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**TUYERE PUNCHING MACHINE**

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This invention relates to the removal of accretions from the tuyeres of converters such as the converters which are used for blowing copper matte and the like and more particularly to a power driven machine for punching the tuyeres.

Generally speaking, copper converting comprises blowing with air a quantity of molten matte (essentially a mixture of ferrous and cuprous sulfides) within a refractory-lined vessel called a "converter," the purpose being to render the iron as an oxide for removal as an iron silicate slag, and to oxidize the sulfur of the cuprous sulfide for the production of copper. Certain variations of the process may be achieved by making appropriate adjustments in the amount of air introduced, or the quantity of flux added, or both. The most commonly used vessel is of cylindrical shape and mounted to be rotated about its horizontally disposed central axis. It is equipped with a row of horizontally disposed tuyeres which are mounted in the cylindrical wall. These tuyeres provide openings through the shell and lining and are connected to an outside source of compressed air. During the blowing of air through the tuyeres into the body of molten material in the converter to carry out the converter operation, accretions or encrustations form at the inner extremity of the tuyere pipe. These have to be removed to provide passageway for the air that is being blown through the tuyeres into the molten matte.

Conventional tuyeres are normally arranged in a line and may be mounted at approximately six inch centers, although the number and distance apart of the tuyeres may be different on different converters. As a typical example of known practice, the tuyeres may consist of lengths of 1½" or 2" pipe inserted through holes in the shell and bricked into the refractory lining. The exterior of each tuyere pipe is joined to its own tuyere body, which is rigidly secured to the outside of the converter shell and connected by a downcomer conduit to a bustle pipe through which compressed air is introduced. In addition to serving as a transition piece between the tuyere and bustle pipe, a tuyere body serves as access means to the tuyere so that accretions, which form at the inner extremity during the converting process, may be removed. The tuyere body is provided with a suitable check valve, so that air is normally directed into the converter and not through the external opening to the atmosphere.

Converter tuyeres may be cleaned either manually or mechanically; this cleaning operation being more commonly called tuyere punching. In the manual method, a rod having a head is thrust through the external tuyere body into the tuyere pipe at the same time unseating the check valve which disadvantageously causes a large part of the compressed air to escape to the atmosphere. By the manual punching method, accretions are removed to keep the passageway open for air through the tuyere into the molten charge in the converter.

Mechanical punching devices have heretofore been suggested and patented. The prior art devices have utilized mechanical means, such as a pneumatic device positioned at each tuyere location acting through small air cylinders provided with pistons and suitable exhaust ports. This apparatus imparts a forward and backward stroke to a short length of punch rod, simulating the principle of manual

punching, but the insertion and retraction strokes are rendered at much higher velocities. Also there are prior art constructions in which a large and cumbersome frame work is attached to the converter or mounted independently, upon which is mounted a movable carriage, carrying a punch rod driven by a fluid operated cylinder which is mounted on the carriage. Those devices in one way or another have drawbacks. Among other things, some do not make adequate provisions for punching the tuyeres with a sufficient force for effective tuyere cleaning or with a force that can adequately be adjusted for the differences in the resistance to removal of the accretions at various tuyeres during a punching cycle of successive tuyeres, or adequate provision for avoiding undue strain upon the apparatus during the punching of a tuyere which is plugged with an accretion or incrustation that unduly resists removal from the tuyere, or adequate provision for ready adjustment of the length of the stroke of the punch rod for varying conditions of the converter lining, or are so intricate or cumbersome as to present problems of operation and maintenance which render them commercially unfeasible.

The apparatus provided by this invention overcomes the drawback of prior devices. It comprises a fixed platform mounted independently of the converter on which is mounted a track providing a guideway along the row of tuyeres of the converter; a power driven carriage movable along said track comprising a table on which is adjustably mounted a hydraulic cylinder whose piston rod carries a punch rod which is reciprocable for punching a selected tuyere, the punch rod being retractable after a punching operation so that the carriage may be automatically moved along said track to positions for selectively punching the tuyeres in a row of tuyeres, an hydraulic system operative automatically to operate the hydraulic cylinder, means for controlling depth of penetration of the punch ram and at different selected pressures to vary the punching force of the punch rod in accordance with conditions of the accretions encountered during a tuyere punching operation and means operative to protect the apparatus from undue stresses when usually resistant accretions are encountered by the punch rod, tuyere means designed to cooperate with the punch rod to avoid unwanted withdrawal of accretions outwardly into the tuyere on the return stroke of the punch rod and to avoid escape of pressurized air in the tuyere body during a tuyere punching cycle, the various mechanisms being electrically and adjustably indexed and controlled for automatic power driven converter punching.

Although the novel features which are believed to be characteristic of the invention are pointed out in the annexed claims, the invention itself, as to its objects and advantages, and the manner in which it may be carried out may be better understood from the more detailed description which follows, taken in connection with the accompanying drawings forming a part hereof, in which:

FIG. 1 is a perspective view showing in a general way a copper converter and the arrangement of the tuyeres, carriage platform and power driven travelling puncher carriage movable on a track supported on the platform, the hydraulic cylinder and punch rod adjustably mounted on the carriage table and the general arrangement of the hydraulic pressure system embodying the invention;

FIG. 2 is a view in elevation and partly in section, and somewhat diagrammatic, showing a side view of the puncher and illustrating its relation to a typical tuyere;

FIG. 3 is a view on line 3—3 of FIG. 1 illustrating the means for actuating limit switches mounted along the carriage guidetrack;

FIG. 4 is a view in elevation on line 4—4 of FIG. 3; FIG. 5 is a view in elevation, partly in section and partly broken away on 5—5 of FIG. 1;

FIG. 6 is a view in section on line 6—6 of FIG. 5;