

(Continued from preceding page)

The surface of this type table deck lies in two or more substantially parallel horizontal planes. The lowest plane, extending forward from the feed end, constitutes the greater portion of the deck surface and is known as the stratification and primary concentration zone. The highest plane, known as the plateau, or cleaning zone, extends back from the concentrate discharge end and is connected to the lower plane, along a diagonal line, by a beveled strip known as the resistance plane. The upward slope of this resistance plane is just steep enough to allow the mineral strata to advance, but at the same time, holds back the upper and sand strata; thus forcing a constant, well defined line of separation between the two.

The standard riffling system on this type table consists of wide, flat riffles, longitudinal to the deck and covering all but the plateau or cleaning zone. These riffles are so spaced as to leave comparatively narrow channels for carrying heavy minerals only, with consequent displacement of the sand from between them; thus causing the pulp to spread out in a thin bed which permits more rapid and thorough stratification of the mineral and sand.

These tables are made in three types: triplex plateau sand table; single plateau fine sand table; and single plateau slime table. Each of these is in turn, by proper combination of riffling, height of plateau, internal arrangement of head motion, rate of reciprocation and length of stroke, assembled for the particular work it is to perform. In all other respects, insofar as general shape, foundation piers, under-structure, and overall dimensions are concerned, the three types are identical.

Standard Deister Plat-O Concentrating Tables are furnished in two different installation types; one for erection directly on concrete piers, and the other on steel longitudinal main channel frames. Further information will be gladly furnished upon request.

*Table Deck Type	Capacity Tons Per 24 Hrs.	Overall Dimensions		H. P.		Approximate Shipping Wt., Lbs.	
		L	W	Belt	Motor	Concrete Pier	Channel Frame
Triples Sand Table	500-150 on Minus 12" Material	17'5"	7'	1	3	3000	3550
Sand Table	39-40 on Minus 30-Mesh Material	17'5"	7'	1	3	3000	3550
Slime Table	15-30 on Minus 80-Mesh Material	17'5"	7'	1	3	3000	3550

\*Decks, on all types shown, are same size—6 foot narrow width, 7 foot widest width, and 14 foot length. Height can be made to meet customer requirements. Other sizes available.

## TABLE, Denver-Wilfley Concentrating



Denver-Wilfley Concentrating Table

THE Denver-Wilfley Concentrating Table is a mechanically operated, longitudinally reciprocating table consisting of a self-oiling, enclosed type head motion; a deck having a plane surface partly rifflled; and a sturdy under-structure with a tilting device. It separates materials into bands and handles the coarsest sands with excellent results. Thousands of these tables are in use the world over and their efficiency, long life, and low upkeep are features recognized by the entire mining industry.

The upper unit shown in the accompanying illustration is equipped with a steel frame. This is the latest, improved type, single deck Denver-Wilfley Concentrating Table. It has oil-immersed rocker bearings which carry the deck on a steel frame that is bolted to cast iron separators. This insures maximum rigidity and alignment of the mechanical parts. Operation is by an enclosed, self-oiling, head motion and the tilting device consists of a tilting cradle and rods which work through miter gears and assure the operator of positive, non-slip adjustment when once set.

The second unit in the illustration shows the same table with the exception that this unit is designed for operation on a concrete understructure consisting of three concrete piers. This is the ideal table for isolated plants as the shipping weight is approximately 30% less than the steel frame type. It can be used wherever concrete piers can be erected. This design assures maximum rigidity which insures correct maintenance of mechanical alignment.

The lower concentrating table in the illustration is of similar construction but is built with a considerably reduced deck area, having approximately one-fourth the area of the other units. This table is ideal for pilot plant work and can be made with either a steel or concrete frame.

Capacity of any concentrating table is increased as the size of the feed is increased. The better the sizing or classification of the table feed, the better the separation, i.e., (1) the larger the tonnage that can be handled, (2) the higher the grade of concentrates that can be produced, and (3) the higher are possible recoveries.

Various types of Denver-Wilfley Concentrating Tables are available for use on many types of treatment problems. For some of the many applications of these units, further details on their construction, and capacities under various operating conditions, write to any Denver Equipment Company office and additional data will be gladly furnished.

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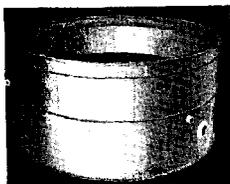
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*Machine Size	Capacity Tons Per 24 Hrs.	Stroke	Frame Type	Dimensions		
				L	W	H
6-C	15-150	3/4"-1"	Concrete	17'7"	5'11"	3'3"
6-S	15-150	3/4"-1"	Steel	17'7"	5'11"	3'3"
12-C	5-20	3/4"-1"	Concrete	11'8"	3'11"	2'10"
12-S	5-20	3/4"-1"	Steel	11'8"	3'11"	2'10"

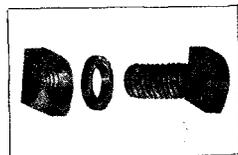
*Machine Size	Deck-Size		Speed R. P. M.	Motor H. P.	Approx. Shipping Wt., Lbs.	
	L	W			Belt	Motor
6-C	14'9"	5'11"	240-300	1 1/2	2000	2200
6-S	14'9"	5'11"	240-300	1 1/2	2800	3000
12-C	7'6"	3'6"	260-300	1	1200	1340
12-S	7'6"	3'6"	260-300	1	1500	1640

\*The 12-C and 12-S units are half-size with approximately one-fourth the area of the other units.

## TANK, Denver Bolted Steel



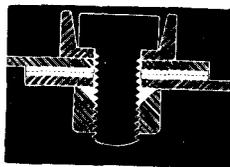
Denver Bolted Steel Thickener Tank



Patented Recessed Nut—Special Composition DiI-Proof Washer—Bolt with 90,000 Pound Tensile Strength

(Continued on next page)

THE Denver Bolted Steel Tank has proved extremely valuable in mining and milling operations. The special design and construction features of this tank, which allow field bolting, give great strength, insure long life, and yet maintain light weight, make it particularly adaptable to all mining uses. It is used for ore bins, solution or water storage, and for agitators, conditioners, and thickeners. The fact that it is built in sections and packed knocked down simplifies fabrication and and it can be easily set up by ordinary workmen. This tank is very economical because it can be enlarged, or made smaller, or a damaged section replaced without difficulty. There is no loss with the bolted steel tank as it can be quickly dismantled and moved to another site.



Sectional View of Bolt and Patented Recessed Nut Assembly Which Provides Leak-Proof Joint Seal

Denver Bolted Steel Tank is formed and punched so that it fits perfectly. The patented, leak-proof nut insures a water-tight joint; the nuts are recessed with special, oil-proof gaskets (as shown in the illustration at left) which stop any possibility of leaks around bolt threads.

These tanks are ideal for use in any locality and are particularly desirable for use in tropical or semi-tropical countries where deterioration of other types of tanks may be very rapid. No matter what your application or where your plant is located, the use of these tanks should be considered as mass production and standardization have allowed considerable reduction in the prices.

While the diameters listed are standard, Denver Bolted Steel Tanks can be furnished in any height desired. Where the exact volume needed for your requirements is not indicated, use the standard diameter which most closely fits your problem and increase the height to give necessary capacity.

Diameter	Height	GAUGES OF STEEL				Rim Angle in Inches	CAPACITY		WEIGHT LBS.		Displacement Cu. Ft.
		Bot-tom	1st Ring	2nd Ring	3rd Ring		Cu. Ft.	Gals.	Un-crated	Crated	
7' 6"	8' 0 1/2"	14	14	10	...	2x2x1/2	370	2765	1050	1300	78
7' 6"	8' 0 1/2"	10	10	...	...	2 1/2 x 2 1/2 x 3/8	370	2765	1815	2100	78
7' 6"	10' 0"	14	14	10	...	2x2x1/2	462	3456	1220	1595	85
7' 6"	10' 0"	10	10	...	...	2 1/2 x 2 1/2 x 3/8	462	3456	2140	2675	85
8' 2 1/2"	8' 0 1/2"	14	14	...	...	2x2x1/2	538	4024	1315	1645	85
8' 2 1/2"	8' 0 1/2"	10	10	...	...	2 1/2 x 2 1/2 x 3/8	538	4024	2300	2750	85
8' 2 1/2"	10' 0"	14	14	...	...	2x2x1/2	672	5030	1900	1875	90
8' 2 1/2"	10' 0"	10	10	...	...	2 1/2 x 2 1/2 x 3/8	672	5030	2650	3050	90
8' 2 1/2"	12' 0"	12	12	14	...	2x2x1/2	806	6036	2250	2800	95
8' 2 1/2"	12' 0"	10	10	12	...	2 1/2 x 2 1/2 x 3/8	806	6036	2900	3600	95
11' 8"	10' 0"	12	12	...	...	2x2x1/2	1068	7990	2750	3450	115
11' 8"	10' 0"	10	10	...	...	2 1/2 x 2 1/2 x 3/8	1068	7990	3450	4200	115
11' 8"	10' 0"	8	8	...	...	3x3x1/2	1068	7990	4100	4900	115
11' 8"	12' 0"	12	12	14	...	2x2x1/2	1282	9588	3110	3980	125
11' 8"	12' 0"	10	10	12	...	2 1/2 x 2 1/2 x 3/8	1282	9588	3835	4600	125
11' 8"	12' 0"	8	8	10	...	3x3x1/2	1282	9588	4700	5600	125
11' 8"	16' 1"	12	12	14	...	2x2x1/2	1709	12784	3600	4500	150
11' 8"	16' 1"	10	10	12	...	2 1/2 x 2 1/2 x 3/8	1709	12784	4630	5600	150
11' 8"	16' 1"	8	8	10	...	3x3x1/2	1709	12784	5600	6700	150
15' 4 1/2"	12' 0"	12	12	14	...	2x2x1/2	2218	16584	4200	5400	180
15' 4 1/2"	12' 0"	10	10	12	...	2 1/2 x 2 1/2 x 3/8	2218	16584	5500	6800	180
15' 4 1/2"	12' 0"	7	7	8	...	3x3x1/2	2218	16584	7300	8900	180
15' 4 1/2"	16' 1"	12	12	14	...	2x2x1/2	2957	22112	5050	6300	185
15' 4 1/2"	16' 1"	10	10	10	...	2 1/2 x 2 1/2 x 3/8	2957	22112	7000	8600	185
15' 4 1/2"	16' 1"	7	7	8	...	3x3x1/2	2957	22112	8800	10200	185
15' 4 1/2"	20' 0"	12	12	12	14	2x2x1/2	3606	27640	6270	7800	215
15' 4 1/2"	20' 0"	10	10	10	10	2 1/2 x 2 1/2 x 3/8	3606	27640	8290	10000	215
15' 4 1/2"	20' 0"	7	7	8	8	3x3x1/2	3606	27640	10200	12400	215

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Our desire is to make you "Happier, Healthier and Wealthier."

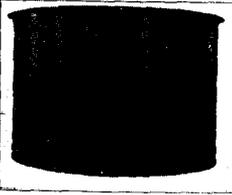
21' 8" x 8"	16' 1"	12	12	14	...	24x24 1/2	5808	43456	7400	9250	221
21' 8" x 8"	16' 1"	10	10	10	...	3x3 1/2	3808	43456	9900	12000	221
21' 8" x 8"	16' 1"	7	7	8	...	3x3 1/2	5808	43456	13200	16000	221
21' 8" x 12"	20' 0"	12	12	12	...	2x2 1/2	7260	54320	9400	11750	245
21' 8" x 12"	20' 0"	10	10	12	...	3x3 1/2	7260	54320	11450	14000	245
21' 8" x 12"	20' 0"	7	7	8	...	3x3 1/2	7260	54320	15500	18900	245
21' 8" x 14"	24' 1 1/2"	10	10	12	...	2x2 1/2	8770	65618	12250	15300	268
21' 8" x 14"	24' 1 1/2"	7	7	8	...	3x3 1/2	8770	65618	10500	20200	268
21' 8" x 14"	24' 1 1/2"	3	3	7	...	3x3 1/2	8770	65618	21600	26300	268
26' 1 1/2" x 14"	16' 1"	12	12	12	...	2x2 1/2	8592	64272	10800	13500	260
26' 1 1/2" x 14"	16' 1"	10	10	10	...	3x3 1/2	8592	64272	13500	18500	260
26' 1 1/2" x 14"	16' 1"	7	7	8	...	3x3 1/2	8592	64272	17400	21000	260
26' 1 1/2" x 20"	20' 0"	10	10	12	...	2x2 1/2	10740	80340	14550	18000	320
26' 1 1/2" x 20"	20' 0"	8	8	10	...	3x3 1/2	10740	80340	17800	21700	320
26' 1 1/2" x 20"	20' 0"	7	7	8	...	3x3 1/2	10740	80340	20350	24900	320
26' 1 1/2" x 24"	24' 1 1/2"	10	10	12	...	3x3 1/2	12973	97051	16300	20400	364
26' 1 1/2" x 24"	24' 1 1/2"	7	7	8	...	3x3 1/2	12973	97051	21800	26500	364
26' 1 1/2" x 24"	24' 1 1/2"	3	3	7	...	3x3 1/2	12973	97051	28600	34500	364
129' 8 1/2" x 16' 1"	10	10	12	10	...	3x3 1/2	11120	83200	14750	18400	345
129' 8 1/2" x 16' 1"	10	10	12	8	...	3x3 1/2	11120	83200	16700	20300	345
129' 8 1/2" x 16' 1"	10	10	12	8	...	3x3 1/2	11120	83200	21250	26000	345
129' 8 1/2" x 20' 0"	10	8	10	12	...	3x3 1/2	13900	104000	20000	25000	425
129' 8 1/2" x 20' 0"	10	7	7	8	...	3x3 1/2	13900	104000	24700	30000	425
129' 8 1/2" x 20' 0"	10	3	3	7	...	3x3 1/2	13900	104000	31200	38000	425
129' 8 1/2" x 24' 1 1/2"	10	10	12	12	...	3x3 1/2	16791	125632	20200	25200	520
129' 8 1/2" x 24' 1 1/2"	10	7	7	8	...	3x3 1/2	16791	125632	25000	32300	520
129' 8 1/2" x 24' 1 1/2"	10	3	3	7	...	3x3 1/2	16791	125632	33000	42700	520
138' 7 1/2" x 16' 1"	10	10	12	...	...	3x5 1/2	18784	140512	22960	27600	600
138' 7 1/2" x 16' 1"	7	7	8	...	...	3x5 1/2	18784	140512	30400	37000	600
138' 7 1/2" x 24' 1 1/2"	8	8	10	10	...	3x5 1/2	28363	212173	34000	41500	750
138' 7 1/2" x 24' 1 1/2"	3	3	7	7	...	3x5 1/2	28363	212173	49200	60000	750
154' 11 1/2" x 16' 1"	8	7	8	...	...	3x6 1/2	38000	284240	47000	58500	1000
154' 11 1/2" x 16' 1"	3	3	7	...	...	3x6 1/2	38000	284240	64500	77000	1000
154' 11 1/2" x 24' 1 1/2"	7	7	8	...	...	3x6 1/2	57380	429202	62000	74500	1375
154' 11 1/2" x 24' 1 1/2"	3	3	7	...	...	3x6 1/2	57380	429202	80500	96500	1375
190' 2 1/2" x 16' 1"	8	7	10	...	...	3x6 1/2	102350	765600	98400	118000	2000
190' 2 1/2" x 16' 1"	3	3	7	...	...	3x6 1/2	102350	765600	142300	170000	2000
190' 2 1/2" x 24' 1 1/2"	7	7	8	...	...	3x6 1/2	154550	1156000	124600	149500	2500
190' 2 1/2" x 24' 1 1/2"	3	3	7	...	...	3x6 1/2	154550	1156000	161200	192000	2500

\*Displacement in cubic feet when crated for export shipment.  
 \*Double Row Bolts first ring of shell.  
 \*Triple Row Bolts lower ring, Double Row Bolts second and third rings.

## TANK, Denver Welded Steel

MODERN methods of manufacture have made the welded steel tank not only practical but in many instances more economical than any other type of tank. The Denver Welded Steel Tank is extensively used in the mining, processing, and industrial fields and is ideal for the agitating, conditioning, or thickening of heavy liquids or pulps.

Denver Welded Steel Tanks are being used more and more extensively in the smaller sizes and particularly where



Denver Welded Steel Tank

ever the fluid line varies considerably. The larger sizes of Denver Welded Steel Tanks are used in many locations where field erection can be undertaken, the site is relatively permanent, and salvage is not a primary consideration.

Standard Denver Welded Steel Tanks are made with heavy, double-welded construction. The side and bottom plates are of heavier metal than normally supplied and added strength is also secured by an angle iron rim. All standard tanks are sufficiently strong to stand the weight of the superstructure, rotating mechanisms, or flooring ordinarily used in metallurgical, processing, or other industrial plants.

Tanks ten feet in diameter and smaller can be shipped completely erected on a standard railway car while tanks larger than ten feet in diameter can be furnished either for field riveting or welding, whichever may be desired or most practical.

If the standard tanks listed here do not meet the requirements for your installation, tanks can be engineered to meet your particular needs. Let us make recommendations for the type and capacity of tanks best suited to your plant when taking into consideration the properties of the material to be stored or treated, cost, location, and climatic conditions.



FIGURE 1



FIGURE 2



FIGURE 3

(Continued on next page)

Recover Your Mineral As Soon As Free.

Denver Equipment Company publishes DECO TREFOIL, an exchange of helpful engineering information designed to improve milling. DECO TREFOIL is published every other month. If you are connected with mining and do not receive DECO TREFOIL please write to us.

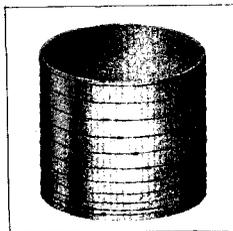
*Tank Size		Capacity Gallons	Gallons Per Extra Foot Depth	Thickness Material—Gauge		Approx. Shipping Weight Pounds
Diam.	Depth			Bottom	Side	
3'	3'	169	53	14	14	153
3'	4'	212	53	14	14	195
4'	4'	376	94	12	12	421
4'	5'	470	94	12	12	494
5'	5'	735	147	10	12	669
5'	6'	882	147	10	12	759
5'	7'	1029	147	10	12	848
6'	6'	1269	212	10	12	949
6'	7'	1481	212	10	12	1057
6'	8'	1693	212	10	12	1164
7'	7'	2022	288	10	10	1356
7'	8'	2310	288	10	10	1495
8'	8'	3008	376	8	8	1789
8'	9'	3384	376	8	10	1948
8'	10'	3760	376	8	10	2107
9'	8'	3807	476	8	10	2090
9'	9'	4283	476	8	10	2335
10'	8'	4700	588	8	10	3049
10'	10'	5875	588	8	10	3584
10'	12'	7050	588	8	10	4120

\*Data given is for standard Denver Welded Steel Tanks (see Figure 1) with flat bottom, heavy welded construction, and angle iron rim. Diameters of steel tanks are measured on inside.

*FLAT BOTTOM (See Figure 2)				*CONE BOTTOM (See Figure 3)			
Tank Size	Capacity Gallons	Extra Foot Depth	Approx. Shp. Wt. Lbs.	Tank Size	Capacity Gallons	Extra Foot Depth	Approx. Shp. Wt. Lbs.
Dia. Depth	Gal-lons	Foot		Dia. Depth	Gal-lons	Foot	
5' 4'	588	147	557	5' 4'	546	147	542
6' 4'	846	212	745	6' 4'	775	212	684
7' 5'	1446	288	1091	7' 5'	1328	288	1038
8' 6'	2256	376	1482	8' 6'	2114	376	1410
9' 6'	2855	476	1744	9' 6'	2645	476	1653
10' 8'	4700	588	3049	10' 8'	4390	588	2883

\*Small size Denver Welded Steel Thicker Tanks with steel overflow launders.

## TANK, Denver Wood



Denver Wood Tank

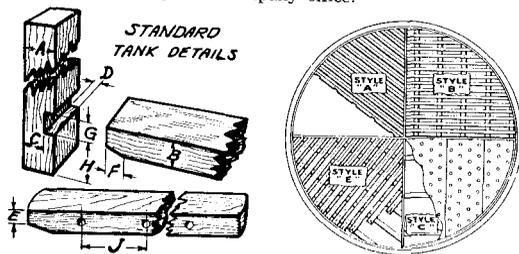
THE Denver Wood Tank is made of selected Douglas Fir, Redwood, Yellow Pine, or Cypress, whichever is best adapted to your particular problem. For example, where unusual climatic conditions occur, as in tropical and semi-tropical countries, special redwood creosoted tanks are preferable. Denver Wood Tanks are made from the finest quality lumber, treated in kilns to retain the life of the wood and add to its strength and durability. Staves are milled

(Continued on next page)

to the true circular outline of the tank, and edges dressed smooth to radial lines. This insures ease of erection and, when equipped with the proper number of hoops and lugs, a uniform distribution of stresses when handling high specific gravity materials.

The sides of the tanks are made straight, without taper, unless otherwise specified, and are beveled to fit proper diameter, insuring water-tight joints. Sufficient round hoops and lugs of proper size are furnished to take care of pulps or solutions up to 1.25 specific gravity as standard.

More complete information can be obtained by writing any Denver Equipment Company office.



SEE DIMENSIONS BELOW

SEE DESCRIPTION BELOW

Di	1 1/2" Stock	2" Stock	2 1/2" Stock	3" Stock	3 1/2" Stock	4" Stock	5" Stock	6" Stock	
A	1 1/2"	1 1/2"	1 1/2"	1 1/2"	2 1/2"	2 1/2"	3 1/2"	5 1/2"	
B	1 1/2"	1 1/2"	1 1/2"	2 1/2"	2 1/2"	2 1/2"	3 1/2"	5 1/2"	
C	1 1/2"	1 1/2"	1 1/2"	1 1/2"	2 1/2"	2 1/2"	3 1/2"	5 1/2"	
D	1 1/2"	1 1/2"	1 1/2"	1 1/2"	2 1/2"	2 1/2"	3 1/2"	5 1/2"	
E	1 1/2"	1 1/2"	1 1/2"	1 1/2"	2 1/2"	2 1/2"	3 1/2"	5 1/2"	
F	1 1/2"	1 1/2"	1 1/2"	1 1/2"	2 1/2"	2 1/2"	3 1/2"	5 1/2"	
G	1 1/2"	1 1/2"	1 1/2"	1 1/2"	2 1/2"	2 1/2"	3 1/2"	5 1/2"	
H	1 1/2"	1 1/2"	1 1/2"	1 1/2"	2 1/2"	2 1/2"	3 1/2"	5 1/2"	
J	Not over 4'				Not over 5'				
	Stave Length		1 1/2"—2" Lumber		Stave Length		3"—6" Lumber		
	0'—9'		3"		4'—14'		4"		
	10'—14'		4"		16'—24'		5"		
	16'—20'		5"						

\*Maximum finished thickness of 2" and 3" Douglas Fir.

NOTE: The diameters of wood tanks are measured on the OUTSIDE, and in figuring capacities the thickness of the staves and the length of the chime, plus the width of the croze, must be taken into consideration. Overflow launders for thickeners weigh approximately 25 pounds per foot.

### FALSE AND FILTER BOTTOMS FOR TANKS (See illustration above)

STYLE A: Bottom consists of grating of croze strips 1 1/4"x1 3/4" Douglas Fir laid on edge 1 1/4" apart. Filter cloth protected by thin wood band 3/8" thick placed around outer edge of these strips.

STYLE B: Bottom consists of grating of croze strips 1 1/4"x1 3/4" Douglas Fir laid on edge and placed 2" centers. On bottom strips is placed a grating made of 3/8"x3/8" Douglas Fir strips spaced 1" apart, a thin wood band 3/8" thick is placed around outer edge of strips.

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**STYLE C:** Bottom constructed of 1" Douglas Fir floor, provided with  $\frac{1}{2}$ " holes approximately 2" apart, and supported by croze strips.

**STYLE E:** Bottom does not require filter cloth. It consists of triangular strips about 3"x3"x $\frac{1}{2}$ " spaced  $\frac{1}{2}$ " apart and resting on crozed strips 1 $\frac{1}{2}$ "x1 $\frac{1}{4}$ " Douglas Fir, laid on edge 2' centers. Spaces between triangular strips are filled with gravel, sand and quartz, level with the upper edge.

## TESTING SERVICE, Denver Ore



Denver Equipment Company's Batch Ore Testing Laboratory



Part of Denver Equipment Company's Continuous Ore Testing Laboratory

Following standard accepted practice, results in the Denver Laboratory should be equalled or slightly bettered in large scale operation.

These tests will determine the most economical treatment process, the grade of concentrates and recovery, and the financial possibilities of the project. If your ore has not been tested, this procedure should be considered as it affords a reliable and inexpensive means of providing maximum information for investment in a commercial treatment plant. Complete details on obtaining a representative sample of your ore, helpful shipping information, ore testing procedures, and utilization of test results will gladly be furnished.

**Reliable Denver Ore Tests insure your mining investment.**

DENVER Equipment Company maintains complete ore testing plants under the personal supervision of experienced, widely known metallurgists. The most modern machines are used, and tests for flotation, amalgamation, gravity concentration, and cyanidation are being made daily. Accurate results can be assured and charges are based upon the actual cost of testing.

Reports submitted on the test work include all details of the tests, i.e., mesh of grind, dilution, conditioning and flotation time, reagents required, ratio of concentration, assays, recoveries, and other important metallurgical data. Based upon this information, the best treatment method and flowsheets are submitted. The laboratory machines used in test work are similar to the large scale units recommended and with the procedure fol-

## THICKENER, Denver Spiral Rake



Typical Installation of Denver Spiral Rake Thickeners in Counter-Current Decantation Cyanide Plant



Patented Denver Single Spiral Rakes —Note Sturdy Construction

DENVER Spiral Rake Thickeners are used to dewater pulps in many processes, either to reclaim the solution or to lower the moisture content of the solid constituent of the pulp. This unit is also extensively used in counter-current decantation systems such as applied to the cyanidation of gold and silver ores and other chemical processes.

Denver Spiral Rake Thickeners are built in several types —the exact type depending upon the specific application.

The use of patented Denver Spiral Rakes is of special significance as it results in a structure of greater strength with the further advantage that the time required to move a particle from the periphery of the tank to the center is greatly reduced. This is important in that the quicker settled material is moved to

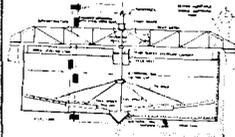
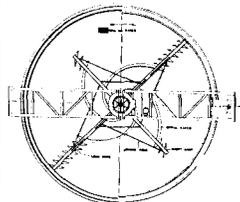
the center discharge, the less trouble will be encountered due to overloads.

The rake assembly used in Denver Spiral Rake Thickeners, up to and including the 20' diameter, is usually a single spiral. As the thickener diameter increases, the rake assembly is modified to meet requirements. Essentially, the

pattern followed is to use spiral rakes singly, then, as the diameter increases, to use a double spiral with auxiliary angle rakes near the periphery of the tank. The rake assembly is attached to the rake shaft through a steel spider. The advantage of steel over cast iron at this critical point is readily apparent.

If, for some special reason, the use of an angle rake assembly is preferable, thickeners equipped with this type rake assembly are available.

The gear reducer unit of Denver Spiral Rake Thickeners is totally enclosed in a cast gear-housing which incorporates a rake lifting device. This rake lifting mechanism may be either hand operated, with suitable gearing to allow easy hand operation,



Plan and Elevation Detail of Larger Size Denver Spiral Rake Thickener

(Continued from previous page)



Truss Type Superstructure for Denver Spiral Rake Thickener—Note Duplex Denver Adjustable Stroke Diaphragm Pump Mounted on Superstructure in Background



Denver Spiral Rake Thickener in Cyanide Circuit of Gold Milling Plant

or motor driven. Automatic rake lifting devices are also available.

Low operating speeds required by the rake assembly are obtained through a worm gear reduction. The worm gear is of modern steel construction with cut teeth. The machine cut worm pinion which drives the gear is of special bronze.

The complete enclosure of the worm gear and pinion, which operate in a bath of oil within the gear housing, prevents the entrance of foreign material and oil leakage. Grease fittings are provided for the lubrication of the worm and rake shafts.

All Denver Spiral Rake Thickeners are designed with a low-head type superstructure that meets exacting specifications. The superstructure

can be supplied completely assembled or knocked down, as specified by the customer or dictated by transportation facilities, and it may be of either welded or bolted construction. If a Denver Diaphragm Pump is to be used with the thickener, it is advisable to order beam extensions as in this way a mounting is provided for the pump and the cost is much less than providing mountings in the field.

Tanks for Denver Spiral Rake Thickeners may be wood, welded steel, bolted steel, or concrete. Denver Equipment Company's experienced engineering staff will gladly assist with the proper tank selection to meet specific requirements.

The center feed well is constructed of rolled steel plate and equipped with height adjustment rods so that an optimum setting can readily be obtained. Heavy rolled steel plate is also used in forming the discharge cone which has a rim with bolt holes for attaching it to the tank.

Type of drive required may be specified by the customer, such as belt drive from a lineshaft; gearmotor direct-connected with the worm shaft; V-belt drive from gearmotor; chain drive from gearmotor, or auxiliary jackshaft mounted on superstructure to drive from a high speed motor.

There are several types of overload alarms available. Although the equipping of thickeners with overload alarms is usually advisable, the use of patented Denver Spiral Rakes has a very definite tendency to eliminate overload conditions due to the rapid removal of settled solids.

Since the capacity of a thickener depends upon the settling rate of the material to be handled, Denver Equipment Company, which maintains a completely equipped metallurgical laboratory, will gladly determine these require-

ments and investigate the possibility of conditioning the pulp to improve its settling rate. Thickening tests are conducted free of charge to the customer. Let us conduct tests on the material you wish to thicken and make recommendations for the proper equipment to solve your thickening problem.

More complete information can be obtained by writing any Denver Equipment Company office.

Thickeners to meet your requirements are available in sizes up to 80' in diameter.

Material	*Mill Feed Square Feet	*Flotation Concentrates Square Feet	*Tailings Square Feet
Amorphous or Colloidal Granular	10-12 6-8	15-20 10-12	7-9 3-5

\*Average settling rates in area required to settle a ton of dry solids per 24 hours. These figures are only indicative and settling tests are recommended.

WOOD THICKENER TANKS (Specifications)			BOLTED STEEL THICKENER TANKS (Specifications)		
Diameter (Outside)	*Depth (Outside)	Settling Area Sq. Ft.	Diameter (Inside)	*Depth (Inside)	Settling Area Sq. Ft.
3'	3'	5.6	7'8"	5'	46.1
4'	4'	10.5	9'2½"	6'	66.8
5'	5'	17.0	11'8"	8'	108.0
6'	5'	25.2	15'4½"	8'	186.0
8'	6'	46.1	21'6¾"	8'	363.0
10'	8'	73.3	25'1¾"	10'	535.0
12'	8'	104.0	29'6½"	10'	697.0
14'	8'	143.0	38'7½"	10'	1170.0
16'	8'	189.0	54'11½"	12'	2372.0

\*Average depths listed. Other depths can be furnished.

#### LARGER CAPACITY WOOD THICKENER TANKS (Specifications)

Diameter (Outside)	*Depth (Outside)	Settling Area Sq. Ft.	Diameter (Outside)	*Depth (Outside)	Settling Area Sq. Ft.
18'	8'	241.0	32'	10'	779.0
20'	10'	299.0	34'	10'	881.0
22'	10'	363.0	36'	10'	990.0
24'	10'	434.0	38'	10'	1104.0
26'	10'	511.0	40'	10'	1225.0
28'	10'	594.0	45'	10'	1552.0
30'	10'	683.0			

\*Average depths listed. Other depths can be furnished.

(Continued on next page)

**Please Give Us the Opportunity to quote prices and delivery on standard equipment to meet your needs.**

(Continued on next page)

**WELDED STEEL OR CONCRETE THICKENER TANKS**  
(Specifications)

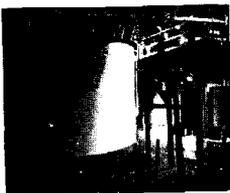
Diameter (Inside)	*Depth (Inside)	Settling Area Sq. Ft.	Diameter (Inside)	*Depth (Inside)	Settling Area Sq. Ft.
3'	3'	7.1	30"	10'	707.0
4'	4'	12.6	32"	10'	804.0
5'	5'	19.6	34"	10'	908.0
6'	5'	28.3	36"	10'	1018.0
8'	6'	50.3	38"	10'	1134.0
10'	8'	78.0	40"	10'	1257.0
12'	8'	113.0	45'	10'	1590.0
14'	8'	154.0	50'	10'	1964.0
16'	8'	201.0	55'	10'	2376.0
18'	8'	254.0	60'	12'	2827.0
20'	10'	314.0	65'	12'	3318.0
22'	10'	380.0	70'	12'	3848.0
24'	10'	452.0	75'	12'	4418.0
26'	10'	531.0	80'	12'	5027.0
28'	10'	616.0			

### THICKENER, Denver Tray

THE Denver Tray Thickener consists essentially of a superstructure and mechanism mounted on a tank, or on piers for larger sizes, with two or more sealed compartments superimposed, one above the other. A set of rakes operates in each compartment.

The principal advantage of a Denver Tray Thickener is that the required floor space to obtain a certain thickening area is markedly reduced. The total feed to the thickener may be divided and fed in parallel to two, three, or more compartments rather than introducing the same amount of feed into one thickener.

Denver Tray Thickeners may have the several compartments operated in series, if several washing steps are required, as well as in parallel. The feed may be introduced into the top compartment; the thickener solids removed from the first compartment by means of a Denver Adjustable Stroke Diaphragm Pump and introduced into the second compartment, and so on through the several washing stages. In such an arrangement the wash solution is first added to the feed entering the last compartment and the overflow from the last compartment mixed with the feed



Denver Tray Thickener

going to the preceding tray. In this way the pulp progresses from the top compartment to the bottom compartment and the solution progresses from the bottom compartment to the top compartment for final overflow.

Rather than allow the feed to flow by gravity from one compartment to another, it has been determined that much higher washing efficiencies are maintained by using a Denver Adjustable Stroke Diaphragm Pump and actually removing

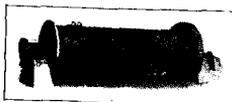
the thickened solids from each compartment before it is passed on to the next compartment. Thus, the operation of the unit is under positive control.

To seal and prevent leakage of solution or solids between compartments, advantage is taken of the fact that the heavy density settled material in the upper compartment will counterbalance a greater column of solution in the lower compartment. The use of this simple phenomenon eliminates the need of mechanical seals, with troublesome glands, stuffing boxes, and the necessity of repacking due to abrasion.

The type of construction of Denver Tray Thickeners follows very closely that used in other Denver Thickeners insofar as type of superstructure, gearing, and other details of design. The principal difference, other than the general tray construction, is that a tray thickener of a given size will naturally require a larger mechanism and heavier superstructure to meet the load requirements of the several compartments.

More complete information can be obtained by writing any Denver Equipment Company office.

### TUBE MILL, Denver



Denver Tube Mill

THE Denver Tube Mill is widely used for the fine grinding of various materials in many industrial plants, as well as in ore milling where it is necessary to reduce the particles to 150 or 200 mesh. Even finer grinds can be obtained

when operation is in closed circuit with a suitable classifier. This unit is essentially a secondary mill, taking a feed of 1/4" or finer, according to characteristics of the material to be ground and the capacity to be maintained.

Liners can be furnished of hard iron, manganese steel, or for the chemical industries, silx blocks can be used. Flint pebbles or small steel balls are generally used as grinding medium.

These mills are heavily constructed of steel plate with cast heads securely mounted on the shell. The entire mill is then swung in a lathe to insure perfect alignment of trunnions. Two manholes are provided on opposite sides, generally near the ends, to allow inspection and change of liners.

Drive may be through spur gear with friction clutch pulley on the pinion shaft, by V-belt, speed reducer, or direct-connected to the motor through a flexible coupling and herringbone gears. A scoop feeder is standard and is usually equipped with a special lip to suit conditions.

(Continued on next page)

**May We Please Work With You On All  
Your Equipment Needs?**

Mill Size		*Capacity Tons Per 24 Hours	**Pebble Charge Tons	Motor H. P.	Mill Speed R. P. M.	†Approx. Shipping Wt., Lbs.
Dia.	L					
4'	8'	25	2.5	20	32	20000
4'	10'	27	3.1	25	32	22000
4'	12'	29	3.7	30	32	24000
4'	14'	35	4.4	40	32	26000
4'	16'	38	5.0	40	32	28000
4'	18'	39	5.6	40	32	30000
4'	20'	40	6.3	50	32	32000
5'	10'	46	4.9	40	28	33500
5'	12'	50	5.9	50	28	37000
5'	14'	54	6.8	50	28	40500
5'	16'	59	7.8	50	28	43000
5'	18'	64	8.8	60	28	46000
5'	20'	70	9.8	60	28	49000
5'	22'	75	10.8	75	28	51500
6'	12'	71	8.5	75	24	43700
6'	14'	80	9.6	75	24	47500
6'	16'	90	11.3	100	24	52200
6'	18'	96	12.8	100	24	55800
6'	20'	107	14.7	100	24	59400
6'	22'	118	15.1	125	24	63000
7'	14'	108	13.5	100	20	52000
7'	16'	120	15.4	125	20	54000
8'	16'	186	20.1	150	18	75000
8'	20'	220	25.1	200	18	78000

\*Capacity based on regrinding 8 mesh feed to 100 mesh with suitable classifier.

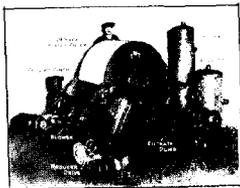
\*\*Pebble charge is approximate.

†Approximate weight of mill with liners—no pebble charge.

NOTE: Other sizes of these mills are available and special sizes can be made to meet special conditions. Let us make recommendations for the type and size grinding unit to best satisfy your requirements.

Use Denver Ore Tests to verify or improve your present flowsheet.

## VACUUM EQUIPMENT, Denver Filter and Utility

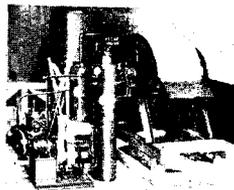


Denver Drum Filter Showing Accessory Denver Vacuum Equipment

(Continued on next page)

DENVER Filter and Utility Vacuum Equipment has been developed to meet the requirements of various filtering or other problems requiring the use of vacuum. The arrangements available have been designed to supply the most economical and efficient operation possible.

In the operation of vacuum equipment for filtering, the moisture is drawn through the



4'x4' Denver Drum Filter and Accessory Denver Vacuum Equipment

vacuum trap, low pressure blower, and dry vacuum pump.

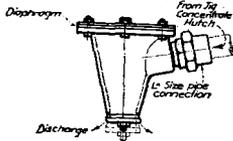
In addition to vacuum systems for filtering, various capacities of vacuum systems are available to provide vacuum for precipitation plants or general uses. In some instances it is most economical to utilize a vacuum-pressure combination arrangement.

Additional information and estimates on Denver Filter and Utility Vacuum Equipment to answer your particular problem will be sent upon request.

## VALVE, Denver-Dowsett Density

DENVER-DOWSETT Density Valve is a simple, automatic control for discharging hutch concentrate from the Denver (Selective) Mineral Jig. By its use, concentrate is automatically discharged in predetermined quantities at high density, eliminating risk of inattention by manual labor. Where a rougher-cleaner jig combination is used, this valve makes an ideal device for feeding the secondary machine.

Operation of this density valve depends on the weight of the settled granular jig concentrates gradually overcoming



Denver-Dowsett Density Valve

the water pressure previously created in the valve. As the amount of concentrate increases, it closes the feed pipe to the valve and also increases the weight on the discharge disk. When this weight exceeds the decreasing pressure, the valve opens and discharges its contents as well as the contents of the feed pipe. Then the water pressure in the jig

hutch causes the water rushing into the valve to expand against the canvas diaphragm, on account of the limited discharge opening around the disk, and this causes the discharge disk to be raised to the closed position. The cycle is then repeated.

The Denver-Dowsett Density Valve is low in cost, easy to install, and requires no power or operating attention. Let us make recommendations for equipping your jigs with these automatic valves.

(Continued on next page)

Density Valve Size	Mineral Pig Size	Overall Diameter	Overall Height	Size Pipe Connection	Dis-charge Disc Diameter	Approx. Shipping Weight, Pounds
1	8" x 12"	8"	7"	1 1/2"	2"	20
1	12" x 18"	8"	7"	1 1/2"	2"	20
1	16" x 24"	8"	7"	1 1/2"	2"	20
2	24" x 36"	10"	9"	2"	3"	37

## VIBRATOR, Syntron Electric



Syntron Electric Vibrator Operating on Pyramidal Hopper Feeding Ore onto Conveyor. Belt—Note Compactness and Rugged Construction

THE Electric Vibrator provides an extremely efficient, simple and economical solution to the problem of making the most stubborn material flow freely. No longer need there be a sticking together of wet ore in the ore bin, or the arching over and hanging up of materials in hoppers and chutes with resulting lowered operating efficiency.

The powerful vibration of the simple, electro-magnetic vibrator is controlled by a separate, wall-mounted "Controller," which is furnished

with each vibrator. The dial rheostat in the controller varies the power of vibration. By merely turning the manual dial rheostat the power of vibration can be turned down to provide the most effective vibration required for the purpose. The controller is in a separate, dust-proof housing, arranged for wall-mounting at any desirable distance away from the vibrating mechanism attached to the bin, hopper, or chute.

These vibrators are furnished in many different sizes. Units are available that range from those equipped to handle large tonnages in ore bins down to the small noiseless model best suited to be attached to a dry reagent feeder. Reagent feeder applications are numerous, but a well-known use is where the vibrator is utilized to keep moist lime or soda-ash stirred up and flowing evenly.

In an ore bin with a flat bottom and a center discharge, the material, especially when wet, will build up in the corners and form a dead storage space just inside the walls of the bin. One or two vibrators mounted on the outside of the ore bin (opposite to each other, when two are used), will eliminate the work that otherwise frequently has to be done by hand with a pick and shovel. Another, and possibly more important aspect, is that maximum treatment efficiency is assured by an even feed to crushers or ball mills.

This small, inexpensive unit will save man-hours, assure a smooth running mill through providing an even feed, and will pay for itself in the first few months of its operation.

These vibrators are also available at extra cost with totally-enclosed explosion-proof, or water and dust-proof cases. Also, for special jobs where danger of explosion or fire exists, a water or air-pressure vibrator can be furnished. A major advantage of these hydraulic vibrators over electric

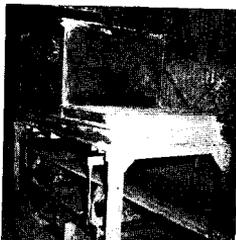
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vibrators is that they can be made to run at a slow speed as well as at a high speed (2400 to 4800 vibrations per minute). Further information gladly furnished on request.

Machine Size	Approx. Bin Capacities Cu. Ft.	Maximum Thickness Hopper Metal	*Input Watts	Net Wt. Lbs.		Approx. Ship. Wt., Lbs.
				Vibra-tor	Con-troller	
V-4	1	1/20"	15	5	5 1/2	13
V-9	2	1/16"	45	13 1/2	5 1/2	21
V-15	7	1/8"	60	16 1/2	6	25
V-25	20	3/16"	150	22	10	65
V-55	50	1/4"	300	40	10	80
V-75	260	3/8"	600	98	15	190
V-200	600	1/2"	1000	215	35	350
V-500	1000	.....	2500*	660	115	975

\*All units for 25, 50, or 60 cycle AC current and all units except V-500 equipped for 110/220 or 440 volt. V-500 available only for 220/440 volt. NOTE: Standard speed, all units shown, 3,600 vibrations per minute.

## WEIGHTOMETER



Weightometer Weighing Ore on Belt Conveyor

THE Weightometer is ingeniously designed to perform the function of continuously weighing moving loads by mechanically multiplying together two variable quantities and totalizing the successive products into a continuous reading.

These variable quantities consist of—first, the ever varying load on the conveyor which is often subject to extreme and very rapid fluctuations, and second, the slightly varying speed of the conveyor belt. The speed of any conveyor, while usually considered as constant, in reality

varies slightly with the load. In continuous weighing, unless both conditions are taken into consideration, any final results will be erroneous.

The Weightometer integrates both variables perfectly because the integrator registering disc instantaneously reacts to variations of, and corresponds at all time to, the true position of the scale beam; also, the true speed of the conveyor is at all times transmitted to the integrator belt. For these reasons the remarkable accuracy of weighing with the Weightometer is consistent and assured.

(Continued on next page)

Each Weightometer is carefully designed and built for the exact service intended, and for the conveyor upon which it must operate. However, the unit is applicable to all conditions and services and can be designed for use, not only upon belts, but upon bucket and pan conveyors as well. Thus, it is generally suitable to any size, type, inclination, capacity, and speed compatible with good conveyor practice.

The resulting weights in every case may be indicated and totalized in short tons, long tons, metric tons, barrels, or any other unit required by the customer.

Weightometers are in use on 12" belts handling but a few tons per day, on intermediate size belts, and on 60" belts carrying 2,400 tons per hour, or two-thirds of a ton per second. Any tonnage carried on a belt conveyor may be weighed with a Weightometer.

Its basic design is one of maximum flexibility, thus any Weightometer can easily be converted from its original load capacity to another capacity or from one conveyor belt size to another belt size at a minimum of trouble and expense. This is a valuable feature because of the permanence of the Weightometer. Some Weightometers have weighed over 40,000,000 tons of material and continue in excellent operating condition with accuracy of performance unimpaired.

Further details gladly furnished on request.

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**DECO Equipment is Designed for "24 Hour Service." This is important because "one hour's delay means no profit today" and with today's high operating costs continuous service is more important than ever before.**

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**Complete Milling Equipment From Testing . . . To Feeder . . . To Dryer.**

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# DENVER LABORATORY EQUIPMENT

## **Testwork Essential to Mining Industry**

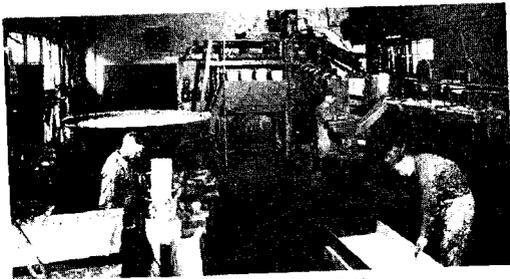
The development and use of good laboratory ore testing equipment has proved indispensable to the mining industry. The many advantages to be derived from its proper use have been so well established that its installation is considered essential to maximum profit. Its use has eliminated the chance factor in both proposed and operating commercial ore dressing plants, and, also of prime importance, its wide adoption by educational institutions has resulted in better trained engineers for the industry.

## **Many Uses for Denver Laboratory Equipment**

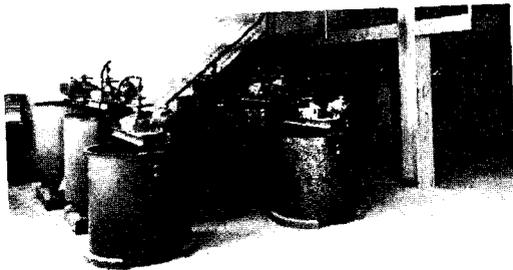
World wide use by the mining industry, governmental research laboratories, commercial laboratories, and mining and metallurgical departments of educational institutions, has proved that results obtained from Denver Laboratory Equipment can be duplicated by commercial size Denver Machines.



Assay Laboratory



Continuous Flotation Test Plant



Continuous Cyanide Test Plant

### Free Bulletins Available on Selection, Installation, and Use of Denver Laboratory Equipment

Copies of Bulletin LG3-B5 "Laboratory Ore Dressing Equipment," Bulletin LG3-B2, "Equipment for Continuous Ore Testing Plants," Bulletin LG3-B1, "Assay Laboratory Equipment for Mines," and Bulletin LG-2B, describing a continuous cyanide test plant, available free on request.

Our desire is to make you "Happier, Healthier and Wealthier."

Following are some of the many ways Denver Laboratory Equipment is being used:

1. To investigate thoroughly, at low cost, before making a commercial installation. This permits determining whether or not the ore can be profitably treated, establishes the most economical method of treatment, and enables selection of the proper type and size of equipment for a commercial plant.
2. For continued experimentation to improve recoveries and reduce costs in operating mills.
3. For research on complex or particularly difficult metallurgical problems.
4. For testing ores from new mine developments.
5. To solve metallurgical problems encountered with changes in character of ore in operating mills.
6. For research on new flotation applications.
7. For training students in schools.
8. For investigations of new and existing treatment methods by government mining bureaus.
9. By chemical supply companies to develop new flotation reagents and other ore dressing agents.

Equipment required for such test work may consist of just a few items or of a very complete installation. Selection may be made to best meet each condition from Denver Equipment Company's complete line of batch and continuous equipment for crushing, screening, grinding, flotation, gravity concentration, cyanidation, amalgamation and assaying. This Denver Laboratory Equipment is described on the following pages.



Batch Laboratory

## LABORATORY AGITATOR, Denver (Bottle Type)



Denver Laboratory (Bottle Type)  
Agitator—Porcelain Jar Shown  
on Rollers

roll is easily adjustable to practically every bottle size.

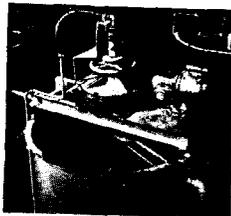
Jars are manufactured in many sizes and styles for various capacities and conditions. All jars are made of the best material, and three kinds are available: (1) Porcelain Jars—carefully molded and fired to obtain the proper degree of vitrification so as to give acid and wear resisting qualities for agitation and grinding. (2) Metal Jars—made of metals most resistant to the action of a grinding charge, such as Monel, stainless steel, cast steel, and bronze. (3) Pyrex Jars—are transparent and enable observation during grinding or agitating action.

Rolls Size	Number of Rollers	Roller Length	Dimensions			H.P. Motor	Approx. Shipping Wt., Lbs.
			L	W	H		
24"	2	24"	42"	24"	11"	1/4	290
24"	4	24"	44"	30"	11"	1/4	360
48"	2	48"	66"	24"	11"	1/4	400
48"	4	48"	66"	30"	11"	1/2	520

Jar Types and Sizes	Outside Diam. Inches	Height Inches	Total Volume In Gallons	*Grinding Charge			Speed R.P.M.
				Sand Lbs.	Pulp Gals.	Pebbles Lbs.	
Sample	5.2	5.71	0.283	1 1/2	0.17	2	80-100
Abco	5.75	6.5	0.33	2	0.20	2 1/2	80-90
Trojan	8.75	9.65	1.387	5	0.83	8	60-70
Ajax	12.5	9.6	2.5	10	1.5	16	40-50
Jar "A"	13.0	12.5	4.0	15	2.4	25	40-50
Jar "B"	14.75	16.5	6.6	25	4.0	45	40-45
Jar "C"	11.13	13.63	4.0	15	2.4	25	40-50
Jar "D"	22.5	24.63	25.0	85	15.0	160	30-40
No. 1 Eureka	17.72	10.0	7.66	30	4.6	50	40-45
No. 2 Eureka	17.72	18.7	15.6	60	9.4	100	40-45
No. 3 Eureka	22.5	19.0	23.8	80	14.3	150	30-40
No. 4 Eureka	24.0	46.5	60.3	180	36.0	400	30-40

\*Either sand or pebbles may be used as a grinding medium and pulp capacity shown is in addition to quantity of whichever grinding medium is desired.

## LABORATORY AGITATOR, Denver Air-lift



Denver Laboratory Air-lift Agitator

DENVER Laboratory Air-lift Agitator was specially developed for use in continuous testing laboratories and pilot plant operations. This agitator is similar in design to a large scale continuous commercial agitator and accordingly the results obtained can be directly calculated for the large tonnages of commercial operation.

Gear drive mechanism is totally enclosed, with integral rake lifting handwheel. Rotating paddles maintain pulp in suspension. Air-lifts and distributing launders can be furnished for central agitation or at the periphery of the tank. Steel tank is furnished as standard. Unit is completely self-contained and can easily be moved as various flow-sheet arrangements may require.

Size	Overall Width	Height Above Tank	Total Height	Motor H.P.	Approx. Ship. Wt. Lbs.
30" Dia. 30" Depth	2' 11"	1' 9"	4' 3"	1/4	500
36" Dia. 36" Depth	3' 5"	1' 9"	4' 9"	1/4	660
48" Dia. 48" Depth	4' 5"	1' 9"	5' 9"	1/4	970

## INQUIRIES

Your inquiries are solicited. Further details, specifications and bulletins on any items listed in this handbook will be supplied promptly. We will be most happy to give you our recommendation on any problem without obligation. Our primary objective is to help you by supplying sound information and proven mill equipment that will make more profit for you.

## What can we do to help you?

### LABORATORY AGITATOR AND CONDITIONER, Denver (Patented) Batch and Continuous

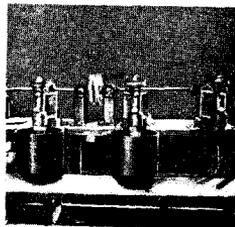
SINGLE batch, multiple batch or continuous Denver (Patented) Laboratory Super-Agitator and Conditioner is available to meet the needs of small or large batch laboratories or continuous pilot test plants. This agitator is designed for use in metallurgical, chemical and process laboratories to agitate, condition, aerate, or mix any combination of liquids or liquids and solids which will flow through a 10 mesh screen. It is distinctive in that it is particularly well suited for any job requiring intense agitation and aeration and for handling pulps of high density and those containing high specific gravity solids . . . the kinds of material so difficult to handle in ordinary types of agitators and conditioners. Both batch and continuous units are compact, efficient, and easily cleaned. The results of testwork conducted by the continuous unit can be duplicated by the commercial size while batch unit results may be closely approximated in commercial practice.



Denver (Patented) Batch Laboratory Super-Agitator and Conditioner  
—Note Adjustable Stand

THE Denver (Patented) Batch Laboratory Super-Agitator and Conditioner is a simple, flexible unit, low in cost and durably constructed for dependable operation. This unit approximates as closely as possible the operation of the commercial Denver (Patented) Super-Agitator and Conditioner in batch testwork.

The patented central standpipe provides positive and controlled circulation and aeration. Feed enters the standpipe and is positively circulated by the propeller . . . thus, there is no possibility of

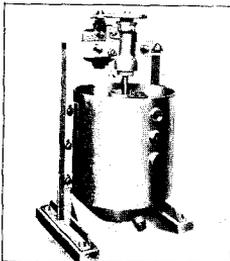


Multiple Denver (Patented) Batch Laboratory Super-Agitator and Conditioner

Three sizes of heavy cast spherical bottom Pyrex jars and two agitators are furnished as standard equipment with the single unit. These jars have a capacity of 1.75 Gals. (6.62 Liters), 3.37 Gals. (12.75 Liters) and 5.03 Gals. (19.03 Liters).

THE Denver (Patented) Continuous Laboratory Super-Agitator and Conditioner accomplishes the agitation of pulp in the continuous laboratory or pilot plant that produces results that can be duplicated in commercial practice. These jars have a capacity of 1.75 Gals. (6.62 Liters), 3.37 Gals. (12.75 Liters), and 5.03 Gals. (19.03 Liters).

Multiple conditioner units, as illustrated, are available when it is necessary to condition several pulps simultaneously. A number of units can be mounted on a single base, with individual rubber covered supports and driven by V-belts from a common lineshaft and motor.



Denver (Patented) Continuous Laboratory Conditioner and Super-Agitator

the material short circuiting across the agitator and no settling of solids. Flow of pulp down the standpipe, combined with rotation of propeller, pulls air into the propeller zone where it is finely disseminated throughout the pulp.

Multiple agitator units, as shown at the left, are available to agitate several pulps simultaneously. A number of units can be mounted on a single base, with individual rubber covered supports and driven by V-belts from a common shaft.

THE Denver (Patented) Continuous Laboratory Conditioner and Super-Agitator effects the conditioning of pulp in the continuous test laboratory or pilot plant that helps to produce results that can be duplicated in actual plant practice. This unit is ideal for continuous test work, as each sample can be thoroughly conditioned before flotation, with intermediate discharge points allowing adjustment of conditioning time.

This machine is rugged, self-contained, and easily portable. Unit is equipped with an all-steel tank which can be

completely drained through the plug in the conical base. The superstructure supports the shaft, with totally enclosed ball bearing housing, and motor drive.

This conditioner can also be used as a pulp storage tank, as a source of constant feed to a concentrating table or filter, or as an agitator.

## May We Please Work With You On All Your Equipment Needs?

(Continued on next page)

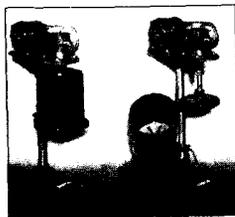
LABORATORY CONDITIONER AND SUPER-AGITATOR,  
Denver (Patented) Batch

Machine Size	Dimensions			Motor H.P.	Approximate Shipping Wt., Lbs.	
	L	W	H		Belt	Motor
No. 1	25"	15"	47"	¼	330	330
No. 2B-2-Unit	31"	30"	29"	¼	300	350
No. 3C-3-Unit	46"	30"	29"	¼	400	475
No. 4D-4-Unit	62"	30"	29"	¼	500	575

LABORATORY CONDITIONER AND SUPER-AGITATOR,  
Denver (Patented) Continuous

Machine Size Inches	Capacity Cu. Ft.	Dimensions			Motor H.P.	Approximate Shipping Wt., Lbs.	
		L	W	H		Belt	Motor
12x18	1.17	15"	17"	30"	¼	170	200
18x24	3.28	22"	26"	41"	¼	300	360
24x36	8.84	29"	32"	53"	¼	500	560

LABORATORY AMALGAMATION CLEAN-UP  
PAN, Denver



Denver Laboratory Amalgamation Clean-Up Pan—Note Shoes and Dies

THE Denver Laboratory Clean-Up Pan is similar in design to the commercial machine and is used to amalgamate high grade ore or flotation and table concentrates. It can be operated successfully for batch or continuous work.

The unit is mounted on a stand with an adjustable base, so that the charge can be removed easily from the container. The shaft, which has the grinding shoes at the bottom, is driven from the reducer drive and speed can be varied by an adjustable pulley.

Flouring of the mercury is eliminated by the design of the adjustable shoes, which permit mercury to lodge in the amalgam zone underneath the stationary die. This clean-up pan is both a grinding machine and an amalgamator.

Machine Size	*Capacity Kgs.	Dimensions			H.P. Motor	Approximate Shipping Wt., Lbs. Motor Drive
		L	W	H		
12"	2	18"	10"	34"	¼	228

\*Dilution 4 to 1.

LABORATORY AMALGAMATION PAN,  
Denver Hand



Denver Laboratory Amalgamation Pan

THE Denver Laboratory Hand Amalgamation Pan provides a convenient inexpensive method of testing the annealability of various gold ores to plate amalgamation. Small quantities of a gold ore can thus be tested by hand without resorting to the use of amalgamation plates.

Either a silver plated standard steel pan or a less expensive copper bottomed steel pan can be supplied. The silver plated pan is recommended as results are more nearly comparable with plate recoveries. However, the copper bottomed pan is an excellent amalgamating unit when coated with mercury.

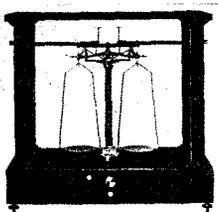
The pans are made in a standard diameter of 16" and weigh 2 to 2½ pounds. Various other diameters can be supplied on special orders.

LABORATORY ASSAY EQUIPMENT, Denver

PROPER assay equipment is an integral part of every complete ore dressing laboratory and also will find practical use in many industrial and chemical laboratories. No less important are the benefits derived by mining companies through maintaining their own assay laboratories. A private assay laboratory allows the company to set up a more complete and regular schedule for mine and mill assays, and results of these assays are available much sooner. Regularity and rapidity of assays gives closer mill control as milling procedures may be adjusted to fit quality of mill feed or meet smelter requirements.

Assaying for research assay laboratories, commercial assay laboratories or mine assay laboratories is divided into two general classes: fire assays for precious metals such as gold and silver, and wet, or chemical assays for other metals such as copper, lead, zinc, iron, insoluble, etc. Denver Laboratory Equipment includes units for every phase of assaying and recommendations can be made to suit your particular requirements. Many of the necessary units for establishing any desired size of assay laboratory are described in detail in this section. Bulletin LG3-B1, "Assay Laboratory Equipment for Mines," recommending generally equipment needed and assay laboratory layout, available free on request.

## LABORATORY BALANCE, Denver (Ainsworth Type T) Analytical



Denver (Ainsworth Type T) Laboratory Analytical Balance

THE Denver (Ainsworth Type T) Analytical Laboratory Balance has a capacity of 200 grams and is sensitive to 1/40 milligram, thereby meeting more exact requirements than general analytical balances.

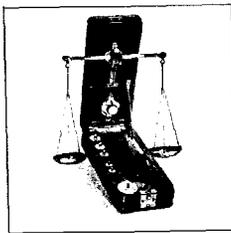
The beam is of aluminum alloy, 6" long, with edges of triangular shaped agate. The beam is graduated with 100 divisions each side of the zero center. Two removable nickel-plated pans, 3 inches in diameter, and a rider carrier for each side of the beam are furnished. Two 10 milligram

beam riders are supplied. All metal parts are heavily gold plated except for the stirrup drop levers which are finished in black crystallized lacquer. Case is aluminum, finished in black crystallized lacquer with a counterpoised front door and removable rear door, and includes spirit levels and four leveling screws.

A zinc lined case can be supplied for export shipment if desired. This balance can also be provided with a key-board operated carrier which greatly increases the speed of handling fractional weights up to and including one gram.

Balance Capacity Grams	Dimensions			Approx. Ship. Wt., Lbs.	
	L	W	H	Domestic	Export
200	20"	10"	18"	70	100

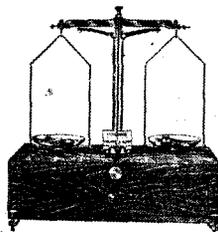
## LABORATORY BALANCE, Denver Pocket Assay



Denver Laboratory Pocket Assay Balance

THE Denver Pocket Assay Balance is an accurate precision instrument designed to fold up into a compact wood case which also accommodates the weights and pincers. When raised, the lid supports the beam from which the saucer shaped pans are suspended. When the box is closed, its dimensions are 6" x 2 3/4" x 1 1/2". Weighing capacity is 10 grams, sensitivity 1/4 mg. The instrument is furnished with a set of weights, 10 grams to 1 mg.

## LABORATORY BALANCE, Denver Pulp



Denver Laboratory Pulp Balance

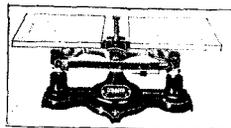
THE Denver Laboratory Pulp Balance illustrated here is very useful for measuring small quantities of reagents and for general laboratory work. It is furnished in capacities from 100 grams to 3,000 grams. Sensitivity varies from 1 mg. on the smaller sizes to 10 mg. on the large sizes.

This balance can be supplied either as shown or with a glass case for protection against drafts and dust. The bearings are of agate, knife edges of steel, and all brass parts are polished and lacquered. The case is fitted with a level and four leveling screws to ensure accuracy.

Balance Capacity Grams	Sensitivity Milligrams	Length of Beam Inches	Diameter of Pans Inches	Dimensions			Approx. Shipping Wt., Lbs.
				L	W	H	
100	1	7	2 3/4	15"	8"	12"	17
150	1	7	3 3/4	15"	8"	12"	17
300	2	9 1/4	4	16"	8"	12"	20
600	5	10 1/2	5	16"	9"	12"	23
1500	10	11 1/2	6	17"	9"	12"	25
3000	10	14 1/2	7	17"	10"	14"	29

\*Approximate shipping weights are for balances without glass cover case. For glass case add 40%.

## LABORATORY BALANCE, Denver (Harvard) Trip Scale



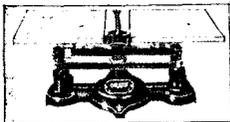
Single Beam Denver (Harvard) Trip Scale Laboratory Balance

THE Denver (Harvard) Trip Scale Laboratory Balance is for general laboratory work and finds particular use in weighing products from screen sizing tests.

The capacity of this balance is 2 kilograms. The single beam type shown at the left is graduated to 10 grams in 1/10 gram divisions. The bearings are agate and are completely housed against dust. The plates are interchangeable and replaceable and are made of molded white opal glass 6 inches square. All the metal parts are cadmium plated to resist corrosion, and beam is of nickel silver.

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LABORATORY BALANCE (Continued from previous page)



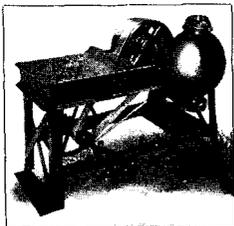
Double Beam Denver (Harvard) Trip Scale Laboratory Balance

The double beam type has the upper beam graduated to 10 grams in 1/10 gram divisions; the lower beam to 200 grams in 10 gram divisions. Capacity is 210 grams without extra weights; total capacity is 2000 grams. This balance is of the same construction as the single beam type.

Brass metric balance weights are available in ranges from 1 gram to 1000 grams for use with Denver (Harvard) Laboratory Trip Scale Balances.

Style	Capacity Grams	Dimensions			Approx. Ship. Wt., Lbs.	
		L	W	H	Domestic Export	
Single Beam	2000	14"	5 3/4"	6"	20	25
Double Beam	2000	14"	5 3/4"	6"	20	25
Triple Beam	2610	14"	5 3/4"	6"	25	30

LABORATORY BALL MILL, Denver (Closed) Batch



Denver (Closed) Laboratory Batch Ball Mill—Belt Drive—Steel Stand

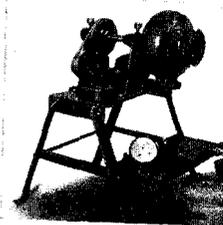
FOR fine grinding in laboratory flotation work, wet grinding is necessary in several stages in order to approximate the actual grinding conditions of a ball mill and classifier in plant operation. With this Denver Laboratory Batch Ball Mill it is possible to grind successfully in several stages without dilution, because the large feed opening and small discharge hole (which retains the balls while the mill is being discharged) permits quick and thorough

draining with the use of a minimum of wash water. Used in conjunction with a Denver (Closed) Laboratory Batch Ball Mill, a laboratory batch classifier saves time.

Machine Size	Cap. Kg.	Steel Stand	Dimensions			Motor H.P.		Approx. Shipping Wt. Lbs.	
			L	W	H	Belt	Motor		
15" x 10"	9	With	54"	49"	46"	1/2	760	950	
15" x 10"	9	Without	48"	19"	26"	1 1/2	525	770	

\*A recommended 100 pound charge of assorted alloy steel grinding balls is available at small additional cost.

LABORATORY BALL MILL, Denver (Open) Batch



Denver (Open) Laboratory Batch Ball Mill—Motor Drive—Steel Stand

THE Denver (Open) Laboratory Batch Ball Mill makes possible simulation of grinding in a ball mill-classifier circuit by grinding a fixed time, then hand classifying with a sieve and a bucket and returning the sand to the mill for further grinding. Pulp volume can be kept at a minimum by control of wash water since the ball load does not dump out. Thus fine or coarse grinding is accomplished with ease of manipulation. The mill is used considerably as a regrind unit for further size reduction of flotation concentrates, table concentrates, middlings, and other mill products.

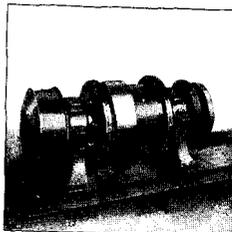
Air may be introduced to the pulp, if desired, through the open end of the cast steel drum.

The Denver (Open) Laboratory Batch Ball Mill can be used for the amalgamation of table and flotation concentrates, by using one 4" ball during the grinding action. A few slight changes provide for mounting an Abbe Jar on, the driving shaft opposite the drum. This affords an excellent combination laboratory grinding unit.

Machine Size	Cap. Kg.	Steel Stand	Dimensions			H.P. Motor	*Approximate Shipping Wt., Lbs.	
			L	W	H		Belt	Motor
12" x 5"	2-4	With	39"	25"	42"	1/4	340	465
12" x 5"	2-4	Without	30"	19"	18"	3/4	305	405

\*A recommended 40 pound charge of assorted alloy steel grinding balls is available at a small additional cost.

LABORATORY BALL-ROD-TUBE MILL, Denver Batch or Continuous

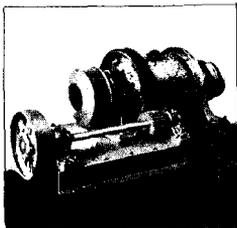


12" Denver Laboratory Ball Mill with Base for Rod Mill

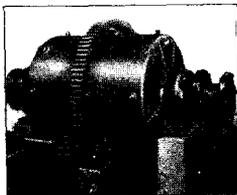
DENVER Laboratory Ball-Rod-Tube Mill is for grinding large quantities of ore in batch or continuous work. A grate discharge allows quick emptying for batch work; and a trunnion discharge, for continuous work. This flexible unit can also be used as an amalgamator.

The welded steel base can be provided in lengths suitable for supporting one, two, or three drums. One drum constitutes a ball mill; two, a

(Continued on next page)



16" Denver Laboratory Ball Mill



30"x36" Denver Convertible Ball Mill

rod mill; and three, a tube mill. The construction permits easy and rapid addition or removal of drums for conversion from one type to another, the trunnion being moved along the channels to accommodate the various lengths.

The grinding drums are made with thick walls, thus eliminating the necessity of liners and the possibility of salting samples.

This grinding mill has many commercial applications, since special acid resisting drums and heads can be furnished. Hard iron or alloy steel replaceable liners are easily inserted where wear is an item as in continuous use.

For continuous pilot test plants utilizing No. 7 or No. 8 Denver "Sub-A" Flotation Machines, ball mills with larger grinding capacities are required. The 30" Denver Convertible Ball Mill is ideal for this application. Capacity of this mill with single section is 3 to 5 tons per 24 hours

while the double section mill, illustrated above, has a capacity of 6 to 9 tons per 24 hours.

*Machine Size	Capacity Lbs./Hr.	Dimensions Without Steel Base			Motor H.P.	Approx. Ship. Wt., Lbs.	
		L	W	H		Belt	Motor
12"x11"	50	34"	20"	19"	1	970	1000
12"x24"	100	47"	20"	19"	1½	1000	1100
12"x36"	150	60"	20"	19"	2	1100	1360
16"x16"	150	47"	41"	25½"	1½	1450	1850
16"x32"	300	65"	41"	25"	3	1900	2150
16"x48"	450	83"	41"	25"	5	2350	2750

\*Dimensions are inside the grinding sections.

\*\*30" diameter mills can be furnished for laboratory use also. Please see page 17 for details.

## LABORATORY BUCKBOARD AND MULLER, Denver

THE Denver Laboratory Buckboard and Muller is an extremely useful addition to most ore dressing or industrial laboratories. It accomplishes the quick reduction of small quantities of ore or other crushable materials to a fine powder. The unit consists of a chilled iron buckboard grinding surface, two sides of which are rimmed, and the desired type and weight of muller. The buckboard grinding surface is planed smooth and standard mullers have rounded crushing

(Continued on next page)

faces. Mullers may be purchased separately from either standard types shown or special from the three sizes of each type listed in the table and classified by rounded or flattened crushing faces. Rounded face mullers as listed have hickory axe type handles and flattened face mullers are equipped with hickory pick type handles.

Type	Dimensions Buckboard			Approx. Buckboard Wt., Lbs.	*Standard Mullers Wt., Lbs.	Separate Mullers with Axe Type Handles		Separate Mullers with Pick Type Handles	
	L	W	H			Size	Wt. Lbs.	Size	Wt. Lbs.
1	18"	12"	3"	58	15				
2	20"	18"	4"	83	15				
3	24"	20"	4"	130	20				
4	30"	24"	5"	212	25				
5	36"	24"	5"	238	25	Small	15	Small	20
6	36"	30"	6"	286	35	Large	25	Large	35

\*Mullers shown as standard are furnished with rounded crushing faces except for the 35 pound size for the 36" by 30" buckboard which is furnished with a flattened crushing face as standard.

## LABORATORY CLASSIFIER, Denver Batch



Denver Laboratory Batch Classifier  
Stand Is Not Included with Unit

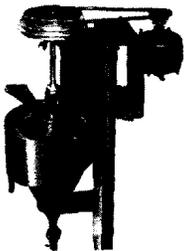
THE Denver Laboratory Batch Classifier is used to classify or settle the pulp from Denver Laboratory Batch Ball Mills, and the results approximate the work done by standard commercial classifiers and ball or rod mills in closed circuits.

This unit consists of a funnel with a variable spigot discharge through which the material passes into the hopper-shaped tank. The size of the overflow material is controlled by the slope of the tank and the size of the spigot opening in the bottom of the funnel.

As the pulp passes into the tank the sands settle to the bottom and the slimes overflow at the discharge lip. This unit is of simple, sturdy construction and foolproof operation. It is recommended for classifying -100, -150, or -200 mesh, and is usually supplied with Denver Laboratory Batch Ball Mills. Shipping weight is 10 pounds.

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

## LABORATORY CLASSIFIER, Denver Centrifugal



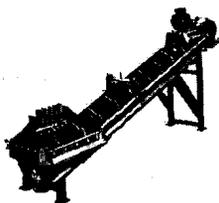
Denver Laboratory Centrifugal Classifier

THE Denver Laboratory Centrifugal Classifier embodies a new principle in classification. The feed is introduced into a center well where it falls on a rotating impeller which forces the material outward and upward. The sands settle through the upward current and are discharged at the bottom spigot. The slimes rise and overflow around the rim of the classifier, while a portion of the slimes is recirculated with the primary feed to help in washing the sand particles. The velocity imparted to the pulp by the rotating impeller

supplies the necessary rising current without an excess of water. There are several adjustments for regulating the size of the particles in the overflow and sand discharge. Recommended where sand grains are coated with colloids and a very fine and uniform overflow product is desired without excessive dilution, this unit also made in commercial sizes.

Machine Size	Dimensions			H.P. Motor	Approx. Shipping Wt., Lbs.	
	L	W	H		Belt	Motor
9"	19"	17"	40"	1/4	125	145

## LABORATORY CLASSIFIER, Denver Cross-Flow



9" Denver Laboratory Cross-Flow Classifier

DENVER Laboratory Cross-Flow Classifier is designed to operate continuously for washing, classification or desliming of industrial materials as well as metallic minerals. This unit is built in three different sizes to fit the variety of problems encountered in continuous test work.

The wide adjustable overflow weir with straight line surface flow provides efficient classification of coarse and fine material. An outstanding

mechanical advantage, especially for intermittent operation, is provided by having the lower bearing entirely above the pool. No contamination of pulp is caused by surplus of forced lubrication required in other classifiers. Adjustable cast iron flights are easily replaced. Steel tank includes supporting legs to form a complete unit.

(Continued on next page)

More complete information can be obtained by writing any Denver Equipment Company office.

Machine Size	Tank Length	*Capacity, Tons		R.P.M. Conveyor	Motor H.P.	Approx. Weight, Pounds
		Overflow	*Sand			
6" Simplex	4' 6"	5	20	14-30	1/4	350
9" Simplex	5' 8"	10	40	14-30	1/4	520
12" Simplex	7' 10"	20	70	14-26	1/2	690

\*Overflow capacity is in tons dry solids per 24 hours based on 65 mesh separation, specific gravity of material 2.7, with 20% solids in overflow. Sand raking capacity is in tons dry solids per 24 hours at average speed of conveyor.

## LABORATORY CLASSIFIER, Denver Hydraulic

THE Denver Laboratory Hydraulic Classifier is designed for use in laboratories where tests on sizing or the concentration of feeds are conducted.

This unit is made in 2, 4, or 6 compartments. Each compartment is 4"x4" and is provided with glass sides so that



Denver Laboratory Hydraulic Classifier

the conditions existing in each chamber can readily be observed. Only enough water is necessary to keep the solids in full teter. As the sands accumulate in the classifier pockets, the effective density of sand-water mixture increases and thumb-screws on valve rod assemblies may be adjusted to discharge sand from each compartment as required. The finer the sand the less water required. When pressure regulating valves and product

valves are set, no further adjustment is necessary.

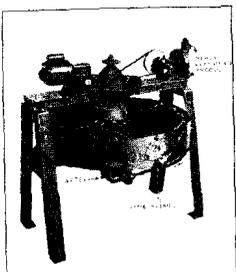
The compartments are so arranged that the perforated constriction plates for the coarser feed are nearer the feed end with each succeeding compartment arranged for a smaller mesh product.

Each compartment has an average capacity of 500 to 600 pounds of aggregate per hour.

*Machine Size	Number of Compartments	Dimensions			Approximate Shipping Wt., Lbs. Domestic Packing
		L	W	H	
4"x4"	2	1'8"	1'5"	2'6"	85
	4	2'5"	1'5"	2'6"	155
	6	3'1"	1'5"	2'6"	225

\*Odd number of compartments can be supplied such as 3, 5 or 7.

## LABORATORY CLASSIFIER, Denver Hydro-



Denver Laboratory Hydroclassifier

DENVER Laboratory Hydroclassifier is suitable for a variety of classification, desliming, and washing problems in continuous testing laboratories. By splitting a portion of the pulp circuit in large tonnage plants, useful operating and control information can be easily and accurately obtained.

Specifications of the Denver Laboratory Hydroclassifier are similar to those of the commercial unit. Totally enclosed running-in-oil gear mechanism drives the steel shaft and rugged spiral rakes.

The bottom washing cone ensures the complete removal of any mechanically entrapped fine material. Welded steel tank and sturdy frame make this a self-contained portable unit. Discharge is controlled by a spigot, or positively by a Denver Laboratory Suction-Pressure Diaphragm Pump.

More complete information can be obtained by writing any Denver Equipment Company office.

Machine Size	Overflow Capacity Tons / 24 Hrs.		R.P.M. Rake	Motor H.P.	Approximate Shipping Weight, Lbs.	
	100 Mesh 20% Solids	325 Mesh 10% Solids			Belt	Motor
30"	15	2.8	3-6	3/4	450	400
36"	22	4.0	3-6	3/4	550	500
48"	39	7.2	2-5	1/2	600	650

Denver Equipment Company publishes **DECO TREFOIL**, an exchange of helpful engineering information designed to improve milling. **DECO TREFOIL** is published every other month. If you are connected with mining and do not receive **DECO TREFOIL** please write to us.

## LABORATORY CLASSIFIER, Federal Dry

LABORATORY separation of dry material finer than 200 mesh is efficiently made in the Federal Air Classifying Unit B. Powder metallurgists, as well as those working in plastics, ceramics and other non-metallics, report that results are constant. Variations of 1/10 of one per cent in duplicate tests are obtained. Fractionation of uniformly dense material at 2.5 and 5 microns, with unit B, is not unusual.

Sample to be tested is fed by a screw conveyor into centrifugal classifier, shown centrally. Air is admitted and controlled by pressure valve, directly above motor. Collector, on left side of unit, is built similar to the classifier. It may be equipped with a graduated mesh valve to govern both maximum and minimum size of particles delivered to bottom flask. Impalpable dust is caught in 5" cloth tubes, not shown, fastened to the panel back. Final air discharge is from these cloth tubes.

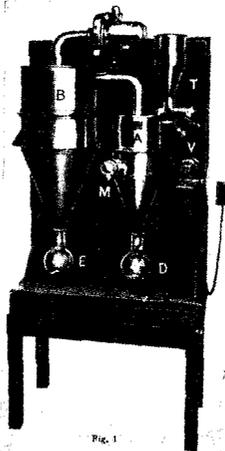


Fig. 1

Federal Laboratory Dry Classifier  
Small Supporting Table Not  
Furnished

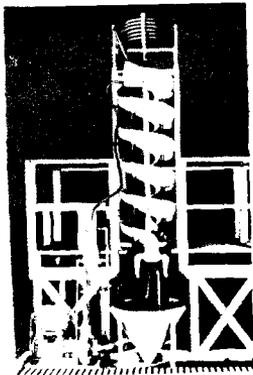
The classifier has a diameter of 8", and the collector 12", both being fabricated from 24 oz. copper sheets. Head section

of classifier is lined with sheet of hard brass to resist abrasion. Elbows are seamless and connected by sleeves to facilitate cleaning. Fan and feeder motor will operate on any 110 or 220 volt lighting circuit. Unit is mounted on a 31"x42" steel shelf. Size of packing case 21"x33"x48".

Capacity Lbs. Per Hr.	Dimensions			Motor H.P.		Approx. Ship. Wt. Lbs.	
	L	W	H	Fan	Feeder	Domestic	Export
120-180	31"	21"	48"	3/5	1/20	190	220

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

## LABORATORY CONCENTRATOR, Humphreys Spiral



Humphreys Laboratory Spiral Concentrator

THE Humphreys Spiral Concentrator is a simple, efficient gravity concentrator which effects a separation between minerals of the proper size range that have sufficient difference in their specific gravity.

This concentrator is a spiral conduit of modified semi-circular cross-section, with outlets for removal of concentrate and middling. Pulp is introduced at the top of the spiral. As the pulp follows the spiral channel, lighter particles in the pulp stream move outward and upward into the fast moving part of the pulp stream. The heavy particles move to the inner, slow moving portion of the stream, where they are drawn off through concentrate

or middling outlets. Adjustable splitters allow any portion of the concentrate or middling to be diverted through the outlets. Tailing discharges from lower end of spiral. A full-size spiral is used for laboratory testing. Two arrangements are suggested for test work.

In the closed circuit test unit illustrated, although a full-size spiral is used, as little as 20 pounds of material will indicate the possibility of spiral concentration in a batch test. By removing measured quantities of products, and adding like amounts of feed in repeated steps, substantial samples may be taken for analysis and estimates of capacity. Results from this procedure, using 100 to 300 pounds of material, are close to pilot test results.

Another arrangement, also using a full-size spiral, is a small pilot plant, and is suitable for test work where a larger quantity of material can be handled. The storage tanks may be built on the job from drawings supplied. This unit allows continuous feeding of material and permits accumulation of concentrate and tailing in separate tanks, which may then be re-run as feed for second stage concentration or scavenging of tailing.

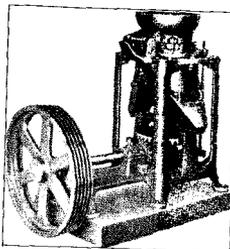
*Spiral Model	Height Discharge	Capacity Tons Per Hour	Dimensions Frame			Motor H.P. Pump	Approx. Shipping Wt., Lbs. Spiral Only
			L	W	H		
24A Single 5-Turn	2'3"	3/4-1 1/2	2'4"	3'0"	8'4"	1	750
24C Single 5-Turn	2'3"	1-2	2'4"	3'0"	7'10"	1	850

\*Model A is for most ore concentration problems. Model C is for use on coal.

## LABORATORY CONDITIONER

— See LABORATORY AGITATORS

## LABORATORY CRUSHER, Denver (Cone and Ring Type) Coffee Mill



Denver (Cone and Ring Type) Coffee Mill Laboratory Crusher. Showing Gear and Pinion and Grooved Pulley. Note Sturdy Construction

IN the Denver (Cone and Ring Type) Laboratory Crusher the crushing of quartz from 1/2 inch or 3/4 inch to 20 mesh can be accomplished at the rate of 4 pounds per minute. For many years it has been standard equipment in samplers, mills and large mines where continuous or intermittent dry grinding is done.

The ore is ground between a revolving cone and a bell-shaped hopper, leaving the machine through double discharge openings. Size of product is controlled by a conveniently located handwheel. Drive is by a gear and pinion, supplied with tight and loose 18"x6" pulleys for flat belt drive, to operate about 150 R.P.M. on drive shaft. Grooved tight pulley and V-belt drive with 5 H.P. motor is also available.

Machine Size	Capacity Pounds per Hr. 1/2" to 20-mesh	Dimensions			H.P. Motor	Approx. Shipping Wt., Lbs.	
		L	W	H		Belt	Motor
No. 1	35-50	40"	22"	40"	2	600	800
No. 2	200-250	60"	22"	42"	5	950	1200

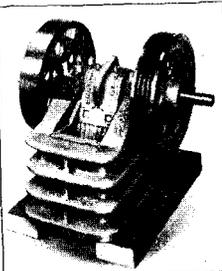
## LABORATORY CRUSHERS, Denver Jaw

DENVER Laboratory Jaw Crushers are available with three sizes of jaw openings and various capacities to suit the needs of batch laboratories and all continuous laboratory test plants and pilot test plants. Various construction features on the three types of Denver Laboratory Jaw Crushers ensure their ruggedness and durability for constant usage over long periods of time. All units have main frame cast in one piece and reversible jaw plates cast of manganese steel. The smaller size crushers are furnished for belt drive or motor drive and with either of these drives provision is made for hand operation if desired. The larger units are available for power drive only with belt or motor. Let us make recommendations for type and size crusher for your batch laboratory or continuous or pilot test plant.

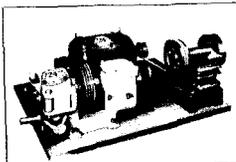
## Denver Laboratory Forced Feed Jaw Crusher

THE Denver (Type H) Laboratory Forced Feed Jaw Crusher is furnished in three sizes. The 5"x6" size is excellent for crushing in ore testing laboratories and continuous test plants. The 2¼"x3½" and 3¼"x4½" sizes are ideal for assay or batch testing laboratories for such uses as sample crushing.

This crusher is the high capacity, forced feed type with a one piece cast alloy iron frame. The eccentric bumper is special nickel cast iron and mounted on two tapered roller bearings which are sealed to exclude dirt. The eccentric shaft is machined from chrome nickel. The bearings are equipped with alloy bronze cast insets. All bearings are fitted with Kleansel fittings. Jaw plates and cheek plates are reversible and are of manganese steel. The safety toggles on these units may be either long or short, the length depending on the size product desired. All sizes of crushers are available for motor drive using V-V or flat belt drive and the 2¼"x3½" and 3¼"x4½" sizes may be furnished for hand or belt drive. Cast steel frames can be supplied.



5"x6" Denver (Type H) Laboratory Forced Feed Jaw Crusher



Denver Crusher-Pulverizer Unit With 2¼"x3½" (Type I) Laboratory Crusher

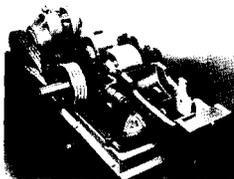
The 2¼"x3½" Denver (Type H) Laboratory Forced Feed Jaw Crusher is available incorporated into a crusher-pulverizer unit on a common base with a single driving motor. The pulverizer unit is the Denver-McCool Laboratory Pulverizer which is of the disk type, designed for grinding virtually any material, and for pulverizing to any mesh in one operation. This crusher-pulverizer unit is compact, efficient, and portable and ideal for use in laboratories.

Crusher Size Inches	*Capacities Pounds Per Hour	Motor H.P.	Flywheel Size, In.		Speed R.P.M.	Dimensions			Approx. Weight, Lbs.
			Diam.	Face		L	W	H	
2¼"x3½"	50-100	1	9 ½"	2 ½"	350-450	15"	17"	14"	150
3¼"x4½"	300-500	2	13 ¾"	2 ½"	350-380	18 ¾"	18 ¾"	17"	365
5x6	500-2000	5	18"	4 ½"	325-375	27"	27"	25"	630

## LABORATORY CRUSHING ROLLS, Denver (Type M)

THE (Type M) Denver Laboratory Crushing Rolls embody the latest improvements and are constructed as a self-contained unit with proper provisions for adjustment and lubrication, and are completely housed and protected from dust.

The main frame is cast in one piece and of the best grade of gray iron. The stationary roll journal box is cast in the frame and movable roll is mounted on a sliding saddle of especially heavy design which slides on a machined surface. All bearings are outside of the housing. The shaft



Denver (Type M) Laboratory Crushing Rolls With Housing Open

is of forged steel of sufficient diameter to withstand severe strains and shocks without deflection.

All roll shells are made of heavy selected rolled steel set to provide highest wearing qualities. Roll shells are bored to a straight taper corresponding to the taper of the cast iron hub and are held in place by shrinkage and reinforced by heavy lug bolts. The roll hub

is securely keyed to the shaft by a full hub length key. The movable roll is held in position by two double helical springs which are housed in main frame casting. The springs are held at any desired tension by lock nuts and the machine may be dismantled without changing adjustment of the springs.

Roll alignment is provided by split safety collars which are set in a recess turned in the shaft, making perfect alignment possible under severe operating conditions.

Heavy cast iron housing with replaceable white iron cheek plates is provided, and the housing may be opened from either side for inspection while rolls are in operation.

Various drives are available. The unit drive with one motor and one set of double V-belts mounted with crushing rolls on a common base of welded steel is ideal for normal laboratory crushing operation.

Let us make recommendations for your laboratory unit.

Machine Size Inches	*Capacity			Dimensions		
	Size Feed	Size Product	Tons Per Hour	L	W	H
10x6	0.37"	0.10"	2.00	3 ½"	2'0"	1'5"
16x10	0.75"	0.18"	6.00	4'0"	2'5"	2'5"
20x12	0.94"	0.23"	16.00	4 ½"	2'11"	2'6 ¾"

\*Capacity figures are based on medium hard material and uniform feed.

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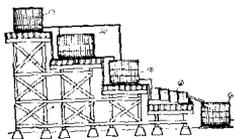
Machine Size inches	Speed R. P. M.	Motor H. P.	Main Pulley Size Inches		Small Pulley Size Inches		Approximate Shipping Wt., Lbs.	
			Diam.	Face	Diam.	Face	Domestic	Export
0x6	225	2	18	3	18	3	1000	1100
16x10	200	5	36	6	18	5	3500	3850
20x12	170	10	52	8	26	6	7000	7700

Use next larger size motor for continuous operation.

What can we do to help you?

Our desire is to make you "Happier, Healthier and Wealthier."

### LABORATORY CYANIDE PLANTS, Denver Batch and Continuous



Denver (Batch) Laboratory Cyanide Plant Mounted on Wood Frame

THE Denver (Batch) Laboratory Cyanide Plant was designed to assist the purchaser in determining what style of plant he needs for his particular ore. While an assayer's test offers no particular difficulty, the ore may pack and prove impervious to solution when full size mill operation is attempted. To do away with this possibility a low cost and efficient method for making preliminary tests has been developed.

The Denver (Batch) Laboratory Cyanide Plant has a 3-ton capacity and a shipping weight of approximately 3000 pounds. The leaching tank is 3½ feet deep and is fitted with a false bottom and a duck filter cloth. A hand pump is connected to the sump tank by a suction pipe for pumping solution back to the solution tank. Denver (Patented) Laboratory Super-Agitator and Conditioner and Denver Laboratory Drum Filter are additions which make these batch test plants even more flexible. THE Denver (Continuous) Laboratory Cyanide Plant makes possible the carrying out of cyanide tests through a great

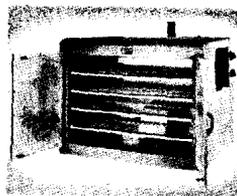
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One Circuit of Denver (Continuous) Laboratory Cyanide Plant

for expanding your laboratory or for your proposed batch or continuous cyanidation laboratory or pilot test plant.

### LABORATORY DRYER, Denver (Oven Type)



Denver (Oven Type) Laboratory Dryer Electrically Heated

THIS new Denver Laboratory Dryer is a simple, efficient, economical unit—ideal for drying concentrate samples and industrial or laboratory products. Circulation of air at controlled high temperatures makes drying faster—more efficient.

Precise temperature, humidity and drying conditions are maintained with a sensitive thermostat control and an air-circulating damper. An accurate stem

thermometer enables quick determination of oven temperatures without opening the dryer doors.

Operating costs are low—generally less than 5 cents an hour—because the efficient asbestos air-cell insulation and the tight construction keep the heat in the dryer. They also prevent excessive heat in the room.

Portability makes the dryer even more useful. Weighing only 108 pounds, it can easily be moved to any location, connected to the nearest outlet, and it is ready for use. Outside Dimensions—30" wide, 25" deep, 24" high. Electrical—Single phase, 50-60 cycle, 110 volt. 220 volts optional.

(Continued on next page)

Insulation—Asbestos air-cell insulation.  
 Finish—Gray wrinkle baked enamel. Plated hardware.  
 Construction—Heavy gauge steel, contour formed for greater strength.

Equipment—Four sliding shelves, heating elements, six-foot asbestos covered cord.

There is adequate capacity for most laboratory or small plant operations. Eight 2"x12"x23" pans can be accommodated on the four sliding shelves. And because of the forced circulation, all shelf space may be used. For greater capacity, two or more dryers may be stacked and operated either at the same or different temperatures.

## LABORATORY DRYER, Denver (Rotary)



Denver (Rotary) Laboratory Dryer

THE Denver (Rotary) Laboratory Dryer is a simple, inexpensive unit for use in continuous pilot test plants where it is necessary to reduce the moisture content of flotation concentrates, table concentrates or any other product of ore testing. This unit is also used to determine control factors for production purposes

in continuous test plants operating on chemical or industrial products requiring drying or heating.

Three main types of Denver (Rotary) Laboratory Dryers can be supplied. The direct heat unit is used when it is permissible for the drying gases to come in direct contact with the material being dried. Partition plates are provided which increase the heating surface. Drying may be by hot air or exhaust gases from other operations. If this drying gas has a deleterious effect on the product, then an indirect heat type dryer can be supplied. A further derivation is the Denver-Tedrow (Rotary) Laboratory Dryer in which steam is used as the drying medium.

## DENVER INDIRECT HEAT TYPE

Size of Dryer	*Cap. Tons Per 24 Hours	**Dimensions Outside Brickwork			Speed R.P.M.	Motor H.P.	Approx. Ship. Wt. Lbs. Iron Work Only
		L	W	H			
24"dx15'1"	13	16'0"	11'9"	7'7"	7½	3	12,000
24"dx20'1"	16	21'0"	11'9"	8'0"	7½	3	13,000
36"dx20'1"	38	21'0"	12'9"	8'6"	5	5	14,400
36"dx30'1"	55	31'0"	12'9"	9'4"	5	5	17,000

\*Capacity based on 10% moisture, wet weight, in material fed to dryer, and 3.26 pounds of moisture evaporated per hour for each cubic foot of volume of main cylinder.

\*\*Customer furnishes and erects the brickwork setting for the dryer in accordance with drawings furnished by Denver Equipment Company

(Continued on next page)

## DENVER DIRECT HEAT TYPE

Size of Dryer	*Cap. Tons Per 24 Hours	Dimensions			Speed R.P.M.	Motor H.P.	Approx. Shipping Wt., Lbs.
		L	W	H			
24"dx15'1"	18	26'6"	3' 8"	7'9"	7½	3	12,000
24"dx20'1"	25	31'6"	3' 8"	8'2"	7½	3	13,000
36"dx20'1"	55	33'0"	4'10"	8'8"	5	5	14,400

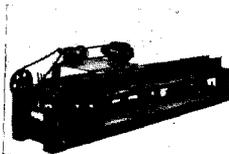
\*Capacity based on 10% moisture, wet weight, in material fed to dryer, and 3.26 pounds of moisture evaporated per hour for each cubic foot of volume of main cylinder.

## DENVER-TEDROW STEAM TYPE

Size	*Cap. Tons Per 24 Hours	Dimensions			Speed R.P.M.	Motor H.P.	Approximate Ship. Wt., Lbs.		
		Cyl. Dia.	L	W			H	Belt	Motor
No. 1	8	18"	11'0"	4'8"	3'10"	4	2	5100	5650
No. 2	26	25"	15'0"	5'0"	4' 4"	3	5	6350	7000
No. 3	54	36"	19'6"	6'0"	5' 6"	2½	7½	8450	9300

\*Capacity based on 10% moisture, wet weight, in material fed to dryer, and 3.26 pounds of moisture evaporated per hour for each cubic foot of volume of main cylinder.

## LABORATORY FEEDER, ORE, Denver Belt



Denver Laboratory Belt Ore Feeder

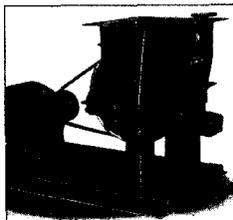
FEEDING ore at the rate of 100 to 200 lbs. per hour requires very careful control for uniform results in continuous laboratory test work. Because of its accuracy the Denver Laboratory Belt Ore Feeder is ideal for this application.

The step zone pulley drive provides means of changing belt speed... skirt boards may be spaced any distance desired from center to edge of belt... depth of material may be varied as spread on the belt. These three adjustments provide an easy means of regulating the feed rate to cover the normal capacity range required. Higher speed sheaves available to provide greater capacity.

Machine Size	*Range of Belt Speeds with Standard Drive Ft. Per Hr.	Dimensions			Motor H.P.	Approx. Ship. Wt., Lbs.	
		L	W	H		Belt	Motor
6'x6'	10.2—28.2	7'6"	35"	18"	¼	340	460
9'x9'	8.0—22.6	10'9"	38"	21"	¼	570	615
12'x12'	10.1—27.8	13'8"	41"	23"	½	950	980
15'x15'	9.0—25.0	16'2"	42"	27"	¾	1150	1250
18'x18'	11.6—32.2	21'7"	45"	47"	½	1300	1400

\*Range of belt speeds may be varied by using various size and ratio driving sheaves.

## LABORATORY FEEDER, ORE, Denver Dry Shaker



Denver Laboratory Dry Shaker Ore Feeder

ACCURATE tests often demand a constant, uniform feed of dry material. This is particularly true when feeding to a concentrating table or jig. The Denver Laboratory Dry Shaker Ore Feeder is a simple, economical unit for these applications. The steep, sloping sides of the hopper drop the material to be fed onto a shaking pan feeder. The depth of the material on the pan is regulated by an adjustable gate, and speed of cam shaft and length of stroke of the shaking pan are also variable. This feeder is furnished for motor and V-belt drive, or for drive from a concentrating table.

Machine Size	Capacity Hopper, Cu. Ft.	Dimensions			Motor H.P.	Approx. Ship. Wt., Lbs.	
		L	W	H		Belt	Motor
No. 1	0 25	24"	9"	14"	1/6	60	90

## LABORATORY FEEDER, ORE, Denver Hopper

THIS all steel Denver Laboratory Hopper Ore Feeder is particularly designed for use with the No. 5 and No. 7 Denver "Sub-A" Continuous Laboratory Flotation Test Plants. It is of welded steel construction with speed reducer and motor on a single base.



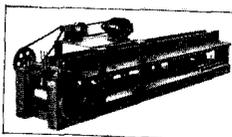
Denver Laboratory Hopper Ore Feeder Equipped with Conveyor

As the hopper for feeding the ore is directly over the conveyor belt, it is often furnished as a single unit. The hopper is equipped with an adjustable gate to regulate the amount of ore fed to the belt. The hopper feeder and conveyor belt as a single unit is compact and easily portable and therefore may be readily moved to change direction of feed whenever desired.

Let us make recommendations for your feeder installation.

Machine Size	Hopper Capacity, Cu. Ft.	Dimensions			Motor H.P.	Approx. Ship. Wt., Lbs.	
		L	W	H		Belt	Motor
6"x18"	1 4	30"	24"	48"	1/4	330	365
9"x54"	Optional	5'5"	25"	21"	1/2	400	550
12"x72"	Optional	6'10"	28"	23"	3/8	550	700

## LABORATORY FEEDER, REAGENT, DRY, Denver (Belt Type)



Denver (Belt Type) Laboratory Dry Reagent Feeder

DENVER (Belt Type) Laboratory Dry Reagent Feeder is particularly well suited to feeding reagents, such as lime or soda ash, which become lumpy or sticky and tend to clog hopper type feeders in any but a very dry climate. Also, any dry reagents used in very small quantities, such as zinc dust in cyanide precipitation, are most conveniently and accurately fed by this belt type feeder. This unit is ideal for obtaining accuracy essential for uniform results in laboratory test work.

A step-cone pulley drive controlling speed of belt, skirt boards adjustable from center to edge of belt to control width of feed, and depth of reagent on belt, provide three adjustments for accurately controlling quantity of material fed. Drives for higher belt speeds can be provided to increase capacity. Pressed-steel head and tail pulleys, and babbitted bearings ensure reliable, continuous operation. On motor driven feeder the fractional horsepower sleeve-bearing motor and speed reducer may be mounted on the top, side or bottom of the unit.

Machine Size	Range of Belt Speeds with Standard Drive Ft. per Hour	*Capacity Lbs., Per Hour Soda Ash	Dimensions			H.P.	Approximate Shipping Weight Pounds	
			L	W	H		**Belt	Motor
6"x6'	2.1- 5.7	8-23	7'6"	1'10"	1'7"	1/4	340	460
9"x9'	3.1- 8.6	19-54	10'9"	2' 1"	1'9"	3/4	570	615

\*Capacity feeding 2" deep with skirt boards at maximum width.  
 \*\*Belt driven unit furnished with speed reducer but without drive pulley.  
 NOTE: Data required to determine size and type feeder: test plant tonnage per 24 hours, name of reagent, amount fed in pounds per ton plant feed or solution, and type of drive with electrical characteristics.

**Reliable Denver Ore Tests insure your mining investment.**

## LABORATORY FEEDER, REAGENT, DRY, Denver (Cone Type)

DENVER (Cone Type) Laboratory Dry Reagent Feeder is the most commonly used feeder for dry reagents except for those that absorb moisture readily and tend to become lumpy or sticky. This feeder is lower in cost than the belt type and is compact and easy to install ahead of ball mill, over a conditioner or in any part of a test plant circuit.

Three adjustments are provided for varying rate of feed—step-cone pulley drive permits speed change; an adjustable collar on hopper bottom allows full range of feed rate at each drive speed; and the scraper may be set to cut any desired width of reagent from the rotating disk.

A coarse screen across the top of the hopper prevents lumps entering when filling and stirring rod attached to the rotating disk insures a smooth gravity flow onto the disk. A rib or scraper on the underside of the rotating disk moves reagent falling into pan under disk out to spout.

The Denver (Cone Type) Laboratory Dry Reagent Feeder is of all metal construction rigidly mounted on a steel base. Rotating disk is mounted on a totally enclosed vertical speed reducer which is driven by a motor and step-cone

pulley drive. Standard motor driven unit is equipped with a 1/2 H.P. single phase, 60 cycle, 110 or 120 volt 1800 r.p.m. sleeve bearing motor. This durable construction assures dependable, trouble free operation with a minimum of attention.

Machine No.	Size	Hopper Capacity		Maximum Feed Lbs. Per Hour	Dimensions			H.P.	Approx. Ship. Wt., Lbs.	
		Cu. Ft.	Pounds Soda Ash		L	W	H		* Belt	Motor
6"	0.8	46	14.2	18"	22"	29"	3/4	95	130	
12"	1.7	97	23.9	20"	17"	43"	3/4	140	175	

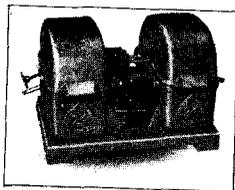
\*Belt driven unit furnished with speed reducer but without drive pulley.

NOTE: Data required to determine size and type feeder: test plant tonnage per 24 hours, name of reagent, amount fed in lbs. per ton plant feed or solution, and type of drive with electrical characteristics.

## LABORATORY FEEDER, REAGENT, WET, Denver



12" Simplex Denver Laboratory Wet Reagent Feeder with Cover Removed



12" Duplex Denver Laboratory Wet Reagent Feeder

DENVER Laboratory Wet Reagent Feeder is ideal for use in laboratory continuous test plants.

This feeder is a compact, self-contained unit mounted on a wood base. It occupies minimum space and may be conveniently placed near continuous test plant grinding or flotation circuit as required.

The Denver Laboratory Wet Reagent Feeder is equipped with a revolving disc, carrying a variable number of cups around its outer rim. Micro-meter adjustment is easily and quickly made with a convenient handwheel which moves the drip trough in or out to increase or decrease the amount of reagent caught in the trough, giving accurate control of reagent feed. The speed of the disc may be varied if desired and a float valve is provided to maintain

constant level of reagent in the tank. Adjustments have been reduced to a minimum to simplify control. Covers for tanks are furnished to keep reagent clean.

Machine Size	Maximum Capacity in c. c. per minute (Each compartment) at different peripheral speeds of disc				Tank Capacity Gallons	CUPS		Disc Dia. Inches
	*7.5 f.p.m.	11.2 f.p.m.	17.1 f.p.m.	34.2 f.p.m.		c.c. Vol. Per Each	**No. Per Disc	
No. 12	.190	.285	.428	.855	2	10.5	10	1 1/4

\*All feeders are furnished as standard for operation at this speed unless otherwise specified.

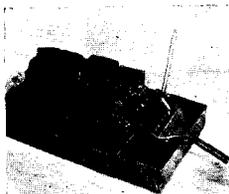
\*\*Number of cups furnished as standard.

Machine Size	No. of Compartments	Overall Dimensions			Motor H.P.	Approximate Shipping Weight Lbs.	
		L	W	H		Belt	Motor
No. 12	Simplex Duplex	18"	16"	16"	1/20	110	130
		18"	24"	16"	1/20	205	225

NOTE: Data required to determine size and type feeder: test plant tonnage per 24 hours, name of reagent, amount fed in lbs. per ton plant feed or solution, and type of drive with electrical characteristics.

### What can we do to help you?

## LABORATORY FEEDER, REAGENT, WET, Denver (Special Bent Tube Type)



Denver (Special Bent Tube Type)  
Laboratory Wet Reagent Feeder

THE Denver (Special Bent Tube Type) Laboratory Wet Reagent Feeder is a very accurate feeder for wet reagents in quantities as low as one drop per minute. It is ideal for applications where it is essential to have very exacting control of minute amounts of reagents.

This unit was developed in the Denver Ore Testing Laboratory and is available as a complete feeder, or as an attachment for converting any

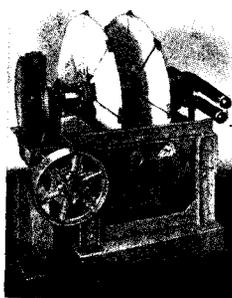
of the Denver disc type feeder mechanisms to this type feeder by removal of the cups and attachment of the dip tube. The complete unit consists of a 1/20 H.P., 110 volt, single phase, 60 cycle, sleeve bearing motor direct connected with a speed reducer with a disc mounted on the speed reducer shaft. Three dip tubes for attachment to disc are provided with each unit. Capacity of these tubes is varied by distance of inlet hole above bottom tip of tube. Tubes have capacities varying respectively from 1 to 3, 3 to 6, and 6 to 10 drops per minute. A 20 gauge riveted and soldered steel tank, supported on the end of the base by hooks so it is easily detached, stores the reagent. This simple, inexpensive unit is ideal for use in continuous testwork such as with a No. 5 or No. 7 Denver Continuous Test Plant.

Machine Size	Range of Feed Rate Drops Per Minute	Motor H. P.	Tank Cap. Quarts	*Dimensions			Approximate Shipping Wt., Lbs.	
				L	W	H	Belt	Motor
No. 1	1-10	1/20	3.92	22½"	14"	8¾"	30	45

\*Length of unit includes 3" extension of reagent discharge spout.

Use Denver Ore Tests to verify or improve your present flowsheet.

## LABORATORY FILTER, Denver Disc



Two Disc Denver Laboratory Disc Filter

DENVER Laboratory Disc Filter is an alternate to the Denver Laboratory Rotary Drum Filter and is primarily for use in continuous testing plants. However, it also has splendid application in commercial plants for testing and determining filtering capacity or selection of filtering media, etc., for continuous operation.

It consists of one or more discs rotating in a tank, on a common shaft. The discs are divided into segments and covered with a suitable filter medium and are connected through an appropriate valve assembly to a vacuum system, causing the proper segments to be under suction at the

right time. The exclusive gravity drainage feature of this filter gives the driest possible product. All filtrate drains by gravity down the grooves in the disc segment to the drainage pipe and out the valve, before discharge of the filter cake. The adjustable valve mechanism permits accurate setting of valve position to suit operating conditions. Over-size filter parts and piping provide rapid removal of filtrates. The steel filter tank is of double welded construction. The tanks for two or three disc units may be furnished with partitions for filtering several products simultaneously.

As the capacity of a filter depends largely on the nature of the material to be filtered, particularly the amount of fine material and slimes and the percent solids, preliminary tests should always be made.

Machine Size Discs	Total Filtering Area Sq. Ft.	*Cap. Lbs. Per Hour	Dimensions			H. P.		Approx. Shipping Wt., Lbs.
			L	W	H	Without Vac. Equip.	With Vac. Equip.	
2' 1	4.5	50-80	3' 0"	2' 10"	2' 8"	¼	1¾	400
2' 2	9.0	100-166	4' 0"	2' 10"	2' 8"	¼	2	550
2' 3	13.5	150-240	5' 0"	2' 10"	2' 8"	½	2¾	700
4' 1	22.0	240-320	3' 7"	5' 2"	4' 10"	¾	4¾	1300
4' 2	44.0	480-646	1' 9"	5' 2"	4' 10"	¾	6¾	1750
4' 3	66.0	720-960	7' 11"	5' 2"	4' 10"	¾	9¾	2200

\*Based on operation without thickeners and filtering 300 pounds per square foot in 24 hours. For pyritic gold, pyrite, or zinc concentrates, assume 400 lbs. per square foot. With a thickener, capacities 50 to 100% greater can be obtained.

## LABORATORY FILTER, Denver Drum



36" x 12" Denver Laboratory Drum Filter

THE Denver Laboratory Drum Filter is an ideal unit for every laboratory in working out continuous filtering problems. It will successfully dewater finely ground materials such as flotation concentrates and cyanide tailings to secure the best washing and drying of the filter cake. The filter capacity and moisture content and the nature of the cake depend upon physical characteristics of the material handled. This filter is a practical unit for continuous laboratory test plants, schools and commercial laboratories as well as pilot test plants. It is equally valuable

in industrial and chemical laboratories wherever it is necessary to save water for reuse, or dewater solids.

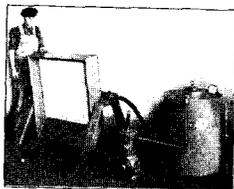
This unit has a drum cast in one piece with integral pipe connections and port which reduces first cost and maintenance cost. The pipes cast in the drum are large with steep sloping drains and no sharp corners. The drum is vacuum and pressure tight and will not warp or leak even if operated intermittently. Drum is of cast iron but can also be furnished in an alloy metal, depending upon the material to be filtered. The valve assembly consists of two sections; the valve which rotates in a heavy cast iron trunnion and carries the filtrate piping, and the valve port plate which is stationary and adjustable for regulating the filter cycle. There are two connections in the valve port. The tank is made of steel, strongly welded and with extra heavy structural supports. Filter is driven through a totally enclosed worm gear reducer which runs in an oil-tight housing.

Denver Laboratory Drum Filters, in sizes up to and including the 3' diameter x 2' length, have drums cast in one piece. Sizes larger than the 3' diameter have the drums made up of cast iron filter segments. For pilot plant operations requiring filter capacities greater than 3 tons per 24 hours, 4' and larger diameter filters are available.

Machine Size	*Cap. Lbs. Per Hour	Total Filtering Area Sq. Ft.	Dimensions			H.P.		Approx. Shipping Wt., Lbs.
			L	W	H	Without Vac. Equip.	With Vac. Equip.	
Dia. Lgth								Belt Motor
18" 6"	25-42	2.33	2'8"	2'7"	2'0"	1/4	1	380 440
18" 12"	50-84	4.66	2'8"	3'1"	2'0"	1/2	1 1/2	450 550
36" 12"	84-170	9.00	4'3"	4'3"	4'1"	3/4	2 3/4	1100 1225
36" 24"	170-250	18.00	4'3"	5'3"	4'1"	1	3 3/4	2200 2350

\*Capacities based on filtering 300 lbs. per square foot in 24 hours without thickener. For pyritic gold, pyrite, or zinc concentrates, assume 400 lbs. per square foot. With a thickener, capacities 50 to 100% greater can be obtained.

## LABORATORY FILTER, Denver Pan



Simplex Denver Laboratory Pan Filter with Vacuum Equipment

THE Denver Laboratory Pan Filter has been designed primarily to handle filtering problems requiring capacities between those of small laboratory filters and standard commercial drum or disc filters. It is an ideal unit in Denver Continuous Test Plants for filtering tailings and concentrates. The pan also has volume and area enough to serve in thickening the product to be filtered in the average No. 5 and No. 7 Denver Continuous Test Plant.

Material to be filtered is handled on a batch basis in the following manner: The pan is filled with the material to be filtered. Vacuum is applied and the cake is left on the bottom of the pan from where it is easily removed by shoveling or by tilting the pan in its trunnions. If the material is slow filtering, clear liquid may be siphoned from the pan.

For laboratory and plant use the Denver Laboratory Pan Filter is available with one or more pans and all may be operated from a common vacuum source. Vacuum equipment consists of a vacuum receiver and a heavy duty vacuum pump. The duplex pan filter, consisting of two filtering pans of equal area, is preferred where more than one product is handled simultaneously or where simulating continuous filtration of a single product. One pan can be filled while the second is finishing the filtration period and being discharged.

Filter Size	Filter Capacity Tons per 24 Hours			
	Table Concentrates	Flotation Concentrates	Cyanide Sands	Cyanide Slimes
2'x2' Simplex	5/8-1	1/2-1	3/4-1	1/2-1
3'x3' Simplex	1 1/2-2 1/2	1-2	1 1/2-2 1/2	1-2
2'x2' Duplex	1 1/4-2	1-2	1 1/4-2	1-2
3'x3' Duplex	3-5	2-4	3-5	2-4

Filter Size	Filter Area Sq. Ft.	Receiver Capacity Gallons	Dimensions			Motor H.P.	Approx. Ship. Wt., Lbs.
			L	W	H		
2'x2' Simplex	4	47	35"	34"	32"	3/4	410 520
3'x3' Simplex	9	60	47"	45"	41"	1	530 660
2'x2' Duplex	8	60	56"	34"	32"	1	810 1010
3'x3' Duplex	18	75	93"	45"	41"	2	1060 1245

## LABORATORY FILTER, Denver Pressure



Denver Laboratory Pressure Filter

WITH the Denver Laboratory Pressure Filter it is possible to dewater a great number of mill samples every day. The quantity of pulp to be filtered at each operation will determine the size best suited for your requirements.

Because of an ingenious arrangement of the yoke, it is impossible to open the filter without first releasing the air pressure. The yoke cannot be removed until the "Quick as a Wink" connection has been severed. This safety pressure type of filter is essential for use in universities, schools, and test plant laboratories. It can be used as either a vacuum or pressure filter.

Machine Size	Filter Area Sq. Inches	Volume, Gallons	Dimensions			Approximate Shipping Wt., Lbs.
			L	W	H	
6"	28 27	1 12	11"	8"	20"	95
8"	50 26	2 40	13"	10"	24"	130
10"	78 54	4 18	15"	13"	28"	167
12"	113 10	5 95	20"	18"	28"	300

**Reliable Denver Ore Tests insure your mining investment.**

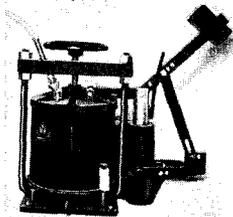


When the Denver Equipment Company was first organized, the firm specialized in the art of flotation. In improving results and in perfecting new processes, it became necessary to devote attention to other units in the flow-sheet. Thus, to improve overall recoveries, other machines were developed, until today a complete line of "Standard-Reliable-Efficient" Denver Equipment is available, from "Feeder to Dryer," for application in the mining, processing, chemical and manufacturing industries.

## LABORATORY FILTER, Denver (Counter-Balanced) Pressure

THE Denver (Counter-Balanced) Laboratory Pressure Filter is designed to handle bucket samples of mill pulps. Due to the counter-balanced mechanism, it can be operated as easily and quickly as the smaller sizes.

While the filter is being filled, the cover is held back by the weight of the counter-balance. During filtering, the yoke holds the filter medium tightly in place, forming a complete seal. Safety is assured by the "Quick as a Wink" pressure coupling which must be disconnected before the filter can be opened.



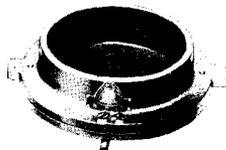
Denver (Counter-Balanced) Laboratory Pressure Filter

For removal of the filter cake, the cylinder is revolved to the side and the filter cake is completely exposed. This unit can also be used as a vacuum filter.

The ease and rapidity of filtering samples with this unit allows time for the handling of a large number of mill samples every day. This compact, efficient filter is particularly needed for use on samples where removal of moisture is difficult and slow speed is desired.

Machine Size	Filter Area, Sq. Inches	Volume, Gallons	Dimensions			Approximate Shipping Wt., Lbs.
			L	W	H	
12"	113.1	5.95	37"	18"	28"	460

## LABORATORY FILTER, Denver Vacuum



Denver Laboratory Vacuum Filter

THE Denver Laboratory Vacuum Filter consists of two castings. The upper one is the pulp container and is heavy enough to form an air seal between the filter medium and the base. Two dowel pins, which keep the castings in position, eliminate clamps and thumb screws.

The pulp to be dewatered is poured into the container, the vacuum is applied, and the solids are left in a cake on the filter paper. The filter paper and cloth are supported by a

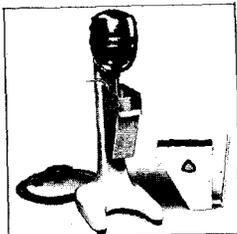
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wire screen placed over the drain grooves in the base. A tapped opening is provided for the filter connection. The filter cake can be washed if desired. A laboratory handling pulps needs a number of these inexpensive units for quick and accurate filtering.

Machine Size	Area, Sq. Inches	Capacity Volume, Gallons	Dimensions			Approximate Shipping Wt., Lbs.
			L	W	H	
12"x3"	72	0.93	16"	14"	5"	73
12"x12"	72	3.74	16"	14"	14"	98

### LABORATORY FLOTATION CELL, Denver "Sub-A" 50 Gram



50 Gram Denver "Sub-A" Laboratory Flotation Cell with Extra Tank

QUALITATIVE flotation research-testing is efficiently conducted with the 50 gram Denver "Sub-A" Laboratory Flotation Cell. General character of the ore, effect of various reagents, pulp density, alkalinity, and other conditions affecting larger scale testing can be studied. This machine is also useful in testing small samples such as concentrates obtained from other testing, mill products, and chemical by-products.

The 50 gram Denver "Sub-A" Laboratory Flotation Cell is equipped with a single phase, 60 cycle, 110 volt motor including two-speed switch. An extra enameled tank is furnished with each unit for convenience.

Additional data gladly furnished upon request.

#### LABORATORY FLOTATION CELL

Machine Size (Capacity in Grams at 4:1 Dilution)	Volume In Liters			*Approximate Ship. Wt., Lbs.		Export Volume Cu. Ft.
	Full	1" Below Lip	2" Below Lip	Domestic	Export	

\*Weights shown include Denver Laboratory Vanning Plaque Pan, Denver Alkacid Laboratory pH Indicator, and set of sample flotation reagents furnished free with each order for one or more units.

### LABORATORY FLOTATION CELL, Denver "Sub-A" 500, 1000, and 2000 Gram



500, 1000, and 2000 Gram Denver "Sub-A" Laboratory Flotation Cells

THE outstanding feature of the Denver "Sub-A" Laboratory Flotation Cell is that it is designed to incorporate the same basic principles of operation which have made the commercial size Denver "Sub-A" Flotation Machine so successful. Gravity flow is utilized. Positive feed to the recessed disk impeller with diffuser is obtained.

Variable speed is provided by a standard variable speed motor with V-belt drive. Thus slow speed can be obtained for conditioning and high speed for flotation. Adjustment of speed while machine is operating is made by simply moving a convenient lever arm.

Bearings are totally enclosed in a one-piece ball bearing shaft assembly. This assures trouble-free operation.

All corners are rounded to prevent salting and tank interior has baked enamel finish. Spigot is provided on side of cell for withdrawing pulp sample during operation. Glass side can be furnished to permit observation of froth condition during testing.

With each order of one or more laboratory flotation cells is included a set of sample reagents, Denver Vanning Plaque, and a Denver Alkacid Tester.

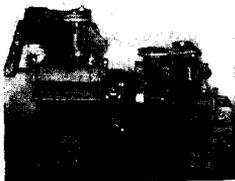
More complete information can be obtained by writing any Denver Equipment Company office.

Machine Size (Capacities in Grams at 4:1 Dilution)	Volume In Liters			Motor H.P.	* Approximate Shipping Wt., Lbs.		Export Volume Cu. Ft.
	Full	1" Below Lip	2" Below Lip		Domestic	Export	
1000	5.15	4.46	3.81	3/4	255	270	10
2000	10.88	8.78	7.43	3/4	340	365	11

\*Weights shown include Denver Laboratory Vanning Plaque Pan, Denver Alkacid Laboratory pH Indicator, and set of sample reagents furnished free with each order for one or more units.

Mill design and Flowsheet design are also services of Denver Equipment Co. Write for details how these services might help you.

## LABORATORY FLOTATION CELL, Denver "Sub-A" Unit



No. 7 and No. 5 Denver "Sub-A" Laboratory Unit Flotation Cells

IN laboratory continuous test plants it is often desirable to use a Denver "Sub-A" Laboratory Unit Flotation Cell in the ball mill-classifier circuit to remove coarse free mineral before it has a chance to become slimed or coated with colloids. A single cell of the Denver "Sub-A" Laboratory Flotation Machine is well suited for this application. It is of unit construction and

will handle coarse, high density pulps such as those normally discharged from a laboratory ball mill.

When using a Denver "Sub-A" Laboratory Unit Flotation Cell in the grinding circuit it is advisable to install an 8 or 10 mesh trommel screen on the ball mill discharge in order to remove tramp oversize. This will assure a steady operation even when handling small volumes of pulps normally encountered in laboratory test plants.

The No. 5 Denver "Sub-A" Laboratory Unit Flotation Cell is recommended for the No. 5 Denver Continuous Test Plant, and the No. 7 for the larger No. 7 Denver Continuous Test Plant. These cells may also be used in the regular flotation circuit if desired.

Machine Size	Cell Capacity Per Hour Lbs.	Effective Cell Volume Liters	Height Feed Inlet	Height Discharge Outlet
No. 5	100	6-7	4"	7"
No. 7	200	24-26	4 3/4"	9 5/8"

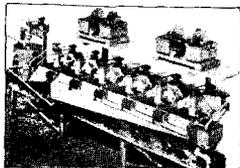
Machine Size	Cell Dimensions			H.P. Motor	Approximate Shipping Wt., Lbs.	
	L	W	H		Without Motor	With Motor
No. 5	17"	21 3/4"	26"	1/4	220	260
No. 7	22"	30 1/2"	32"	1/2	450	500

**A Denver Mineral Jig or Denver "Sub-A" Unit Flotation Cell In Your Grinding Circuit Will Recover Mineral As Soon As Free.**

## LABORATORY FLOTATION MACHINE, Denver "Sub-A" No 5 and No. 7



4-cell No. 5 Denver "Sub-A" Laboratory Flotation Machine



6-Cell No. 7 Denver "Sub-A" Laboratory Flotation Machine, Denver (Patented) Laboratory Conditioner and Super-Agitator and Laboratory Wet Reagent Feeders

THE Denver "Sub-A" Laboratory Flotation Machine is used for continuous laboratory test work and small pilot plants. It is similar to the standard commercial machines as far as basic design is concerned; however, it is built in single cell units to allow greater flexibility in testing. Tests made with this unit in the laboratory can be duplicated with large scale units in plant operation, and this fact has made the Denver "Sub-A" Laboratory Flotation Machine universally accepted in commercial, government and educational test plants.

Continuous test work is of prime importance and is the link between early batch testing and commercial plant installation. Many large operators maintain a small continuous test plant as a pilot for the main production unit.

It is essential therefore that test or pilot plant results be duplicated in parallel units. Incorporated in both No. 5 and No. 7 Denver "Sub-A" Laboratory Flotation Machines are the same basic principles and advantages as are available in their larger counterparts—gravity flow, pulp level control, and extreme flexibility.

The cells are cast individually and equipped with easily adjustable pulp level control and froth removal paddle. Any cell can be used for roughing, cleaning or recleaning as there is a feed or middling return connection to the impeller at the front of each cell.

Ordinarily these flotation cells are used in series of four or more units and when incorporated in a continuous plant, the tied-up middling product problem is eliminated. Accurate results are assured as the cells are built with rounded corners for quick and easy draining and cleaning through convenient drain outlets.

Belt drives for these machines are quarter twist drive with V-belts, sheaves, jackshaft and jack supporting framework. Motor drives are individual for each cell through V-belts.

The effective volume of these machines, using water as pulp and operating with air on a pulp level 2" below the lip, is 7,460 cc., (7.46 liters) for the No. 5 and 28,200 cc., (28.2 liters) for the No. 7. In actual operation, with normal reagents and pulps, the effective volume based on operating pilot and test plants is only slightly lower.

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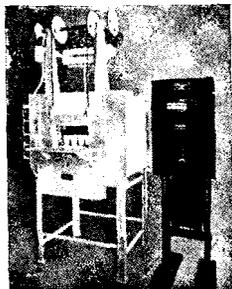
For test or pilot plants where greater capacity is required, No. 8 or No. 12 Denver "Sub-A" Flotation Machines are usually used. Details on the No. 12 Denver "Sub-A" Flotation Machine may be found under Flotation Machine, Denver "Sub-A."

Machine Size	6-Cell Machine Capacity Lbs. Per Hour	Effective Volume Liters/Cell	Height Feed Inlet	Height Discharge Outlet
No. 5	100	6-7	4"	7"
No. 7	200	24-26	4 3/4"	9 5/8"

Machine Size	Cell Dimensions			Overall Dimensions 6-Cell Machine			*Motor H.P.	Approx. Ship. Wt., Lbs. Per Cell	
	L	W	H	L	W	H		Belt	Motor
No. 5	17"	21 1/2"	26"	6'10 3/8"	1'9 1/2"	2'11 5/8"	1/4	220	260
No. 7	22"	30 1/2"	32"	9' 0 1/4"	2' 6 1/2"	2'7 7/8"	1/2	450	500

\*Motor driven machines have each cell equipped with individual motor drive which provides a maximum of flexibility for laboratory or pilot plant use.

### LABORATORY FURNACE, ASSAY, Denver (Electric)



Denver (Electric) Laboratory Assay Furnace

THE Denver (Electric) Laboratory Assay Furnace provides absolute, constant control of temperature, as well as positive control of atmospheric conditions. It is economical, clean, noiseless and no muffles are required. Off-peak power is frequently used, resulting in low operating cost.

Heating elements are U-shaped bars of nickel chromium, connected in series by nickel strips and iron clips for good contact. With the automatic control provided, there is no danger of overheating or burning out parts.

No muffle is required as the furnace is of the open type. Crucibles and cupels are supported on a crucible hearth of extremely high thermal conductivity. Low sides and back wall protect the bottom heating elements in case of spills.

Furnace lining is composed of specially designed refractory blocks, enclosed in a jacket of high-temperature insulating brick 4 1/2" thick. This, in turn, is surrounded by a thick layer of low-temperature insulation and steel jacket.

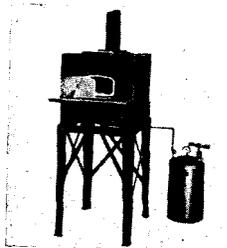
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Air is drawn into the furnace, and fumes carried from it, by means of an electric exhaust fan, or by natural draft operating through a manifold at the rear of the furnace.

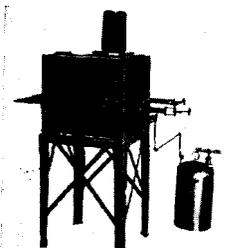
Denver (Electric) Laboratory Assay Furnace is available in four models; choice of manual or automatic control of temperature, manual or electric door operation, forced or natural draft in the ventilating system.

Capacity Crucibles		Heat Chamber Dimensions			Overall Dimensions			KW Power Consumption	Approx. Ship. Wt., Lbs.	
20 gm	30 gm	L	W	H	L	W	H		Domestic	Export
35	24	25"	16 1/4"	7 3/4"	50 3/4"	47 1/4"	98"	15-25	3400	3600

### LABORATORY FURNACE, ASSAY, Denver (Muffle Type, Gasoline)



Denver (Muffle Type, Gasoline) Laboratory Assay Furnace



Side View of Denver (Muffle Type, Gasoline) Laboratory Assay Furnace

THE Denver (Muffle Type, Gasoline) Laboratory Assay Furnace is ideal where a light, easily portable, and compact furnace is desired. Type 481 in this series is the lightest assay furnace with which dependable results are obtainable. Stand and clay-lined pipe have been omitted on this type to reduce weight to a minimum for prospecting. Each of the other units is furnished with stand, burner, tank, pipe and fitting, one clay-lined pipe and a muffle.

The Denver Gasoline Burner which is supplied with this furnace is of the double injector type and gives the quickest and highest possible heat. The air pump on the gasoline tank is built inside the tank which makes a strong and compact unit. All tanks, except the small one supplied with Type 481, are equipped with pressure gauges.

Complete data and estimates on assay and test equipment will be gladly furnished. Let us make recommendations for your proposed installation.

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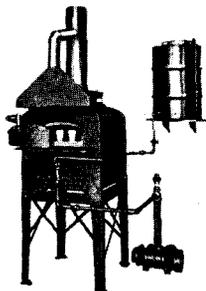
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Model No.	Crucible Capacity		Cap. Gas. Gals.	Outside Muffle Dimensions, Inches			Floor Space Inches		Approx. Ship. Wt. Lbs.
	No.	Size		L	W	H	L	W	
481	6	10 Gram	5	10	6 1/2	4 1/2	13	18	185
483	8	20 Gram	10	12	8 1/2	5 1/2	20	21	570
484	15	20 Gram	10	16	10 1/4	6	23	24	720
485	20	20 Gram	10	18	15 1/4	7	28	28	885

### LABORATORY FURNACE, ASSAY, Denver. (Muffle Type, Oil)



Type 4411 Denver (Muffle Type Oil)  
Laboratory Assay Furnace—Low  
Pressure



Type 4411 Denver (Muffle Type, Oil)  
Laboratory Assay Furnace

WHERE economy, efficiency, large capacity operation and quick results are required, oil has proved to be an ideal fuel for assay furnaces. With the Denver (Muffle Type, Oil) Laboratory Assay Furnace a fusing heat is obtainable in 30 minutes and reducing or oxidizing atmospheres can be maintained absolutely. Three sizes of muffles have been standardized and these are built in one, two, and three muffle combinations for safe shipment and convenience in assembling. Any number of units up to twelve can be connected to one large blower and to one oil supply, thus reducing the unit cost of large batteries of furnaces. Each installation is equipped with its own motor blower, thus rendering it independent of any other equipment about the plant. The control of the burner is positive and variable and exact adjustments are possible.

DENVER Low Pressure (Muffle Type, Oil) Laboratory Assay Furnace is designed for installation wherever 50 or 60 cycle electric current is available for blower motor.

DENVER Medium Pressure (Muffle Type, Oil) Laboratory Assay Furnace is designed to give assayers who are without

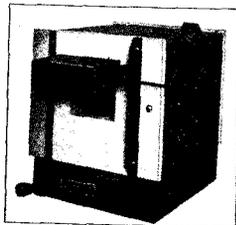
50 or 60 cycle current the advantages of a fuel oil furnace. One of the most efficient combinations is the positive pressure belt driven blower that can be connected to any lineshaft or gasoline engine. As many assayers prefer medium pressure burners, the belt driven blower can be

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replaced with a blower of the same type and capacity, but with a standard speed motor equipped with V-belt drive.

Model No.	Number of Muffles	Cap. Number 20 Gram. Cruc.	Outside Muffle Dimensions, Inches			Floor Space Inches		Low Pressure Motor Blower		Med. Press. Ship. Wt. Lbs.	Approx. Lbs.
			L	W	H	L	W <sub>2</sub>	Type	H.P.		
								1 1/2	1 1/2		
4410	1	18	20 1/2	12 1/4	8	32	28	125	1 1/2	2180	1910
4410	2	36	20 1/2	12 1/4	8	32	57	250	1 1/2	2705	3435
4410	3	54	20 1/2	12 1/4	8	32	86	250	1 1/2	5890	5715
4411	1	24	21	14 3/4	7 3/8	32	30	125	1 1/2	2400	2130
4411	2	48	21	14 3/4	7 3/8	32	63	250	1 1/2	4385	4115
4411	3	72	21	14 3/4	7 3/8	32	93	250	1 1/2	6310	6135
4412	1	30	25	17 1/4	9 1/8	34	33	250	1 1/2	2670	2400
4412	2	60	25	17 1/4	9 1/8	34	68	250	1 1/2	4960	4650
4412	3	90	25	17 1/4	9 1/8	34	103	250	1 1/2	7080	6950

### LABORATORY FURNACE, MUFFLE, Denver (Electric)



Denver (Electric) Laboratory Muffle  
Furnace

GENERAL laboratory work such as fusions, ignitions, heating metals and alloys is efficiently done in this furnace. It is also useful in a testing laboratory for roasting concentrates and mill products prior to cyanidation or other treatment.

This furnace is of the muffle type. There are four heating units in the furnace, each consisting of a heating coil supported in grooves of a refractory plate. The top and bottom units are interchangeable, like-

wise the two side units. Safe working temperature is 1750° F, but for intermittent periods of short duration the furnace may be operated at a maximum temperature of 1850° F. By means of a selective connection at the rear of the furnace either 115 or 230 volts A.C. or D.C. may be used.

Control of temperature at any point between 1000° F and the maximum of 1850° F may be supplied by a separate rheostat or by one built integral with the furnace. This unit can also be furnished with a special indicating pyrometer to provide an easy means of reading heating chamber temperature if desired.

(Continued on next page)

**May We Please Work With You On All  
Your Equipment Needs?**

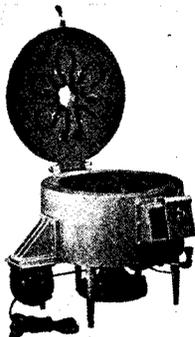
(Continued from preceding page)

*Type No.	Number Of Crucibles	Crucible Size Grams	Dimensions Heating Chamber			Watts Power Consumption	Floor Space Inches		** Approx. Ship. Wt. Lbs.
			L	W	H		L	W	
51	6	10	8"	5 1/4"	3 3/4"	1150	14"	13 3/4"	95
52-62	4	5	10"	4 1/2"	3"	1440	17 1/2"	14"	107
54-64	8	10	12"	5 1/2"	3 3/4"	1880	19 1/4"	15 1/2"	148
56-66	8	20	14"	7 1/2"	5 1/4"	3400	22 1/2"	19"	240

\*Types No. 62, 64, and 66 have rheostat integral.

\*\*Approximate shipping weight includes rheostat.

## LABORATORY FURNACE, ROASTING, Herreshoffing Unit



Herreshoffing Unit Laboratory Roasting Furnace—Electrically Heated

IN order to meet the demand for a very small roasting furnace for the purpose of conducting laboratory tests, there has been developed the Herreshoffing Unit Laboratory Roasting Furnace. It is a self-contained apparatus including all of the necessary factors for making small volume tests.

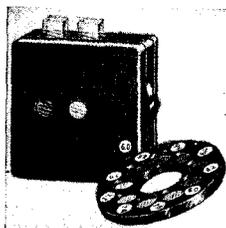
This unit has proved itself a valuable device and excellent results have been obtained in the roasting of ores, the re-activation of oil filtering media, the calcination of limestone and the heat treatment and drying of other materials.

Standard equipment provided with this unit includes a 1/20 H.P., 110 volt, 60-cycle motor driving blower, gas burner and a 3" diameter by 24" long stack with damper. However, the Herreshoffing Unit Laboratory Roasting Furnace is so designed that an electrical heating element can be attached at any time.

This unit is compact, light and efficient and is an extremely useful item for any ore dressing laboratory. Detailed information will be promptly furnished on request.

Type	Inside Diam.	Outside Diam.	Height	Approximate Ship. Wt. Lbs.	
				Domestic	Export
Gas Fired Unit	13"	18 1/4"	18 1/4"	40	50
Electrically Heated Unit	13"	18 1/4"	18 1/4"	35	45

## LABORATORY INDICATOR, pH, Denver



No. 605-H Denver Laboratory pH Indicator Showing Color Wheel

THE control of pH is recognized as an important factor in both batch and continuous laboratory testwork.

Colorimetric pH control is widely used because of its simplicity which allows its use without technical training. The only requirement is that the operator be able to match colors, making it possible for the average worker to obtain accurate results.

The No. 605-H Laboratory pH Indicator is enclosed in a durable, corrosion-resistant housing. Compartments for all parts: color disc, two square tubes, a pipette, and indicator reagent, are provided.



Block-L Denver Laboratory pH Indicator

The Block-L, Utility-L, and Roulette-L Laboratory pH indicators are simple, compact units for a wide range of standard pH readings. The Roulette-L Indicator is equipped with artificial daylight reading for night operation.

## LABORATORY pH INDICATOR (Continued from previous page)

For recommendations as to equipment for a specific problem, give range of pH values to be determined and nature and characteristics of material. Let us recommend the unit best suited to your particular problem.

Model H No.	Range No. of Stds.	pH Range	Light Source	Overall Dimensions		
				L	W	H
605-H	21	0.2-13.6	Daylight Inc. Mazda	3 3/4"	1 1/2"	3 3/4"
607-H	21	0.2-13.6		3 3/4"	4 3/4"	3 3/4"

Model L	Range No. of Stds.	pH Range	Accuracy	Light Source	Dimensions		
					L	W	H
Block-L	20	0.2-13.6	0.20pH	Daylight Inc. Mazda	8"	2"	5 3/4"
Roulette-L	20	0.2-13.6	0.10pH		26"	26"	16"
Utility-L	20	0.2-13.6	0.25pH		13"	13"	8"

## LABORATORY INDICATOR, pH, Denver Alkacid

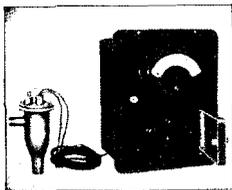


Denver Alkacid Laboratory pH Indicator

DENVER Alkacid Laboratory pH Indicator gives a quick, simple measurement of pH of liquids within a range of pH 2 to pH 10 with an accuracy of  $\pm 1$  pH. The indicator consists of a spool of  $\frac{1}{4}$  inch test paper enclosed in a transparent plastic cover  $2\frac{1}{2}$  inches in diameter. Mounted on the cover is a color chart showing the five distinct color changes that the paper undergoes at the various pH ranges.

The unit is supplied filled with one fifteen foot roll of test paper, and rolls for refill are readily available.

## LABORATORY INDICATOR, pH, Denver Electric



Model R Electric Laboratory pH Indicator

THE Electric (Hydrogen Ion) Laboratory pH Indicator with glass electrodes, provides a quick method of determining and controlling acidity or alkalinity. Accurate pH determination can be made with ease on practically all substances, regardless of color, suspended solids, colloids, and oxidizing or reducing agents present. Such outstanding flexibility makes this unit ideal for laboratory testwork.

The pH readings by this unit are positive and extremely accurate due to their being true readings of the hydrogen ion content of the solutions being tested. Readings are more accurate than by color comparison. Unit is equipped with reference electrodes of the saturated potassium chloride-camelot type, and rugged factory sealed glass electrodes. The accuracy of this indicator is unaffected by vibration or electro-static disturbances and a built-in temperature compensator automatically adjusts

for a wide range of temperature variations. Indicator consists of the electrode system and a compact case which houses the registering devices and instruments.

In addition to units for pH measurements on laboratory samples, models are available for continuous pH measure-



Model G Electric Laboratory pH Indicator

ment and recording for continuous or pilot test plants, which are simulating operation of commercial plant.

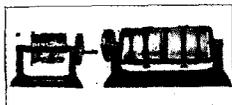
Units are furnished with operating instructions and various accessory materials such as 100 milliliters of saturated potassium chloride solution and 1 pint of concentrated buffer solution.

This indicator is widely used in ore dressing, chemical, and all types of industrial laboratories. Let us make definite recommendations as to the equipment required for your specific laboratory problems.

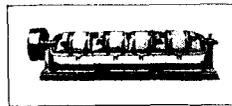
Model	Use	pH Range	Accuracy	Dimensions			Approx. Shipping Wt., Lbs.
				L	W	H	
G	Laboratory	0-13	.01 pH	9"	11 $\frac{1}{2}$ "	11"	31
M	Intermittant or Continuous	0-14	.05 pH	9 $\frac{3}{4}$ "	13 $\frac{3}{4}$ "	9"	37
R	Continuous	0-7	.10pH	12"	13"	16 $\frac{1}{2}$ "	85
		3-10	.10pH	12"	13"	16 $\frac{1}{2}$ "	85
		6-13	.10pH	12"	13"	16 $\frac{1}{2}$ "	85

*Recover Your  
Minerals  
as Soon as  
Free*

## LABORATORY JAR MILL, Abbe



Abbe Laboratory Jar Mills—Style M  
Single and Double Units



Abbe Laboratory Jar Mill Style M  
Quadruple Unit

THE Abbe Laboratory Jar Mill pulverizes materials by friction and the fall of pebbles or balls contained within a rotating jar. In operation the jar is filled almost to the center plane with pebbles, and enough crushed material is added to fill the interstices between the pebbles and bring the charge to about 3/5 of the capacity of the jar. Usually a coarse screen is used to separate the pebbles from the material after grinding.

This unit is particularly adapted to pulverizing and

mixing dry or wet materials and is manufactured in many sizes and styles for various capacities and conditions. Number of jars handled varies with mill size.

Jars are manufactured in many sizes and are of the best material. The three kinds available are: (1) Porcelain Jars—carefully molded and fired to obtain the proper degree of vitrification so as to give acid and wear resisting qualities for grinding and agitation. (2) Metal Jars—made of the metal most resistant to the action of a grinding charge, such as Monel, stainless steel, cast steel, and bronze. (3) Pyrex Jars—are transparent and enable observation during grinding or agitating action.

Jar Types and Sizes	Out-side Diam. Inches	Height Inches	Total Volume In Gallons	*Grinding Charge			Speed R.P.M.
				Sand Lbs.	Pulp Gals.	Pebbles Lbs.	
Sample	5.2	5.71	0.283	1½	0.17	2	80-100
Abco	5.75	6.5	0.33	2	0.20	2½	80-90
Trojan	8.75	9.65	1.387	5	0.83	8	60-70
Ajax	12.5	9.6	2.5	10	1.5	16	40-50
Jar "A"	13.0	12.5	4.0	15	2.4	25	40-50
Jar "B"	14.75	16.5	6.6	25	4.0	45	40-45
Jar "C"	11.13	13.63	4.0	15	2.4	25	40-50
Jar "D"	22.5	24.63	25.0	85	15.0	150	30-40
No. 1 Eureka	17.72	10.0	7.66	30	4.6	50	40-45
No. 2 Eureka	17.72	18.7	15.6	60	9.4	100	40-45
No. 3 Eureka	22.5	19.0	23.8	80	14.3	150	30-40
No. 4 Eureka	24.0	46.5	60.3	180	36.0	400	30-40

\*Either sand or pebbles may be used as a grinding medium and pulp capacity shown is in addition to quantity of whichever grinding medium is desired.

## LABORATORY JAR MILL, Denver

THE Denver Laboratory Jar Mill is ideal for use in pulverizing, mixing of dry and wet materials, and agitation of all types of pulps. Two large bottles or as many as six small

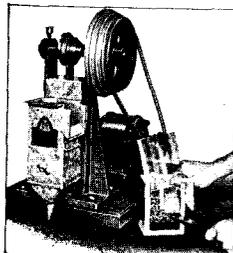


Denver Laboratory Jar Mill

Low initial cost and reliable operation make this machine a desirable unit for laboratories of any size.

Machine Size Inches	Number of Rollers	Roller Length Inches	Dimensions			Motor H.P.	Approx. Shipping Wt. Lbs.
			L	W	H		
24	2	24	42"	24"	11"	¼	290
24	4	24	44"	30"	11"	¼	360
48	2	48	66"	24"	11"	¼	400
48	4	48	66"	30"	11"	½	520

## LABORATORY JIG, Denver (Harz Type)



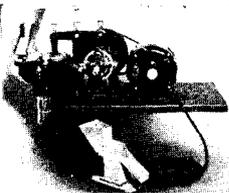
Denver (Harz Type) Laboratory Jig  
with Hopper Removed

THERE are many ores, such as zinc, lead, iron, and fluor-spar which can be treated economically in jigs handling very coarse feeds; either to make a high grade concentrate or to discard a coarse, clean tailing. The Denver (Harz Type) Laboratory Jig accurately tests the possibilities of such an ore.

The entire screen compartment is removable at the end of a test, and has a glass side, through which the bedding can be observed. By removing the glass, it is easy to separate the concentrate, middling, and tailing layers for analysis. The speed and the length of the plunger stroke are adjustable through an eccentric and a 4-step cone pulley.

Machine Size	Capacity Lbs. Per Hour	Dimensions			Motor H.P.	Approx. Ship. Wt., Lbs.	
		L	W	H		Belt	Motor
No. 1	18-24	25"	15"	25"	¼	100	120

## LABORATORY JIG, Denver (Selective) Mineral No. 1M



No. 1M Denver Laboratory (Selective) Mineral Jig (Low Dilution Type) with Extra Hopper

DENVER Laboratory (Selective) Mineral Jig, No. 1M, is a laboratory unit built in the same manner as the commercial Denver (Selective) Mineral Jig. The rotating water valve, timed to admit water only on the plunger up-stroke, is on the end of the eccentric shaft. The shaft is mounted on two adjustable bearing stands with bronze bushed bearings and the eccentric itself is adjustable.

A sturdily constructed walking beam mechanism actuates the plunger which is sealed with a rubber diaphragm.

The construction of the screen compartment differs from that of the commercial unit in that the entire top part of the jig is removable, which makes for ease of cleaning in the laboratory. Two wing nuts hold the compartment in place and allow its quick removal, while a gasket makes the seal watertight.

The hutch compartment is cast iron, which is sand blasted and finished with baked enamel so that no crevices or pockets will remain to salt the next test. Two removable screen compartments are furnished, each with a different sized screen and the necessary bedding material. The spare compartment is shown in the foreground of the illustration.

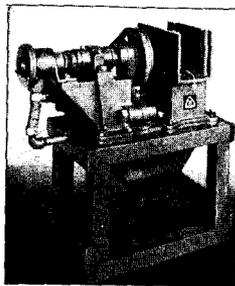
The concentrates fall into a detachable glass jar which screws against another gasket. This feature is of great assistance as the type of product is readily inspected as it accumulates and the necessary adjustments can be made without the necessity of re-running the sample. The possibility of salting at this point is eliminated by the opening in the bottom of the hutch extending through the gasket into the neck of the jar. To release entrapped air from under the diaphragm at the beginning of each run, a small air cock is provided. A siphon arrangement is provided by which the water remaining in the hutch can be drained to a level below the neck of the jar. Thus the jar can be removed without spilling. The jig has a screen size of 1½" by 2¼" and it is designed for use with batch samples as small as 2,000 grams. A sample of this size can be jigged with a resulting pulp which will require additional dilution or subsequent flotation test. Thus no dewatering will be necessary between these two tests. Since cast iron is used throughout, cyanide solution can be fed to the unit instead of water when desired.

The No. 1M Denver Laboratory (Selective) Mineral Jig is ideal for use in the grinding circuit of a No. 5 Denver Test Plant. It may also be used in the No. 7 Denver Test Plant when handling high ratio ores.

(Continued from previous page)

Machine Size	Capacity Lbs. Per Hour	Dimensions			Motor H.P.	Approx. Ship. Wt., Lbs.	
		L	W	H		Belt	Motor
No. 1M	20-25	24"	14"	17"	¼	75	105

## LABORATORY JIG, Denver (Selective) Mineral 4"x6"



4"x6" Denver Laboratory (Selective) Mineral Jig (Low Dilution Type)

DENVER Laboratory (Selective) Mineral Jig, size 4"x6", is between the commercial size 8"x12" Simplex Denver (Selective) Mineral Jig and the No. 1M Denver Laboratory (Selective) Mineral Jig, due to its applicability to both commercial and test work.

Although the 4"x6" Denver Laboratory (Selective) Mineral Jig is ideal for many uses in commercial work, it also has considerable merit as a unit for use in pilot mill operation and in large batch laboratory tests. It is suited for non-metallic or open-circuit work in the laboratory, especially

where a large quantity of concentrate must be obtained. This size jig is most desirable for trial installation in large tonnage mills to determine the desirability of a jig in the circuit, as it can operate on small quantities of material of the same size as that handled by the commercial size jig.

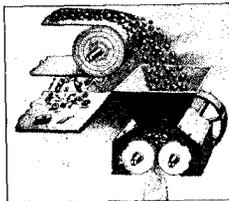
The 4"x6" Denver Laboratory (Selective) Mineral Jig has a single hutch compartment and a reversible screen compartment constructed of cast iron so that cyanide solutions can be fed to the unit instead of water when it is desired.

The rotating water valve is timed to admit water only on the plunger up-stroke and is located on the end of the eccentric shaft. The eccentric shaft is mounted in a ball-bearing double-pillow-block type bearing. An adjustable eccentric is used for varying the movement of the rubber diaphragm. The upper trash screen consists of a four mesh woven-wire cloth. Two lower wedge-bar screens are furnished with each jig, one with 2 millimeter openings and the other with 5 millimeter openings.

When the jig is used on continuous tests a steel stand is recommended for mounting of the jig. The steel stand is arranged with a shelf for holding a glass jar which accumulates the jig concentrate as it discharges from the hutch. The jar allows the inspection of jig product during test.

Machine Size	Capacity Pounds Per Hr.	Steel Stand	Dimensions			Motor H.P.	Approx. Ship. Wt., Lbs.	
			L	W	H		Belt	Motor
4"x6"	150-500	With	18"	26"	46"	¼	290	315
4"x6"	150-500	Without	18"	23"	24"	¼	175	200

## LABORATORY MAGNET, (Pulley or Suspended Type)



(Pulley Type) Laboratory Magnet

MAGNETS of the suspended or magnetic pulley type are often advisable for use with continuous pilot test plants as the occurrence of such foreign materials as tramp iron are not unusual in ore being tested on a large scale. The use of magnets will frequently prevent otherwise expensive and troublesome breakage in the crusher or damage to crushing rolls, with resultant shutdown and loss of testing time.

The (Suspended Type) Laboratory Magnet is usually placed above the ore conveyor preceding the jaw crusher. Width of conveyor belt, depth of ore being conveyed and average percent of foreign material to be eliminated determine the size of magnet required. This type magnet is furnished either circular or rectangular.

The high intensity (Pulley Type) Laboratory Magnet is one of the most practical, satisfactory, and economical magnets in use today. Used as the head pulley of a conveyor, the shaft of the magnetic pulley can very often be made to correspond with the shaft of the original pulley. It is only necessary then to place the magnetic pulley into the existing bearings. Magnetic pulleys are wound for either 110 or 220 volts and are furnished for direct current only. Rectifiers are available to enable use of alternating current.

Let us make recommendations for your continuous laboratory or pilot test plant.

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Denver Ore Tests are made on an "actual cost" basis. This brings the world's finest laboratory equipment and skilled technicians to your service at a very low cost.

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## LABORATORY MAGNET, Denver Alnico Horseshoe



Denver Alnico Laboratory Horseshoe Magnet

THE Denver Alnico Horseshoe Laboratory Magnet is a small extremely powerful hand magnet. It is an alloy of aluminum, nickel and cobalt, and is many times stronger than the ordinary horseshoe magnet. It is extremely resistant to demagnetization and is affected only slightly by shock or temperatures as high as 1200°F. This magnet provides an invaluable tool for the assayer, mineralogist, and

test plant operator. Minerals that are even moderately magnetic may be separated from non-magnetic material with this magnet and it is small and light enough to carry about in your pocket.

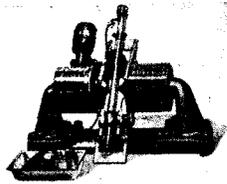
Size	Dimensions			Approximate Shipping Wt., Lbs.
	Height	Width	Thickness	
Small	1 1/4"	1 1/2"	3/4"	1
Large	1 3/4"	1 3/4"	3/4"	1
Extra Large	1 1/2"	2 1/4"	3/8"	1



May We Please Work With You On All Your Equipment Needs?

## LABORATORY MAGNETIC SEPARATOR, Dings-Davis Tube Tester

THE Dings-Davis Laboratory Magnetic Tube Tester Separator has been accepted as standard for determinations of magnetic content of ores and for checking efficiencies of wet separators. It is applicable to highly magnetic material such as magnetite, powdered iron, flue dust and ferro-silicon. The grade of concentrate that can be produced at any mesh size is quickly determined with this apparatus.



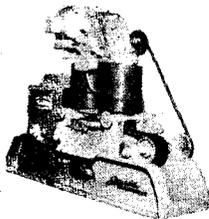
Dings-Davis Laboratory Tube Tester  
Magnetic Separator

The tube tester consists of an electro-magnet, between the poles of which a glass tube is set at an angle of approximately 45°. The tube is supported by an agitating mechanism which is agitated by a small universal electric motor. The tube is simultaneously rotated and agitated between the magnetic poles when the apparatus is in operation.

Let our engineers make recommendations for the type and size magnetic separator units best suited to your problems.

Direct Current Watts Required	Approximate Shipping Wt., Lbs.
210	500

## LABORATORY MAGNETIC SEPARATOR, Stearns (Ring Type)



Stearns (Ring Type) Laboratory  
Magnetic Separator

THE Stearns (Ring Type) Laboratory Magnetic Separator differs materially from the cross belt type; a steel take-off ring is employed in place of belts, to carry the magnetic material beyond the conveyor belt to final delivery. The laboratory unit is popular in many types of ore testing for treating small quantities of material for the recovery of feebly magnetic minerals. Standard accessories include rheostat, ammeter and switch, all mounted on a switch panel.

No. of Poles	Belt Width	Approximate Capacity Lbs. per Hr.	Dimensions			Watts D.C.	Approximate Shipping Wt., Lbs.
			L	W	H		
2	2½"	150	33"	20"	30"	440	450
2	6"	400	88"	36"	66"	440	1750

## LABORATORY MICROSCOPE, Denver



Denver Laboratory Microscope for  
Preliminary Inspections and Mill Use

QUICK determination of a sample can often be made by means of a microscope. Over-all losses can be reduced even in a flotation circuit by examining the various test plant products with a microscope without waiting for the return of assays.

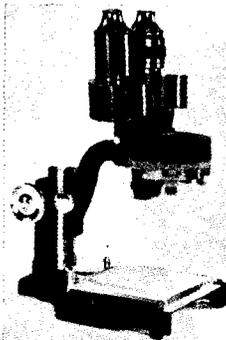
The general purpose microscope is also being extensively used to determine the association of minerals by examining the polished surface made with a Denver Laboratory Specimen and Rock Cutter. Denver Equipment Company carries a line of practical, inexpensive microscopes to supply the needs of mill laboratories and

prospectors. These simple microscopes are available with magnifications ranging from 30 to 300 diameters. Fitted for examining either opaque or transparent objects, types with or without stages and stands may be obtained.

By eliminating accessories such as iris diaphragms, Abbe condensers, and fine focusing adjustments, these microscopes are made obtainable at very low cost although built along the lines of larger microscopes.

Inspection microscopes are also available for examination of surfaces, cutting edges, and cut sections of metals.

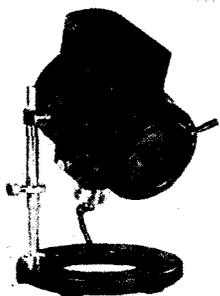
## LABORATORY MICROSCOPE, Denver Binocular



Denver Binocular Laboratory Micro-  
scope With Vertical Body

THE Denver Binocular Laboratory Microscope, because of its depth of focus and wide field, clearly brings into prominent view features not otherwise observed with the ordinary monocular microscope. It is for this reason the binocular microscope is considered standard equipment in mill control and ore dressing research laboratories.

This microscope has a removable glass stage and the arm may be lowered to a point where, with the glass stage removed, it may focus on any portion of a large area which the instrument is placed upon. It may be equipped with paired eye pieces and objectives to obtain magnifications



Denver Laboratory Microscope Lamp

from 3.6 up to 210.0 times. Magnifications of 39.1 and 115.6 are recommended and in general will fill the requirements of the average laboratory investigating minerals and mill products.

In locations where a bright light is not available a microscope lamp, as shown in the illustration, is recommended.

The lamp uses a 100 watt, 115 volt bulb and condensing lenses project the light as a brilliant spot onto the microscope field. The size and intensity of the spot of light is controlled by moving lamp in sideway and by a diaphragm.

*Model No.	Magnification Range	Stage Dimensions		**Dimensions Extended			Approx. Shipping Wt. Lbs.
		L	W	L	W	H	
56	7.5 X 3.6X-21.2X 6.0X-39.1X	2½"	2½"	7½"	6"	12"	13.5

\*Furnished with vertical binocular body—inclinocular body available.

\*\*Model No. 55 same as No. 56 except that unit is equipped with base, inclination joint and mirror which are easily removable. Add 4" to height for base.

## LABORATORY MINERALIGHT

—See MINERALIGHT

## LABORATORY PAN, Denver Vanning Plaque



Denver Vanning Plaque Laboratory Pan—White Baked Enamel Finish

THE Denver Vanning Plaque Laboratory Pan was originally designed by Professor Richards and has found wide acceptance for panning small amounts of fine material. The surface is white, with baked enamel finish. This unit is especially useful for laboratory work in studying the products from concentration tests. It is available in one size only and shipping weight is one pound.

## LABORATORY PULVERIZER, Denver-McCool

THE Denver-McCool Laboratory Pulverizer is an economical, simple, durable, and amazingly rapid and efficient disc type grinder. It is designed for grinding virtually any material and will produce a fine mesh sample in one operation. This unit



Denver-McCool Laboratory Pulverizer with Hinged Housing for Grinding Mechanism Swung Open to Show Grinding Discs

is particularly adapted for use by assay offices and metallurgical, chemical, and industrial laboratories.

This pulverizer is the only self-contained laboratory grinder which has both a vertical and a horizontal planetary movement. Thus the rotating disc always has the

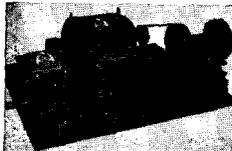
proper angular curvature with relation to the stationary disc. This feature is particularly desirable due to the greatly lengthened life of wearing parts and the unusual uniformity of the final product.

The revolving disc is attached by a ball-and-socket joint with spring tension. This enables the disc to automatically align itself with the stationary disc. The constant contact of the two discs tends to perfect the crushing efficiency as evidenced by uniformity of product and high capacity of this pulverizing unit.

The main shaft is hollow. Located eccentrically within it is the disc driving shaft which, through the range of gearing, has a much greater speed than the pulley speed. The resultant high speed of the rotary disc accounts in a large measure for the exceptional capacity and fineness of product of the Denver-McCool Laboratory Pulverizer.

A self-locking device holds the hinged grinding chamber in place and affords easy and quick access to the chamber for removing ground samples and cleaning. The adjustment of the grinding discs to each other is automatic and positive and various settings can be made while the machine is in operation.

When ordering advise the kind of material to be pulverized, as well as the desired fineness of the finished product, as there are three types of grinding discs.



Denver Laboratory Crusher-Pulverizer Unit With Motor Drive

THE Denver-McCool Laboratory Pulverizer is available incorporated into a crusher-pulverizer unit on a common base with a single driving motor, as shown at left. The crusher unit is the 2¼" x 3½" Denver Type "H" Forced Feed Laboratory Jaw Crusher, which is of the high capacity type with a one-piece cast alloy iron frame and reversible manganese steel jaw and cheek plates.

This crusher-pulverizer unit is a compact, efficient, portable combination, ideal for use in any laboratory.

Let us make recommendations for the proper size crusher-pulverizer combination to suit your specific requirements.

#### DENVER-McCOOL LABORATORY PULVERIZER

Model No.	*Capacity Pounds Per Hour	Dimensions			Speed R. P. M.	**Motor H. P.	Approx. Ship. Wt. Lbs.	
		L	W	H			Belt	Motor
6½F	60	30"	11"	15"	250	3	340	625
9½K	120	34"	15"	20"	275	5	550	985

\*¼" feed of hard rock to 100 mesh.

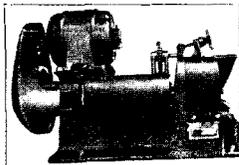
#### DENVER LABORATORY CRUSHER-PULVERIZER

Machine Size	*Capacity Pounds Per Hour	**Dimensions			Speed R. P. M.	**Motor H. P.	**Approx. Ship. Wt. Lbs.	
		L	W	H			Belt	Motor
2¼" x 3¼" Crusher	50-150	.....	.....	.....	350-450	.....	.....	.....
With Model No. 6½F Pulverizer	60	50"	40"	17"	250	3	758	1076
With Model No. 9½K Pulverizer	120	50"	40"	22"	275	5	1000	1532

\*Figures on pulverizer capacity are based on ¼" feed of hard rock to 100 mesh and are for pulverizer only, not combined unit. Figures on crusher capacity based on 2¼" feed of hard rock reduced to ¼".

\*\*For combined unit.

#### LABORATORY PULVERIZER, Denver-McCool (Gearless Type)



Denver-McCool (Gearless Type) Laboratory Pulverizer

THE Denver-McCool Laboratory Pulverizer (Gearless Type), as illustrated at left, has been designed to give ½ more capacity with ½ less horsepower consumption than the previous models. It is an ideal unit for grinding virtually any material and for pulverizing to any mesh in one easy operation.

Although using the time proved gyratory motion of the original McCool, this unit has been designed to eliminate all gears and oil leakage. By the elimination of all unnecessary parts it is made quiet, smooth running, and practically vibrationless and for this reason requires only 1/3 the H.P. of the previous models. It is a self-contained unit with a micrometer adjustment near the grinding chamber lock and handy to the operator for changing the size of the product. The motor, the shaft assembly and the housing move together as a sealed unit in deve-

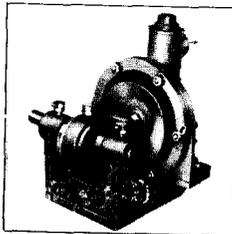
(Continued on next page)

tail slides toward the grinding chamber to compensate for disc wear. With this method the shaft is not drawn in or out of its bearings and exposure to dust and wear is avoided. The 9" diameter discs rotate at 800 R.P.M. and at the same time travel around their own axis at 200 R.P.M. inside an eccentric outer sleeve.

Model No.	*Capacity Pounds per Hour	Dimensions			Speed R.P.M.	Motor H.P.	Approx. Ship. Wt. Lbs.	
		L	W	H			Without Motor	With Motor
9 inch	160	45"	15"	31"	800	2	825	930

\*¼" feed of hard rock to 100 mesh.

#### LABORATORY PUMP, DIAPHRAGM, Denver Suction-Pressure



¾" Denver Suction-Pressure Laboratory Diaphragm Pump for Belt Drive—Note Adjustable Eccentric

THE Denver Suction-Pressure Laboratory Diaphragm Pump is widely used for the pumping and control of the discharge of thickened concentrates, pulps, and hydroclassifier sands in continuous laboratory test plants. This pump is also applicable to commercial installations where the volume of material to be handled is small.

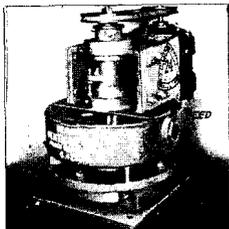
These Denver Suction-Pressure Laboratory Diaphragm Pumps are available in ¾" simplex or 1¼" simplex or duplex units. Belt or motor drive can be furnished.

Size	Type	Speed R. P. M.	Range of Stroke in Inches	Capacity per Min. at Max. Stroke and 40 R. P. M.	
				Cu. Ft.	Gallons
¾"	Simplex	40-60	0-1"	0.31	2.33
1¼"	Simplex	40-60	0-1½"	0.67	5.00
1¼"	Duplex	40-60	0-1½"	1.34	10.00

Size	Type	Dimensions			Motor H. P.	Approx. Shipping Wt. Lbs.	
		L	W	H		Belt	Motor
¾"	Simplex	1½"	0'8¾"	0'10¾"	¼-¾	60	140
1¼"	Simplex	1'8"	1'6¾"	1'3¾"	¾-1	280	475
1¼"	Duplex	1'8"	3'1½"	1'3¾"	1-2	480	725

Denver Suction Pressure Pumps are available of stainless steel and other metals for special applications.

## LABORATORY PUMP, SAND, Denver Vertical



¾" Denver Laboratory Vertical Sand Pump

THE Denver Laboratory Vertical Sand Pump is particularly valuable in the continuous test plant. The feed falls directly onto the runner by gravity, requiring no intake head. This permits small volumes of heavy and coarse sands as well as frothy pulps to be pumped without excessive dilution. The wearing parts are of extra heavy material and quickly replaceable, while wear on the runner and follower is compensated for by an adjusting screw. The upper and lower bearings are enclosed in a single sealed bearing unit located above and away from the pump and splash. Cone pulleys can be used to offer a choice of three speeds.

This pump can be direct connected if desired.

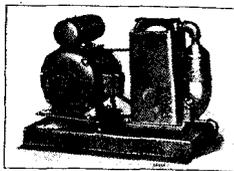
Machine Size	*Cap. G.P.M.	*Cap. Dry Tons Per 24 Hours	Dimensions			Motor H.P.	Approx. Ship. Wt. Lbs.	
			L	W	H		Belt	Motor
¾"	15	27	23"	12 ¾"	22 ¼"	½	220	315
1"	30	54	27 ¾"	14 ½"	23"	¾	328	490

\*Capacity based on 25% solids by weight.



DECO Equipment is Designed for "24 Hour Service." This is important because "one hour's delay means no profit today" and with today's high operating costs continuous service is more important than ever before.

## LABORATORY PUMP, VACUUM-PRESSURE, Denver (Non-Lubricated Cylinder)



Denver (Non-Lubricated Cylinder) Laboratory Vacuum-Pressure Pump

THE Denver (Non-Lubricated Cylinder) Laboratory Vacuum-Pressure Pump is recommended for use in the chemical, food, brewing, distilling, and other industries. This unit is ideal for any application requiring a small compressor or vacuum pump with a clean oil-free discharge.

The cylinder and crankcase are contained in a single casting, and the compression cylinder is separated from the crankcase by a cast-in wall with a special seal which prevents oil from working along the crosshead.

The piston is of steel and incorporates a special three-piece carbon ring, with a metallic expansion ring between the carbon ring and the piston for self-lubrication which ensures trouble-free operation.

Machine No.	Size Vacuum Pump or Compressor		Compressor Rating		*Vacuum Pump Rating		Motor H.P.
			10 Lb.	25 Lb.	RPM	Piston Displ. CFM	
	Bore	Stroke	RPM	Piston Displ. CFM	RPM	Piston Displ. CFM	
NX5	5"	1 ¼"	500	7.1	.....	.....	¼
NX7	5"	1 ¾"	760	10.8	.....	.....	¾
NX1	5"	1 ¾"	.....	.....	760	10.8	1
V-NX5	5"	1 ¼"	.....	.....	760	10.8	1 ½

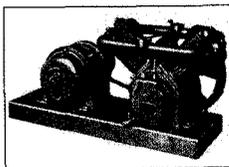
\*Maximum vacuum possible is 27 ¾ inches of Mercury.

Machine No.	**Dimensions			Approximate Shipping Wt. Lbs.		Volume Boxed for Export Cu. Ft.
	L	W	H	Domestic	Export	
NX5	25"	15"	16"	125	165	9
NX7	25"	15"	16"	130	170	10
NX1	25"	15"	16"	135	175	10
V-NX5	25"	15"	16"	125	165	9

\*\*Overall dimensions for base-plate mounted units.

A Denver Mineral Jig or Denver "Sub-A" Unit Flotation Cell In Your Grinding Circuit Will Recover Mineral As Soon As Free.

## LABORATORY PUMP, VACUUM-PRESSURE, Denver (Piston Type)



Denver (Piston Type) Laboratory Vacuum-Pressure Pump

THE Denver (Piston Type) Laboratory Vacuum-Pressure Pump is recommended for laboratory use where more free air displacement and continuous operation at higher pressure and vacuum than shown elsewhere in this section are required. In addition to the operation of filters, pressure or vacuum may be required in connection with

laboratory devices such as air lifts, agitators, and also in cleaning crushing equipment.

A pressure pump may be used in a laboratory for both pressure and vacuum and details are available upon request as to the most suitable way of making such an arrangement in your laboratory.

*Machine Size	**Piston Displ. CFM	**Pressure Lbs.	**Vacuum Inches Hg	†Motor H.P.	Size Inlet Pipe	Size Disch. Pipe
3x2 $\frac{3}{4}$	9	40	1	3 $\frac{1}{4}$	3 $\frac{1}{4}$ "	3 $\frac{1}{4}$ "
3 & 3x2 $\frac{3}{4}$	18	40	1	1	1"	1"
4 & 4x2 $\frac{3}{4}$	32	40	1	2	1 $\frac{1}{4}$ "	1 $\frac{1}{4}$ "

\*Size 3x2 $\frac{3}{4}$  is single cylinder pump; all others are two cylinder pumps as illustrated.

\*\*Figures shown are maximum pressure and maximum vacuum. Piston displacement is at 800 revolutions per minute.

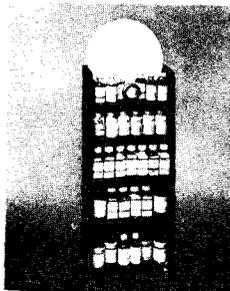
†Motor H.P. listed is for vacuum pump. For similar displacement, when operated as a pressure pump, use next size larger motor.

*Machine Size	Dimensions (With Motor)			Size Flat Belt Pulley	Approximate Shipping Weight, Lbs.			
	L	W	H		Domestic		Export	
				Belt	Motor	Belt	Motor	
3x2 $\frac{3}{4}$	42"	19"	16"	12"x2 $\frac{3}{4}$ "	125	250	175	300
3 & 3x2 $\frac{3}{4}$	42"	19"	17"	12"x2 $\frac{3}{4}$ "	130	320	180	370
4 & 4x2 $\frac{3}{4}$	46"	22"	19"	16"x3 $\frac{3}{4}$ "	230	450	280	500

\*Size 3x2 $\frac{3}{4}$  is single cylinder pump; all others are two cylinder pumps as illustrated.

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

## LABORATORY REAGENTS, Denver Flotation

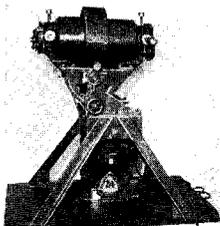


Denver Laboratory Flotation Reagents and Accessories in Testing Cabinet

DENVER Laboratory Flotation Reagents are furnished in a handy wooden case which provides an excellent cabinet for their storage. Forty of the most widely used flotation reagents are included in this compact case in quantities sufficient for several tests employing most types of laboratory batch flotation testwork. A Denver Vanning Plaque Laboratory Pan and a Denver Alkacid Laboratory pH Indicator are provided as part of the testing set. Net weight of the reagents, case, and accessory items is 40 pounds.

With each order for one or more Denver "Sub-A" Laboratory Flotation Machines this set of Denver Laboratory Flotation Reagents, including vanning plaque pan and pH indicator, is furnished free of charge.

## LABORATORY ROD MILL, Denver



Denver Laboratory Rod Mill—Motor Drive With Steel Base

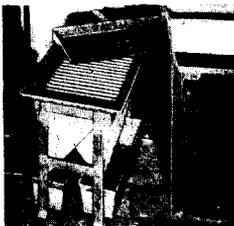
MANY grinding problems requiring a minimum amount of fines can be solved by the Denver Laboratory Rod Mill which assures a uniform product without overgrinding. It can be used as a batch ball mill or as a continuous grinding unit. The mill can be rotated at any angle, being held in position by the handwheel clamp. If the mill is rotated vertically, the entire charge can be emptied with a minimum amount of washwater; and a grate discharge holds

back the rods or balls depending upon grinding medium. The Denver Laboratory Rod Mill can either be mounted on a steel frame (as shown in the illustration above), or bolted to a laboratory bench. The grinding drum can be easily and thoroughly cleaned out as it is a single casting with round corners.

Machine Size	Capacity Kg.	Steel Stand	Dimensions			Motor H.P.	Approx. Ship. Wt. Lbs.	
			L	W	H		Belt	Motor
7"x14"	3	With Without	38"	34"	36"	1 $\frac{1}{2}$ 1 $\frac{1}{2}$	600	650
7"x14"	3		25"	19"	19"		460	510

## LABORATORY SAMPLE SPLITTER, Denver

THE Denver Laboratory Sample Splitter is a simple, inexpensive unit with no moving parts to break or wear out and



Denver Laboratory Sample Splitter  
With Scoop and Sampling Pans

the advantages of the design of this unit are easily apparent over others of similar pattern. Division channels perform splitting and a final separation of the channel discharges into two representative parts is accomplished by having every other division channel deliver into the same receptacle. The division channels are steep enough to prevent clogging and are quickly and thoroughly cleaned.

This unit is substantially constructed and is the handiest, most convenient, and most

accurate sample splitter yet devised for hand operation. The hopper is set in a rigid, four-legged support, and additional equipment consists of a scoop, four sampling pans, and a cleaning brush. Let us make recommendations for the best size and type sampling equipment for use in your particular laboratory.

### LABORATORY SAMPLE SPLITTER, Denver (Jones Type)

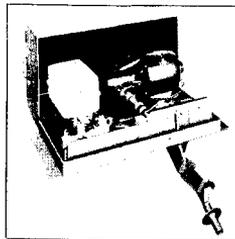
Machine Size	Rifle Width	Dimensions			Approx. Shipping Wt. Lbs.
		L	W	H	
6"x8"	3/4"				35
8"x10"	3/4"	16"	15"	17"	70
10"x18"	3/4"	23"	14"	17"	85

### LABORATORY SAMPLE SPLITTER, Denver (Improved Type)

Machine Size	Rifle Width	Dimensions			Approx. Shipping Wt. Lbs.
		L	W	H	
5"x4 1/2"	1/2"	5"	4 1/2"	7"	30
7 1/2"x5"	1/2"	7 1/2"	5"	8 1/2"	35
10"x5 1/2"	1/2"	10"	6"	9 1/2"	40
13 1/4"x7 1/2"	3/4"	13 1/4"	7 1/2"	11"	45
18"x10 1/2"	1"	18"	10 1/2"	13"	55

We have often been referred to as the "Diagnosticians of the ore dressing industry." Perhaps we can help you with your mineral recovery problems. Please let us try.

## LABORATORY SAMPLER, Denver Ore



Denver Laboratory Ore Sampler

THE Denver Model "L" (Laboratory) Automatic Sampler is especially designed for continuous pilot plant test work of small tonnage for ore and pulp sampling. Cutter travel is 8", and is actuated by a synchronous motor-driven time switch, adjustable for 5, 6, 7 1/2, 10, 15 or 30 minute intervals. The 1/6 horsepower gear-motor is equipped with a cut tooth pinion with overrunning clutch which engages a cut tooth rack to

which the cutter is attached. Cutter is adjustable for either vertical or horizontal sampling, and handles particles to a maximum size of 3/16". A tight fitting, dust-proof cover protects the mechanism from contamination. The base is welded steel. You will find the Model "L" is ideal for your testing plant.

Machine Size	Dimensions			H.P. Approx.	Approx. Shipping Wt. Lbs.
	L	W	H		
Model "L"	25 1/2"	23 3/4"	17 3/8"	1/6	175

## LABORATORY SAMPLER, ORE, Denver



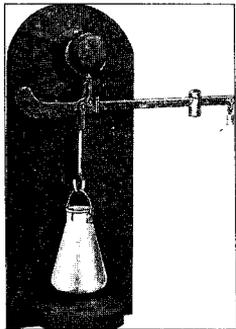
Denver Laboratory Ore Sampler

THE proper sampling of ore in the crushing section of a Denver Laboratory Test Plant is very often a problem involving considerable handling and labor if the proper equipment is not available. Accuracy of the final sample, and therefore test results, may also be impaired if too much manual labor enters into the operation.

It is generally agreed that the most accurate sampling is done by mechanical and automatic methods if the mechanical sampler is properly designed for the specific problem or operation.

Machine Size	Overall Dimensions			Speed R.P.M.	Motor H. P.	Approx. Shipping Wt. Lbs.
	L	W	H			
No. 1	56"	29"	31 1/2"	36	1/4	485
No. 2	56"	29"	31 1/2"	36	1/4	455

## LABORATORY SCALE, Denver Pulp Density



Denver Laboratory Pulp Density Scale

THE Denver Laboratory Pulp Density Scale provides a fast and accurate means of determining the specific gravity of pulps and liquids, so essential in laboratory testwork. It simplifies the procedure of obtaining specific gravity of laboratory test plant products and thereby effects a considerable saving in the time of skilled laboratory personnel.

This scale is used wherever metallurgical results depend on the ratio of water to solids such as in ball mill discharge, conditioner discharge, agitator circuit, etc.

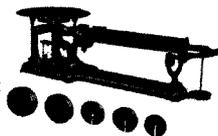
The construction of the unit is shown in the accompanying illustration. The pulp container is made of spun aluminum and has an overflow slot near the top which permits easy, accurate filling to exactly one liter. In balanced position, with full pulp container, the reading on the beam gives the specific gravity of the pulp direct. The percent solids is then obtained by applying this reading to the pulp density table which is furnished with each Denver Laboratory Pulp Density Scale.

Capacity Grams	Approximate Shipping Weight Lbs.		Export Volume Cu. Ft.
	Domestic	Export	
1500	7	11	1.1
2300	7	11	1.1
4000	7	11	1.1



**A Denver Mineral Jig or Denver "Sub-A" Unit Flotation Cell In Your Grinding Circuit Will Recover Mineral As Soon As Free.**

## LABORATORY SCALE, Denver Pulp and Solution

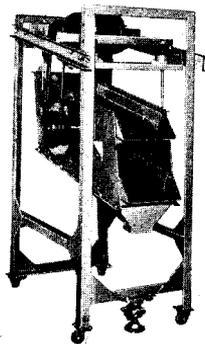


Denver Laboratory Pulp and Solution Scale with Weights

DENVER Laboratory Pulp and Solution Scale is built for applications where scales must be able to withstand rapid handling, mechanical shock, and considerable wear from frequent use. The Denver Laboratory Pulp and Solution Scale meets these requirements while retaining utmost sensitivity.

It is provided with two weighing beams with sliding poises, the large beam graduated from 0 to 1000 grams and the smaller from 0 to 100 grams. An additional beam with poise is placed beneath the weighing beam to balance the empty container used to hold the material weighed. The graduations and figures are white and easily readable against a black background. Scale is supplied graduated for Avoirdupois or Troy readings instead of Metric when so desired. Dimensions 34" x 11" x 10". Shipping weight, 65 pounds. Other size scales are available to suit various laboratory requirements. Let us recommend type and size best suited to your needs.

## LABORATORY SCREEN, Denver-Dillon (Portable) Vibrating



1'x3' Double Deck Denver-Dillon (Portable) Laboratory Vibrating Screen with Discharge Hopper

DENVER-DILLON (Portable) Laboratory Vibrating Screen is available as a self-contained unit for experimental and production work. This small portable machine has the same "Floating Circle" action as the larger, higher capacity Denver-Dillon Vibrating Screens and gives the same quiet, efficient, care-free performance.

The patented design of this unit requires just two bearings instead of the four used in ordinary mechanical screens. This cuts power costs in half and reduces maintenance costs by eliminating the additional two bearings and shaft.

The driven sheave and balance wheels are on the center line of the shaft. The shaft supports no other load and is subjected to no flexing or bending; it rotates freely on its central axis. Demountable assembly may be completely removed from either side.

(Continued from previous page)

Tension is uniformly maintained on quickly replaceable screen sections and rubber-cushioned camber bars arch the screen sections and prevent whipping and undue vibration. For separations at 65 mesh and finer, these bars must be spaced closer together than standard.

Standard machines are arranged for single or two-deck operation, mounted on casters, provided with floor lock, and equipped with feed hopper. A back plate, front plate with extended spouts, fines hopper and cover plates provide a complete dust enclosure with feed and discharge openings beaded for attachment of flexible chute connections or "socks."

The suspension frame pivots on the rear support and angle is adjustable on 2½ degree graduations in the front supporting member. The ½ H.P. motor is carried on a spring mounted base plate on the suspension frame. Three-deck machines can be furnished.

Let us make recommendations for equipment and layout to suit your particular continuous test plant screening installation.

Additional data gladly furnished upon request.

Screen Size	Dimensions			Motor H.P.	Approx. Ship. Wt. Lbs.		Export Volume Cu. Ft.
	L	W	H		Domestic	Export	
1'x2'	2'-0"	2'-6"	6'-6"	½	400	480	26
1'x3'	3'-0"	2'-6"	6'-6"	½	550	660	30
1½'x3'	3'-0"	3'-0"	6'-6"	½	650	780	40
1½'x4'	4'-0"	3'-0"	6'-6"	½	800	960	46

## Recover Your Mineral As Soon As Free.

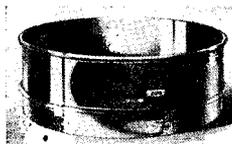
### LABORATORY SIEVE, Tyler Standard



Half-Height Tyler Standard Screen Scale Laboratory Sieve

The sieves may be nested together for convenience in making a screen analysis and should always be provided with bottom pan and top cover to facilitate the sifting operation and protect the fine wire cloth when not in use.

(Continued on next page)



Full-Height Tyler Standard Screen Scale Laboratory Sieve

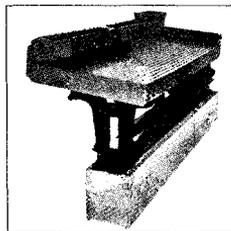
down to 400 mesh are also available for special work if required. The 8" diameter sieve will fit the Denver Laboratory Testing Sieve Shaker and this unit will handle up to 8 full-height nested sieves or 16 half-height nested sieves, including bottom pan and cover. For specifications, dimensions, and operating details on this machine see Denver Laboratory Testing Sieve Shaker.

Tyler Standard Laboratory Sieves are all within the specifications of the United States Bureau of Standards and are also marked with the equivalent United States series number.

Sieve Size Diameter	Full-Height Sieve			Half-Height Sieve		
	Dimensions		Approx. Ship. Wt. Lbs.	Dimensions		Approx. Ship. Wt. Lbs.
	Height	Depth to Cloth		Height	Depth to Cloth	
6"	2¾"	1¾"	1	1½"	1"	1
*8"	2½"	2"	2	1½"	1"	1½
10"	4"	3"	3	2½"	1½"	2½
12"	4¼"	3¼"	3½	2½"	1½"	3

\*The 8" diameter full-height or half-height sieves will fit into the Denver Laboratory Testing Sieve Shaker. Other sizes listed are for hand operation.

### LABORATORY TABLE, Deister Plat-O Concentrating



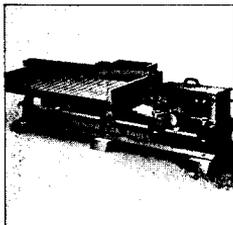
Deister Plat-O Laboratory Concentrating Table

THE Deister Plat-O Laboratory Concentrating Table is ideally suited for treating small quantities of ore in experimental plants and ore-testing laboratories, and for use as a pilot table in large plants. The 28" wide x 62" long deck, actuated by a half-size Plat-O self-oiling head motion, will give results comparable to those that can be obtained with a full size table.

This laboratory table is a simple, low cost, durably constructed unit incorporating the latest design features.

Deck Size	Water Gallons Per Min.	Speed R.P.M.	Motor H.P.	Approx. Shipping Wt. Lbs.
28"x62"	1-6	300-375	½	780

## LABORATORY TABLE, Denver-Wilfley Concentrating



Denver-Wilfley Laboratory Concentrating Table—Belt Driven

FOR running laboratory tests on a small scale, a laboratory size concentrating table is an indispensable unit. The action of the Denver-Wilfley Laboratory Concentrating Table duplicates that of the commercial units and laboratory results can be accurately reproduced in commercial operation. This laboratory table is also used extensively as a pilot table to indicate the efficiency of a flotation circuit.

This table consists of a single or double deck mounted on a steel channel understructure, with enclosed self-oiling head motion, improved draw bar, and a positive tilting device. For small scale pilot plant operation the 50"x24" deck is recommended, and for batch test work the 40"x18" with two decks (one for sands, the other for slimes) is most desirable.

For use in batch operations, a set of special product pans has been designed for catching the middlings, concentrates, and tailings. These contain small supplementary pans which can be shifted for cutting samples.

Additional data gladly furnished upon request.

Machine Size	Cap. Tons Per 24 Hrs.	Deck Size		*Overall Dimensions			**Motor H.P.	Approx. Ship. Wt., Lbs.	
		L	W	L	W	H		Belt	Motor
13A	1/2-2	40"	18"	68"	22"	17"	1/4	260	355
13B	3/4-3	50"	24"	78"	28"	14"		315	410

\*Length shown is for motor driven unit—deduct 13" to obtain length of belt driven unit.

\*\*Horsepower required for belt driven units is 1/8 H.P.

Denver Equipment Company publishes DECO TREFOIL, an exchange of helpful engineering information designed to improve milling. DECO TREFOIL is published every other month. If you are connected with mining and do not receive DECO TREFOIL please write to us.

## LABORATORY TEST PLANT, Denver Batch



Denver Batch Laboratory Test Plant

EVERY mine large enough to justify the installation of a concentrating mill should be able to increase its profits by installing a conveniently arranged ore dressing laboratory. The laboratory may consist of a few essential items or of a very complete installation, depending upon the size of the mine and the complexity of the ore dressing problems encountered.

The Denver Batch Laboratory Test Plant makes it possible to conduct tests for flotation, gravity concentration, amalgamation, cyanidation, or any combination of these processes. Batch laboratory machines can be supplied to suit the customer's individual requirements as necessity at various times dictates. Mining companies frequently install a nucleus of equipment to which various additions are made as the value of testwork becomes increasingly apparent.

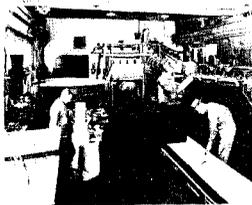
Many mining schools throughout the world have practically standardized on Denver Batch Laboratory Equipment and have made complete installations of Denver Batch Laboratory Test Plants. This wide acceptance is due not only to dependable metallurgical results, but also to the fact that Denver Laboratory Machines demonstrate the principles of standard commercial machines. Government and private testing laboratories use Denver Laboratory Machines because they require units from which standard, accurate results can be obtained and results which can be duplicated in commercial practice.

Complete information on Denver Batch Laboratory Test Plants, contained in Bulletin No. LG3-B5, "Laboratory Ore Dressing Equipment," available free on request. Let us engineer your proposed batch laboratory test plant installation.

DECO Equipment is Designed for "24 Hour Service." This is important because "one hour's delay means no profit today" and with today's high operating costs continuous service is more important than ever before.

Reliable Denver Ore Tests insure your mining investment.

## LABORATORY TEST PLANT, Denver Continuous



Denver Continuous Laboratory Test Plant

THE installation and operation of a commercial plant may involve problems which should be studied under small scale continuous operating conditions. The results secured from such study will eliminate the need for costly experimentation with large tonnages of ore when the commercial plant is placed in operation, and assures selection of the proper size and type of equipment. The Denver

Continuous Laboratory Test Plant offers ample opportunity for the study of many complex problems and thousands of tests have been conducted on widely varying types of materials and ores from customers throughout the world. Following are examples:

1. The milling of ores by fine grinding and flotation requiring the establishment of closed circuits where middling or unfinished products are returned to various points in the flowsheet for additional treatment.

2. The treatment of complex ores by new processes or by the use of new or unusual reagents in flotation.

3. The milling of complex ores requiring the use of combined methods of treatment such as gravity concentration and flotation, or coarse flotation followed by slime flotation, or gravity and amalgamation followed by cyanidation.

4. The cyanidation process for the treatment of gold and silver ores involving the continuous re-use of much of the cyanide solution after removal of the dissolved gold or silver by precipitation.

5. The treatment of tonnage lots of ores and industrial materials by continuous pilot plant operation as a separate circuit or as part of a circuit in a commercial plant.

Recent advances in the art of flotation have broadened the scope of flotation testwork to include materials not previously considered. Besides the metallic minerals, industrial materials and products are now being successfully treated. Coal, cryolite, bauxite, phosphates, apatite, feldspars, syenite, ilmenite, and salt are being concentrated; also milkweed, resins, and grain.

Denver Continuous Laboratory Test Plants are used extensively by universities and government bureaus for research in ore dressing, and by mining companies to determine method of treatment and layout for new projects. With the development of the No. 8 Denver "Sub-A" Laboratory Flotation Machine, continuous testing in parallel with standard mill circuits has become mechanically practical. This allows changes in grinding, conditioning, emulsifying, and reagents to be made under identical mill feeding and mill operating conditions without interruptions or fluctuations in the main circuit. (Continued on next page)

Using as a basis the three sizes of Denver "Sub-A" Laboratory Flotation Machines available, namely the Nos. 5, 7 and 8, these plants can be furnished to fit each particular requirement. The No. 5 has a capacity of 50 to 150 pounds an hour, the No. 7 of 200 to 500 pounds an hour, while the No. 8 will handle 1,500 to 2,500 pounds an hour. These capacities depend, of course, on the material being treated.

Complete information on Denver Continuous Laboratory Test Plants, contained in Bulletin No. LG3-B2, "Equipment for Continuous Ore Testing Plants," available free on request. Let us engineer your proposed continuous laboratory test plant installation.

## LABORATORY TESTING SIEVE SHAKER, Denver

THE Denver Laboratory Testing Sieve Shaker will quickly and efficiently size laboratory products, thus allowing the determination of various important treatment factors. Results of sizing tests and analyses of sized products will determine such important factors as the following:

1. Size at which valuable mineral is freed from the gangue.

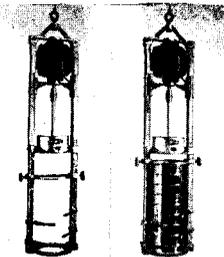
2. Whether tailing losses occur in coarser or finer fractions so that measures can be taken to reduce tailing losses.

3. Fineness of grind secured in the milling circuit.

4. Efficiency of classifier, vibrating screens, and other units in circuit.

5. Necessary steps to secure higher recoveries or lower milling costs.

6. Numerous other points of value to the research engineer and mill operator for improving treatment methods.



Denver Laboratory Testing Sieve Shaker Without Sieves and With Eight Full-Height Sieves in Place

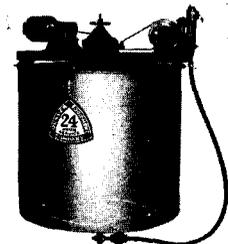
Efficient grinding and milling depend upon accurate screen analysis. The actual screen operation is performed by this Denver Laboratory Testing Sieve Shaker with greatest possible speed. The gyratory motion of the shaking mechanism is such that the sample passes through very rapidly while spring attachments tap the sides of the sieves to prevent particles from adhering or agglomerating. The final product is received in a bottom pan which is firmly clamped into the machine. The high efficiency and low first cost of the Denver Laboratory Testing Sieve Shaker make it indispensable in any laboratory. Capacity of unit is eight full-height or sixteen half-height standard 8" Tyler Sieves, with cover and bottom pan.

A time switch is available for stopping the mechanism at any predetermined time interval up to thirty minutes. This is essential when standardizing and making comparative screen analyses. (Continued on next page)

Size Sieve	Cap. No. Screens*		Dimensions			Motor H.P.	Approx. Ship. Wt., Lbs.	
	Full Height	Half Height	L	W	H		Domestic Export	
8"	8	16	12"	9"	54"	1/6	140	155

\*Including bottom pan and cover.

## LABORATORY THICKENER, Denver Spiral Rake



3'x3' Denver Spiral Rake Laboratory Thickener With Totally Enclosed Gear Reducer and Without Steel Legs—Note 3/4" Denver Suction-Pressure Laboratory Diaphragm Pump for Removal of Thickened Pulp

THE Denver Spiral Rake Laboratory Thickener, for continuous ore testing laboratories and ore dressing and industrial pilot plants, is built as a laboratory unit that embodies the same principles and produces the same results on a small scale as the commercial size Denver Spiral Rake Thickener. Various diameters, from 3 feet up to commercial size units are available. Two convenient sizes for most applications are the 3 foot diameter by 3 foot depth and the 6 foot diameter by 3 foot depth.

The Denver Spiral Rake Laboratory Thickener has the regular patented Denver Spiral Rakes which convey the thickened pulp to center cone in one revolution. Rakes are of heavy angle iron section and will easily withstand overload conditions. Also, there is less chance of overloading due to the design of the patented Denver Spiral Rakes accomplishing rapid removal of thickened pulp.

A 3/4" Denver Suction-Pressure Laboratory Diaphragm Pump is provided for removal of the thickened pulp. Pump is driven by thickener drive which consists of a totally enclosed gear reducer and gearmotor. Entire unit is self-contained, easily portable, and can be set up at any desired point in the plant.

Special shallow tray thickeners for handling extremely frothy materials can also be supplied. Let us make recommendations to suit your laboratory requirements.

More complete information can be obtained by writing any Denver Equipment Company office.

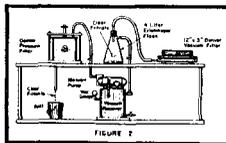
(Continued on next page)

Machine Size Tank Diameter	Tank Depth	*Overall Dimensions			Motor H.P. With Pump	Approximate Shipping Wt., Lbs.	
		L	W	H		Domestic	Export
30"	1'10"	2'11"	2'8"	3'11 1/2"	1/4	400	450
36"	2'10"	3'5"	3'2"	4'11 1/2"	3/4	510	575
48"	2'10"	4'5"	4'2"	5'1"	1 1/4	810	895
60"	4'0"	5'15 1/2"	5'3"	8'3"	1	893	975
72"	4'0"	6'15 1/2"	6'3"	8'3"	1	1075	1210

\*Overall height on 30", 36", and 48" diameter units includes height of steel legs—larger units not furnished with legs.

NOTE: The capacity of any thickener depends upon the settling rate of the material handled and is governed by the physical characteristics of the solids, the method of feeding the pulp or liquid, and the chemical nature and temperature of the liquor.

## LABORATORY VACUUM EQUIPMENT, Denver



Arrangement of Denver Laboratory (Rotary Type) Vacuum-Pressure Pump to Operate Either a (2'x3") Denver Laboratory Vacuum Filter or a Denver Laboratory Pressure Filter—Many Other Arrangements Available

THE handling of wet pulp samples presents a problem to every ore dressing and metallurgical laboratory. The use of proper size and type filters with required vacuum equipment will simply and efficiently eliminate many of the difficulties.

Denver Laboratory Vacuum Equipment is available for all sizes of laboratories and continuous pilot test plants.

Necessary units for any capacity laboratory vacuum system are available and arrangements for individual or interdependent vacuum-pressure systems have been developed to meet the practical needs of research, commercial, and private laboratories.

A combination vacuum-pressure unit such as the Denver Laboratory (Rotary Type) Vacuum-Pressure Pump is recommended for the average laboratory. The application of this unit and a suggested arrangement for its use is shown in the illustration above. Although one pump can be, and generally is, used for operating both vacuum and pressure filtering equipment; only one system or the other should be in operation at any one time. This pump has a displacement of 3 to 4 cubic feet of free air per minute and will maintain a vacuum of 20 to 25 inches of mercury column or a pressure of 20 pounds per square inch. This is sufficient for satisfactory operation of the Denver Laboratory Vacuum Filter or the Denver Laboratory Pressure Filter when using either one or the other of the systems in the arrangement illustrated.

The Denver Laboratory (Non-Lubricated Cylinder) Vacuum-Pressure Pump is ideal for use as a small compressor or vacuum pump with a clean, oil-free discharge. As a compressor, piston displacement is from 8 to 11 cubic feet per minute; and as a vacuum pump, a vacuum of 27 inches of mercury can be maintained. (Continued on next page)

**May We Please Work With You On All Your Equipment Needs?**

For laboratories requiring more free air displacement with higher pressures and vacuum, the Denver Laboratory (Piston Type) Vacuum-Pressure Pump is an ideal unit. In addition to operating filters, pressure or vacuum may be required in connection with laboratory devices such as air lifts, agitators, and also for air cleaning of crushing equipment. As much as 40 pounds pressure may be supplied by this pump, and piston displacement range is from 9 to 32 cubic feet per minute. A vacuum giving only 1 inch of mercury barometer can be maintained. A piston type pump, when it is to be used for both pressure and vacuum, should be specified as a compressor.

Vacuum receivers and pressure tanks equipped with gauges and other accessory items are available. Recommended, compact, efficient, arrangement plans for your laboratory vacuum or vacuum-pressure system will be supplied on request. Let us engineer a system to suit your needs.



The Company maintains complete batch and continuous testing laboratories for conducting any type of gravity concentration, flotation, amalgamation or cyanidation tests. With information from the testwork as a basis, Company metallurgists and engineers can recommend the best flowsheet, with the proper type and size of equipment required; furnish all the equipment; make the mill layout, or cooperate in such matters with your own staff or consulting engineers; and provide future field engineering service to assure maximum operating efficiency. Various Company publications are available which supply valuable information on new metallurgical and equipment developments.

## Denver "Sub-A" Flotation

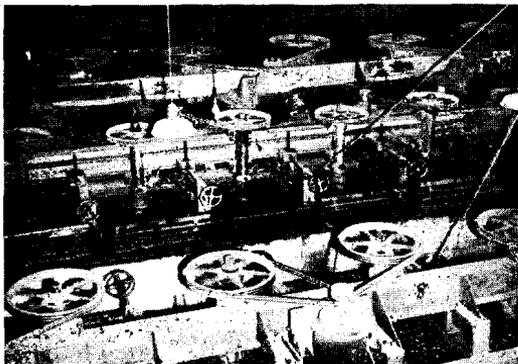
The flotation process is widely used for treating metallic and non-metallic ores and in addition, it is receiving an ever widening application in other industries. A greater tonnage of ore is treated by flotation than by any other single process. Practically all the metallic minerals are being recovered by the flotation process and the range of nonmetallics successfully handled is steadily being enlarged. In recent years the art of flotation has been successfully applied in other than the mining industry, such as flotation of wheat, and other industrial applications. As flotation reagents are further developed, the application of flotation will be more widespread.

The Denver "Sub-A" Flotation Machine has been applied to all types of flotation problems and these machines have continuously demonstrated their superiority. They have given very successful results through a wide range of problems, and their supremacy is fully proven by world-wide acceptance and application.

The feature of the Denver "Sub-A" is the design. The Denver "Sub-A" incorporates all of the basic principles and requirements of the flotation process and these, coupled with the special and exclusive wear features, make it the ideal flotation machine.

### Denver "Sub-A" Cells

Denver "Sub-A" Flotation Cells have been developed over the intervening years since 1927 until today there are over 35,000 cells in operation. Denver Flotation cells are "standard equipment" for an ever widening range of metallurgical and industrial problems. They are being used in plants of all types and sizes and they are giving excellent results at minimum cost at tonnages of a few tons up to 35,000 tons per 24 hours.



**TYPICAL INSTALLATION OF DENVER "SUB-A" FLOTATION MACHINES**

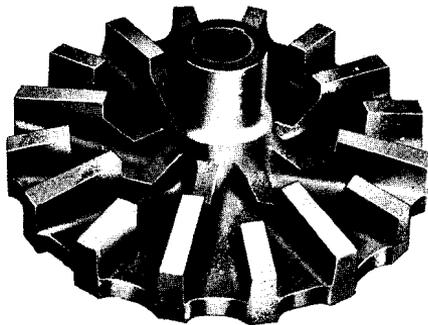
To take care of the wide range of problems confronting the flotation process, the Denver "Sub-A"s are built in a wide and flexible range of commercial sizes, from the No. 8 through the No. 12, No. 15, No. 18, No. 18 Special, No. 21, No. 21 Deep, No. 24 and the No. 30.

There is a particular size machine for every problem and tonnage, with each machine having incorporated into its design features to take care of any condition. This is the basis on which Denver "Sub-A" Cells have been designed. Standard machines are as follows:

The construction of the Denver "Sub-A", Standard Flotation Machine is with double welded steel tank, alloy iron cell side liners, rubber bonded to steel bottom liners, impellers and diffuser wearing plates of molded rubber or alloy iron, individual cell pulp level control, rubber protected shafts and rubber sand relief bushings. To the standard cells the supercharging principle can be quickly adapted as all recent cells are furnished with automatic air seal and air bonnet to which low pressure air is easily connected. Variations from the standard machine allow the pulp to bypass through convenient ports which can be opened or closed while the unit is operating. This feature makes the Denver "Sub-A" either the exclusive positive circulation unit or an open type machine.

### **Denver "Sub-A" in Corrosive Circuits**

Denver "Sub-A" Flotation Cells are built with special design for work in acid and corrosive circuits. The construction of this type machine is similar to the standard Denver "Sub-A" except that the parts in contact with the pulp are of special materials and the tank itself is of wood construction. There is also a variation in design to take care of the special conditions usually associated with acid circuits and for convenience the acid-proof machines are built in 2-cell units.



Order Multi-bladed impellers for your Denver "Sub-A" Flotation Machine.

### **Principles of Operation of the Denver "Sub-A"**

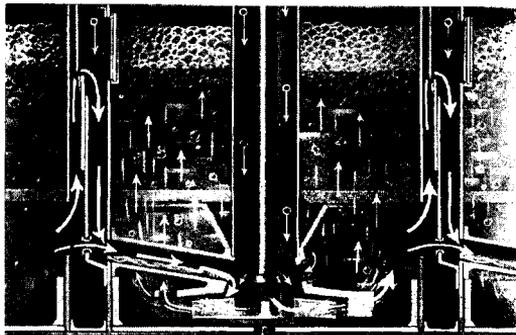
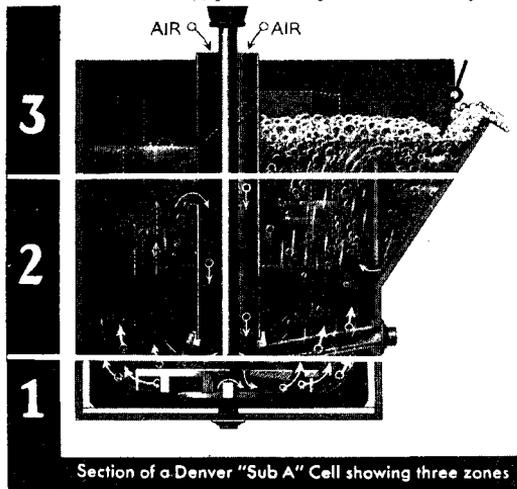
The widespread success of the Denver "Sub-A" Flotation Machine is attributed to the basic qualities of the design of this type flotation machine. Successful metallurgy results from the distinctive gravity flow feature, which assures positive circulation of all pulp fractions with reagents from cell to cell and hence results in high efficiency.

#### **Pulp Flow and Circulation**

The pulp flows by gravity into each cell through the feed pipe, from which it drops directly on top of the rotating impeller below the stationary hood. As the pulp cascades over the impeller blades it is thrown outward and upward from the impeller

and diffuser wearing plate by the centrifugal action of the impeller. The pulp is kept in complete circulation by the impeller action and as the flotation reaction takes place, the pulp is passed from cell to cell. Pulp overflows to each succeeding cell over an adjustable weir gate in the partition. This gate gives accurate control of pulp level as the pulp passes through the machine. To take care of coarse oversize each cell has a rubber sand relief opening in the partition weir casting which feeds oversize direct to the impeller of the next cell without short circuiting. Circulation within each cell itself and return of middlings is by means of adjustable openings in the hood above each impeller, although for normal operation these are kept closed, except for middling return.

Circulation in Denver "Sub-A" Flotation cells is highly efficient due to the distinctive gravity flow feature. This method of pulp circulation assures the positive circulation of all pulp fractions with resultant maximum treatment of each and every particle. It is an established fact that the mechanical method of circulating material is the most positive and economical, particularly where the impeller



DENVER "SUB-A" FLOTATION CELL IN OPERATION

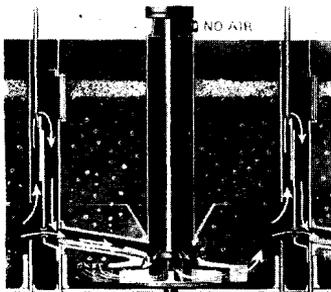
is below the pulp. A flotation machine must not only be able to circulate coarse material (encountered in practically every mill circuit) but also must re-circulate and retreat the difficult middling products.

An alternate pulp flow is obtained from cell to cell by the side ports in the partitions. The ports are adjustable so that a portion of the pulp can pass from cell to cell through these ports and consequently bypass the impeller and weir overflow.

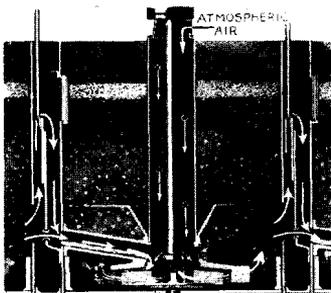
It is not essential to have each individual cell with separate weir gate control; however, for most installations this is recommended. An alternate arrangement is with gate control every two to four cells for pulp level control, and free pulp passage from cell to cell, by means of the ports, as well as cell to cell overflow. The arrangement is actually a "grouping" without sacrificing the positive circulation feature.

### Aeration and Mixing

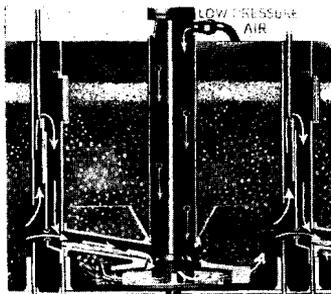
The passage of pulp through the cell and the action created in the impeller zone draws air down the stationary standpipe and from the partition along the feed pipe. This positive suction of air gives the ideal condition for average flotation and the action in the impeller zone thoroughly mixes the air with the pulp and reagents. As this action proceeds, a thoroughly aerated live pulp is produced and furthermore, as this mixture is "ground" together by the impeller action, the pulp is intimately diffused



SUPPRESSED FLOTATION



STANDARD FLOTATION



SUPERCHARGED FLOTATION

with exceedingly small air bubbles which support the largest number of mineral particles.

For particular problems the aeration in the Denver "Sub-A" can be augmented by the application of "Supercharging," whereby fully controlled air under low pressure is diffused into the pulp. This feature is accomplished by the introduction of air from a blower or turbo-compressor through the standpipe connection into the aerating zone where it is pre-mixed with the pulp by the impeller action. This supercharging of the pulp creates a highly aerated condition which is maintained by the automatic seal in the cell partition. Supercharging is of particular advantage for low ratio of concentration and slow-floating ores.

It is recommended for use with all No. 30 installations. Supercharging has been responsible for (1) better metallurgy; (2) lower power consumption; (3) increased capacity (4) reduced reagent consumption; (5) improved operating conditions.

Throttling of air in the Denver "Sub-A" Flotation Machine is of benefit when suppressed flotation is required. This is accomplished by cutting off or decreasing the size of air inlet on the standpipe. Suppressed flotation finds its chief use in grain flotation, certain nonmetallics and occasionally in cleaner or recleaner operations.

The aeration and mixing of the pulp with reagents all takes place in the lower zone of the cell. This thorough mixing, which is below the stationary hood, is to a considerable degree responsible for the metallurgical efficiency of the cell.

Supercharging Denver "Sub-A" Flotation Cells by increasing the sub-aeration is obtained with a small volume of air at low pressure. The air bonnet and automatic air seal are integral parts of all standard Denver "Sub-A" Cells; hence, to increase the aeration all that is required is a connection from the air bonnet to a source of air supply.

### Separation

The aerated pulp, after leaving the mixing zone, passes upward by displacement to the central section of the cell. This is a zone of quiet and is free from cross currents and agitation. In this zone, the mineral-laden air bubbles separate from the worthless gangue and pass upward to the froth column

without dropping their load, due to the quiescent condition. The gangue material follows the pulp flow and is rejected at the discharge end of the machine.

It is in the separation zone that effective aeration is essential and this is assured in the Denver "Sub-A" as the air is broken up into minute bubbles. These finely diffused bubbles are essential for carrying a maximum load of mineral.

### **Concentration**

The mineral-laden bubbles move from the separation zone to the pulp level and are carried forward to the overflow lip by the crowding action of succeeding bubbles. To facilitate the quick removal of mineral-laden froth, Denver "Sub-A" Flotation Machines are equipped with froth paddles. Froth removal can be further facilitated by the use of crowding panels which create a positive movement of froth to the overflow.

Concentrates produced by Denver "Sub-A"s are noted for their distinctive high grade and selectiveness. The spitzkasten built into Denver "Sub-A" cells is partially responsible as it allows a quiescent zone just before froth removal in order that middling fractions may fall back into the pulp flow. Machines are built with single overflow as standard, but double overflow can be supplied.

### **Operating Advantages with Denver "Sub-A"**

- (1) Coarse material handled
- (2) No choke-ups or lost time
- (3) Middling return without pumps
- (4) Positive cell control

These are several of the distinctive advantages obtained with the use of Denver "Sub-A" Flotation Cells which are found in no other flotation machine. The combination of these several advantages is necessary to obtain successful flotation results.

### **Coarse Material Handled**

Positive circulation of all pulp fractions from cell to cell is assured by the distinctive gravity flow principle of the Denver "Sub-A". No short circuiting can occur through the machine; hence, every particle is subject to positive treatment. In instances where successful metallurgy demands the

handling of a dense pulp containing an unusually large percentage of coarse material, the sand relief opening aids in the machine operation. This opening removes from the lower part of the cell the coarse fractions and passes them through the feed pipe to the impeller of each succeeding cell. The sand relief openings assure the passage of slow floating coarse mineral to each impeller and therefore it is subject to the intensive mixing, aeration and optimum flotation condition of each successive cell. The finer pulp fraction passes over the weir or through the intermediate ports. The passage of the coarse fractions through each impeller eliminates short circuiting and thus, both fine and coarse mineral are subject to positive flotation.

### **No Choke Ups or Lost Time**

A Denver "Sub-A" cell will not choke up, even when material as coarse as one quarter inch is circulated. Choking cannot occur as the feed to each cell is to the top of the impeller. After a shut-down, it is not necessary to drain the machine as the stationary hood with diffuser wearing plate protects the impeller and feed pipe from sanding-up. Even though the flotation feed is finely ground, coarse material occasionally gets into the circuit and if the flotation machine does not have the gravity flow feature, sanding and choke-ups will occur. This gravity flow principle of pulp circulation has made possible the widespread phenomenal success of a flotation cell between the ball mill and classifier. The recovery of mineral, as coarse and as soon as possible, in a high grade concentrate is now considered a requisite to a maximum metallurgical efficiency and hence "Sub-A" operators value its "24-hour per day service" and freedom from shut-downs.

### **Middling Returns Without Pumps**

Middling products from Denver "Sub-A"s can be returned by gravity from any cell to any other cell in the average flotation circuit. The flexibility is possible without the aid of pumps or elevators. The middling pulp flows to the required cell and by means of a return feed pipe, falls directly on top of the impeller, assuring positive treatment and aeration of the middling product without impairing the action of the cell. This feature, exclusive with Den-

ver "Sub-A", is of particular advantage in circuits where several cleaning steps are required to bring middling products to final grade.

The initial feed can also enter into the front or back of any cell through the return feed pipe.

### **Positive Cell Control**

Denver "Sub-A" cells are under full control with normal operating conditions. The pulp level is maintained at the desired place with adjustable weirs. Aeration is controlled with flexible methods of air addition which allow variable aeration for different conditions. Any overloads or surges of coarse material from the grinding circuit are effectively taken care of with the sand relief openings, ports or quickly adjustable weirs. With these control features the operator has every opportunity to maintain his circuit in balance. Pulp fluctuations can be minimized and absorbed due to the control features.

## **Metallurgical Advantages with Denver "Sub-A"**

### **Selectivity**

Denver "Sub-A" Flotation Equipment is metallurgically unsurpassed for the production of concentrates most suitable for subsequent thickening, filtering and smelting.

The selectivity of Denver "Sub-A" through all mesh sizes is one of the outstanding features of this flotation machine. Selectivity in Denver Cells is not by chance, but results from the basic principle in design. The distinct gravity flow feature, coupled with the individual cell construction, controlled individually or in groups, and positive circulation through the machine, is to a large degree responsible for the recovery of coarse products by flotation. The advantage of positive circulation becomes obviously important with coarser grinds. A homogeneous and thoroughly mixed pulp is circulated at all times in each cell and there is no tendency towards classification and segregation. Thorough mixing and aeration of all pulp fractions by positive circulation is the only means of obtaining selective flotation and metallurgical efficiency through all mesh sizes. The absence of pulp stratification prevents slime recovery from surface pulp or "drift" of heavy granular fractions through the machine.

Selective flotation with Denver "Sub-A" results in several major features, such as:

- (1) Coarser grind possible
- (2) High Ratio of Concentration
- (3) Coarse products more acceptable for dewatering and smelting.
- (4) Low volume of middling for re-circulation
- (5) Selectivity allows machine to do mechanically that which is frequently attempted with reagents.

### **Recovery:**

Recovery in flotation is of prime importance. In studying recoveries it is essential also to investigate thoroughly the intermediate products produced. It is a simple matter to make a high recovery or a low tailing if no thought is given to the nature of the concentrate produced or circulating load. Denver "Sub-A" Flotation Cells will produce a high recovery, coupled with a high grade concentrate, low volume of middling, and a final concentrate most acceptable for subsequent treatment. The overall efficiency of this flotation machine will assure an equitable balance between recovery and nature of products produced.

### **Balanced Products Analysis**

Denver "Sub-A" Flotation Cells have demonstrated that they alone produce products most acceptable for economic efficiency. In competitive tests where all phases of the operation are studied in thorough detail, it has been proven time and again that Denver "Sub-A"s show metallurgical advantages which contribute to the highest overall efficiency of an entire mining operation. Denver "Sub-A" cells are:

- (1) More selective through all mesh sizes.
- (2) Produce a coarser concentrate.
- (3) Produce a concentrate more acceptable to subsequent treatment.
- (4) Produce equal or higher recovery in conjunction with a higher grade concentrate and higher ratio of concentration.

A comparison of product assays does not give true and complete information with respect to the performance of a flotation machine. Product assays for two flotation machines operating in parallel could quite conceivably be identical, yet the physical char

acteristics of the products recovered and discarded would be entirely dissimilar. Wide differences which would be obvious in detailed investigation might not be indicated by a cursory examination. A detailed study of flotation concentrates shows that Denver "Sub-A"s recover the coarser more granular sulphides which parallel machines lose in the tailing. The higher recovery of coarse concentrate has been the story in every instance where Denver "Sub-A" cells have been on a comparative basis. The use of Denver "Sub-A" cells is responsible for the trend in concentration by flotation of coarse granular concentrates with minimum slimes. Higher recoveries have been possible in many instances by changes in grinding and removal of coarse primary concentrates. Recovery at a coarser grind means a decreased amount of slime mineral in the pulp. Absence of slime in concentrates is reflected in the analysis of the insoluble fraction. Denver "Sub-A" cells always show a lower percentage of slime in concentrate due to selectivity and this means minimum refractories in subsequent treatment.

Variations in tailing analysis show the same differences as those portrayed for concentrates. A detailed study will show where the Denver "Sub-A" rejects slime to waste.

Screen analysis of products recovered and rejected clearly demonstrate the absence of sanding and segregation in Denver "Sub-A" cells and the patented positive circulation principle assures balanced products.

## Capacities

The capacity of a flotation cell, treating any ore, depends upon facts and conditions which can best be determined by experience and test work. The pulp density and flotation contact period required materially affect the capacity of a flotation machine. With these factors known from previous work or test results, the size machine can be determined. Three conditions are factors in determining the proper size machine and number of cells.

### (1) Capacity:

Flotation contact time required for the ore is one of the determining factors in calculating capacity. If an ore is slow floating and requires twelve minute treatment time, and another ore is fast floating and

requires but six minute treatment, it is evident that a machine of only half the capacity is necessary in the last instance. Pulp density and specific gravity of dry solids control the cubic feet of pulp handled by the flotation machine, so are determining factors in calculating the flotation contact period. The Denver "Sub-A" capacity recommendations are conservative figures which are based on years of actual field operation, treating many kinds of material.

### (2) Volume:

The volume of the flotation cell must be known, as the volume in the flotation machine determines the time available for flotation of the values to take place. Therefore, the capacity of any flotation machine is dependent on the volume. All flotation cells having the same volume will have approximately the same capacity, with allowance made for horsepower, the efficiency of the impeller and aeration. As the flotation contact period is very important in any flotation machine, the actual cubical content of any machine should be carefully checked as well as accurate determinations on average pulp specifications.

### (3) Results:

Metallurgical results required from the flotation machine will have considerable bearing on the installed capacity. Several stages of cleaning may be required to give a high grade concentrate and this can be accomplished by the Denver "Sub-A", usually in one machine without resort to pumps for middling return. Results with cells of equal volume will not necessarily be equal because they may not be equally efficient. It may be easy enough to pass pulp through a flotation machine but to have a machine give a high-grade concentrate, to retreat middlings, and to give a low tailing, is an advantage obtained by use of Denver "Sub-A"s.

The maximum results are obtained by the Denver "Sub-A" at minimum cost, as the "Sub-A" recovers the mineral at the critical size in a machine protected fully against wear.

Under the table, problems are given to illustrate the methods of calculating the number of cells required. In order to secure the maximum positive treatment of the mineral, and to produce a high grade concentrate, it is best to have the necessary

Machine	Dilution of Feed		Specific Gravity									
	Water to Solids	Percent Solids	4.5	4.2	3.8	3.4	3.2	3.0	2.7	2.2	1.4	
			Cubic Feet Per Ton									
No. 12 (24x22)	1-1	50	7.69	364	356	347	342	337	328	310	293	
Denver	1 1/2-1	40	262	259	255	251	248	245	241	231	204	
"Sub-A"	2 1/2-1	32	206	198	194	192	191	189	187	181	164	
Volume	3-1	28	162	160	159	157	156	155	153	149	131	
Per Cell	3 1/2-1	22	120	119	118	117	117	115	115	111	106	
No. 15 (24x24)	1-1	50	443	436	427	417	411	406	399	371	314	
Denver	1 1/2-1	40	314	311	306	297	295	286	286	276	244	
"Sub-A"	2 1/2-1	32	240	238	235	232	230	228	225	217	196	
Volume	3-1	28	194	192	191	188	187	186	184	179	164	
Per Cell	3 1/2-1	22	148	147	146	145	145	144	143	138	126	
No. 18 (32x28)	1-1	50	664	655	641	625	616	609	590	557	472	
Denver	1 1/2-1	40	471	469	459	451	447	442	432	415	366	
"Sub-A"	2 1/2-1	32	361	357	353	348	346	343	337	326	293	
Volume	3-1	28	280	280	285	283	282	278	276	267	246	
Per Cell	3 1/2-1	22	252	250	248	246	244	242	240	234	218	
No. 18 Sp. (32x32)	1-1	50	885	872	853	833	822	811	786	743	630	
Denver	1 1/2-1	40	628	622	610	601	595	590	577	553	489	
"Sub-A"	2 1/2-1	32	484	478	471	465	462	457	450	434	392	
Volume	3-1	28	388	384	381	377	374	372	367	357	326	
Per Cell	3 1/2-1	22	328	323	321	327	325	324	320	312	281	
No. 24 (43x43)	1-1	50	287	285	283	281	280	278	275	269	252	
Denver	1 1/2-1	40	228	224	223	221	220	219	218	212	201	
"Sub-A"	2 1/2-1	32	185	183	182	181	180	179	178	176	169	
Volume	3-1	28	159	158	158	157	157	156	155	152	143	
Per Cell	3 1/2-1	22	128	127	128	126	125	125	124	122	118	
No. 24 (43x43)	1-1	50	1475	1453	1422	1368	1359	1351	1312	1240	1050	
Denver	1 1/2-1	40	1058	1028	1002	982	971	961	922	882	813	
"Sub-A"	2 1/2-1	32	802	795	783	774	769	762	750	725	656	
Volume	3-1	28	646	640	635	628	623	620	612	595	548	
Per Cell	3 1/2-1	22	558	551	548	543	540	540	536	531	493	
No. 24 (43x43)	1-1	50	427	475	472	468	466	463	459	449	429	
Denver	1 1/2-1	40	329	324	322	318	317	315	312	304	292	
"Sub-A"	2 1/2-1	32	267	275	272	270	269	268	266	261	241	
Volume	3-1	28	227	227	228	224	223	222	220	215	202	
Per Cell	3 1/2-1	22	186	189	187	186	185	184	182	178	169	
No. 24 (43x43)	1-1	50	306	304	303	302	301	300	298	294	282	
Denver	1 1/2-1	40	242	242	242	242	242	242	242	242	242	
"Sub-A"	2 1/2-1	32	184	184	184	184	184	184	184	184	184	
Volume	3-1	28	142	142	142	142	142	142	142	142	142	
Per Cell	3 1/2-1	22	110	110	110	110	110	110	110	110	110	
No. 24 (43x43)	1-1	50	3690	3625	3560	3470	3420	3370	3280	3095	2925	
Denver	1 1/2-1	40	2620	2590	2550	2505	2480	2450	2405	2305	2075	
"Sub-A"	2 1/2-1	32	2005	1985	1960	1935	1920	1905	1875	1810	1640	
Volume	3-1	28	1595	1580	1568	1552	1550	1530	1495	1450	1370	
Per Cell	3 1/2-1	22	1385	1380	1385	1365	1360	1349	1335	1300	1210	
No. 24 (43x43)	1-1	50	1085	1080	1055	1047	1042	1037	1030	1010	955	
Denver	1 1/2-1	40	840	837	831	827	825	821	812	808	822	
"Sub-A"	2 1/2-1	32	648	648	648	648	648	648	648	648	648	
Volume	3-1	28	518	518	518	518	518	518	518	518	518	
Per Cell	3 1/2-1	22	410	410	410	410	410	410	410	410	410	

total volume divided into at least four cells and preferably six cells, each a separate cell, so that they may be used for roughing, cleaning, or recleaning purposes.

To determine the number of Denver "Sub-A" cells required—multiply the proposed tonnage per day (24 hours) by the time (number of minutes necessary to float the mineral) then divide this product by the proper figure given in the table. This figure is secured by taking the size machine under consideration (find the horizontal line giving the dilution of mill pulp and the vertical line giving the specific gravity of your ore); the figure will be at the point of intersection.

**PROBLEM 1**—How many No. 15 (24x24) Denver "Sub-A" Cells are required to treat 50 tons of gold or lead ore per day, with treatment time 12 minutes, dilution 3 to 1, and sp. gr. 3.0?

$$\frac{\text{Tons (24 hours)} \times \text{Treatment time (minutes)}}{\text{Tabulated tonnage figure}} = \frac{50 \times 12}{162} = 3.7 \text{ cells}$$

**ANSWER**—The result is 3.7 cells, thus use 4 No. 15 Denver "Sub-A" Cells.

**PROBLEM 2**—How many No. 18 Sp. (32x32) Denver "Sub-A" Cells are required to treat 125 tons of lead-zinc ore per day, with treatment time 14 minutes for the lead, dilution 3 to 1, and with treatment time 16 minutes for the zinc, dilution 3 1/2 to 1, and sp. gr. 3.4?

**ANSWER**—(lead)  $125 \times 14 \div 327 = 5.4$ , thus use 6 No. 18 Sp. Cells.

**ANSWER**—(zinc)  $125 \times 16 \div 281 = 7.2$ , thus use 8 No. 18 Sp. Cells.

### Construction of Denver "Sub-A" Flotation Cells

Continuous "24-hour per day service" depends upon the mechanical design and construction of a flotation machine. There is no unit so rugged, nor so well built to meet the demands of the process, as the Denver "Sub-A" Flotation Machine. The ruggedness of each Denver cell is necessary to give long life and to meet the requirements of the process. Numerous competitive tests all over the world have conclusively proved the real worth of these cells to many mining operators who demand "Maximum results at the lowest cost."

The location of the feed pipe and the stationary hood over the rotating impeller account for the simplicity of the Denver "Sub-A" cell construction. These parts eliminate swirling around the shaft and top of the impeller, reduce power load, and improve metallurgical results.

Improvements in construction of Denver "Sub-A" cells during the last ten years have been gradually made as a result of plant scale testing and through suggestions from the mining fraternity. Today the Denver "Sub-A" is mechanically unexcelled with rugged construction, pressure cured wearing parts, heavy duty, dependable drives. The abrasive cell zone is protected with rubber bottom liners and hard iron or Decolloy side liners. The heavy duty shafts are also rubber protected so the entire abrasive zone is sheathed for protection against wear.

The Denver "Sub-A", with its distinctive advantages, is moderately priced, due to standardization and quantity production. There is a definite mechanical or metallurgical reason behind the construction of every part of the Denver "Sub-A" as explained in the following specifications.

#### **All Steel Construction**

The tank for the Denver "Sub-A" Flotation Machine is made of heavy steel . . . joints are electric welded both inside and out. Partition plates are furnished with gaskets and arranged for bolting to partition channels so that if necessary all of the plates can be changed at any time in the field to provide either a right or left hand machine. Right hand machine is standard and will be furnished unless otherwise noted.

Denver "Sub-A" Flotation Machines are also available in wood tank construction especially suitable for corrosive circuits. These machines can be supplied with modifications so that they are ideal for use in special applications.

All cells are placed at a common floor level and due to the *gravity flow* principle of Denver "Sub-A" Flotation Machines almost any number of cells can be used in any circuit at one elevation without the necessity of pumps or elevators to handle the flow from one machine to the next. Operation and supervision is thus simplified.

For export shipments all of the items for the flotation machine are packed, braced, and blocked inside of the steel tank so that minimum volume is required. Safe delivery of parts without damage is thus assured.

#### **Bearings and Housing**

The shaft and bearings of the Denver "Sub-A" are supported in an enclosed ball bearing housing designed to properly carry and maintain the rotating impeller. Both the upper and lower heavy duty, oversized, anti-friction bearings are seated in this housing, insuring perfect alignment and protection against dirt.

Bearings have grease seals to prevent grease or oil getting into the cells; lubrication is only needed about once in six months. Many thousands of these standard bearings are in daily use on Denver "Sub-A" cells, giving continuous service and low horsepower.

#### **Stationary Hood**

The hood, which is located near the bottom of the cell, is an important part of the assembly as it serves a number of purposes. The vanes on this hood prevent swirling of the pulp in the cell, producing a quiet action in the central or separation zone. The hood also supports the stationary standpipe and the hood wearing plate. Aeration of the pulp takes place in the impeller zone just below the stationary hood. The wearing plate is bolted to the bottom of the hood and prevents the impeller from being buried by pulp when the machine is shut down.

#### **Long Life Wearing Parts**

The maintenance cost of wearing parts in many large plants has been reduced to a minimum due to the use of molded rubber parts, which are available for all sizes of Denver "Sub-A" Flotation Machines.

Data from large operations have shown that the life of rubber parts is from six to fifteen times longer than the life of hard iron wearing parts. The slightly greater cost of these parts is therefore more than offset by the longer life. The advantages gained not only in lower maintenance but also in

reduction in horsepower (because of the lower coefficient of friction when using molded rubber impellers) make them most economical. Both receded disk and conical disk wearing parts are also available in special hard alloy iron.

### **Receded Disk Impellers**

Impellers for the Denver "Sub-A" Flotation Machine are built in two types with corresponding wearing plates: (1) Receded Disk Impellers and Diffuser Wearing Plates (2) Conical Disk Impellers and Wearing Plates.

The receded disk impellers and diffuser wearing plates have been proved in commercial installations for many years and are one of the important developments made in the Denver "Sub-A" Flotation Machine. The receded disk impellers and diffuser wearing plates are furnished with all machines unless otherwise specified. The advantages of these parts are as follows:

- (1) Have permitted the increased speed of the impeller without any increase in horsepower.
- (2) Give more aeration with an accompanying greater diffusion of air.
- (3) At higher speeds the air is in a more finely divided state as the bubbles are smaller, and the added aeration results in a deeper froth column.
- (4) Requires less operating attention, particularly toward the end of the machine with a uniform active cell.

Agitation is intense in the agitation zone but elsewhere it is held at a minimum and at the same time the air is finely dispersed throughout the pulp so that the cell surface presents the appearance of a smooth and quiet blanket of froth, conducive to good flotation. Molded rubber parts are recommended due to their lighter weight, perfect balance, and longer life.

In keeping with a long established policy, it is possible to use these parts on any Denver "Sub-A" Flotation Machine irrespective of age, without the necessity of making any major changes, thus adhering to the standard Denver policy of "No yearly models but continually improving."

### **Conical Disk Impellers**

The conical disk impellers and wearing plates, as illustrated, are obtainable for all sizes of machines. The conical disk impellers and wearing plates have been used in Denver "Sub-A" Flotation Machines for many years but are rapidly being replaced by the receded disk impellers and diffusers for general purposes. Conical disk impellers are recommended for Denver Unit Flotation Cells and applications such as treatment of dense pulp and coarse material. Diameters of all impellers have a definite relationship to cell sizes, thus insuring uniform circulation of the pulp.

### **Types of Drives**

The Denver "Sub-A" was the first flotation machine to use the Multi-V-Belt Horizontal Drive, which has proved so successful. Denver "Sub-A" Flotation Cells have been carefully designed to be driven either by a motor and V-belts or by V-belts to a main drive shaft. In the motor driven type the impeller shafts are driven by V-belts, sheaves, and vertical ball bearing motor. This type of motor drive is much more economical and desirable than a direct motor driven unit because it makes any speed range available and does not require a special motor shaft assembly.

The standard drive on all flotation machines of an even number of cells is one motor driving two cells through V-belt drives. If an odd number of cells is ordered, a drive which will prove most economical in first cost and provide the greatest operating efficiency will be furnished. Adjustment of belt tension is provided for in the motor mounting.

### **Paddleshaft Drive**

The paddleshaft drive is taken generally from the last impeller shaft by means of V-belt drive to a speed reducer, which in turn drives the paddleshaft at slow speed. The No. 30 Denver paddleshaft drive is from a gear motor. The quick removal of the mineral froth, in the form of a concentrate, increases the recovery; quick removal of this mineral froth is very important and when a high grade concentrate is desired, the rotating paddles can be regulated as desired.

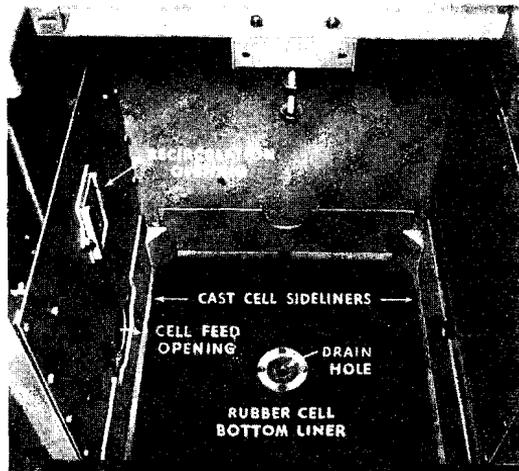
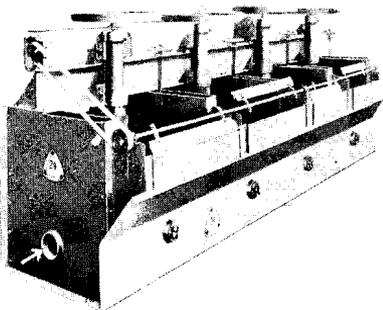
### Positive Pulp Level Control

Every Denver "Sub-A" Cell is actually an individual flotation machine with its own pulp level, controlled by its weir overflow. Correct overflow normally requires this positive pulp level control in each cell even though this adjustment when once made is infrequently changed. There are three methods of regulating pulp level:

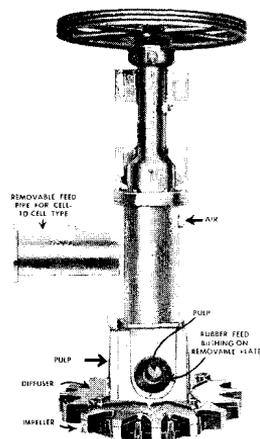
**Weir Blocks**, as illustrated, slide easily into place at the weir, and consist of wood slats held down by means of a steel wearing bar. On the smaller machines, especially, adjustment by this means is easy as the weir is readily accessible. Actual plant practice shows in the normal circuit that it is not necessary to change the pulp level frequently.

**Handwheel operated weir gates** can be provided, as illustrated, so that changes in pulp level in each individual cell can be accomplished by turning the handwheel which is located far above the froth level. Changes in level can be made quickly and easily with minimum effort.

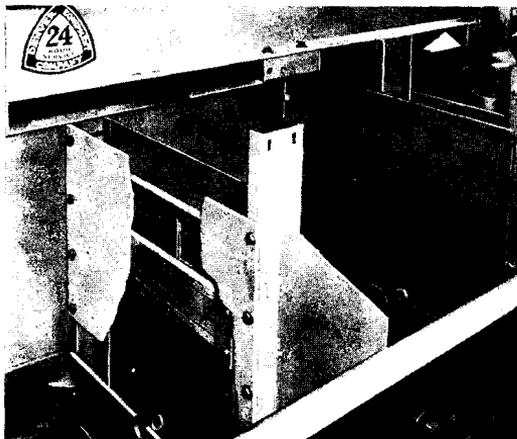
**Gear driven handwheel gates**, as illustrated, can be provided and are especially useful on large size flotation machines. This arrangement brings the control of the pulp level out to the front of the machine making it unnecessary to reach over the froth lip. The use of a gear box with handwheel control reduces the effort required for raising or lowering the gate, and provides a method of quick and easy adjustment.



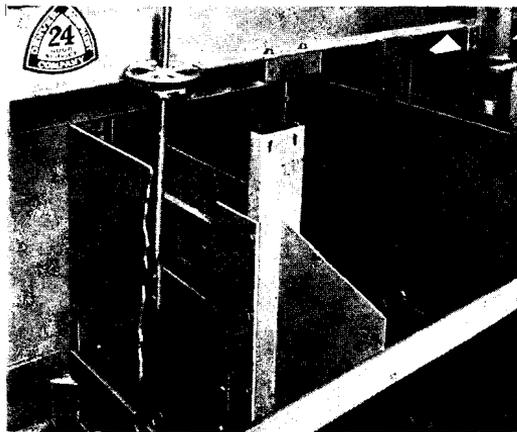
INTERIOR OF DENVER "SUB-A" CELL



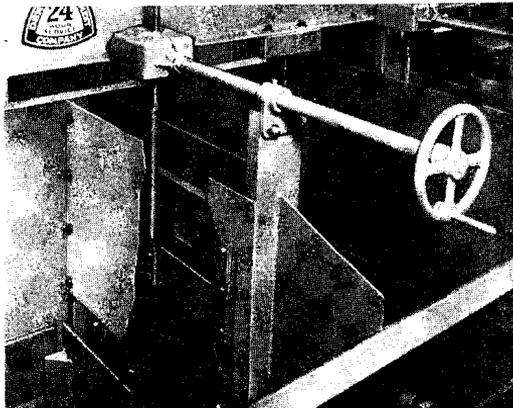
DENVER "SUB-A" IMPELLER AND HOOD ASSEMBLY



WEIR BLOCK PULP CONTROL—CELL PLATE CUT AWAY



HANDWHEEL OPERATED WEIR GATE—CELL PLATE CUT AWAY



GEAR DRIVEN HANDWHEEL GATE—CELL PLATE CUT AWAY

### Interior Cell Design

Cell liners fit easily into the cell and consist of four cast iron liners and a rubber bottom liner. This bottom liner consists of a rubber compound similar to that used on the molded rubber parts, firmly bonded to a steel backing so that it does not rip or blister. This liner is held in place at the edges by the side liners.

Cell drainage is through an easily accessible port at the back of each cell.

A small recirculation gate is provided near the top of each cell so that if desired, a portion of the pulp can be removed from the middling zone and returned to the impeller for retreatment. This recirculation feature influences the production of high grade concentrates in some cases. A gate is provided for this recirculation opening so that an adjustment of the zone and amount of recirculation can be varied.

Denver Flotation Cells are provided with openings in the partition plates for by-passing the pulp from cell to cell without the pulp circulating through each hood feed pipe. In normal operation these partition gates are left closed; however, this arrangement is advantageous when large tonnages are fed to the flotation machine. This arrangement

also allows the machine to be operated in "groups" of cells with the same positive control and circulation applied to each group.

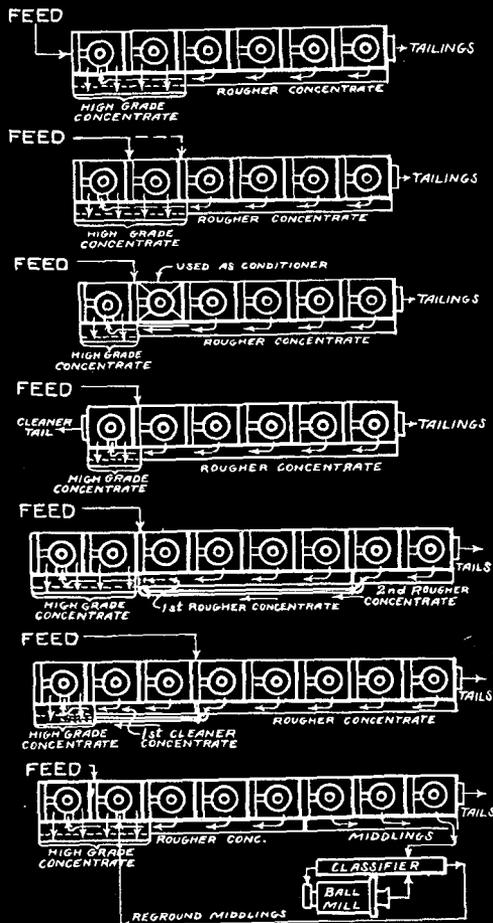
### Impeller Assembly

The impeller assembly, consisting of steel shaft, totally-enclosed spindle bearings, standpipe, air-bonnet, hood, wearing plate, and impeller, fits easily into the cell as a unit. Diffuser and receded disk impellers, as illustrated, are furnished but conical disk impellers can be used if desired. The hood rests on corners of the cell side liners and is provided with keystone plug plates in front and back with recirculation openings. These recirculation opening in the plug plates can be opened, closed or bushed to small sizes as desired but in normal operation are closed. The keystone plug plate can be removed to provide an opening to the impeller for the return of middlings or feed, by means of return feed pipe which is easily placed to fit between the hood and front or back plate of the cell. Openings are provided in front of each cell for the return of middlings into any cell by gravity or these openings can be used to introduce feed into the cell if desired.

### Adjustment of Impeller

Adjustment of the impeller is easily and quickly accomplished from the rear of the machine by means of the threaded rod holding the end of the spindle bearing housing. Proper adjustment of the clearance between impeller and wearing plate is important, and is easily done by loosening the bolts holding the spindle bearing housing and raising or lowering the entire housing by means of the adjustment provided by this threaded rod. After the proper clearance is secured the housing is tightened in place. Guides on each bearing housing keep rotation of impeller in perfect alignment and make vertical adjustment easy.

Use Denver Ore Tests to verify or improve your present flowsheet.



FLEXIBILITY OF FLOWSHEET WITH DENVER "SUB-A"

This policy of continual improvement is the aim for advancement of the Denver "Sub-A". Experiences gained in field studies have shown the factor of safety to use on shafting, bearings, and other operating parts.

Denver Equipment Company pioneered and developed the method of producing molded rubber wearing parts in 1932. Experience in handling practically all types of abrasive pulps, and in circuits with various types of flotation reagents, and oils, have facilitated the development of suitable rubber compounds to meet all conditions. The use of Denver "Sub-A" Flotation with molded rubber wearing parts is extremely valuable to the operator, with the assurance of the lowest possible maintenance cost. Denver molded rubber wearing parts are still the leaders in the field, giving trouble-free service for much longer periods than any other make impeller. Denver molded rubber impellers have handled some very large tonnages and records of 4 and 5 years continuous operation are common.

Rubber bottom cell liners, rubber sand relief bushings, rubber shaft sleeves and alloy iron hoods and feed pipes are all features of Denver "Sub-A".

These features, combined with the sturdy construction of the cells, oversize bearings, heavy duty shafting and rugged cell liners, are showing average maintenance costs including labor for installation of less than \$0.001 per ton in many cases. Even under the most adverse conditions Denver "Sub-A" Cells rarely show total repair cost in excess of \$0.003 per ton.

### Special Features

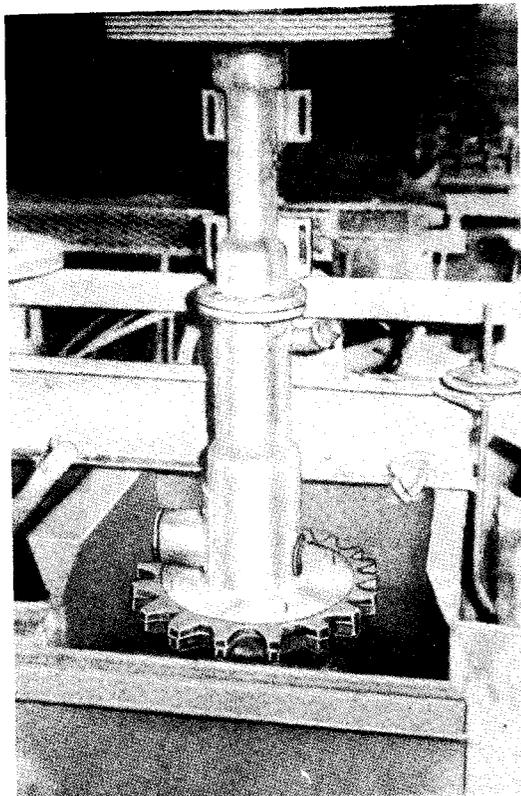
Each Denver "Sub-A" Cell is provided with an air bonnet on the shaft assembly so that low pressure air may be connected if desired. To assure complete diffusion of air in the pulp an automatic seal is built in each weir casting.

When desired, a discharge may be taken at partitions on Denver "Sub-A" Flotation Machines by reversing the weir casting and providing a special weir plate.

Feed may enter any cell of a Denver "Sub-A" Flotation Machine, through the front or back.

The hand of the Denver "Sub-A" may be easily changed in the field by reversing the position of the

weir casting with plate and partition plate. The hood assembly is turned through 180 degrees and the feed liner is changed with the liner in the opposite segment.



Above photo shows the removal of a Denver "Sub-A" impeller assembly. Renewal of wearing parts is both simple and quick.

# Two-Stage Grinding Circuits

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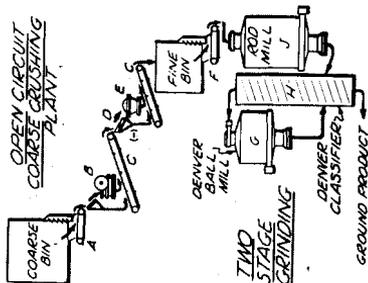
	NAME OF MACHINE	SINGLE-STAGE GRINDING			TWD-STAGE GRINDING		
		CLOSED CIRCUIT CRUSHING			OPEN CIRCUIT CRUSHING		
		HP Installed	HP Actual	Ship. Weight	HP Installed	HP Actual	Ship. Weight
<b>100</b> TONS/24 HOURS Medium Ore 65 Mesh Ball Mill RPM = 75% Critical Rod Mill RPM = 60% Critical	ITEM A 24"x10" Apron Ore Feeder B 10"x16" Denver Jaw Crusher C Two (2) 16" Conveyors D 2'x4' Denver-Dillon Screens E 18" Secondary Cone Crusher F 16"x10" Adjustable Stroke Feeder G 3'x6" Denver Ball Mill H 30"x18" Denver Stroke Classifier I 4'x41/2" Denver Rod Mill J 4'x6" Denver Rod Mill	2 20 3 14 25	1 15 2 1/2 1 1/2 20	8858 6390 4076 711 10051	2 20 3 1 1/2 20	1 15 2 1 1/2 16	8858 6390 4076 711 10051
TOTALS	114 1/2	98 1/2	70623	114 1/2	91 1/2	70450	
<b>200</b> TONS/24 HOURS Medium Ore 65 Mesh Ball Mill RPM = 75% Critical Rod Mill RPM = 60% Critical	ITEM A 30"x10" Apron Ore Feeder B 10"x20" Denver Jaw Crusher C Two (2) 18" Denver Conveyors D 3'x6" Denver-Dillon Vib. Screen E 28" Secondary Cone Crusher F 24"x10" Secondary Cone Crusher G 24"x10" Denver Ball Feeder H 4'x18" Denver Ball Mill I 42"x21 1/2" Denver Classifier J 5'x8" Denver Rod Mill	3 25 6 3 50 11 1/2 150 5	1 2 4 1 1/2 11 1/2 1 125 3	10208 7987 4166 1408 16714 1800 53928 12668	3 25 6 2 25 11 1/2 5 30	1 20 4 1 1/2 16 1 42 67	10208 7987 4166 1408 10051 1800 12668 23033 36651
TOTALS	242 1/2	195 1/2	110853	192 1/2	159 1/2	107972	

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	ITEM	CLOSED CIRCUIT CRUSHING			OPEN CIRCUIT CRUSHING		
		HP Installed	HP Actual	Ship. Weight	HP Installed	HP Actual	Ship. Weight
		<b>350</b> TONS/24 HOURS Medium Ore 65 Mesh Ball Mill RPM = 75% Critical Rod Mill RPM = 60% Critical	A 36"x10" Apron Ore Feeder B 11"x30" Denver Jaw Crusher C Two (2) 20" Conveyors D 4'x8" Denver-Dillon Screen E 18" Secondary Cone Crusher F 30"x10" Adj. Stroke Feeder G 7'x6" Ball Mill H 60"x30" Denver Classifier I 5'x5" Denver Ball Mill J 5'x10" Denver Rod Mill	3 40 6 3 75 2 200 10	2 35 5 2 1/2 60 1 1/2 170 7	11608 12535 4666 2533 23530 2118 78976 24620	4 30 6 3 50 2 10 50 100
TOTALS	339	283	161586	264	235	144163	
<b>550</b> TONS/24 HOURS Medium Ore 65 Mesh Ball Mill RPM = 75% Critical Rod Mill RPM = 60% Critical	ITEM A 48"x20" Apron Ore Feeder B 15"x36" Denver Jaw Crusher C Two (2) 24" Conveyors D 5'x10" Denver-Dillon Screen E 4" Secondary Cone Crusher F 3" Secondary Cone Crusher G 8'x7" Ball Mill H 72"x30" Simplex Classifier I 6'x6" Denver Ball Mill J 6'x8" Denver Rod Mill	7 1/2 60 10 5 150 3 300 10 150	5 48 7 3 1/2 120 2 1/2 250 7 1/2	28368 21189 7486 3800 47008 2448 134200 39500	7 1/2 60 10 5 75 3 10 125 150	5 48 7 3 1/2 60 2 1/2 7 103 130	28368 21189 7486 3800 23530 2448 39500 42707 55532
TOTALS	545 1/2	443 1/2	283999	445 1/2	368 1/2	229580	

## 50-TON TWO-STAGE GRINDING

COARSE BIN  
OPEN CIRCUIT  
COARSE GRINDING  
PLANT



50 Ton 24 Hr. Machine One 54" Dia. Single Stage Grinding Ball Mill  
Ball - 75% Critical Ball Mill RPM - 400, Contact

### SINGLE STAGE GRINDING

ITEM	HP Installed	HP Actual	Shp. Weight
A Denver Ore Feeder	10 1/2	9	3156
B 4' x 10' Denver Jaw Crusher	1 1/2	1 1/2	1922
C 14' Denver Conveyor	7	7	1820
D 4' x 10' Denver Ore Feeder	30	28	18620
E 4' x 5' Denver Ball Mill	7	1	4218
TOTALS	46 1/2	41 1/2	32689

### TWO-STAGE GRINDING

ITEM	HP Installed	HP Actual	Shp. Weight
A Denver Ore Feeder	1 1/2	1	1639
B 4' x 10' Denver Jaw Crusher	2	2	1922
C 14' Denver Conveyor	11 1/2	11 1/2	1535
D 15' x 6' Denver Ball Feeder	1	1 1/4	1470
E 4' x 10' Denver Ore Feeder	30	28	4248
F 3' x 4' Denver Ball Mill	15	12	4712
G 3' x 5' Denver Rod Mill	15	14	3712
TOTALS	46 1/2	37 1/4	23513

TWO-STAGE GRINDING CIRCUITS readily allow for the advantageous use of a Denver Flotation Cell to recover coarse freed minerals as soon as they come from the grinding mill.

### COMPARISON - TWO-STAGE OVER SINGLE-STAGE GRINDING ACTUAL SAVINGS

	50 Ton	100 Ton	200 Ton	350 Ton	550 Ton
CONSUMED HORSEPOWER	2.0	7.4	36	48	75 1/4
CONSUMED WEIGHTS	1500	5881	17433	44119	65213
DOMESTIC EQUIPMENT COSTS	\$404.00	\$301.00	\$7273.00	\$11,927.00	\$21,713.00

Hand of machine designates the position of drive, direction of rotation or direction of flow.

Hand of Machine must be specified for many units. Standard designations for the hand of Denver Equipment Company Machines are illustrated in this bulletin.

Right hand machines are supplied as standard unless otherwise specified.

We want to emphasize your use of sketches to clearly illustrate the location of drive in relationship to feed, concentrate discharge, and tailing discharge of any piece of equipment, about which there may be a question.

Much time and possible expense can be saved by making sure that we understand exactly the way you want your equipment to be manufactured.

Detailed specifications, engineering advice, and elevation drawings of any Denver Equipment Company Machines will be gladly supplied to help you in the proper lay-out and design of your mill.



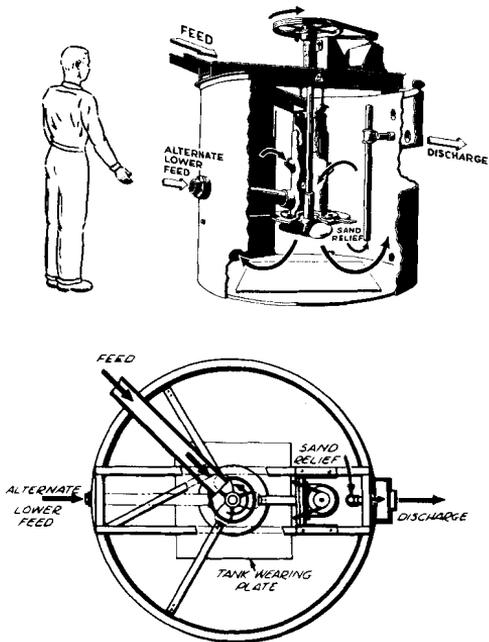
**DENVER EQUIPMENT COMPANY**  
1400 Seventeenth St., Denver 17, Colorado  
Denver Phone CHerry 4466

Offices in New York, Chicago, El Paso,  
Toronto, Vancouver, Mexico D. F.,  
London, Johannesburg

Cable Address: DECO Denver  
Telephone: Denver, Colorado—CHerry 4466

Mailing address:  
Denver Equipment Company  
1400 Seventeenth Street  
P. O. Box 5268  
Denver 17, Colorado

## DENVER SUPER AGITATORS AND CONDITIONERS



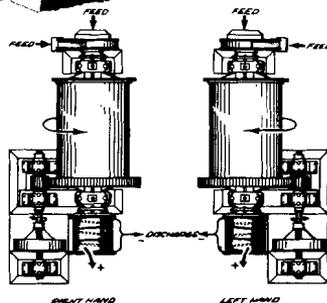
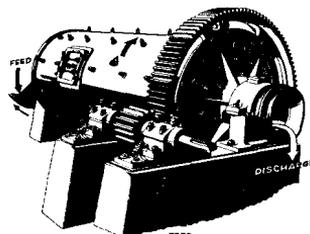
Denver Super Agitators and Conditioners have the standard location of discharge box on the motor side as illustrated.

Please specify if lower feed opening is desired and whether tank is of wood or steel.

If lower feed is specified, it will be located 180° from the discharge box unless otherwise directed.

Note: Diameter of wood tank is measured from outside the staves. Steel tank diameter is measured inside the tank.

## DENVER BALL AND ROD MILLS



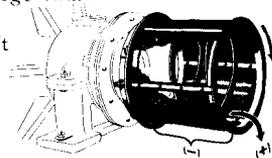
Denver Ball Mills are right hand when mill rotates in a clock-wise direction when facing the discharge end of the mill. Pinion drive shaft is on left side.

Left hand mill rotates in counter clock-wise direction and pinion shaft is on right.

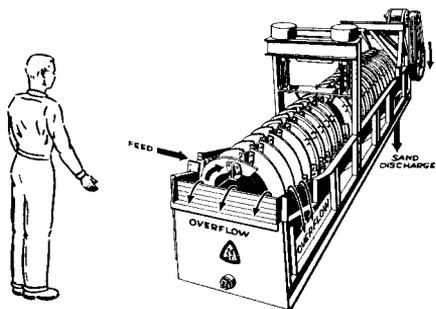
## DENVER SPIRAL SCREENS

Denver Spiral Screens are right hand when used on a right hand ball mill. (Screen rotates clockwise when facing the discharge end.)

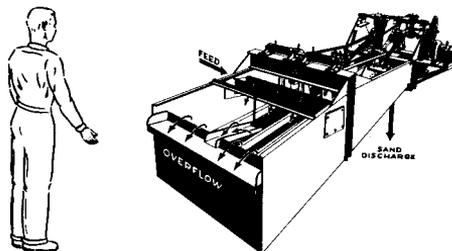
A left hand spiral screen is used on a left hand ball mill.



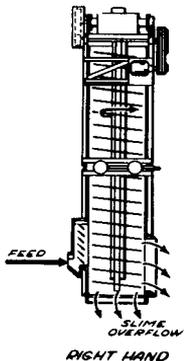
## DENVER SPIRAL CLASSIFIERS



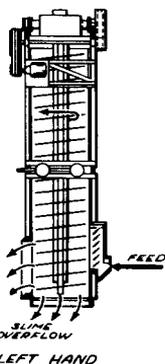
## DENVER RAKE CLASSIFIERS



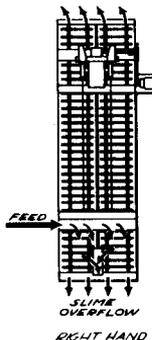
*SAND DISCHARGE*



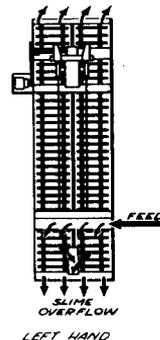
*SAND DISCHARGE*



*SANDS*



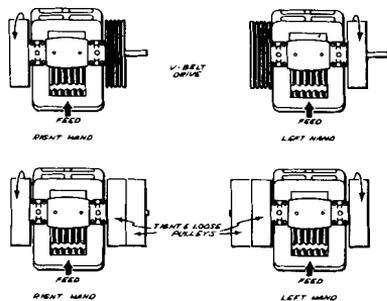
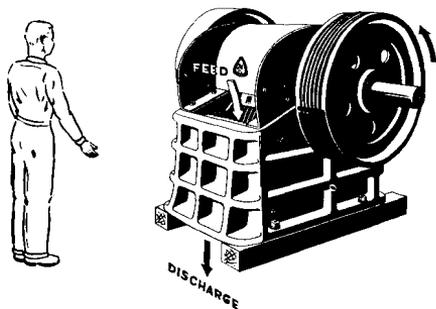
*SANDS*



Denver Spiral Classifiers are right hand when the drive is on the right and feed is on the left as you stand facing the slime overflow.

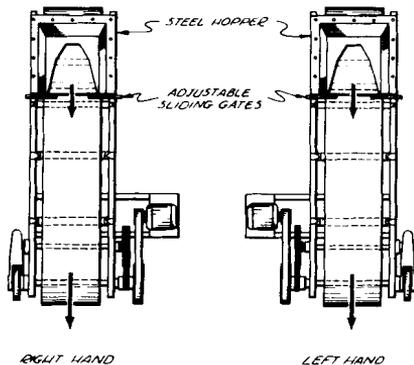
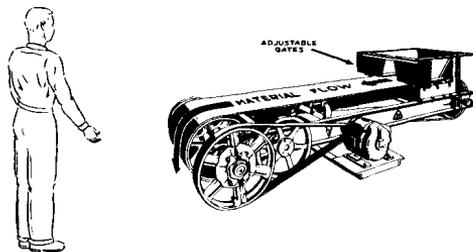
Denver Rake Classifiers are right hand when drive is on the right and feed is on the left as you stand facing the slime overflow.

## DENVER CRUSHERS



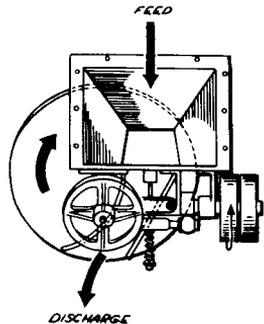
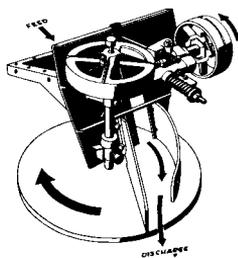
Right hand crusher has grooved flywheel on right hand side when facing feed opening of crusher. Right hand or left hand signifies location of the grooved flywheel as illustrated above. If the crusher is to be flat-belt driven, a tight and loose pulley replaces the grooved flywheel.

## DENVER BELT ORE FEEDERS



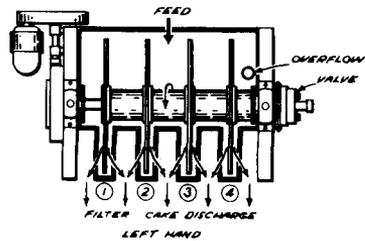
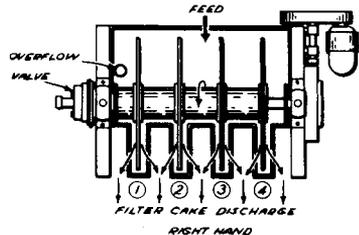
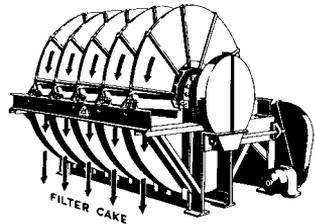
Denver Belt Ore Feeders are right hand when facing the discharge end of the feeder and the motor drive or pulley is on the right.

## CHALLENGE ORE FEEDERS



Denver-Challenge Ore Feeders are right hand when drive pulley or motor bracket is on the right hand side when facing the discharge end of the feeder.

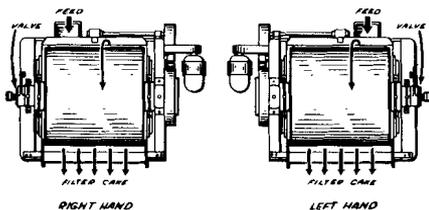
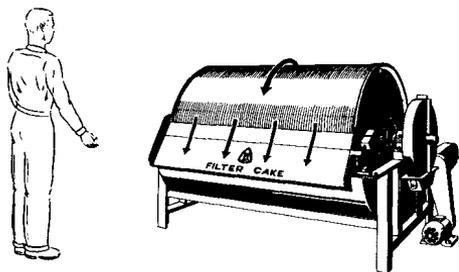
## DENVER DISC FILTERS



Denver Disc Filters are right hand when drive is on the right as you face the discharge or scraper side of the filter.

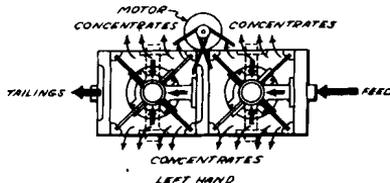
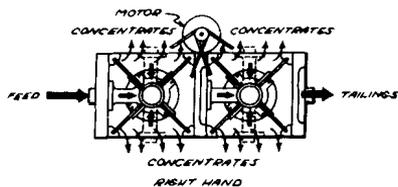
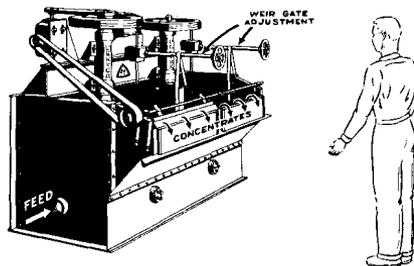
Discs are numbered from left to right when facing discharge irrespective of hand or drive.

## DENVER DRUM FILTERS



Denver Drum Filters are right hand when drive is on right as you face the discharge or scraper side.

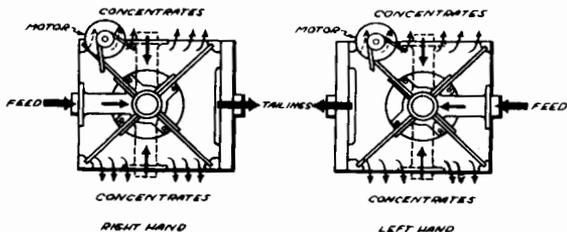
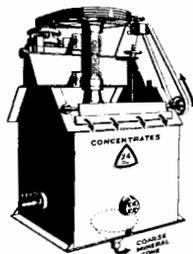
## DENVER "SUB-A" FLOTATION MACHINES



Denver "Sub-A" Flotation Machines are right hand when pulp flows from left to right when facing concentrate overflow (side where spindle bearing housing is mounted).

Froth removal paddle shaft drive is standard on feed end of machine.

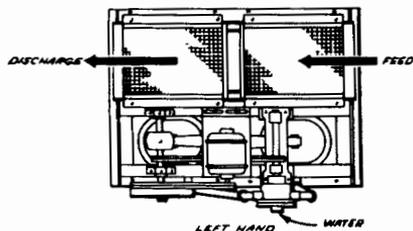
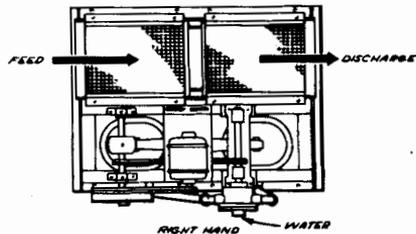
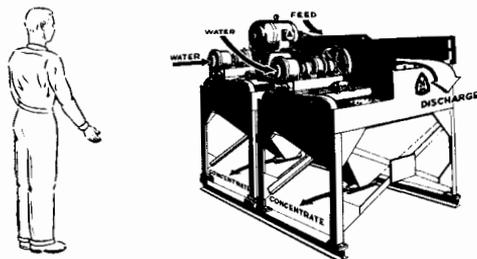
## DENVER UNIT FLOTATION CELLS



Denver Unit Flotation Cells are right hand when pulp flow is from left to right when looking at the unit cell from the concentrate overflow side (side where spindle bearing housing is mounted).

If unit cell is used in ball mill classifier circuit, please submit sketch.

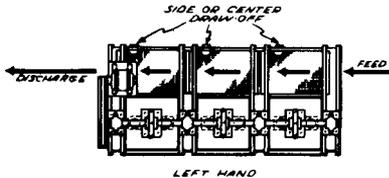
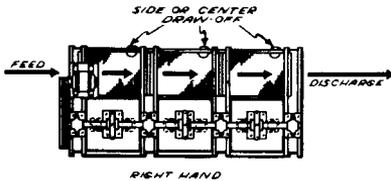
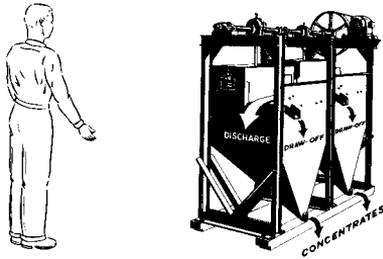
## DENVER MINERAL JIGS



Denver Mineral Jigs are right hand when feed flow is from left to right as you stand on the water valve or drive side facing the jig.

If Denver Mineral Jig is to be used in ball mill classifier circuit, please submit sketch.

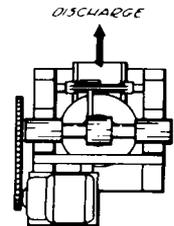
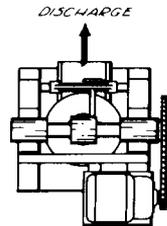
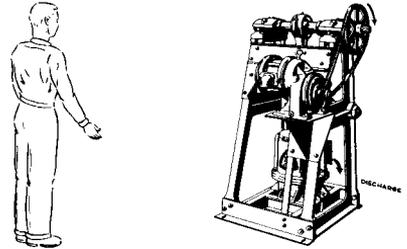
## DENVER IMPROVED HARZ TYPE JIG



Denver Improved Harz Type Jig is right hand when the flow is from left to right when standing on the plunger side facing the jig.

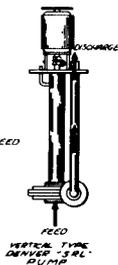
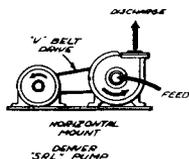
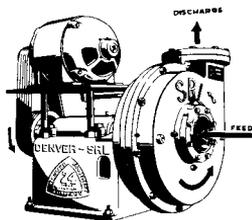
Left hand jig is when flow is from right to left when standing on the plunger side facing the jig.

## DENVER DIAPHRAGM PUMPS



Denver Adjustable Stroke Diaphragm Pumps are right hand when the drive is on the right as you stand in back of the pump (opposite the discharge) facing the pump.

## DENVER SRL SAND PUMPS

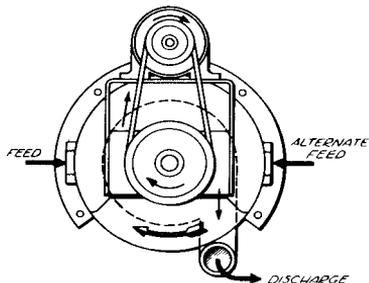
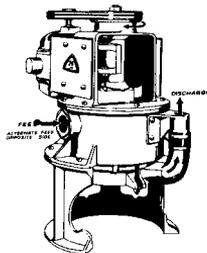


Pumps are not designated as Right or Left Hand. Types of drives for Denver SRL Sand Pumps are:

1. Overhead Motor Mounting
2. Horizontal Drive

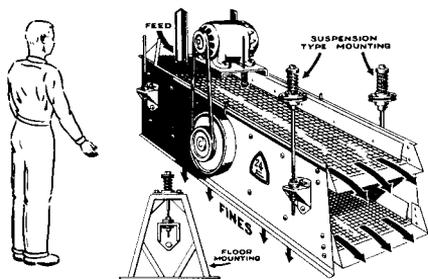
The Denver SRL Sand Pump can be furnished in vertical type for sump pumping.

## DENVER VERTICAL CENTRIFUGAL SAND PUMPS

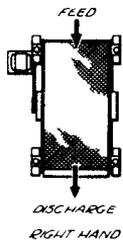


Pumps are not designated as Right or Left Hand. Feed to Denver Vertical Centrifugal Sand Pumps can be introduced from either or both sides as shown above.

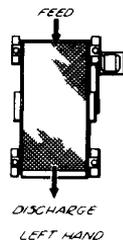
## DENVER-DILLON VIBRATING SCREENS



FLOOR MOUNTING

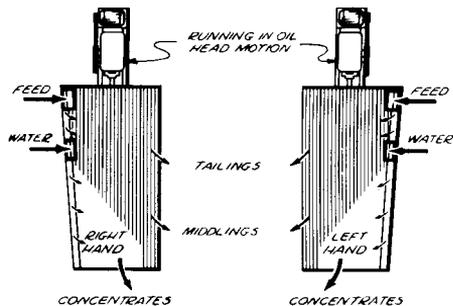
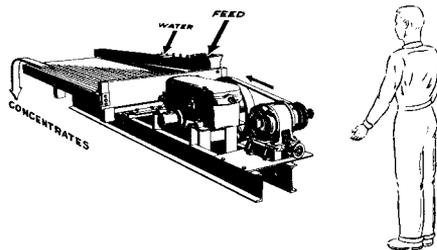


FLOOR MOUNTING



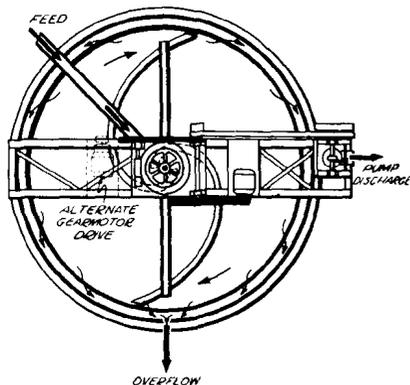
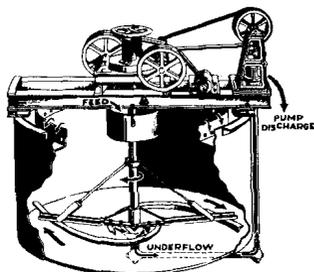
Denver-Dillon Vibrating Screens are right hand when the drive is on the right hand side as you stand facing the feed end of the screen.

## DENVER-WILFLEY TABLES



Denver-Wilfley Tables are right hand when feed box and drive is on the right hand when you stand at the head motion end facing the table.

## DENVER THICKENERS



Denver Thickeners are furnished with V-belt drive to jackshaft and V-belt drive from jackshaft to worm shaft as standard. If a diaphragm pump is furnished by us, superstructure is extended to support pump, and pump can be driven from thickener drive jackshaft with flat-belt.

If desired, gearmotor and chain and sprocket drive can be supplied.

Note: Wood tanks are measured outside the staves. Steel tanks are measured inside the tank.

A Solution to Your Milling Problem . . .

## HOW DENVER EQUIPMENT COMPANY CAN HELP PLAN YOUR MILL

With over 25 years' experience in testing ores from all parts of the world and planning complete milling plants in every country a wealth of information and experience is available at Denver Equipment Company to help you in planning your mill.

For your guidance and assistance we present the information and data in this section of the **DECO ENGINEERS HANDBOOK** to help in the preliminary plans for your mill. We welcome the opportunity to work with you and you are invited to consult with us without charge or obligation.

In this section you will find information on

INTRODUCTION TO PLANNING  
A MILL

LABORATORY TESTING OF ORE  
DESIGNING THE FLOWSHEET

ESTIMATING EQUIPMENT COSTS

ESTIMATING MILL CONSTRUCTION COSTS

TABLES AND CHARTS

UNDIVIDED RESPONSIBILITY FOR  
COMPLETE MILL SERVICE FROM ORE  
TEST TO MILL INSTALLATION

## INTRODUCTION TO PLANNING A MILL

Complete information is available in the following section for planning your milling flowsheet and installation. Careful planning is, of course, necessary starting with the mine, its ore reserves and in obtaining a representative sample of the ore for testing. The assembly of this information provides the basis for establishing the flowsheet and size of equipment necessary for effectively handling your ore.

Typical flowsheets are given for a few of the many ores which are now being successfully treated in various plants throughout the world. Both metallics and non-metallics are covered as well as coal fines, de-inking of paper pulp and various industrial products where Denver "Sub-A" Flo-tation is performing an important job.

Approximate prices are given for all basic items of equipment; for estimating the cost of a plant after the flowsheet is established and equipment sizes selected. Information is also provided to estimate the cost of designing the mill after the mill site is selected. Estimating and factual information is also given to arrive at the installed cost of a mill ready to operate.

Tables and data are presented which are useful in every-day plant and engineering work. Much of this information has come to us from mill operators, designers, engineers and other valuable and important sources.

**YOU NEED THE COMPLETE DENVER SERVICE of Undivided Responsibility . . . from Ore Test to Mill Installation IF you are planning:—**

- (A) New Mill
- (B) Expanded Production
- (C) Changed or Improved Operation

These specialized Deco Services will save you time and money . . . help you develop a profit-making operation and eliminate the hazards of divided responsibility.

## LABORATORY ORE TESTING SERVICE

Comprehensive tests conducted in the Denver Ore Testing Laboratory are the basis for flowsheets—whether technically simple or involved. Design of milling plants based on recommended flowsheets assures desired metallurgical results and economic recovery.

During the past 5 years the Denver Ore Testing Laboratory has successfully completed more than 1,000 tests on 85 different ores from 40 countries. Results of DECO tests are reflected in hundreds of successful installations. An important fact is the duplication of DECO Ore Test Data in full-scale mill operation.

Denver Ore Testing Laboratory provides

- (A) Complete batch or continuous Test Data

- (B) Recommended flowsheet considering local conditions.
- (C) Description and size of equipment to produce desired tonnage and economical metallurgy.

### TESTING THE ORE IS THE ONLY WAY TO ASSURE MAXIMUM PROFIT

Every ore presents a different milling problem. A process which provides good metallurgy on one ore may not be successful on another, apparently similar ore. Even if identical ores were found, local transportation, water and market conditions would possibly dictate different methods of treatment.

Only through comprehensive ore tests can the necessary data be obtained to establish the flowsheet and equipment required to assure maximum net profit on milling a particular ore.

### OBTAINING A REPRESENTATIVE SAMPLE

The first important step in determining the best method of treating any ore is the preparation of the sample to be tested. This work should be carefully done by a competent engineer or mining man. The sample must represent as closely as possible the actual ore to be milled, if the results obtained in the laboratory are to be equalled in a large scale plant.

The object of sampling is to obtain a portion which will represent the average ore with reference to both character and grade.

While 100 pounds of ore is usually sufficient for comprehensive batch laboratory testing, a sample of this size should be cut down from several tons, reducing the size of the pieces as the sample is cut smaller until the final portion consists of crushed ore of 1" or smaller.

### CRUSHING TO PROPER SIZE

The ore must be crushed fine enough to assure thorough mixing to obtain a representative sample. However, for testing purposes it is essential to have freshly crushed ore. To best meet both of these requirements it has been found that one inch material is most satisfactory. This permits crushing in the laboratory just prior to test work.

### PACKING

After the proper sample has been obtained care should be taken in packing the ore for shipment. In many cases sacks (preferably double) or boxes are satisfactory; providing however, that they are sufficiently strong to prevent breakage in transit. When shipping concentrates or freshly mined sulphides, tightly closed cans are better as oxidation will be held to a minimum.

### IDENTIFICATION

Whatever method of packing is used, samples should be carefully marked with tags, both **INSIDE** and **OUTSIDE OF THE PACKAGE**. This is because outside tags sometimes become destroyed or illegible in transit. Inside tags should be placed in heavy envelope for added protection.

For convenience in shipment of samples, the Denver Equipment Company will be pleased to furnish both sample tags envelope and shipping tag. In shipping a sample, the detachable end of the tag should be filled out giving the name of the shipper and positive identification of the sample. This portion of the tag is then detached from the main tag and placed in the envelope and enclosed inside of the sample being shipped. This insures proper identification when sample is received.

If more than one package is shipped, each should be properly identified, and if different samples are to be combined for testing, the proportions should be definitely stated.

#### SAMPLES FROM OUTSIDE THE UNITED STATES

Samples from outside the United States should always be forwarded through customs brokers and should be marked "SAMPLES WITHOUT VALUE." The forwarding agent should be supplied with all necessary information and documents to facilitate passing the shipment through the customs.

When shipment is made, please notify the Denver Equipment Company, giving the name of forwarding agent, transportation time, dates and a full description of the shipment.

#### SHIPPING CHARGE

Shipping charges are to be prepaid, whether sent by express or freight.

## DENVER LABORATORY ORE TESTING

The cheapest form of insurance available to those contemplating a concentration plant, is an ore test. Batch tests on small samples may be sufficient to give the desired information. Sometimes it is necessary to run a continuous test in a pilot plant.

Whatever the cost of this test work, it is a drop in the bucket compared to the money it can save. It will tell you first of all whether the mineral or minerals can be concentrated with a useable product. It will determine the type and size of equipment necessary. It will give data that can be used for estimating treatment costs and for making complete economic analyses. Don't underestimate the importance of thorough testing.

### Estimated Deco Laboratory Ore Test Charges

#### Batch Testing:

1. Bulk Flotation, metallics.....	\$250.00
2. Selective and differential flotation, metallics .....	350.00
3. Flotation tests, non-metallics.....	350.00
4. Batch cycle test if desired with bulk metallic, non-metallic, or selective flotation test.....	add 100.00
5. Denver Mineral Jig or Unit Cell test.....	60.00
6. Complete investigation which may involve gravity, flotation, etc.....	400.00
7. Gravity and amalgamation, gold ore.....	150.00
8. Complete gravity investigation by jigging and tabling.....	300.00
9. Amalgamation test.....	40.00
10. Cyanidation, gold and silver ores.....	200.00
11. Denver Buckman Tilting concentrator test.....	100.00
12. Heavy Media Testing .....	400.00

Laboratory batch ore tests include an examination of the ore with head sample analysis, tests by

gravity, amalgamation, flotation, etc., as specified or required. Crushing, grinding, thickening, filtering and essential engineering information is established to determine equipment sizes. A detailed report including metallurgical results, assays, flotation reagents, recommendations, and a flowsheet is submitted on completion of the test work.

The above estimated prices are based on actual cost for labor, supervision, and assay charges. These estimated prices are average for testing ores which do not present any unusual metallurgical problem which may involve experimental research on grinding, reagents, and chemical analysis. This, of course, increases actual costs but money spent at this stage of the program is low cost insurance, indeed.

A 100 lb. representative sample of the ore crushed to minus 1" is usually adequate for a batch testing program.

Petrographic and microscopic examination of the ore and products is often desirable and useful in establishing mineral association, degree of grinding necessary to liberate the minerals, and in general, what can be done with your ore. Estimated cost of a microscopic examination of an ore and its mill products is approximately \$500.00.



Comprehensive tests conducted in the Deco Ore Testing Laboratory are the basis for flowsheets and solutions to many difficult treatment problems. The care and accuracy used on each test makes possible test reports and recommendations that can be duplicate in full-scale operations.

## Pilot Plant Testing

Deco pilot plant testing charges are based on laboratory pilot plant rental, power, water, lights, assays, chemicals, labor, supervision, and any special equipment which may be required. Batch testing should always be performed first in order to establish pilot plant flowsheet requirements, ore treatment characteristics, and reagents necessary to intelligently proceed with the work on a pilot plant basis.

A minimum of 5 tons of ore is necessary for a pilot plant test using the facilities available at the Denver Equipment Company Laboratory. The estimated cost of treating 5 tons of ore through our laboratory is approximately \$3,000.00. The Denver pilot plant is capable of treating 200 to 300 lbs. of ore per hour and usually a two-week period is required to complete a pilot plant test on 5 tons of ore.

Pilot plant tests are only recommended where it is not possible to determine from batch or cycle tests the disposition of all products or middlings. Often these tonnage lot tests are necessary to secure several hundred lbs. of concentrates or products for further evaluation in establishing markets, etc. This is particularly true on non-metallics such as talc, clay, phosphate, potash, fluorspar, feldspar, barite, etc.



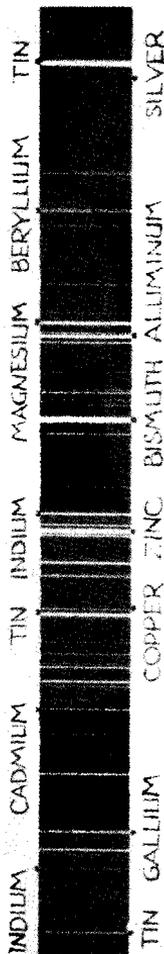
## Laboratory Assay Charges

Denver Equipment Company does no assaying. All samples and test products are sent to local commercial assayers or chemists of our or your choice for analysis and they provide us with certificates of assay or analysis. This arrangement keeps test work up to its maximum standards of reliability and eliminates any question as to the accuracy of the final results.

Following are approximate assay charges now in effect in the Denver area:

Antimony .....	3.00	Magnesium .....	3.00
Aluminum .....	\$ 3.00	Manganese .....	1.50
Arsenic .....	3.00	Mercury .....	3.00
Barium .....	2.00	Molybdenum .....	3.00
Beryllium .....	15.00	Nickel .....	3.00
Bismuth .....	4.00	Phosphorus .....	3.00
Boron .....	5.00	Platinum .....	10.00
Cadmium .....	10.00	Potassium .....	5.00
Calcium .....	1.50	Silica .....	3.00
Calcium Fluoride .....	3.00	Silver .....	1.00
Chromium .....	3.00	Sodium .....	5.00
Colbalt .....	5.00	Strontium .....	5.00
Columbium .....	15.00	Sulfur (acid) .....	1.50
Comb. Rare Earths .....	5.00	Sulfur (fusion) .....	2.50
Copper .....	1.00	Tantalum .....	5.00
Gallium .....	15.00	Thallium .....	10.00
Gold .....	1.00	Thorium .....	5.00
Gold and Silver.....	1.50	Tin .....	4.00
Graphite .....	3.00	Titanium .....	5.00
Indium .....	15.00	Tungsten .....	4.00
Insoluble .....	1.00	Uranium .....	10.00
Iron .....	1.00	Vanadium .....	3.00
Lead .....	1.00	Zinc .....	1.00
Lithium .....	5.00	Zirconium .....	10.00
Spectrographic qualitative for any metal .....	2.00		
Complete Qualitative Spectrographic Analysis including Geiger Counter Test .....	7.50		

A spectrographic analysis completely answers the needs of the mining or industrial man who must know with certainty what metals are contained in his ore or product, and approximately how much. It will detect any one or all of 67 rare and valuable metals which may be in the sample, even when present in quantities too small to be found by chemical methods. A percentage estimate is given for each metal present, which is sufficiently accurate for preliminary purposes. Spectrographic analysis should be made on unknown or doubtful ores, since valuable metals such as gallium, hafnium, cesium, etc., may be overlooked if chemical analyses are made.



Above is a section of a spectrogram with some of the lines identified. These lines are always in the same place for a given element and are a positive means of identification. For qualitative analysis the identification of two or more lines of a particular element definitely establishes its presence, and for quantitative analysis the intensity of the lines, determined on a microdensitometer, is a measure of the amount of that particular metal in the sample.

The utility of the spectrograph is unlimited. Analyses which are impossible chemically, can be made with ease and precision with this instrument. Gallium, hafnium, most of the rare earths and several other elements can not be detected by routine chemical analysis but are readily found by the spectrograph. Beryllium, cadmium, tantalum, columbium, etc. are easily detected spectrographically, but are difficult if not impossible to find by chemical methods when present in small amounts.

The lines in the above spectrogram were produced by a sample containing 1% or less of the respective metals; from this it can be seen that spectrographic analysis is positive and extremely sensitive. Metals which are present in quantities as low as 001% are detected in samples too small for chemical analysis—even in a sample as small as a pinhead.

This laboratory, which pioneered the use of the spectrograph in Denver in 1937, is the only complete chemical laboratory facilities. All spectrographic analyses in this laboratory are made on a large grating type spectrograph and the results obtained are guaranteed to be accurate.

You may be losing money on your ores and metallurgical or industrial by-products because of the presence of unknown valuable metals.

## Today's Ore Test— Tomorrow's Flowsheet

Intelligent ore testing can be the difference between a sound business investment in a mining operation and a highly speculative "venture."

Ore Testing takes the guesswork out of answering the question of "can this ore be milled profitably." It also gives conclusive answers to the subordinate questions of "what type of flowsheet will give the greatest net return on this operation, and can increased value and/or increased mill capacity be obtained by the addition or substitution of equipment in the mill?"

In other words, ore testing is the key to the basic question of the economic possibility of a mining operation. It gives the answer to this question at a minimum of expense without making a costly investment in equipment to learn it the hard way.

### Selection of Treatment Process

The results obtained through ore testing and the intelligent interpretation of the results very often lead to a simple method of treatment giving good profits, where some other treatment might mean less profit or an actual deficit. Fig. 1 shown gives a good illustration of what proper selection of treatment methods based on ore testing can result in. Test results give you facts.

Data from ore testing not only allows determination of the proper method of treatment, but gives a sound basis for the selection of the proper equipment to be included in the flowsheet.

The Denver Equipment Ore Testing Laboratory is continually being confronted with and solving such problems. Very often situations arise where the most common methods of treatment may not be successful but little known and ingenious methods may be applied. The flowsheet in Figure 2 shows the results obtained from testing a complex lead-zinc-copper-iron ore containing values in gold. Exceptionally high grade and recovery were obtained in this instance. Utilizing a patented process special reagents made profitable production of lead-copper and zinc-iron concentrates and subsequent separa-

tion of these concentrates into four (4) separate products.

Although flotation has made profitable the beneficiation of many low grade ores both metallic and non-metallic, it is not always true that flotation will give the greatest economic return. For instance, in many cases, cyanidation of gold ores either direct or as part of a composite method of treatment may be the answer to the question of, "what treatment will give the greatest dollar value return on the mill investment?"

Ore testing gives definite and conclusive answers to the following type of metallurgical question.

An ore sample was received at the Denver Equipment Laboratory of a character which would ordinarily respond to the counter-current decantation method of cyanidation for extracting gold. Samples of the same ore gave results concurring with test work by others but this method was not recommended due to settling difficulties encountered.

Work was not stopped here, however. Eventually, a successful method for treating this ore was found by sacrificing a small loss in slime. Figure 3 shows the final flowsheet evolved with recoveries indicated which made profitable installation of a reasonable cost plant, overcoming the difficulty arising from the physical characteristics of the ore.

### Increasing Profits in Operating Mills

Very often it is possible to improve recoveries in a mill which is already operating, by instituting new techniques or altering the flowsheet. There are many possibilities of such improvement.

Change of reagents in a flotation circuit may give higher recovery, a better grade of concentrates or both. A Denver "Sub-A" Unit Flotation Cell installed in the grinding circuit may permit an increase in tonnage milled, a decreased loss in slimes and a better overall recovery.

Denver Mineral Jigs installed in the grinding circuit in cyanide mills have proved very successful in increasing recovery. It is always advisable to recover your mineral values as soon and as coarse as possible.

Net return of an operation may be increased by production of bullion at the mine instead of shipping ore, or by the treatment of concentrates.



## Free Milling Gold Ores

Many problems on free milling gold ores have been solved by the Deco Testing Laboratory. One free milling gold ore received for testing the application of the Denver Mineral Jig in the Ball Mill Classifier circuit gave the following results:

Head Ore, 0.65 oz. Gold per ton (Assayed)  
0.643 oz. Gold per ton (Calculated)

Amalgam from Amalgamation of Jig Concentrate:  
0.471 oz. Gold from one ton head ore, or  
73.3% of Gold from the original heads.

Residue after Amalgamation:  
10.14 oz. Gold per ton of residue, or  
16.1% of the Gold from the original heads.

Ratio of Concentration: 98:1 Jig Tailing:  
0.07 oz. Gold per ton tailing or  
10.6% of the Gold in the heads.

On this ore, the Denver Mineral Jig, with its selective action, recovered 89.4% of the gold in the ore, producing at the rate of only one ton of concentrates from every 98 tons of ore. Calculations from these results, based on gold payment of \$31.81 per oz. at a smelter, and \$35.00 per oz. at the mint, deducting a minimum smelter treatment charge of \$4.00 per ton of concentrates, shows that the jig concentrates shipped without amalgamation would return \$18.40 per ton of head ore; whereas shipping bullion to the mint and amalgamation residue to a smelter would return \$19.70 per ton of head ore, or a difference of \$1.30 per ton of ore in favor of amalgamation. At a lower ratio of concentration, tests showed that the recovery could be increased to as high as 94% of the gold in the ore.

## Industrial Applications

More and more Industrial operations are turning to reclamation of products formerly considered waste, and manufacture of additional by-products. Test work on such problems is continually going forward.

One company which uses a large amount of silver was reclaiming a considerable portion of this valuable metal from waste product by smelting. Recovery by this method was relatively good but there was a large quantity of slag from the original smelt-

ing operation on hand which contained much silver in the form of fine beads.

The Denver Equipment Ore Testing Laboratory was called upon to attempt a solution to the recovery of this silver. Test work indicated that the material could be crushed, ground and then treated with the Denver Mineral Jig. A high recovery of this silver in a concentrate assaying over 50% silver was found possible.

Similar methods can often be used in recovering valuable metals from old retorts and crucibles. Valuable minerals contained in floor sweepings in industrial plants can often be profitably recovered using standard ore dressing equipment. In their work the engineers in the Ore Testing Division keep constantly before them not only the question of "can the metallurgical results be obtained," but "can they be obtained in a manner that will make a profitable operation?"

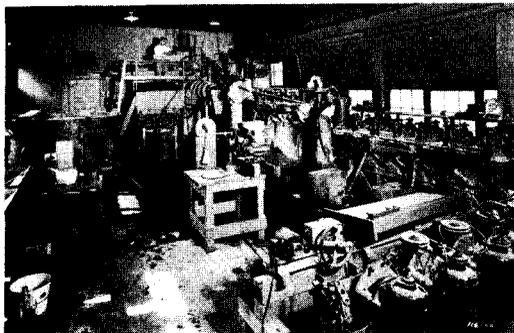
Such work has not been confined to ores from the United States alone. The Ore Testing Division of the Denver Equipment Company has on file reports on samples from all parts of the world; tin from Bolivia, China and the Malay States; gold and copper from Mexico, Africa and South America; silver and manganese from the East Indies; complex ores from Australia and New Zealand; gold and silver ores from Alaska; potash from France and many other ores from Bolivia, Yugoslavia, Canada, South America, Alaska, Central America, Turkey, Mexico, Australia, the East Indies and elsewhere.

More and more the desirability, and the actual necessity, of conducting exhaustive test work on ores and industrial products at the very beginning of such operations is becoming recognized. It is for this purpose and also as a service to the Ore Dressing and other Industries, that the Denver Equipment Company Ore Testing Laboratory is maintained. The charges for this test work are very nominal. Just sufficient to cover the actual operating costs including the analysis and assay (both fire and chemical) of the test products made.

## Continuous Tests

Inasmuch as the Denver Equipment Company has facilities available for continuous flotation testing of ore, consideration should be given to the possibility of following up batch test work with continuous testing, and in this case a sample of approximately five tons should be prepared. Such testing provides an intermediate, or pilot plant step, between batch testing and large scale operations to further insure successful commercial milling.

Write to any one of conveniently located Denver Equipment offices for further details on this continuous testing service.



Comprehensive tests conducted in the Deco Ore Testing Laboratory are the basis for flowsheets and solutions to many difficult treatment problems. The care and accuracy used on each test makes possible test reports and recommendations that can be duplicate in full-scale operations.

## CHARGES FOR TEST WORK see page 351.

Charges for testing your ore are maintained at a very minimum by The Denver Equipment Company. These test charges are based on the actual cost of doing this work in order that the company can be of the greatest service to the mining industry in providing not only the best and proper equipment, but also the best metallurgy that can be obtained.

## FLWSHEETS

From the many hundreds of flowsheets prepared by Denver Equipment Company based on test work and from operating plants throughout the world, we present a few of the more typical ones for your information and guidance.

Many of these flowsheets are in use in various plants and others present a composite of the good features of many successful installations.

Typical flowsheets are shown for both metallics and non-metallics as well as industrial products, wastes, etc. De-inking of waste paper by flotation, for example, is coming into prominence with Denver "Sub-A" Flotation as it is now possible to recover for the paper industry a useful and usable product on a much more attractive basis than in the past.

Your flowsheet should be designed without "bottlenecks" or weak links which present problems that can seriously effect operating efficiency. The old saying of "one hour's delay means no profit today" is more true today than ever before due to higher operating costs. This adage emphasizes the importance of having your flowsheet designed efficiently and tailored for your specific operation, and the need for selecting standard reliable equipment designed to give you continuous 24-hour service.



## FLWSHEETS

The flowsheets shown on the following pages are based on actual data obtained from successful operating plants. Metallurgical data are shown in these flowsheets which incorporate Denver "Sub-A" Flotation Machines, Denver Unit Flotation Cells, and Denver Selective Mineral Jigs as well as other standard Denver milling equipment.

The Denver "Sub-A" Flotation Machine, the Denver Selective Mineral Jig and the Denver Unit Flotation Cell have revolutionized flowsheet design and have made it possible for both small and large plants to increase recoveries and economical return.

The Denver "Sub-A" Unit Flotation Cell and the Denver Selective Mineral Jig have been perfected to meet the most important principle in ore dressing . . . "Recover Your Mineral As Soon As Free!" To recover this free mineral, either the Unit Flotation Cell or Jig or both can be installed in the grinding circuit without auxiliary equipment such as pumps or elevators, and for successful operation do not usually require more water than necessary for classifier dilution.

These flowsheets also show some other more important arrangements made possible with standard Denver Machines.

Many of the flowsheets given here have been made possible because of the fact that a coarse pulp—particles as coarse as  $\frac{1}{4}$ "—

can be circulated in the Denver "Sub-A" Flotation Machine without sanding or choke-ups and with high metallurgical efficiency.

Denver "Sub-A" Flotation Machines have the gravity flow principle and flexibility that has made possible the development and application of many of these flowsheets. In fact, the elimination of pumps in handling concentrates for cleaning and re-cleaning has simplified flowsheets and reduced operating expenses to the operator's advantage and profit. It should be pointed out that it is not only the cost of pump wearing parts but the time lost in shut-down for pump repair that is important in profitable mill operation.

The basic principles illustrated and described here can well serve as basis for other ideas that will increase recovery or add to the simplicity of mill operation.



This book is designed to help you. There may be other ways that we may help you, and if so, please let us know because it is our sincere desire to be of service.

## FLWSHEET No. F-1

**DESCRIPTION** Selective flotation flowsheet of two or more products. By utilizing selective flotation, two or more minerals in an ore are separated into individual high grade products.

**ORE TREATED** The most common of ores treated in this manner are lead-zinc-iron, copper-zinc-iron, copper-nickel, but application may be made to other two or three mineral separations. This flowsheet, without a Denver Unit Flotation Cell or a Denver Mineral Jig, is applicable to ores where the values are in the base metals alone.

**ADVANTAGES** The various minerals contained in the ore can be concentrated into products each containing a major portion of one separate metal. In this manner, it is possible to secure the greatest net return for each of the metals, shipping each one to the smelter that offers the best schedule for payment on the metal.

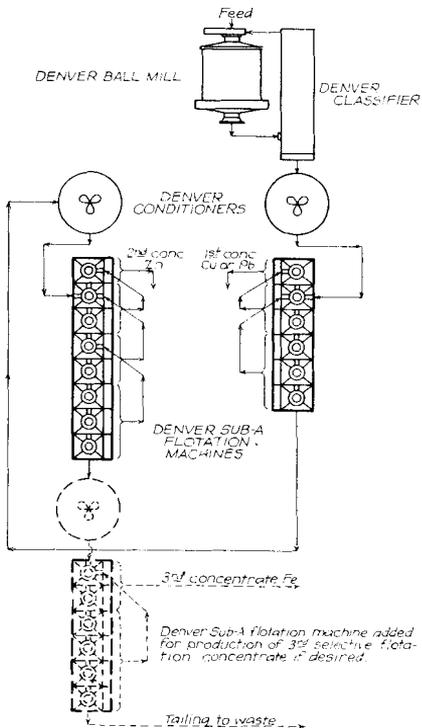
**COMMENTS** In many cases, where the minerals are freed at a coarse mesh, savings are made in grinding costs through the use of the proven Denver "Sub-A" Flotation Machine which is the only flotation unit capable of effectively handling coarse feeds.

The sulphide iron minerals contained in practically all base metal ores, may be recovered from the tailings where the product can be marketed for the sulphur or where precious metals are closely associated with these minerals: an additional conditioner and flotation machine make this step feasible. As many as five individual concentrates are being produced from a single ore in actual milling practice.

Successful milling plants use proved methods



## FLWSHEET, SELECTIVE FLOTATION



All of these flowsheets proved in the field



## FLWSHEET No. F-2

**DESCRIPTION** Selective flotation flowsheet of three products.

**ORE TREATED** Sulphide ores of lead, copper and zinc are primarily treated. This flowsheet can also be applied to other ores wherein the separation of base metals or nonmetallic minerals may be desired.

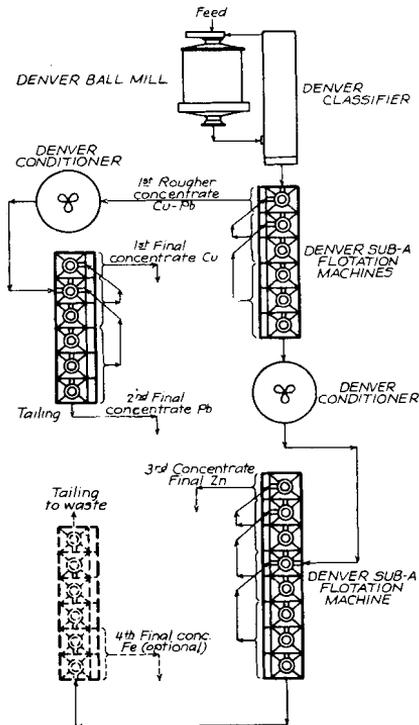
**ADVANTAGES** The first flotation machine in a copper-lead-zinc separation would produce a copper-lead concentrate. This copper-lead concentrate would go to a second machine wherein the copper would be floated off, leaving a high-grade lead residue. Since the amount of copper-lead concentrate being treated would be small as compared to the original tonnage of the mill, excessive flotation capacity would not be required, as would be in the case of FLOWSHEET No. F-1 wherein the first machine would produce a lead concentrate, and a second machine would produce a copper concentrate, but both machines treating the large tonnage of the original feed.

**COMMENTS** In the case of the lead-copper cited above, the floatability of the lead and copper sulphides are so close together as to make a conventional separation impractical. By recovering these two into a single rougher concentrate, their recovery is accomplished and the preferential floating of one can be brought about through depressing the other. This separation is of particular interest as the copper may be recovered first, leaving a high-grade lead residue: whereas in other cases the lead may be floated first, leaving a high-grade copper residue.

*Successful milling plants use proved methods*



## FLWSHEET, SELECTIVE FLOTATION



*All of these flowsheets proved in the field*



## FLWSHEET No. F-3

**DESCRIPTION** Coarse flotation followed by regrind of coarse rougher concentrate and selective flotation or cleaning.

**ORE TREATED** Ores wherein the minerals can be freed from the gangue at a coarse mesh and subsequently separated from each other after finer grinding.

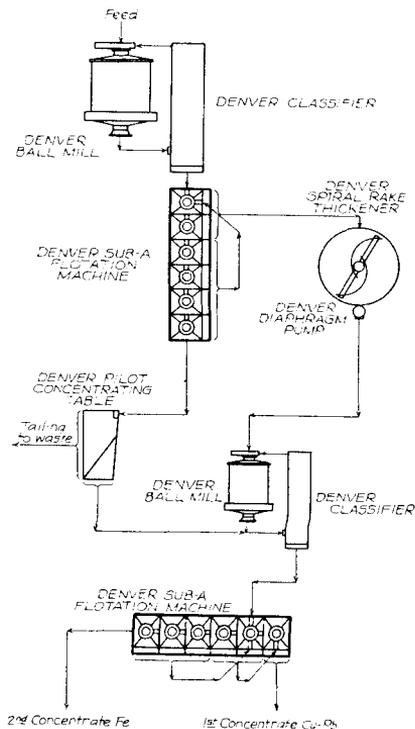
**ADVANTAGES** For low cost operation of a selective plant wherein two concentrates are produced, this flowsheet has the advantage of eliminating fine grinding on the bulk of the ore. As an illustration, assume the ore being treated is a sulphide ore with chalcopyrite and pyrite containing gold values in both minerals, and that the minerals are freed from the gangue at a coarse mesh. The first flotation machine following the coarse grind produces a rougher concentrate containing all the minerals. These minerals are re-ground to free the chalcopyrite from the pyrite, and selective flotation or cleaning is carried out at a finer mesh in the second machine which gives a high-grade copper concentrate leaving a gold-iron concentrate product or an iron residue if gold is not a factor.

**COMMENTS** When the ore contains any free gold, the Denver Mineral Jig should be used in both primary and secondary (regrind) grinding circuits to remove this free gold since depressing reagents used for selectivity in sulphide separation also affect fine gold particles. Use of the Denver Mineral Jig results in greater recovery of precious metals where present. See FLOWSHEET No. J-3.

*Successful milling plants use proved methods*



## FLWSHEET, COARSE FLOTATION



*All of these flowsheets proved in the field*



## FLWSHEET No. F-4

**DESCRIPTION** Regrinding of flotation middling or flotation cleaner tailing and refloating the ground product.

**ORE TREATED** Flotation middling containing valuable mineral particles attached to the gangue particles and which can be freed by finer grinding.

**ADVANTAGES** Middling is designated as such because it contains material which lowers the grade of the desired mineral concentrate to such an extent that it cannot be considered as a finished concentrate.

This middling contains valuable mineral particles attached to gangue particles, which, when returned for retreatment in the flotation machine without regrinding, again find their way to the middling product or are lost in the tailing. But with these flowsheets by regrinding and liberating the valuable mineral, it can then be removed with the flotation concentrate and the gangue content then becomes tailing.

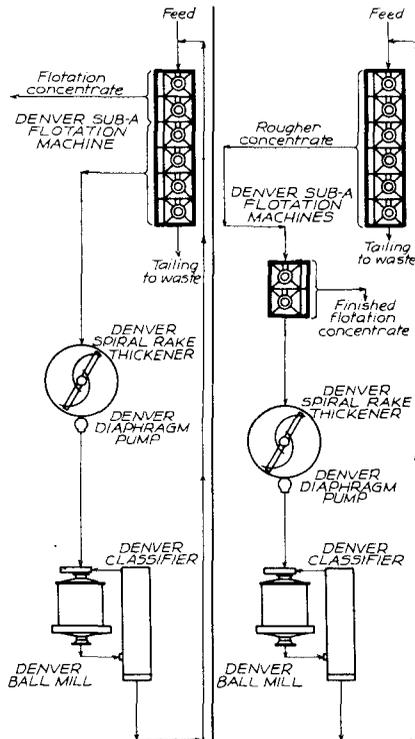
The result is a higher grade concentrate with better recovery. These flowsheets show regrinding the middling, preventing the retention of middling in the flotation circuit or its loss into the tailing. After regrinding, the freed mineral floats rapidly and is recovered successfully in the finished clean concentrate.

**COMMENTS** This procedure makes possible the production of the maximum amount of finished high-grade concentrate and improves recovery. It also permits coarser grinding in the primary circuit, increasing mill capacity, and confines fine grinding to only the fractional part of the ore on which this is actually required. See FLOWSHEET No. F-3.

*Successful milling plants use proved methods*



## FLWSHEET, FLOTATION



*All of these flowsheets proved in the field*



## FLWSHEET No. F-5

**DESCRIPTION** Flotation following table concentration, open circuit grinding.

**ORE TREATED** When the mineral in an ore is freed at a coarse mesh, this flowsheet gives high recovery and high capacity. The practice is limited in scope, as on ores requiring fine grinding, closed circuit is preferable, and on ores wherein the gold is free, amalgamation or cyanidation alone or with flotation, may give better results.

**ADVANTAGES** In this particular case, one product is desired in a good grade concentrate containing the gold and silver values which can be marketed profitably.

The open circuit grinding allows maximum tonnage through the grinding mill, and the table following removes coarse heavy mineral. Dilution in the flotation machine may be high but efficiency can be sacrificed in order to handle the larger tonnage possible with this flowsheet. In cases wherein flotation necessitates a denser pulp, a dewatering device such as a thickener or sand cone could be installed ahead of the flotation machine.

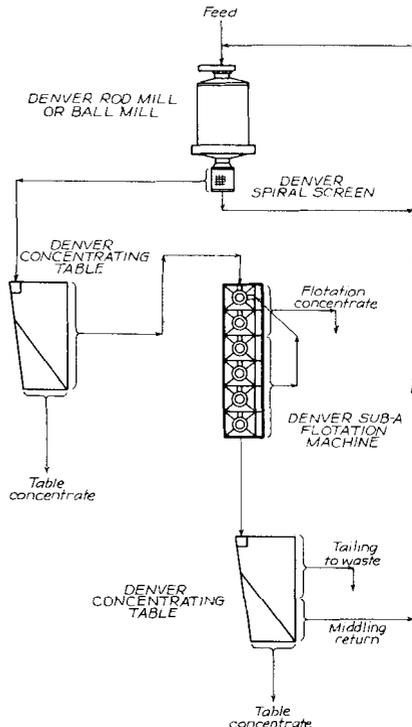
**COMMENTS** The flotation machine is required to handle a coarse feed, and for this reason, the Denver "Sub-A" has been used as it is the only machine capable of this duty, yet retaining the ability to give high recovery, good grade of concentrate, low operating and maintenance costs.

The use of a Denver Mineral Jig in place of the table ahead of the flotation machine should be a great advantage since very little water is needed for the Jig operation.

*Successful milling plants use proved methods*



## FLWSHEET, FLOTATION AND TBLING



*All of these flowsheets proved in the field*



## FLWSHEET No. F-6

**DESCRIPTION** Flotation followed by cyanidation of flotation concentrates. In this flowsheet the flotation concentrates produced are reground and treated by cyanidation.

**ORE TREATED** Sulphide ores wherein base metal values are negligible (such as pyrite) but with good gold and silver values, or in cases where increased returns can be secured from the marketing of a gold and silver bullion over and above the returns that could be secured from marketing the flotation concentrate.

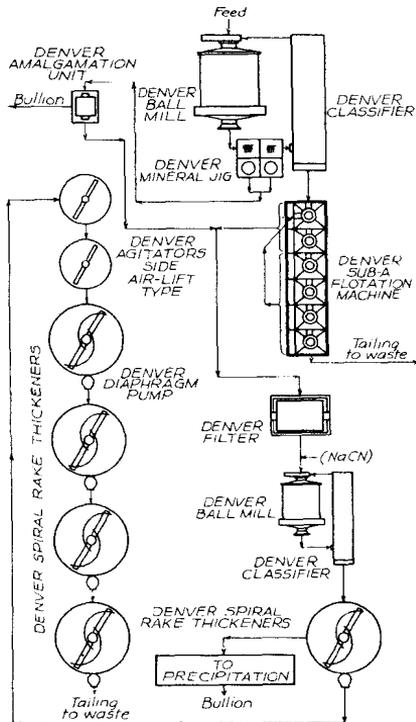
**ADVANTAGES** Where adaptable, a plant using this flowsheet can be built for about sixty per cent of a straight cyanide plant. The production economics of either are the same, as the precious metals are produced in bullion form. Lower operating costs often result by removing the mineral values in a flotation concentrate, which is a small part of the tonnage of ore treated, regrinding this concentrate and cyaniding this reduced tonnage. In a number of cases where the gold is closely held in arsenopyrite or combined in tellurides the flotation concentrate is roasted prior to cyanide treatment. In these cases there have been tremendous savings in plant investment and operating costs by confining this treatment to small tonnage of concentrates.

**COMMENTS** This flowsheet shows a continuous cyanide treatment plant for the concentrates. Where less than 12 to 15 tons per day of concentrates are recovered, simple batch plants are used with great success, with capacities as low as 1 ton per day. The step of regrinding the concentrates can be eliminated in some cases.

*Successful milling plants use proved methods*



## FLWSHEET, FLOTATION AND CYANIDATION



*All of these flowsheets proved in the field*



## FLWSHEET No. F-7

**DESCRIPTION** Flotation with cyanidation of flotation tailings.

**ORE TREATED** Ores containing both oxide and sulphide minerals with gold or silver, or those with cyanicides which must be removed before cyanidation.

**ADVANTAGES** This flowsheet makes possible the milling in one plant of two types of ore, oxide and sulphide. The oxide ore may be readily cyanided but not floatable. The sulphide ore may float readily, but due to the contained copper or other cyanicides it is not amenable to cyanidation.

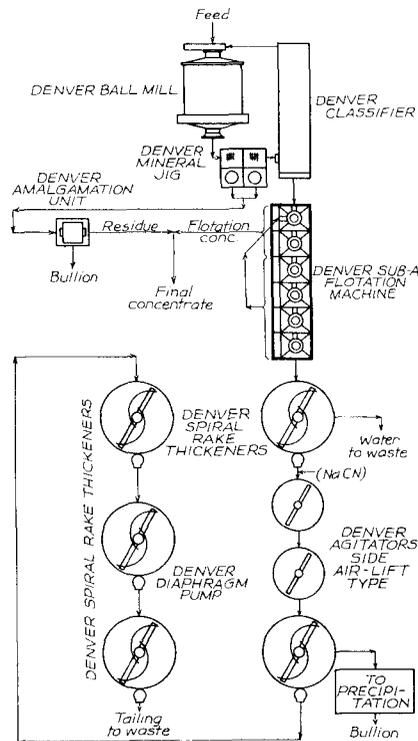
In several cases, cyanicides have interfered with the operation of the cyanide plant and the addition of flotation for removing these has been very successful. In other cases, the economic advantages of cyanide treatment have been made possible on low copper ores by selectively floating a high grade copper concentrate for shipment to the smelter and rejecting a high gold tailing from which the gold is recovered in bullion form through cyanidation.

**COMMENTS** This flowsheet may be applicable in other cases, also, as for example, on a sulphide ore with galena, wherein the lead values could be recovered and shipped to the smelter. In some ores containing pyrite, this pyrite fraction requires finer grinding than does the quartz or other fraction of the ore for maximum recovery by cyanidation. In this case, it might be advisable to remove this pyrite by flotation. (see FLOWSHEET No. U-3) or by the Denver Mineral Jig (see FLOWSHEET No. J-7) for regrinding or roasting prior to cyanidation.

*Successful milling plants use proved methods*



## FLWSHEET, FLOTATION AND CYANIDATION



*All of these flowsheets proved in the field*

