

[54] **GAP CONTROLLING DEVICE FOR A CONE CRUSHER**

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[51] Int. Cl. **B02c 25/00**

[58] Field of Search **241/37**

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[57] **ABSTRACT**

Apparatus is disclosed for controlling the outlet gap of a cone crusher, comprising a detecting core disposed within a main shaft of the cone crusher and a plurality of coils fixedly disposed with respect to the detecting core and forming therewith a differential transformer. A suitable electrical circuit is associated with the differential transformer to develop an electrical signal to be applied to a suitable measuring means such as a meter for providing an indication of the size of the outlet gap. In an illustrative embodiment of this invention, the measuring means is adapted to control the vertical movement of the main shaft of the cone crusher to adjust the outlet gap, thus enabling minerals to be crushed to a predetermined size.

4 Claims, 10 Drawing Figures

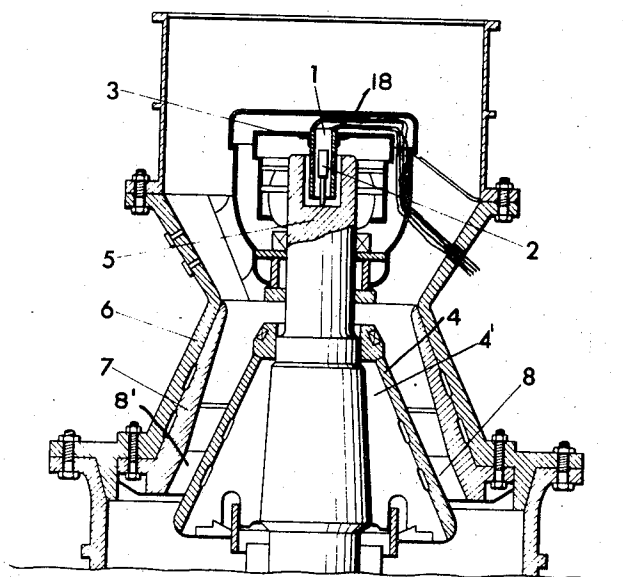


Fig. 1

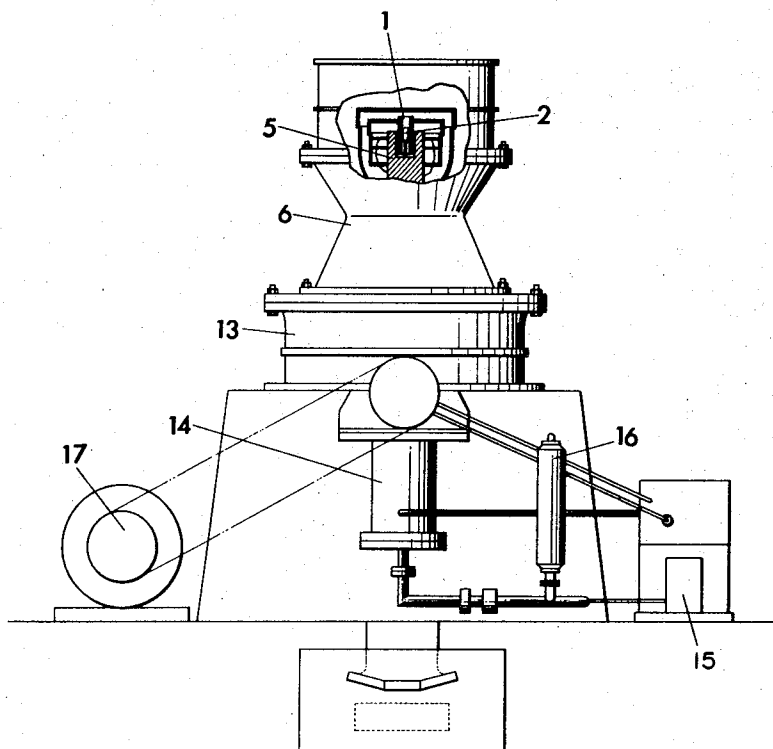
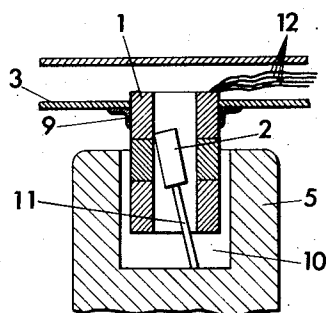


Fig. 3



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Fig. 2

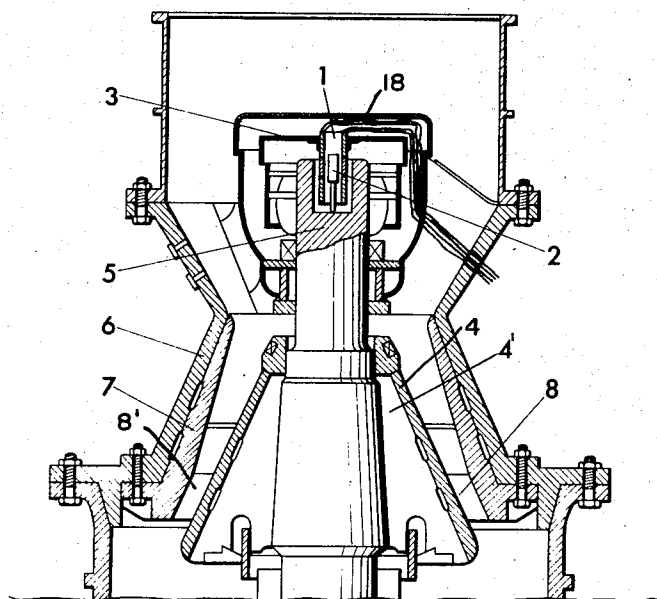


Fig. 4

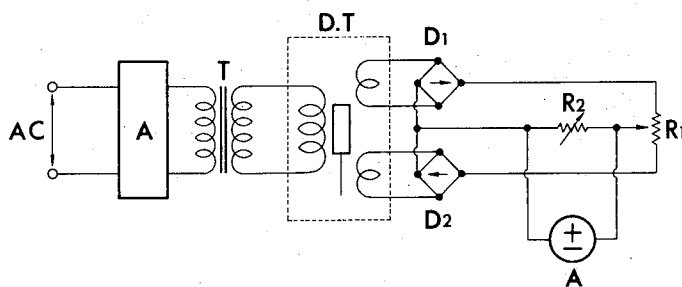
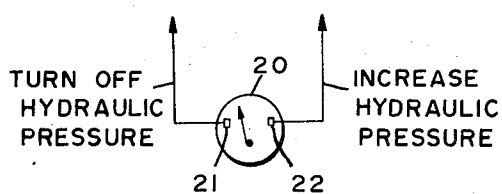


Fig. 10



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Fig. 5

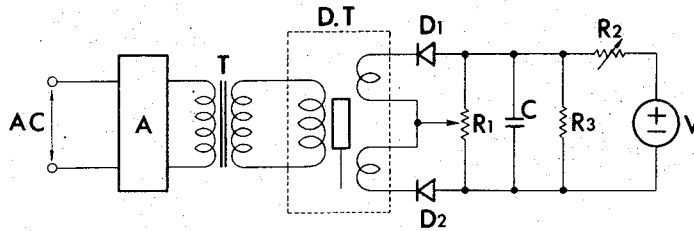


Fig. 6

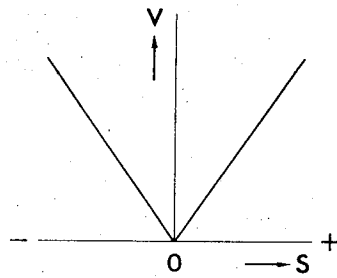


Fig. 8

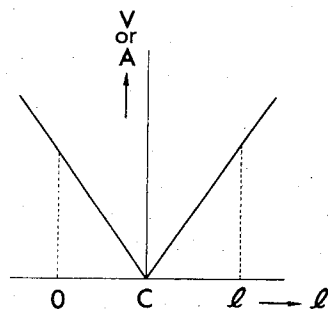


Fig. 7

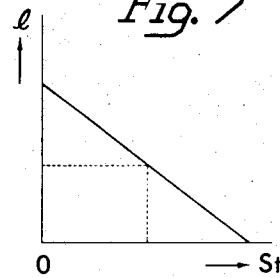
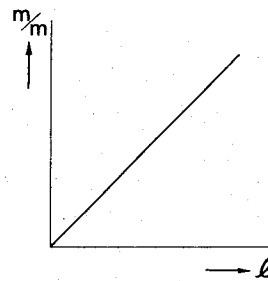


Fig. 9



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GAP CONTROLLING DEVICE FOR A CONE CRUSHER

This invention relates to a gap controlling device for a cone crusher, and more particularly to a device for controlling an outlet gap for minerals in a cone crusher by employing a differential transformer.

As conventional devices for measuring an outlet gap of a cone crusher, a scale is used to actually measure the gap, or in case of remote measurement, there is employed a selsyn transmitter, a selsyn receiver, a potentiometer or the like. These conventional types of measurements described, however, tend to cause troubles due to complicated construction in mounting said selsyn transmitter or the like on a main shaft of a cone crusher, and besides, requires large capacity for attaching said apparatus which inevitably makes the whole cone crusher larger than desired.

It is, therefore, an object of the present invention to provide a gap controlling device for a cone crusher which is simple in mechanism and enables an outlet gap provided in a cone crusher to be measured and controlled with accuracy.

It is another object of the present invention to provide a gap controlling device for a cone crusher which can be compactly mounted on a cone crusher requiring no additional capacity for attaching the same advantageously from the economical point of view.

It is a further object of the present invention to provide a gap controlling device for a cone crusher which affords almost permanent length of life.

It is a still further object of the present invention to provide a gap controlling device for a cone crusher which can be remotely and automatically controlled.

Essentially, according to the present invention, there is provided a device for controlling an outlet gap of a cone crusher which comprises a detecting core disposed in a main shaft, at its top portion, of the cone crusher and vertically displaceable according to the under-mentioned vertical movement of the main shaft; a stationary member which carries coils fixedly mounted in registry with said detecting core, said detecting core and said stationary member, in combination, forming a differential transformer and adapted to detect the width of the outlet gap according to displacement of the detecting core and to convert the detected width to an electric signal selected from the group consisting of a voltage and a current to actuate a meter whereby the width of the outlet gap is electrically indicated; and a means adapted to effect vertical movement of the main shaft of the cone crusher according to indication of the meter thereby to adjust the outlet gap, thus enabling minerals to be crushed in a predetermined size.

The foregoing and other objects, features and advantages of this invention will be made apparent from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a diagrammatic front view of a cone crusher provided with a gap controlling device according to the present invention, partly shown in a vertical section;

FIG. 2 is an enlarged sectional view of the upper part of the cone crusher shown in FIG. 1;

FIG. 3 is an illustrative sectional view showing a differential transformer employed in a gap controlling device according to the present invention;

FIGS. 4 and 5 respectively show instances of circuit connection diagrams for a differential transformer employed in a gap controlling device according to this invention;

FIG. 6 is a diagram showing one of the features of a differential transformer in which the axis of abscissa shows displacement S of a detecting core, and the axis of ordinate shows output voltage V of the differential transformer;

FIG. 7 is a diagram showing the relationship between an outlet gap l of a cone crusher and stroke St of a hydraulic cylinder which is employed as a means for effecting vertical movement of the main shaft of the cone crusher, said relationship being determined depending upon designing;

FIG. 8 is a diagram showing the relationship between an outlet gap l of a cone crusher and output voltage V or current A of a differential transformer, which is determined depending upon the above-shown diagrams;

FIG. 9 is also a diagram showing the relationship between an outlet gap l and the scale of a voltmeter or an ammeter indicated in a unit of m/m in proportion to an outlet gap l ; and

FIG. 10 illustrates a suitable measuring device such as a meter with limit contacts for controlling the movement of the cone crusher shaft.

Referring now to FIGS. 1 and 2, which illustrated a cone crusher provided with a gap controlling device according to the present invention. Numeral 3 is a stationary member upon which a differential transformer including coils is mounted; 4 is a mantle and 4' is a mantle support or a mantle filling; 5 is a main shaft; 6 is an upper frame and 7 is a cone cave fitted to the inner wall of the upper frame 6. Numeral 8 designates an outlet gap formed on the right of the mantle between the mantle 4 and the cone cave 7. Numeral 8' designates a like outlet gap which is formed on the left of the mantle and larger in width than said right-hand outlet gap 8 as depicted in FIG. 2. When the mantle 4 slowly and swingingly rotates around the main shaft 5, minerals are crushed through a whole outlet gap including outlet gap 8 having a narrower width, which is adapted to be measured by a gap controlling device according to this invention. 13 is an under frame; 14 is a hydraulic cylinder; 15 is a hydraulic motor; 16 is an accumulator and 17 is a motor for effecting rotation of the mantle 4. Numeral 18 designates a lid covering the top portion of the main shaft 5 including the differential transformer.

As illustrated in FIGS. 2 and 3, according to this invention, the differential transformer consisting of a detecting core 2 and the stationary member carrying coils is inserted in a hole 10 formed in the top portion of the main shaft 5 carrying the mantle 4; the hole 10 having a diameter large enough for the hole 10 to receive the differential transformer therein.

The upper portion of the stationary member of the differential transformer having lead wires 12 drawn therefrom is fixed to an upper cover 3 with metal fittings 9. The detecting core 2 is supported by a supporting rod 11 with its lower end rounded and rested on the bottom of the hole 10. The detecting core is freely disposed and merely rests on the bottom on the hole and so, it usually leans against the inner wall of the stationary member though it stands upright at some in-

stants as depicted in FIG. 2. In this state, the detecting call will occur no substantial difficulty in performing its functions for all practical purposes. If the detecting core 2 is fastened vertically to the center of the bottom of the hole 10 in the main shaft 5, it might be damaged with rotation of the mantle 4 when a cone crusher rotates with greater eccentricity at the top of the main shaft, because there is provided a very small clearance between the inner wall of the stationary member 1 of the differential transformer and the outer wall of the detecting core.

Furthermore, the differential transformer may be mounted on the top of the main shaft instead of being encased in a hole, but the whole cone crusher will become too bulky in such construction which is disadvantageous from the economical point of view.

An output voltage V of the differential transformer is exactly proportional to displacement S of the detecting core and varies with continuity, as shown in FIG. 6.

To the input of the differential transformer is applied a constant AC voltage through a constant voltage apparatus A, as shown in the circuit connection diagrams of FIGS. 4 and 5. The output AC voltage is rectified both side-wave in FIG. 4 and half-wave in FIG. 5 into DC voltage through diodes D_1 and D_2 just after the output terminal of the differential transformer. The residual AC voltage becomes 0 by thus transforming the output AC voltage into DC voltage just after the differential transformer. A differential transformer may be connected by lead wires of up to several hundred meters length, to a voltmeter or ammeter, which enables the device of the present invention to be utilized for a remote measuring or a remote controlling.

R_1 is a 0 (zero) regulating variable resistor and R_2 is a span regulating variable resistor.

The shaft of the crusher is connected by any suitable mechanism such as a rod of the hydraulic cylinder, so that the vertical movement of the shaft 5 is effected by an operation of the hydraulic cylinder 14. When the rod is raised by stroke S through the operation of the cylinder 14, the shaft 5 moves upward accordingly by a vertical dimension S . Since the detecting core 2 rests in the top portion of the shaft 5, it moves upward in proportion to the movement of the shaft by a vertical dimension S whereas the stationary member 10 carrying coils is kept in a fixed position irrespective of the vertical movement of the shaft 5. Accordingly, displacement of the detecting core 2 equals the stroke of the shaft 5, i.e., to a stroke of the rod of the hydraulic cylinder 14.

In turn, the displacement S of the detecting core, which corresponds to the outlet gap l , is measured by the circuit of FIG. 4 and a reading of the displacement is displayed by a voltmeter or ammeter; the outlet gap l can be detected from the meter and directly read if the scale of the meter is calibrated in m/m which is used as a unit of the outlet gap l . The relationships are illustrated in FIGS. 6 to 9.

The operation of the present device embodying this invention is described as follows. The differential transformer consisting of the detecting core and the stationary member carrying coils is fitted to a cone crusher as shown in FIGS. 2 and 3. In this instance, setting the base point at the middle of the full width of an outlet gap l_1 by operating the hydraulic cylinder, the

position of the stationary member 1 of the differential transformer is vertically adjusted so that the centers of the stationary member 1 and the detecting core 2 vertically coincide with each other at the middle point of the full width of outlet gap, and the stationary member is then fixedly attached to the upper cover 3. The hydraulic cylinder 14 is operating in a manner well known in the art by supplying selectively as by a valve a pressurized fluid such as oil to the cylinder 14. If the differential transformer is so adjusted that when the outlet gap is 0 (zero), the centers of the stationary member 1 and the detecting core 2 may vertically coincide with each other, only half length of the differential transformer is effective and the total length of the differential transformer must be disadvantageously large.

The outlet gap l is measured by vertical movement of a rod of the hydraulic cylinder 14, that is, vertical displacement of the detecting core 2. Since a meter V or A employed in the differential transformer is a $\pm$ type meter as seen in FIGS. 4 and 5, a pointer of said meter moves laterally in both directions with a center of the point $l_1/2$ and a width from 0 (zero) to l_1 as shown in FIG. 8. The outlet gap can be directly indicated by setting the pointer at 0 (zero) when the gap l is 0 (zero), and calibrating the scale in m/m unit according to indication of the pointer which varies in proportion to the movement of the detecting core 2 as depicted in FIG. 9.

With the above-described calibration of the differential transformer, regulation should be made by operating the 0 (zero) controlling variable resistor R_1 so that the pointer of the meter may stop at the very middle of the scale when the outlet gap is half the full width. On the other hand, in case where the pointer does not indicate 0 (zero) when the gap is 0 (zero), the span controlling resistor R_2 should be operated so that the pointer may stop at 0 (zero).

Once regulation of the meter has been thus completed, there is no need of regulating the same thereafter.

At actual running of the cone crusher, the desired outlet gap can be obtained by vertically moving the hydraulic cylinder according to indication of the meter. Moving upward the hydraulic cylinder makes the gap narrow, while moving the same downward makes the gap wide, thereby enabling minerals to be crushed in a desired size.

The mantle and the cone cave will be worn through a long run of the cone crusher and the actual width of the outlet gap will often get larger than what the pointer of the meter indicates. Stopping the work of the machine for a time, on this occasion, the hydraulic cylinder should be operated to make the gap 0 (zero). In this instance, since the pointer could naturally move leftward from 0 (zero) point corresponding to the amount worn, it should be set at 0 (zero) by way of a pointer regulating screw provided on the meter. As a result, the device of the present invention can be operated ordinarily.

As described, an outlet gap of a cone crusher can be easily and accurately remote-controlled, and a meter relay can be employed in place of a meter, thereby enabling the gap controlling device to be full-automatically operated. With regard to FIG. 10, there is shown a measuring device such as a meter 20 which may be substituted for the meter shown in either of the circuits of

FIGS. 4 and 5. More specifically, the meter 20 includes upper and lower limit contacts 21 and 22, respectively, to set the limits of shaft 5 displacement. In operation, if the rod of the hydraulic cylinder 14 goes down because of leakage in the pressurized oil system, an overload or some other accident to make the gap clearance larger than desired, the needle of the meter 20 will contact the upper limit contact 22 to cause an increase in the oil pressure and therefore to raise the rod and shaft 5, to decrease the size of the gap clearance. Illustratively, an increase in oil pressure could be effected in a manner well known in the art, per se, to throw a relay to thereby energize a pump motor and/or to control the flow of oil as through a known electromagnetic fluid valve. If the clearance becomes too small, the meter needle will contact the lower limit contact 21 to turn off the hydraulic pressure and to prevent the shaft 5 from being lowered further and to prevent the gap clearance from being made larger.

The present device for controlling an outlet gap of a cone crusher employing a differential transformer has such advantages that it is simple in its construction and mechanism, easy to be regulated for providing precise indication of the gap and assures almost permanent period of life.

Although the illustration is made only on one embodiment in which a hydraulic mechanism is employed as a means for effecting vertical movement of the main shaft of the cone crusher, it is apparent that any of other suitable means such as manually operated — or mechanically operated gearing system may be employed alternatively. Therefore, the present embodiment should not be construed to limit the scope of the present invention.

What is claimed is:

1. A device for controlling an outlet gap of a cone crusher which comprises a detecting core disposed in an opening formed within the top portion of a main shaft of the cone crusher and vertically displaceable according to the under-mentioned vertical movement of the main shaft; a stationary member which carries coils fixedly mounted in registry with said detecting core, said coils disposed within said opening to reduce the space required therefor, said detecting core and said stationary member, in combination, forming a differential transformer and adapted to detect the width of the outlet gap according to displacement of the detecting core and to convert the detected width to an electric signal selected from the group consisting of a voltage and a current to actuate measuring means for providing a manifestation of the width of the outlet gap; and a motor means adapted to effect vertical movement of the main shaft of the cone crusher according to indication of the meter, thereby to adjust the outlet gap, thus enabling minerals to be crushed in a predetermined size.

2. A device as claimed in claim 1, wherein said measuring means is calibrated in a unit of m/m, thereby enabling the width of the gap to be directly read.

3. A device as claimed in claim 1, wherein said measuring means includes limit means for controlling said motor means to establish an outlet gap of predetermined range.

4. A device as claimed in claim 1, wherein said detecting core is disposed loosely within said opening of said main shaft to permit the free movement of said detecting core therein.

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