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ALUMINA TRANSPORTATION TO CELLS

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Until recently the transfer of raw materials (alumina and additives) to the electrolytic cells was via potroom crane and ore bucket, resulting in ore spills, causing internal potroom and external air pollution exposure, extra housekeeping, loss of potlife and higher voltage drop. However, alumina can be transferred from central and intermediate storages to the cell hoppers or cell crust directly, in required portions, automatically, in enclosed dustless conveyors. Various methods of material transportation and automatic control are considered. The new methods of material transportation may simplify and decrease the cost of cell superstructure, as well as the cost of cell maintenance.

PRESENT CONDITIONS

For more than a half century alumina and additives has been transferred from storages to electrolytic cells via buckets either carried by crane (Fig. 1), or by vehicles. Each cell has one or more hoppers which require filling daily.

These operations are causing extensive spillages of raw material in the potrooms (Fig. 2).

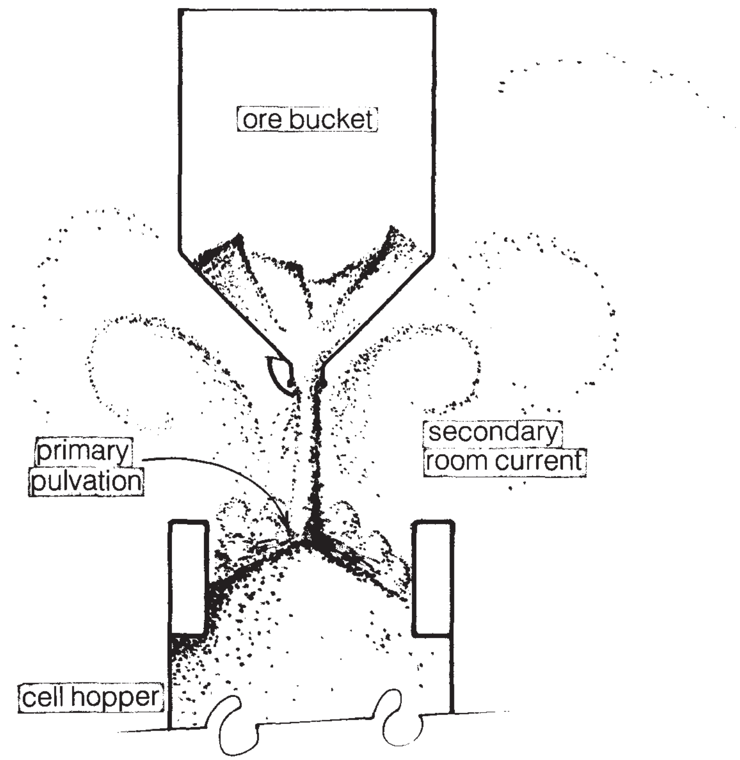

Fig.2 - Disharge of alumina from ore bucket into the cell hopper

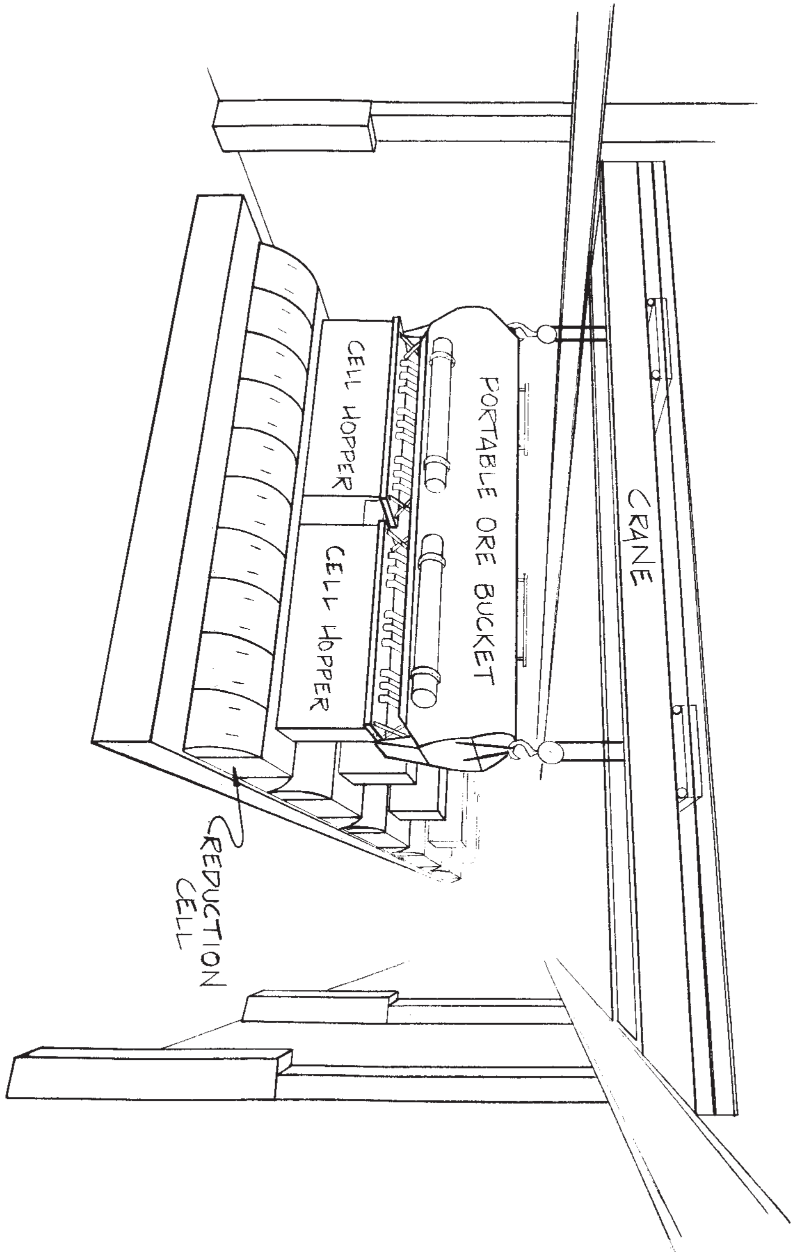

Fig.1 - Portable ore bucket

Investigations and evaluations of potroom dust problems indicate that due to relative high potroom air ventilation velocities (averaging 30 to 40 fpm), practically all sub-44 micron particles exposed to the air currents will be suspended in the potrooms (6). As a result in most instances, this is causing severe worker exposure to dust and atmospheric emissions of particles from the potroom roof monitors, resulting also in extra housekeeping.

Another factor is the use of "enriched" alumina from the dry scrubber installations. It was determined that this type of alumina is in general more free-flowing and contains higher percentages of fines and impurities. The dry scrubbing process using alumina as the adsorbing material (and especially with Soderberg electrolytic cells), turns the white "clean" and nearly-inert alumina into an almost-black and unpleasant material containing fluoride compounds, sulphur dioxide, hydrocarbons and various other compounds.

The measured breathing grain level loading for pot operators in certain exposures is greater in potrooms using "enriched" alumina than in the rest of the plant. Even with the installation of furnaces to process "enriched" alumina before transportation to potlines, the processed alumina is containing fluorides,and therefore, still presenting a potential health hazard.

It was determined that most of the dust in the potroom is generated directly from alumina handling operations; i.e. during filling of the bucket with alumina at the loading station, during discharge of alumina from the bucket into the cell hoppers and (for Soderberg cells) during the anode top cleaning operation.

Attempts to Improve Conditions

During the last decade a number of attempts have been made to improve alumina delivery to electrolytic cells, such as "dustless" buckets, incorporation of "dustless" buckets into the structure of the potroom overhead multipurpose cranes, agglomeration of fine alumina and other.

"Dustless" Alumina Bucket. The most advanced design (Fig. 3) involves the use of baghouse filter with fan and sometimes a small air compressor mounted on the bucket (or on the crane), a retractable hooding system to confine and remove dust as generated, level control to prevent over-filling of cell hoppers, dust-tight bottom dump gates to minimize spilling from bucket during transportation and a sophisticated control system. The development of "dustless" alumina buckets has to be combined with the upgrading of bucket loading stations. In most cases this requires additions of efficient ventilation systems.

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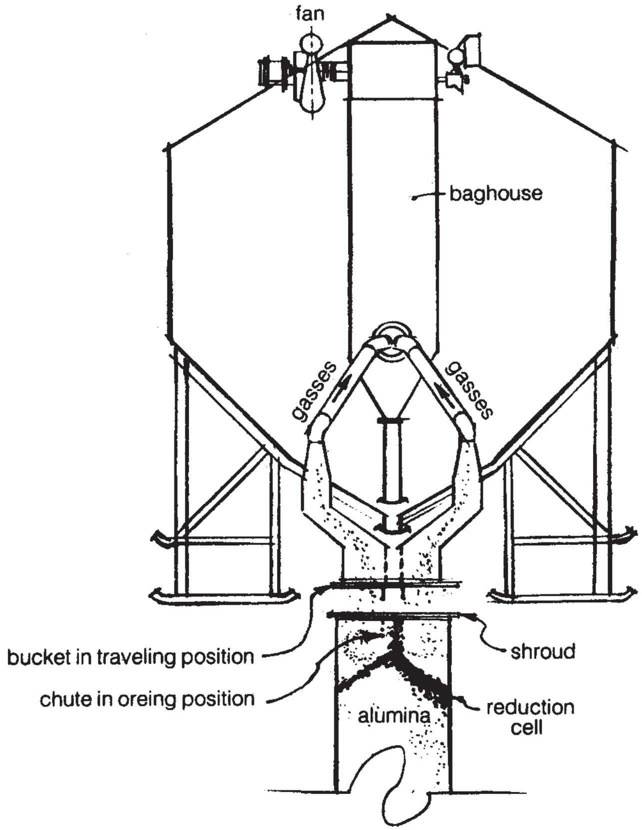

Fig.3 - Advanced alumina bucket during traveling and oreing

Nevertheless, the 10-year experience and survey of many installations has demonstrated that the bucket solution can not satisfy contemporary requirements. The main reason is the inadequacy of the concept itself, requiring operator's skilled personal involvement in hundreds of operations, at each cell, each day, and the relative low reliability of the portable bucket due to the complexity of different mechanisms and therefore resulting also in high maintenance cost.

Bucket Built Into the Crane. An attempt was also made to incorporate an advanced "dustless" bucket, similar as described above into the potroom multipurpose overhead crane (Fig. 4). This concept has practically all the disadvantages of the portable "dustless" bucket, except the control of operations is relatively more convenient. This may reduce some spillages compared to the portable bucket. However, as in the previous case, it will not resolve essentially the hygenic, environmental and housekeeping problems.

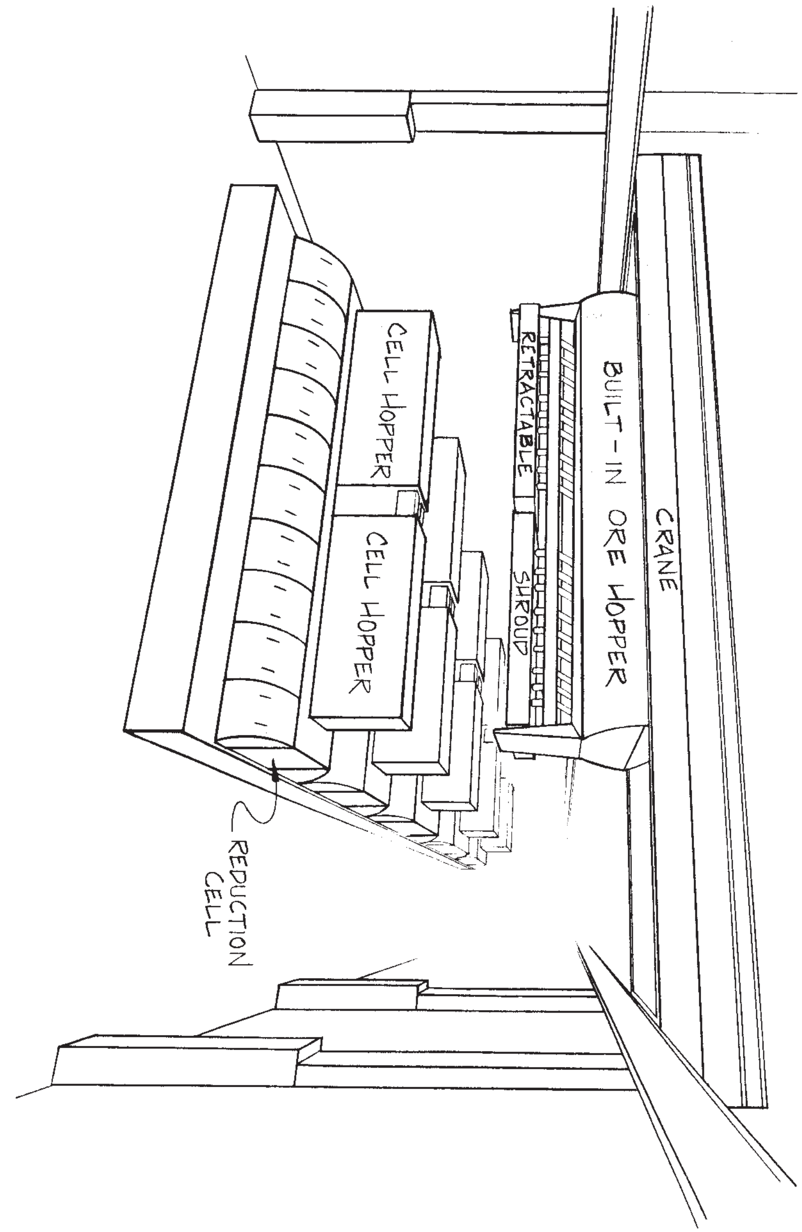

Fig.4 - Ore bucket built into the crane

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Agglomeration of Fines. Use of agglomerated "enriched" and processed alumina will reduce dusting, but if not used with an enclosed conveying system, will doubtless result in dusting, as the fragile agglomerated particles are exposed to normal potroom traffic. Once outside the material handling system, the material is very difficult to recover. Ore agglomeration alone will not stop spilling or even reduce it to a minimum.

EMERGING TECHNOLOGY

During the second half of the last decade technology has made futher progress in both: aluminum production and bulk material handling (4).

In the aluminum industry large and "super" electrolytic cells with continuous point feeding, controlled by computers and combined with improved dry scrubbing systems have been introduced.

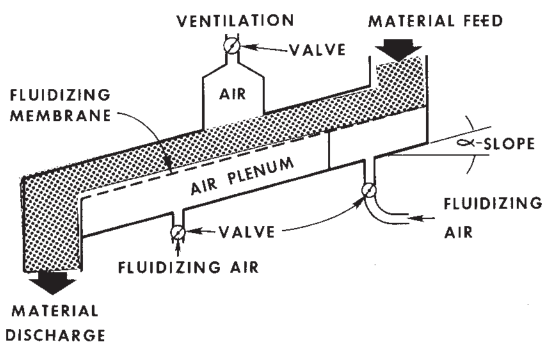

Fig.5 - Choke-fed air-activated gravity conveyor filled with fluidized alumina

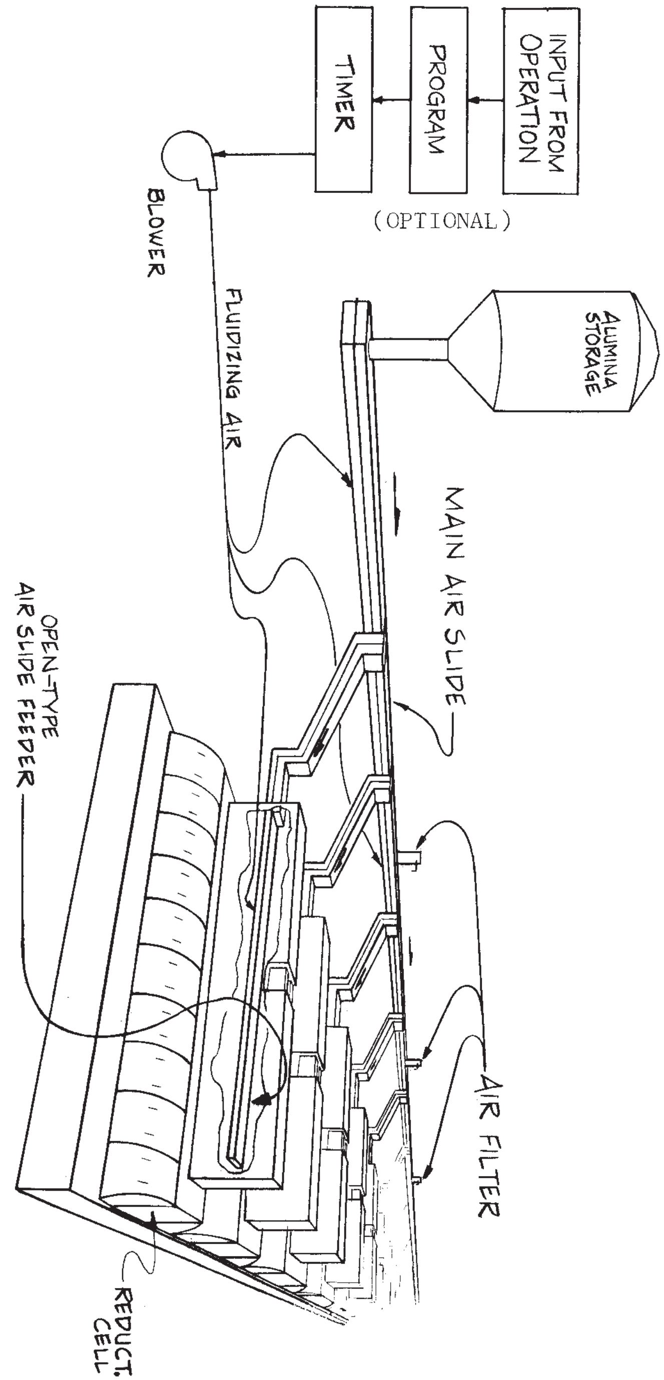

Fig.6 - Alumina transportation to cells - Open-type air slide system

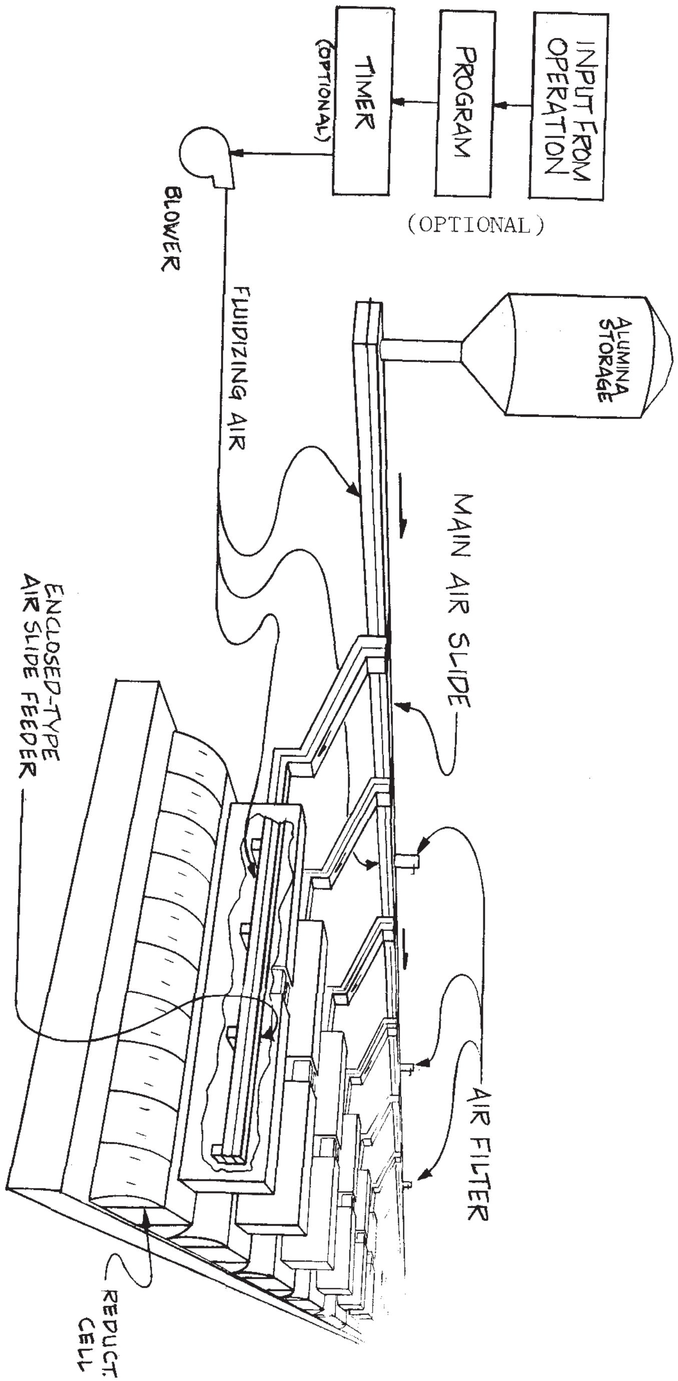

Fig.7 - Alumina transportation to cells - Enclosed-type air slide system

In bulk material handling the fluidization technology (1), reliable system design (3), combined with advanced computer application (2) has experienced a great boost. As a result, choke-fed air-activated gravity conveyors (AAGC) or air slides (Fig. 5), dense-phase pneumatic conveying, cartridge filters, different air-activated material handling devices (4, 5), supported by reliable computer software (2) did emerge.

All these (as often did happen in the history of technology development) has suggested to take a second look on alumina transportation to electrolytic cells. Things, which one time looked unreliable, expensive and doubtful, became much more reliable, economical and real today.

New Approaches

Alumina can be transferred from the storage to any electrolytic cell by automatic, totally enclosed, dustless systems. Such installations, without moving parts, if designed properly (3), can be made reliable (1) and economical. Some examples are given below.

Open-type Air Slide System (Fig. 6). Alumina is transferred from the storage to the electrolytic cells continuously or in accordance with a special operating program by a system, consisting of a main choke-fed air slide with cartridge filters and individual-cell, self-controlling, open-type air slides (7). Special attention is given to the design (including the electrical requirements, heath and erosion resistivity) of the individual cell air slide branches.

If run continuously, all the cell hoppers will be full at all times without the need of any monitoring device or operator's intervention. However, the air rate and the air pressure in the individual-cell air slides shall be tuned accurately.

Enclosed-type Air Slide System (Fig. 7) is similar to the Open-type Air Slide System, except the individual-cell air slides are of the enclosed type. This system, unlike the Open-type, does not require the "fine" tuning of the air rate and the air pressure in the small individual-cell air slides.

Pneumatic Conveyor System (Fig. 8) is similar to the Enclosed-type Air Slide System, except the main air slide is replaced by an automatic dense-phase pneumatic conveyor. If designed properly (2), the dense-phase pneumatic conveyor may be less expensive than the main air slide with supporting steel, access platforms and walkways.

The surge hoppers are kept full at all times without operator's intervention. The alumina feed to individual electrolytic cells is programmed.

Direct Injection System (DIS) consists of penumatic conveying pipes and vessels entirely (Fig. 9). DIS is extremely flexible and capable of delivering desirable (but variable) amounts of alumina to the selected (by operator or computer program) feeding points simultaneously with crust breaking

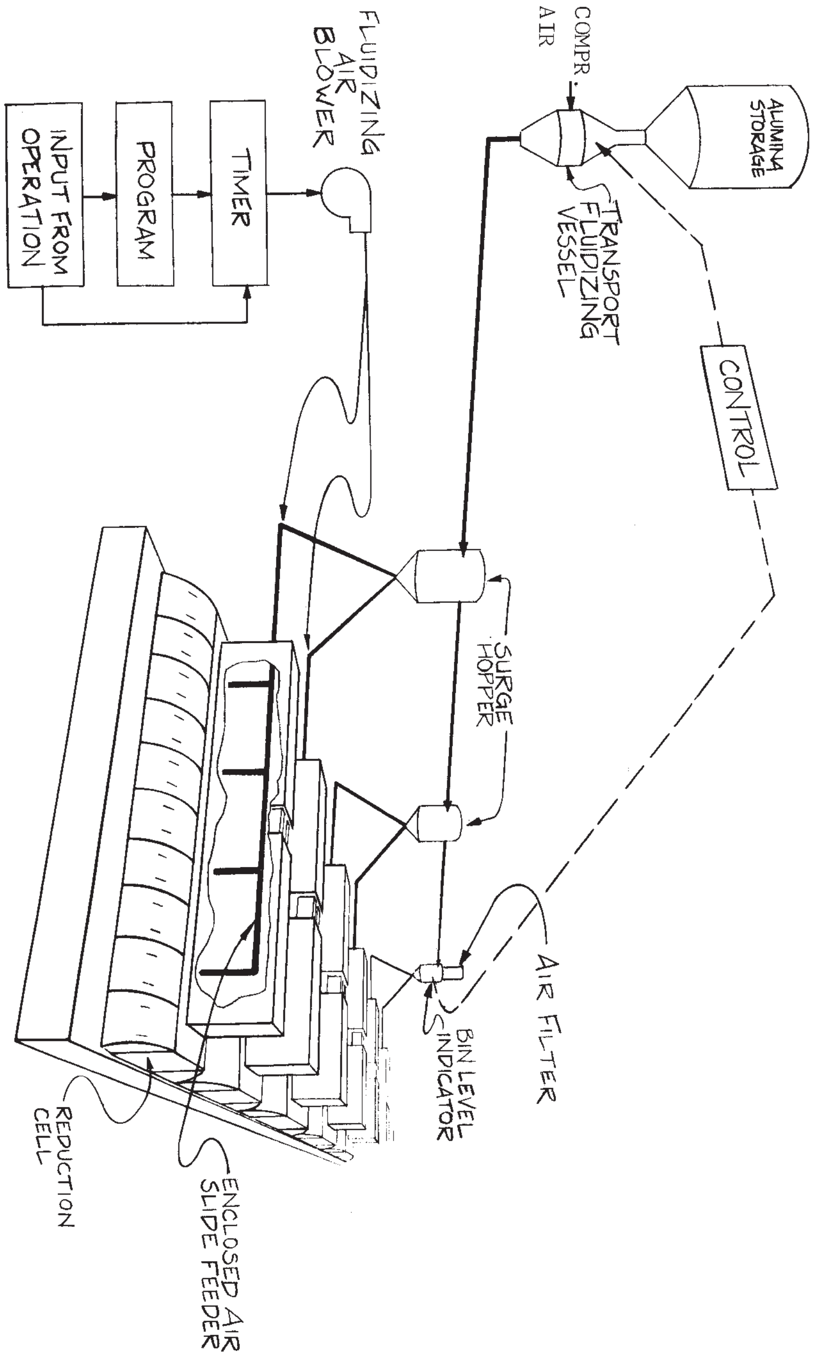

Fig.8 - Alumina transportation to cells - Pneumatic conveyor system

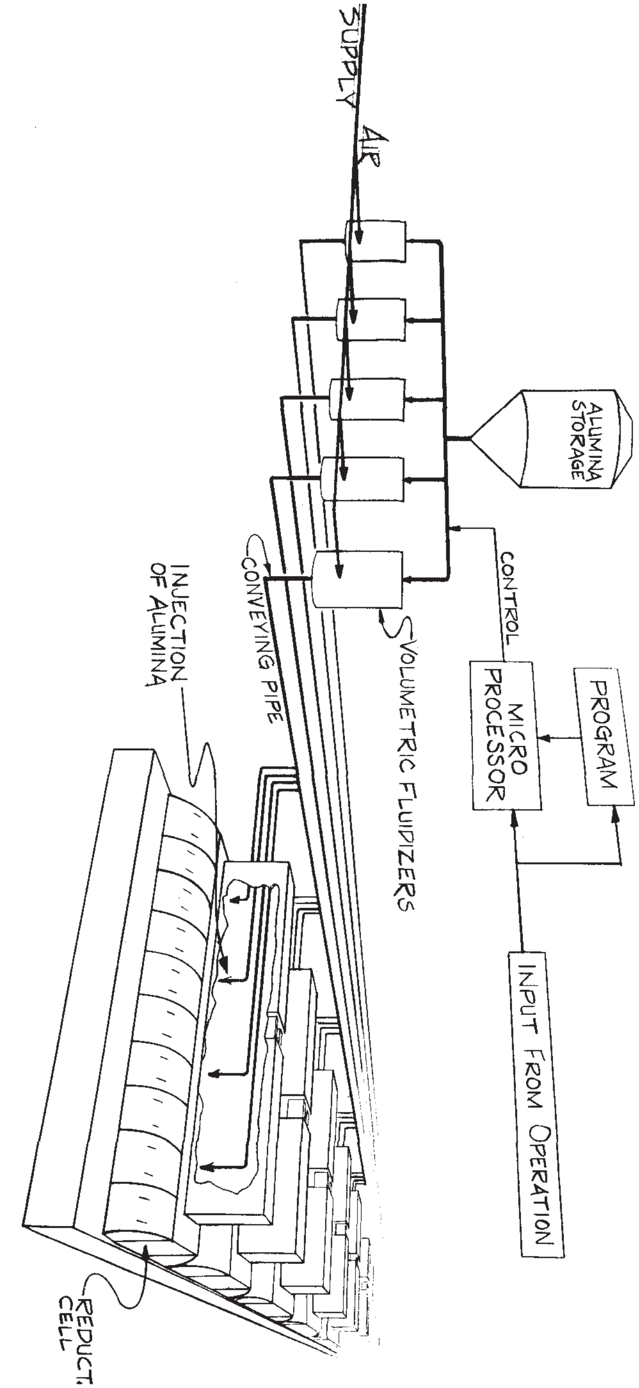

Fig.9 - Alumina transportation to cells - Direct injection system

in the cells. This most advanced and completely automated system, if designed reliably (2, 3) and simultaneously with the electrolytic cell, can affect the design of the cell itself favorably. As an example, it can simplify the cell point feeding system by eliminating the cell alumina volumetric and discharge devices with elaborate mechanisms and individual ore feed control. In turn, this will decrease the volume and the cost of maintenance at hundreds of electrolytic cells.

In addition, the DIS may eliminate or decrease the size of cell ore hoppers. This will decrease the weight and the cost of the cell superstructure. Because of the small quantities of injected alumina, dense mode of alumina conveying and the proximity of alumina discharge to the bath crust, no additional ventilation will be required.

CONCLUSIONS

The enclosed alumina delivery systems in comparison with existing ore buckets have many advantages, allowing to:

- Essentially alleviate the spillage of alumina in the potrooms and therefore improve the hygenic conditions for the operation and reduce OSHA-type problems.
- Substantially reduce the emissions from the roof-top monitors and reduce environmental-type problems from alumina handling.
- Increase potlife due to elimination of spills between cells that over-insulate the cathode.
- Decrease voltage drop due to elimination of spills and contacts between the anode bus and anode rod.
- Lessen the efforts for extra housekeeping in the potrooms and therefore lower the maintenance cost.
- Simplify the multi-purpose crane construction and therefore decrease its cost.
- Increase the crane availability for other potroom work and decrease the workload on potroom crane operators.
- Eliminate the potroom crane filling stations.

In addition, the simultaneous implementation of the most advanced Direct Injection System (Fig. 9), based on dense-phase pneumatic conveying, with the continuous point feeding of alumina could affect the advanced cell design favorably by decreasing the capital and maintenance cost of aluminum production.

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