

Sept. 28, 1965

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3,209,344

SOUND DETECTION SYSTEM FOR BLAST FURNACES

Filed Nov. 15, 1962

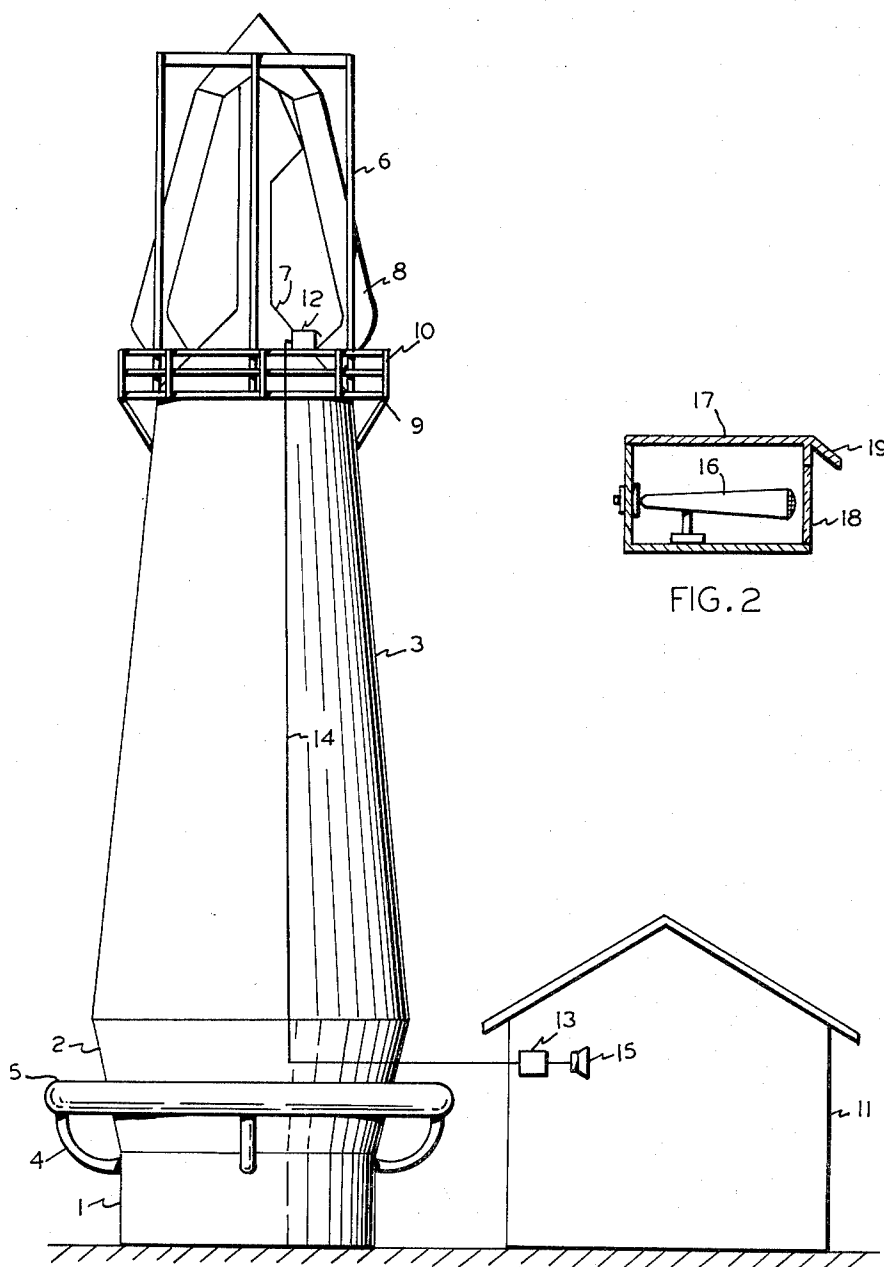


FIG. 1

FIG. 2

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SOUND DETECTION SYSTEM FOR BLAST FURNACES

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Filed Nov. 15, 1962, Ser. No. 237,906

1 Claim. (Cl. 340-239)

This invention relates to blast furnaces and specifically to apparatus for the detection of slip or incipient slip conditions in the furnace.

In normal operation a blast furnace is kept continuously full of ore, stone and coke from hearth bottom to the stockline. Blast air is forced into the furnace hearth through tuyeres evenly spaced about the circumference of the tuyere breast. The blast air is preheated to some practical temperature prior to admission into the tuyere zone of the furnace hearth and its purpose is to oxidize the carbon in the coke so as to generate the heat and gas necessary to effect the chemical processes that are essential in the manufacture of pig iron. The admission of air into the furnace hearth is also continuous and it is apparent that the resulting gaseous products will ascend through the descending column of ore, stone and coke.

For greatest efficiency of the blast furnace process, air is supplied into the furnace hearth at the greatest rate at which the gas can ascend and make its exit from the furnace without causing slipping and the carry over of solid particles. From time to time small particles of ore, stone and coke accumulate in such a manner as to prevent uniform flow of gas over the entire cross section of the descending column of ore, stone and coke. When this condition exists, the same volume of gas is forced through a much smaller area at a highly accelerated rate. The highly accelerated rate of flow of the gas causes small particles of ore, stone and coke to be blown out of the furnace seriously affecting its efficient operation. In addition, the loss of stock from the furnace is considerable and the resulting dust conditions within the plant and adjoining territory are undesirable.

The remedy for this undesirable condition in the furnace is to reduce the flow of air into the furnace hearth for a short interval which in turn will reduce the velocity of the ascending gases and permit the stock in the furnace to settle. It is important that reduction of the flow of air take place as soon as possible to eliminate the inefficiency of "blowing through," "dusting" or "slipping" which are the common terms used to describe a restricted gas flow which becomes highly accelerated.

Since the blast furnace is quite large, it is impractical to try to locate personnel so as to obtain a direct vigil on all parts of the furnace. Furthermore, since the blast furnace is a completely enclosed reaction vessel, it is impossible to observe what is occurring inside except by detection or measurement of conditions which exist in the furnace through the use of various instruments. Accordingly, the condition of the furnace is observed by remote indicators and recorders located in the instrument control room, and the furnace is controlled in response to the various instrument readings. Many methods have been devised for interpreting instrument readings and controlling the furnace so as to detect and eliminate the "slipping" of a furnace. These methods are generally based upon the detection and control of increases in the top pressure of the furnace or the pressure drop across the stock. These indicators are not always accurate, dependable or quick enough, and as a result the corrective measures taken may be too late, inadequate or unnecessary.

As pointed out above, "blowing through," "dusting" and "slipping" are invariably accompanied by increased

gas velocities and the resultant pickup of solid particles from the stock. The appearance of solid particles in the top gases gives a timely and dependable indication of incipient slip or slipping and of the need for corrective action. Accordingly, the invention has for its object the provision of means for detecting the presence of solid particles in the top gases of a blast furnace.

The specific embodiment of the invention described herein is based on the fact that the presence of solid particles in the top gases can be detected by audient means. The impact of these solid particles against the walls of the off-take pipes results in a rattling sound which is detected by a suitably placed microphone and the signal is transmitted from the microphone to the furnace control room.

A full understanding of this invention and its advantages will be gained by consideration of the detailed description and accompanying drawings in which:

FIGURE 1 is a diagrammatic sketch of a blast furnace assembly embodying the present invention, and

FIGURE 2 is a detailed illustration of the audient means which are mounted at the top of a blast furnace embodying the invention.

In FIGURE 1 the assembly includes a blast furnace comprising a hearth 1, bosh 2 and stack 3. Air is blown into the tuyere zone of the hearth by means of tuyeres 4 which receive air from bustle pipe 5. At the top of the stack, the furnace is provided with a conventional bridge structure 6 which supports the double bell charging assembly 7, gas uptake conduits 8 and a deck 9, which is surrounded by handrail 10. At the foot of the blast furnace the instrument control room 11 is conveniently located.

As pointed out above, the invention is based on the fact that slipping can be discovered early by detecting the pickup of solid particles by the gases rising through the furnace. This condition manifests itself as a rattling noise in the up-take pipes. The apparatus illustrated in FIGURE 1 is particularly suitable for providing a signal to the instrument control room. It comprises a microphone assembly 12 mounted on handrail 10, which is connected to an amplifier 13, located in the instrument control room 11 by means of microphone cable 14, and the amplified signal from the amplifier is fed into a speaker 15. This system is left operating at all times, so that the furnace operator may immediately detect the rattling of solid particles in the off-take pipes and take the necessary steps to reduce the blast.

Referring to FIGURE 2, the microphone assembly 12 is seen to be comprised of a highly directional dynamic microphone 16 mounted in a protective case 17. The wall of the case adjacent the front of the microphone consists of a glass-wool filter 18 which is protected from the weather by hood 19. This assembly is mounted on the handrail 10, or at any other suitable position, in close proximity to one of the uptake pipes 8, with the front of the microphone 16 aimed at the up-take pipe.

Of course, any combination of components which will detect the presence of solid particles in the off-take gases and transmit a signal to the control room can be used. A combination which has proven very satisfactory, and which is given only as an example, utilizes an Electro-Voice Model 644 microphone which is balanced to ground and phased on 150 ohms. Approximately 200 feet of two conductor #18 shielded low-capacity microphone cable connect the microphone to a Shure type A86A cable transformer for proper matching of the 150 ohm microphone to a high-impedance amplifier.

The Electro-Voice microphone utilizes a combination of cardioid and distributed front open designs and has a frequency response of 40-12,000 c.p.s. Its directional characteristics are cardioid to 700 cycles, with 20-25 db

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of rejection at the sides and rear above 700 cycles. The amplifier is a Bogen Model CHA10 with a frequency response of 30-15,000 cycles and a hum and noise level 55 db below rated output of 10 watts.

I claim:

A blast furnace system having a hearth, a bosh, a stack, means for charging stock at the top of the stack, means for supplying air under pressure into the hearth whereby a countercurrent flow of air and stock occurs, uptake conduits for taking off gaseous reaction products at the top of the furnace, a microphone mounted outside and adjacent one of the uptake conduits in a position to detect the impact of solid particles entrained in the offtake gases with the walls of the uptake conduit, an amplifier connected to the microphone for amplifying the microphone output, and a speaker located remotely from the micro-

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phone connected to said amplifier whereby a signal is provided in response to solid particles being carried from the stack by the gaseous reaction products.

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