthate	0.3
Pine Oil	0.06
Cresylic Acid	0.04
Copper Sulfate	1.0
Aerofloat 25	0.03

Miscellaneous Data

pH, 7.5
Grind, Jig feed—8 mesh
Grind, Unit Cell feed—28 mesh
Grind, Flotation feed—48 mesh

Mineral or Metal	**COAL**
Description of Ore	A fine coal product obtained from coal washing plant operations, containing high ash.
Assay of Ore, Approximate	Ash ..... 27.4% Volatile matter (VM) 72.6%
Method or Process	Denver "Sub-A" Flotation
Concentrates and Recovery	% Assay: Ash, VM* — % Recovery: Ash, VM* Flotation Concentrate .. 10.3, 89.7 — 25.0, 82.0 Recovery by weight—66% (* Volatile matter)
Reagents, Lbs. Per Ton	Fuel Oil ..... 2.5 Pine Oil ..... 0.12 Alcohol B25 ..... 0.06
Miscellaneous Data	pH, 6.7 to 7.0 Grinding, none required Flotation feed — 10 mesh

Mineral or Metal	**COAL**
Description of Ore	Fine coal contained in a river mud and deposited by river action.
Assay of Ore, Approximate	Ash ..... 43.6% Volatile matter (VM) 56.3%
Method or Process	Denver "Sub-A" Flotation
Concentrates and Recovery	% Assay: Ash, VM* — % Recovery: VM* Flotation Concentrate 11.7, 88.3 — 70.6 (*Volatile matter)
Reagents, Lbs. Per Ton	Fuel Oil ..... 3.0 Pine Oil 1.6
Miscellaneous Data	pH, 7.1 Grinding, none required Flotation feed — 65 mesh

MODERN CONCENTRATION OF MINERALS

Mineral or Metal	**COBALT**
Description of Ore	Ore containing cobalt partly as smaltite and partly as cobaltite or cobalt sulpharsenide, and pyrite, chalcopyrite, and arsenides.
Assay of Ore, Approximate	Cobalt ..... 12.4% Copper ..... 0.5% Iron ..... 12.0% Arsenic ..... 17.0% Sulphur ..... 15.0% Insoluble 24.0%
Method or Process	Denver "Sub-A" Flotation
Concentrates and Recovery	% Co — % Recovery *Flot. Conc ... 30.6 — 34.5 %Fe ..... 4.2 %Cu ..... 0.1 (*Market Requirements: Co+30%, Fe—5%, Cu—0.25%)
Reagents, Lbs. Per Ton	Soda Ash ..... 2.0 Copper Sulphate ..... 1.2 Z-5 Xanthate ..... 0.23 Cresylic Acid ..... 0.12 Sodium Sulphide ..... 1.1 Pine Oil 0.02
Miscellaneous Data	pH, 8.5 - 9.5 Grind, Flotation feed—65 mesh

	COPPER-GOLD-SILVER
Description	A semi-oxidized copper, gold, and silver ore. The copper occurs principally as malachite and azurite with some chalcopyrite and chalcocite and minor amounts of metallic copper.
Assay of Ore	Oz./Ton: Au, Ag — Percent: Cu, Fe, S 0.76, 3.91 — 3.83, 6.21, 0.39
Method or Process	Two-stage Denver Flotation—sulphidization in last stage.
Concentrates and Recovery	Assays Oz./Ton: Au, Ag — % Percent: Cu — Recovery Percent: Au, Ag, Cu 1st Flotation Stage (Sulphide) 4.27, 16.5 — 10.25 — 72.09, 52.09, 32.97 2nd Flotation Stage (Oxide) 0.46, 8.54 — 22.78 — 5.97, 20.74, 56.29
Reagents Lbs. Per Ton	1st Flotation Stage (Sulphide) Soda Ash ..... 1.0 Xanthate (Z-6) ..... 0.7 Yarmor F Pine Oil ..... 0.24 2nd Flotation Stage (Oxide) Denver Sulphidizer ..... 4.0 Sodium Bicarbonate ..... 1.0 Reagent 404 ..... 0.3
Miscellaneous Data	Pulp pH, 8.4 Grind ..... 55% plus 100 mesh, 66.0% minus 200 mesh

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Mineral or Metal	**FLUORSPAR**
Description of Ore	A fluorspar ore containing calcium carbonate as the principal gangue, with some silica and phosphate.
Assay of Ore, Approximate	Calcium fluoride 32% Calcium carbonate 65% Silica 1%
Method or Process	Denver "Sub-A" Flotation
Concentrates and Recovery	%CaF_2 — % Recovery Flot. Conc. 92.0 plus — 78.0 %$CaCO_3$ 5.0 %SiO_2 2.0 (Middling not included)
Reagents, Lbs. Per Ton	Pine Oil 0.04 Soda Ash 2.0 Sodium Silicate 3.0 Quebracho 0.4 Oleic Acid 1.5
Miscellaneous Data	pH, 8.5 Grind, Flotation feed—65 mesh

Mineral or Metal	**FLUORSPAR**
Description of Ore	A fluorspar ore with a siliceous gangue and appreciable amounts of metallic sulphides.
Assay of Ore, Approximate	Calcium fluoride 82.0% Sulphur 0.3%
Method or Process	Denver "Sub-A" Flotation
Concentrates and Recovery	%CaF_2 — %S — %Pb — Recovery %CaF_2 Sulphide Flot. Conc. 72.4 — 5.6 — 7.8 — 3.9 Fluorspar Flot. Conc. 97.0 — 0.03 — — 82.5 (Middling not included)
Reagents, Lbs. Per Ton	Soda Ash 1.0 Z-6 Xanthate 0.1 Oleic Acid 1.2 Quebracho 0.05 Sodium Silicate 2.0 Pine Oil 0.1
Miscellaneous Data	pH, 8.6 Grind, Flot. feed 90% —200 mesh

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MODERN CONCENTRATION OF MINERALS

Mineral or Metal	**FLUORSPAR**
Description of Ore	A fluorspar ore containing calcite and silica as the principal gangue constituents.
Assay of Ore, Approximate	Calcium fluoride 72.0% Calcium carbonate 7.5% Silica 7.0%
Method or Process	Denver "Sub-A" Flotation
Concentrates and Recovery	%$CaF2$ — % Recovery Flot. Conc. 96.5 — 85.0 %$CaCO_3$ 0.8 %SiO_2 0.8 (Middling not included)
Reagents, Lbs. Per Ton	Sodium Silicate 4.0 Quebracho 0.5 Oleic Acid 2.0
Miscellaneous Data	pH, 7.5 Grind, Flotation feed—100 mesh

Mineral or Metal	**GOLD**
Description of Ore	A partially oxidized gold ore in a siliceous gangue with minor amounts of copper and iron sulphides. Some free gold.
Assay of Ore, Approximate	Gold 0.59 oz/ton Silver 0.6 oz/ton Copper 0.2% Iron 2.7% Insoluble 90.5% Sulphur 0.6%
Method or Process	Denver Mineral Jig Amalgamation Denver "Sub-A" Flotation
Concentrates and Recovery	Assay oz. gold/ton — % Recovery Amalgamated Gold, Jig Conc. — 46.5 Flotation conc. and amalgamation residue — 5.80 — 48.6
Reagents, Lbs. Per Ton	Soda Ash 2.0 Z-6 Xanthate 0.2 Pine Oil 0.1
Miscellaneous Data	pH, 8.6 Grind, Jig feed—10 mesh Grind, Flotation feed—48 mesh