## New type of dry, heavy-medium, gravity separator

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Synopsis

The use of pneumatically fluidized powders as media for separating mineral constituents of ores is discussed. Particular requirements are considered and the results of bench-scale, batch and continuous operations are presented. The performance of a small-scale fluid-bed separator (20 to 60 lb/h) has demonstrated that crushed ores, down to sizes of at least 22 mesh, can be tested with a recovery of values better than 90 per cent and with excellent product grades. The factors which require further investigation in the design of larger-scale units are indicated.

Heavy-medium systems have been employed with

increasing finesse since 1927. Formerly, developments

were associated mainly with coal cleaning operations but, since 1936, their field of application has been extended, with considerable advantages, to the beneficiation of a wider range of minerals. In the present state of the art a medium is formed by maintaining suspensions of finely divided solids in liquids, chosen so as to provide fluid densities at controllable levels within the ranges flanked by the densities of the minerals to be separated. As with all commercial separating processes, the effectiveness and economics of heavy-medium separations are directly related not only to the physical properties and associations of the constituents of the feed mixture but also to other factors which are related to the systems themselves. These include the medium losses associated with the float and sink products, and also the maintenance of a medium having a minimum density variation in conjunction with a minimum 'viscous' resistance to ore particle movements. The two components of this latter condition are not compatible and, in practice, it is necessary to tolerate some variation in the density of the medium to achieve adequate freedom of particle movement and separation. A degree of turbulence is often introduced in order to achieve a practical combination of these two components and, as would be expected, this imposes an adverse effect on the resulting separation, particularly of the finer particles in the feed. In any one system all such factors have to be considered and, eventually, optimized.

In certain instances it is necessary or more desirable to operate under dry conditions (for example in arid areas, with soluble mineral constituents, or when previous and/or subsequent separations are dry). A dry, heavy-medium process which appears to provide an adequate, dry, counterpart to the now well known and proved wet system is described. The principles of the wet and dry systems are identical, an

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air-solids fluidized medium being employed with the dry operation; their practical applications, however, differ with respect to equipment design and possibly with respect to performance characteristics.

## General principles of dry, heavy-medium, separating units

Air—solid fluidized systems are well known, particularly in chemical engineering fields; the large gas—solid contact areas provided by such systems result in advantageous heat or mass transfer conditions. Generally, the gas flow is arranged to produce turbulence within the bed, thereby enhancing the designed transfer coefficients. Clearly, for separation purposes a fluid bed with minimum turbulence would be required.

The fluidizing characteristics of most powders conform to a standard pattern which can be represented by the pressure drop-gas flow graph shown in Fig. 1.

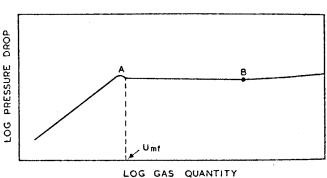


Fig. 1 Pressure drop-gas flow diagram for ideally fluidizing solids

Onset of fluidization occurs at point A when the density  $\rho$  of the bed can be expressed as

$$\rho = (1 - \epsilon) \rho_s + \epsilon \rho_f$$

where  $\varepsilon = \text{overall bed voidage}$ 

encountered.

 $\rho_s$  = density of solids

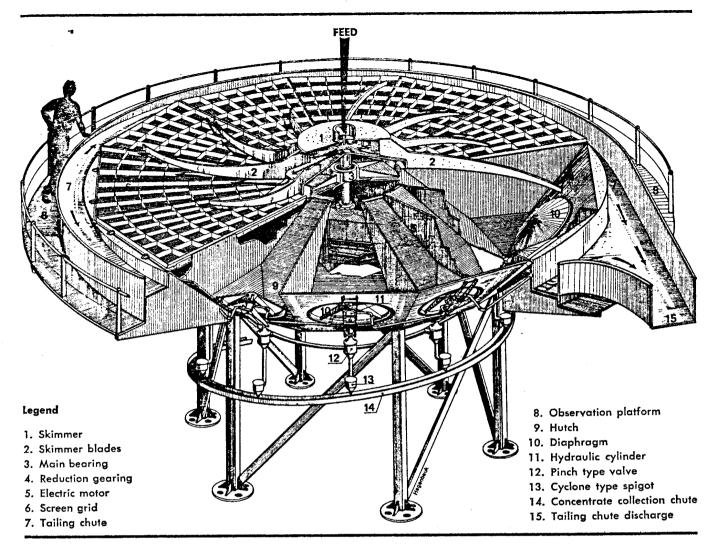
 $\rho_f$  = density of fluid

With increasing gas quantity the bulk bed density decreases slowly until point B is reached although, within this range (AB), the effective density, with respect to the ore, may decrease or increase according to feed particle size. Also, within this range the fluid flow within the bed may change from streamline to turbulent as bubble formation commences. In certain operations such conditions provide an effective mixing

system<sup>1,2</sup> and, wherever possible when density separations are sought, they should be avoided. With higher gas rates, beyond *B*, the bed becomes increasingly

dispersed and further increases in pressure drop are

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SCHEMATIC diagram to show the construction details and operating parts of the new I. H. C.-Cleaveland jig originally for Malaysian tin recovery.

arrangements employing a few circular jigs with their high capacity is that the distribution of the feed over the individual jigs is greatly simplified.

The flow of the slurry from the rotating screen on board the dredge to the jigs is preferably achieved solely by means of gravity, thereby dispensing with the need for power. Is is also very desirable to keep the distribution system as low as possible. Every foot of height increases the level at which very heavy components have to be mounted and also that to which the dredged material must be elevated. It is obvious that the problem of distribution is reduced as the number of jig feed points decreases. A tin dredge treatment plant with a capacity of 600 cubic meters per hour requires 40 3-cell jigs with 42 by 42 inch cells. This necessitates the feed being divided into 40 equal parts. Using a circular jig with a diameter of 25 feet, only two jigs are more than ample for the given output. Thus it is only necessary to split the feed into two parts. This simplification results in many savings in capital and operating costs.

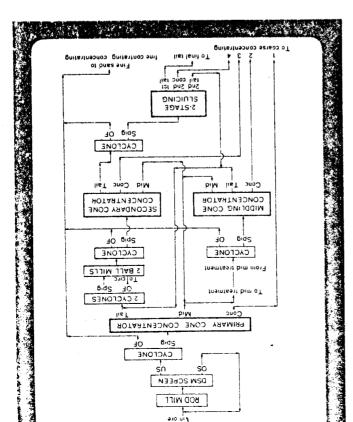
While Cleaveland was busy improving the circular jig, other, quite independent developments were taking place at the I.H.C. Delft laboratory. I.H.C. Holland, long known as one of the world's foremost

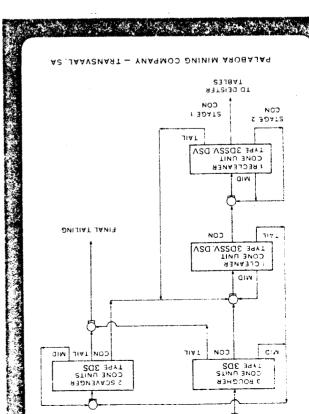
dredge designing and building companies, offers through its Marine Mining Division specialized services ranging from feasibility studies of off shore mining projects through to equipment design and construction. There, engineers were devising a jig drive mechanism which would eliminate the need for back water. The optimum motion of the water in the

Comparison of Conventional Placer Jig with I. H. C.-Cleveland Circular Jig

	Conventional, 42 by 42 inch, Thrce Cells per Flow Line	Circular, 25-foot Diameter
Full load capacity, cubic yards per hour	800	800
Number of flow lines	40	2
Full load per flow line, cubic yard per hour	20	400
Total jig bed area, square feet	1,440	<del>9</del> 22
Full load of area, cubic yard per hour per		
square foot	0.56	0.87
Total width of discharge lips, feet	140	1 <i>57</i>
Full load flow of solids over lips, cubic yard per		
hour per foot	5.7	-5.1
Total length of side walls plus discharge lips, feet	980	157
Number of diaphragms	120	24
Number of drives	60	24
Number of motors	60	3
Sand overload capacity	Less than 25%	More than 100%*
Installed horsepower	120**	80
Approximate total net weight, metric tons	88.5	40

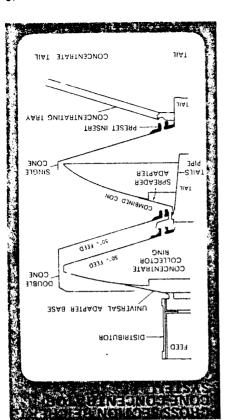
<sup>\*</sup> Due to skimmer. \*\* Excluding back water pump motors.





## recovers minerals by gravity

capabilities. well-established lead in developing



larger equipment with greater tonnage

remove oversize. discharge are screened at 14 mesh to tons per hour of 0.4 percent tin rod mill Wales. In the Ardlethan flowsheet, 70 dlethan Tin ML at Ardlethan, New South mineral sands sector, which was at Ar-

tin in cone concentrator feed. units is of the order of 80 percent of the ling. The individual recoveries of these preconcentrate the feed before wet tabmary duty of the cone concentrator is to necessary for cone operation. The pridensify the feed to 65 percent solids remove fines minus 325 mesh and to The screen undersize is cycloned to

siliceous ore pulp. the wear of a coarse, highly abrasive, cone concentrators can stand up under This installation demonstrates that

## Iron-Ore Concentration

due to be commissioned in 1977. for a full scale iron ore production plant following successful pilot operations, chased Reichert cone concentrators, Company of Canada Limited has purtreated. For example, the Iron Ore iron-ore plants can be successfully Tailings from currently-operating

cost, and the concentrator is following a The future holds many challenges in

> 3. Palabora flowsheet of the Palabora separators to make a finished premium composite grains, enabling the magnetic rejects a large proportion of the coarse fying action of the cone concentrators composites. The concentration classithe coarser titano-magnetite silicate finer pure titano-magnetite grains and are unable to discriminate between the being present. The magnetic separators

> per and molybdenum flotation plants. erals which can exist in tailings of copfor recovery of minor quantities of minapplication demonstrates the potential 60 to 70 percent of the values. This upgrading of 1,000:1 with a recovery of trated. This flowsheet provides for an then treated with the flowsheet illusing is deslimed in hydrocyclones, and copper values. The copper flotation tailzirconium values and some residual plant for the recovery of uranium and flotation tailing from its copper flotation six cone concentrators. The plant treats lation comprises seven circuits, each of Reichert cone concentrators. The instalof the largest single installations of Mining Company, which operates one

the originial installations outside of the 4. Ardlethan Tin flowsheet is one of