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[11] 3,591,296

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[73] Assignee **Nippon Kokan Kabushiki Kaisha**
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[33] **Japan**
[31] **42/23317**

[54] **APPARATUS FOR MEASURING SLOPPING AND SPITTING CONDITIONS OF STEEL-MAKING FURNACE**
2 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **356/215, 266/24**
[51] **Int. Cl.** **G01j 1/46, C21b 7/00**
[50] **Field of Search** 356/215, 73; 266/213, 24

[56] **References Cited**
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ABSTRACT: During operation of a steel-making furnace, the amount of slopping and spitting is measured by an electrooptical means and the electrical value produced therefrom is integrated and counted to determine a desired standardized operating pattern. This assures improved tapping yield and uniformability of constituent; the resulting product has uniform characteristics.

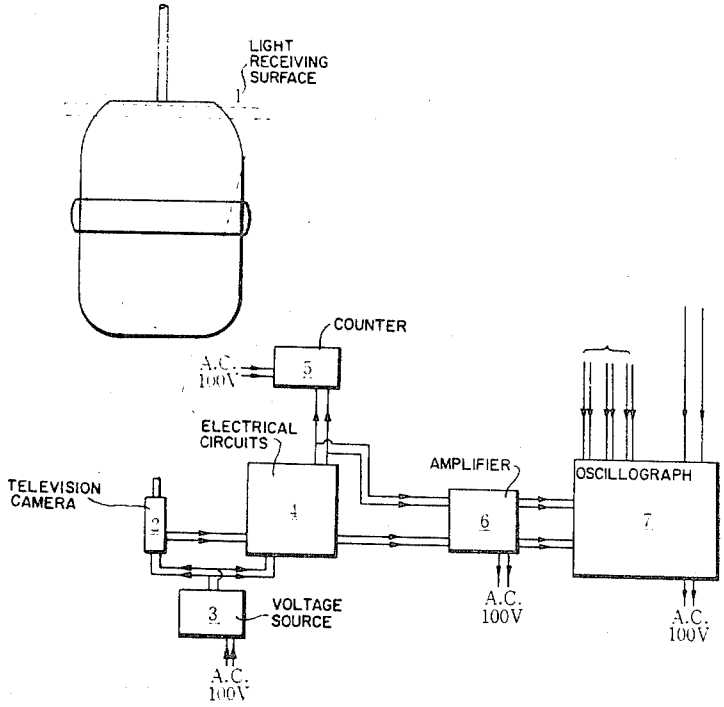


Fig. 1

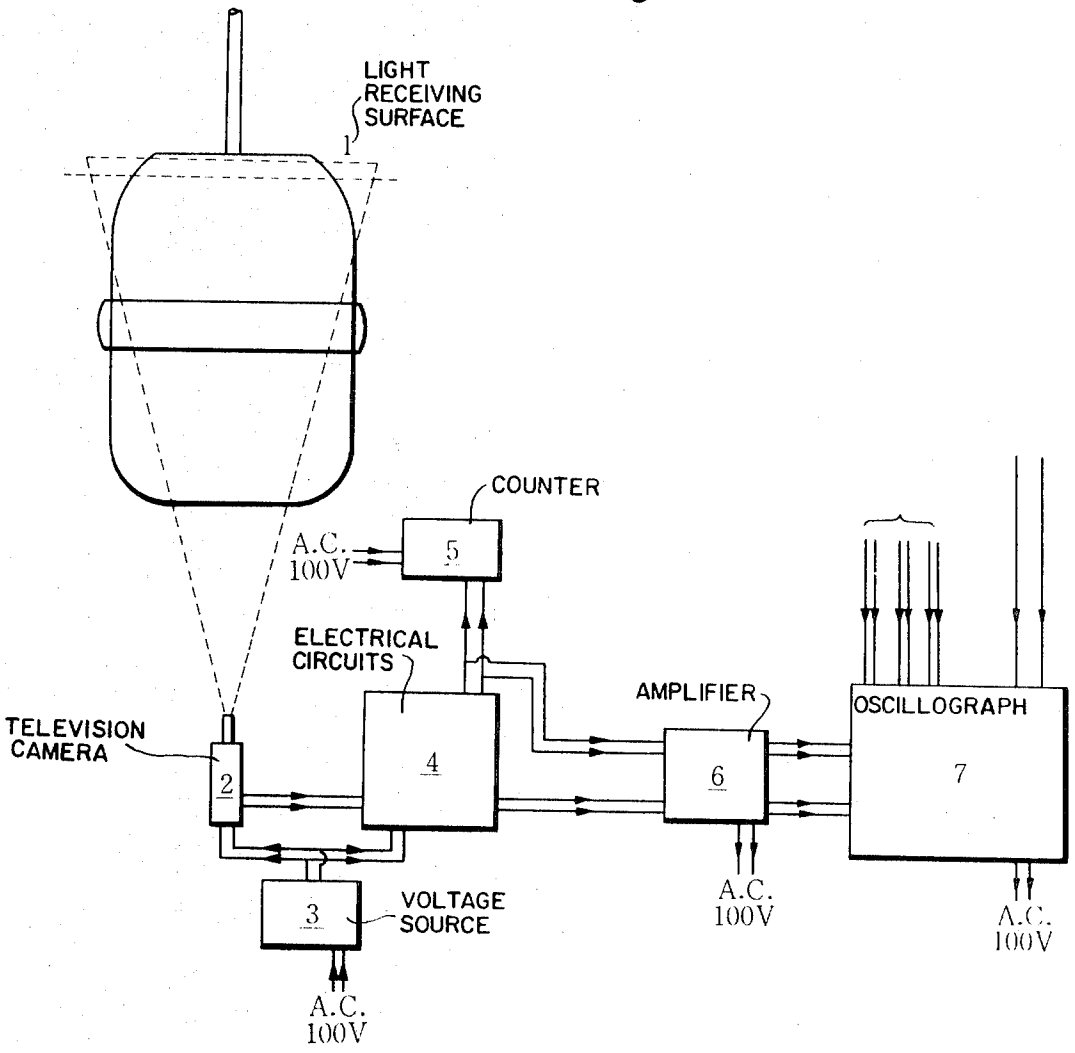

LIGHT
RECEIVING
SURFACE
1
COUNTER
A.C.
100V
5
ELECTRICAL
CIRCUITS
AMPLIFIER
OSCILLOGRAPH
TELEVISION
CAMERA
2
4
6
7
3
VOLTAGE
SOURCE
A.C.
100V
A.C.
100V
A.C.
100V

Fig.2

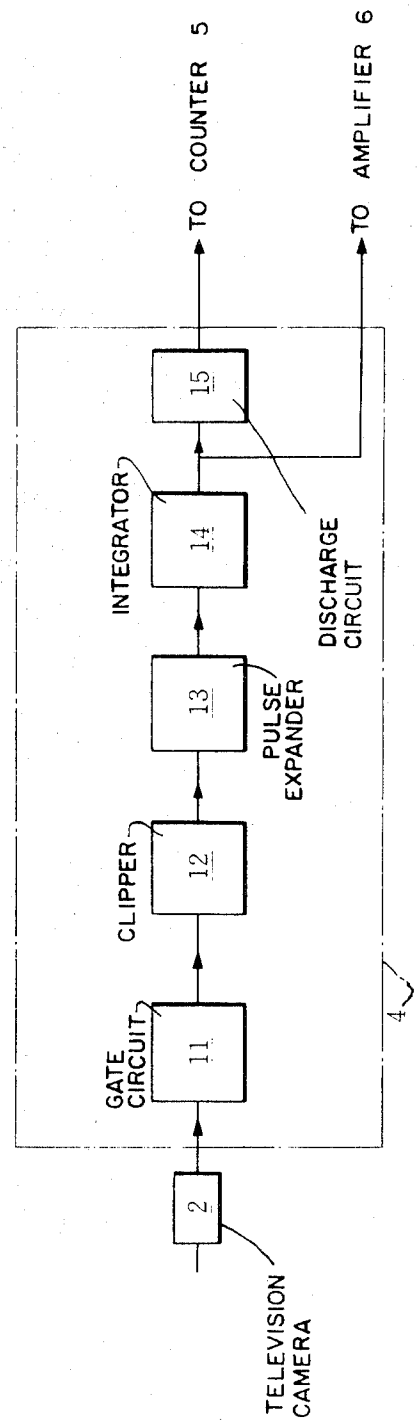

TO COUNTER 5
TO AMPLIFIER 6
15
INTEGRATOR
14
DISCHARGE CIRCUIT
13
PULSE EXPANDER
CLIPPER
12
GATE CIRCUIT
11
4
2
TELEVISION CAMERA

Fig.3A

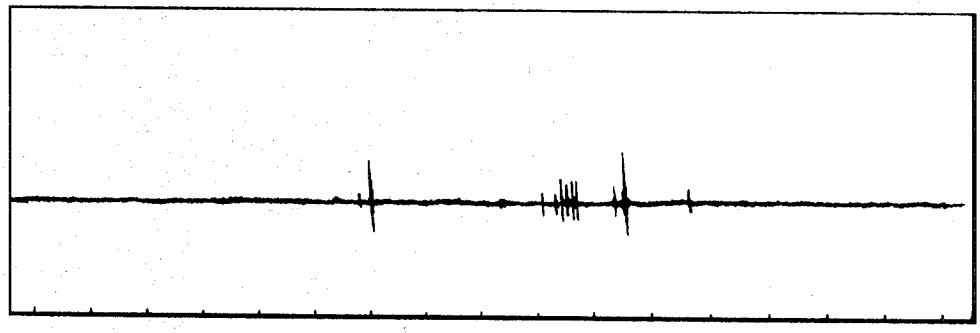
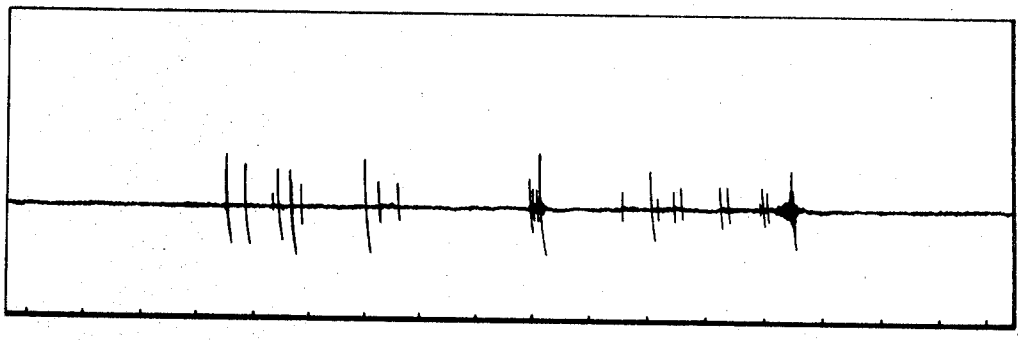


Fig.3B



APPARATUS FOR MEASURING SLOPPING AND SPITTING CONDITIONS OF STEEL-MAKING FURNACE

This invention relates to apparatus for measuring slopping and spitting conditions during operation of steel-making furnaces such as a Basic Oxygen Furnace, whereby to theoretically analyze slopping and spitting conditions to determine the main factors affecting yield and the like, thus determining more detailed operating patterns to produce the desired end product.

As is well known in the art, slag or molten steel is slopped out during the blowing of a Basic Oxygen Furnace (BOF) or other steel-making furnace. However, heretofore it has been the practice to determine the conditions and volume of such slopping and spitting of slag and molten steel by visual observation of the BOF. For example, where the slopping and spitting volume is excessive, the pressure of blowing oxygen is decreased or auxiliary raw materials (iron ore, lime stone or the like) are charged for the purpose of decreasing slopping and spitting. Thus, determination of slopping and spitting volumes and operations to be taken to reduce same have been dependent upon the experience of the furnace operator. As a consequence, the operation is different from one operator to another, thus causing large differences in tapping yield as well as deviation of the characteristics of the resulting steel product. In some cases malfunction of the furnace has resulted. Thus, if it were possible to make quantitative measurements of slopping and spitting conditions so that necessary operations could be performed independent of the experience of the operator, the yield could be greatly improved and product deviation could be reduced.

Further, it has been recognized in the art that if it were possible (1) to find out and record the relation between slopping and spitting and the tapping yield as well as major causes that affect slopping and spitting, and (2) to reveal the main causes that influence the tapping yield by correlating oxygen pressure, period and amount of charging auxiliary materials fluorspar, limestone, and iron ore), height of the lance, operating life of the nozzle as well as the age of said furnace, then it would become possible to prepare more detailed and more suitable furnace operating patterns. However, by prior techniques it has been quite impossible to clarify these points.

Accordingly, it is the object of this invention to provide a novel apparatus for establishing the standardized operating pattern for a steel-making furnace, especially a BOF, which assures improved tapping yield and uniformity of the steel product.

Another object is to provide an electro-optical device for measuring slopping. These and other objects will be more fully understood from the following detailed description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a diagrammatic representation of one embodiment of the measuring apparatus embodying this invention;

FIG. 2 is a block diagram showing electronic devices utilized in the embodiment shown in FIG. 1; and

FIG. 3A and 3B are charts showing slopping and spitting conditions in an actual operation.

The apparatus illustrated in the accompanying drawing is of the type wherein the sloppings and spittings (slag and steel) are detected by an electro-optical device (industrial television camera, photoelectric tube or infrared ray detector) and are then converted into electric values by means of an electronic device 4 and recorded. Thus, for example, an industrial television device 2 is provided to respond to light rays emitted from said sloppings and spittings passing through light receiving surface 1 beneath the mouth of the BOF, thus converting the received light rays into electrical values. To eliminate external light causing an error, a slit is provided for the lens system and the light receiving surface is limited to the position shown in FIG. 1. The output signals from television device 2 are passed through a gate circuit 11 as shown in FIG. 2, to eliminate external electrical disturbances from the source of supply. The signals are then supplied to a clipper circuit 12, which cuts off signals caused by external disturbances such as reflected light and eliminates signals corresponding to a brightness less than a predetermined value. Only signals corresponding to a predetermined value of brightness corresponding to slopping and spittings are passed through clipper 12.

Thereafter pulses caused by light from various directions are integrated with reference to the light receiving surface. To increase the precision of the integration the output from the clipper 12 is passed through a pulse expanding circuit 13 and then through an integrating circuit 14. The output thereof is fed via a coupling circuit 15 to a counter 5 (shown in FIG. 1) to be evaluated. Circuit 15 is preferably a discharge circuit which, when a capacitor contained therein is charged to a predetermined level, generates a pulse by discharging the capacitor. Counter 5 counts these pulses. Thus, brightness is a function of the number of pulses counted. As diagrammatically shown in FIG. 1 a portion of the output of circuit 14 (shown in detail in FIG. 2) is amplified by an amplifier 6 and is then recorded by a suitable device such as a three-element type oscillograph 7. As shown in FIG. 1 electronic devices 2 and 4 are energized by a constant voltage source 3.

FIG. 3 shows the results of measurements of said sloppings. FIGS. 3A and 3B show the results of blowing the same type of steel but with different operators. The use of different operators has resulted in a different time of charging auxiliary raw materials as well as different oxygen pressures, thus bringing about different slopping conditions. In the case shown in FIG. 3A the slopping and spitting volume is small whereas the slopping is large in the case shown in FIG. 3B. This means that the tapping yield has been reduced in the case of FIG. 3B.

According to this invention, in order to objectively judge the slopping and spitting conditions, the conditions are recorded to assure correct operation of the operator and in addition, investigations are made into the relationship between the amount of slopping and the yield of steel. The signal pulses representing slopping and spitting conditions are integrated, counted and recorded as shown in FIG. 1. At the same time, the oxygen pressure, the period and amount of charging auxiliary raw materials fluorspar, limestone and iron ore) are recorded to clarify major causes influencing the slopping and spitting whereby to prepare better operating patterns.

With the novel apparatus described hereinabove, it is not only possible to objectively record the slopping and spitting conditions in a steel-making furnace such as a Basic Oxygen Furnace, thus preventing misoperation by the operator, but it is also possible to quantitatively correlate such as the oxygen pressure, the lance height, the nozzle life, the nozzle shape and the furnace age as well as the condition and volume of slopping and spitting with reference to the period and the amount of charging of auxiliary raw materials. Thus major factors influencing slopping and spitting can be clarified and correlated to establish a high standardization of operating patterns, thereby improving the tapping yield and improving the uniformity and quality of the product.

Although we have described our invention hereinabove in considerable detail, our invention is not limited to the exact and specific particulars disclosed. Other such substitutes, modifications may be used within the spirit of the invention as defined in the accompanying claims.

What we claim is:

1. In apparatus for measuring slopping and spitting conditions of slag and molten steel during operations of steel making, means for measuring the flash brightness of light reflected from the slag and molten steel and which corresponds to said slopping and spitting comprising:

electro-optical means generating a signal responsive to said reflected light;

clipper circuit means coupled to said electro-optical means for eliminating undesirable components of said signal corresponding to undesirable light components;

pulse expanding means coupled to the output of said clipper circuit means;

an integrator coupled to the output of said pulse expanding means; and

means including a counter coupled to the output of said integrator and responsive to the output signal of said integrator for indicating the amount of said slopping and spitting.

2. The apparatus according to claim 4 further comprising a gate circuit coupling the output of said optical means to said clipper circuit means.