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CRUSHING CHAMBER WEAR INDICATOR

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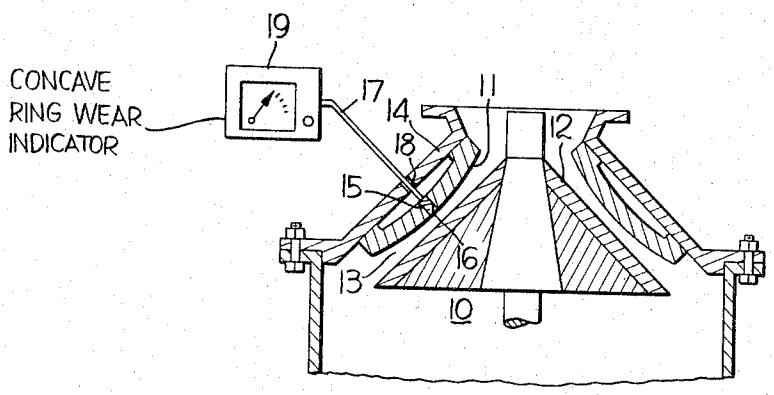


Fig. 1

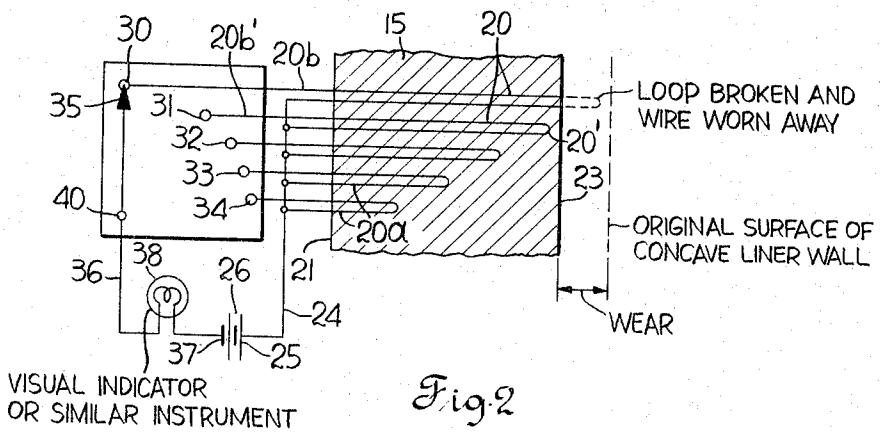


Fig. 2

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CRUSHING CHAMBER WEAR INDICATOR

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This invention relates to cone crushers and the like in which material to be crushed is allowed to flow by gravity through a crushing zone between a replaceable upright truncated conical concave liner wall defining a ring and a gyratory conical head within the concave wall. In particular, this invention relates to providing an indication of the amount of wear that has taken place on the inner concave surface of the liner wall.

The concave liner ring of a gyratory crusher is subjected to considerable wear by the crushing action that takes place between the liner ring and the gyrating conical head that projects upwardly into the concave ring. Therefore the liner ring must be replaced after certain time intervals and the time intervals may vary depending upon the character of the material being crushed. It is undesirable to stop the operation of the machine to make periodic inspections of the ring to determine the amount of wear that has taken place. Accordingly, it is an object of the present invention to provide a signal at a location external of the machine, to indicate the amount of wear without stopping the operation of the machine.

According to a preferred embodiment of the present invention a plug is inserted in the concave liner wall ring at a location where it is desired to determine wear. The plug may be inserted in a hole bored along an axis perpendicular to the inner surface of the liner ring and welded to the ring with the inner surface of the plug being flush with the inner surface of the ring. The plug is precast to contain a plurality of U-shaped loops of insulated electrically conductive wires spaced apart and generally parallel to the central axis of the plug. The free ends of each loop extend outwardly back of the plug and outer surface of the concave liner ring. The looped end of each of the wires is spaced a predetermined distance inwardly from the wear surface of the plug and liner. Such spacing from the wear surface is different for each loop of wire. Therefore as the inner wearing surface of the concave liner ring and the flush end surface of the plug are worn away the loops of wire will be broken one at a time. One end of each loop of wire is connected to a wire which in turn is connected to one of the terminals of a source of electric current which may be, for example, the positive terminal of a dry cell battery. The other ends of the loops are each connected to one of a series of spaced fixed contacts. A movable contact is provided that is adapted to engage each of the fixed contacts one at a time. The movable contact is connected to a wire which in turn is connected to the other terminal of the source of electric current, for example, the negative terminal of the dry cell battery. An audible or visual signaling device, for example, a bell or a light bulb, may be connected in series in the wire connecting the movable contact to the battery.

When the movable contact is moved to touch a first of the fixed contacts connected to a wire with a loop the extends closer to the wear surface than the others, a failure of the bulb to light is an indication that some wear has occurred and that the wear has been enough to break the loop end of that wire. If the movable contact is then turned to touch a fixed contact connected to a wire with a loop spaced a greater distance from the wear surface than the first contacted loop and the bulb does

light, it is then known that wear has not proceeded to expose the looped end of that wire. Thus the amount of wear on the inner surface of the concave liner ring can be determined without stopping operation of the crusher.

Other objects and how they are attained will appear from the following more detailed description of the invention with reference to the drawings in which:

FIG. 1 is a partial view of a gyratory crusher in vertical section; and

FIG. 2 is a schematic diagram of electrical circuits that may be used in this invention.

Referring to FIG. 1, a gyratory crusher 10 is shown that is provided with a wall shown as an upright truncated conical concave liner ring 11 and a generally conical crushing head 12 projecting upwardly within the concave to define therebetween a crushing chamber 13. The concave liner ring 11 is surrounded by a conical shell 14. A plug 15 is fitted in a hole 16 bored perpendicularly to the inner surface of liner ring 11. The plug 15 is fastened to ring 11, as by welding, with the inner surface of the plug flush with the inner surface of ring 11. A cable 17 from plug 15 extends through a hole 18 in shell 14 and is connected to an indicator 19. Plug 15, individual wires within cable 17 and indicator 19 will be described with reference to FIG. 2.

Referring to the diagram of FIG. 2, plug 15 is precast to contain a plurality of U-shaped insulated electrically conductive wire loops 20 spaced apart and generally parallel to the central axis of the plug 15. The free ends of each loop 20 extend outwardly from the back surface 21 of plug 15 and from the outer surface of the concave liner ring 11. The looped end 20 of each of the wires is spaced a predetermined distance inwardly from the wear surface 23 of the plug 15 and the inner surface of liner 11. Such spacing from the wear surface 23 is different for each loop of wire 20. One end 20*a* of each loop of wire 20 is connected to a wire 24 which in turn is connected to the positive terminal 25 of a dry cell battery 26. The other end 20*b* of the loops 20 are each connected to one of a series of spaced fixed contacts 30–34. A movable contact 35 is provided that is adapted to engage each of the fixed contacts 30–34 one at a time. The movable contact 35 is connected to a wire 36 which in turn is connected to the negative terminal 37 of the dry cell battery 26. A light bulb 38 may be connected in series in the wire 36 connecting the movable contact 35 to the battery 26.

The movable contact 35 of the present invention may be in the form of a pointer pivoted about a fixed support 40. The fixed contacts 30–34 are spaced apart in an arcuate display about the fixed support 40 and at a distance from the fixed support 40 that will enable the pointer 35 to touch each of the fixed contacts 30–34 individually as the pointer 35 is turned about the fixed support 40.

To prepare a crusher for operation with the described invention, the crusher 10 will be provided with a liner ring 11 and a plug 15 having all loops of wire 20 embedded varying distances inward of surface 23. The plug 15 will be welded in the hole 16 with the surface 23 flush with the inner surface of liner ring 11. All wires from plug 15 are bound into the cable 17 and liner ring 11 is mounted within crusher shell 14 with cable 17 passing through the hole 18 and connected to the indicator 19. The crusher is then ready for operation and material passing through the chamber 13 will be crushed. After a period of operation of crusher 10 the extent and rate of wear of liner 11 may be measured in a manner that will now be described.

To measure the wear of liner ring 11 pointer 35 is

moved to touch fixed contact 30 connected to a wire 20*b* and a loop 20 that extends closer to the wear surface 23 than the other loops. A failure of the bulb 38 to light indicates that some wear has occurred and the wear has been enough to break the end of wire loop 20 connected to fixed contact 30. The pointer 35 is then turned to touch fixed contact 31 connected to a wire 20*b'* and a loop 20' spaced a greater distance from the wear surface 23 than the first contacted loop 20 and if the bulb 38 does light, it is then known that wear has not proceeded to expose the looped end of that wire. Thus the amount of wear on the inner surface of the concave liner ring can be determined without stopping operation of the crusher.

The more wire loops provided in plug 15, the smaller may be the increments of displacement from the wear surface 23 and the more accurately the exact degree of wear be determined. Further, if the degree of wear is checked frequently, the length of time can be determined for wear to proceed from the breaking of one loop to the breaking of the next loop, and the useful life of the liner ring can be predicted and the day of eventual breaking of the last loop (which may be taken as the indication to replace the liner) can be forecast. Replacement liners can therefore be ordered and their delivery arranged so they are available as needed.

From the foregoing it will be understood that the present invention is possessed of unique advantages. However, such modifications and equivalents of the disclosed concepts such as readily occur to those skilled in the art are intended to be included within the scope of this invention and thus the scope of this invention is intended to be limited only by the scope of the claims such as are, or may hereafter be, appended hereto.

The embodiments of the invention for which an exclusive property or privilege is claimed are defined as follows:

1. A liner for a comminution chamber comprising a wall having a wear surface and a back surface on a side of the wall opposite the wear surface, and a plurality of U-shaped loops of insulated electrically conductive wires partly within the wall, each of the loops having a pair of generally straight sections spaced apart and parallel with respect to each other and such sections of all other loops, each of the pairs being connected on one end to define the loop, each of the loop ends being within the wall and spaced different distances inwardly of the wear surface with the ends of the straight sections opposite the loop ends projecting through and outwardly of the back surface to provide contacts outwardly of the back surface of the wall and provide a plurality of loop circuits into the wall until wearing away of material from said wear surface breaks the loop end of each wire as said wires become exposed in the worn surface.

2. A liner for a comminution chamber comprising a wall having a wear surface and a back surface on a side of the wall opopsite the wear surface and defining an opening through said wall, a plug in said opening having a back surface and a wear surface flush with the wear surface of said wall, and a plurality of U-shaped loops of insulated electrically conductive wires partly within the plug, each of the loops having a pair of generally straight sections spaced apart and parallel with respect to each other and such sections of all other loops, each of the pairs being connected on one end to define the loop, each of the loop ends being within the plug and spaced different distances inwardly of the wear surface of the plug with the ends of the straight sections opposite the loop ends projecting through and outwardly of the back surface of said plug to provide contacts outwardly of the back surface of the plug and provide a plurality of loop circuits into the plug until wearing away of material from said wear surfaces breaks the loop end of each wire as said wires became exposed in the worn surfaces.

3. A liner assembly for a comminution chamber comprising a wall having a wear surface and a back surface on a side of the wall opposite the wear surface, and a plurality of U-shaped loops of insulated electrically conductive wires partly within the wall, each of the loops having a pair of generally straight sections spaced apart and parallel with respect to each other and such sections of all other loops, each of the pairs being connected on one end to define the loop, each of the loop ends being within the wall and spaced different distances inwardly of the wear surface with the ends of the straight sections opposite the loop ends projecting through and outwardly of the back surface to provide a pair of contacts for each loop outwardly of the back surface of the wall, a first contact of each of said pair being connected to a terminal of a source of electric current, another terminal of said source being connected to a movable contact engageable with a second contact of a selected pair to close an electric circuit through a loop connected to the selected pair of contacts, and an electrically actuated signal connected in the circuit to indicate flow of current through the circuit.

4. A liner assembly for a comminution chamber comprising a wall having a wear surface and a back surface on a side of the wall opposite the wear surface and defining an opening through said wall, a plug in said opening having a back surface and a wear surface flush with the wear surface of said wall, and a plurality of U-shaped loops of insulated electrically conductive wires partly within the plug, each of the loops having a pair of generally straight sections spaced apart and parallel with respect to each other and such sections of all other loops, each of the pairs being connected on one end to define the loop, each of the loop ends being within the plug and spaced different distances inwardly of the wear surface of the plug with the ends of the straight sections opposite the loop ends projecting through and outwardly of the back surface of the plug to provide a pair of contacts for each loop outwardly of the back surface of the plug, a first contact of each of said pair being connected to a terminal of a source of electric current, another terminal of said source being connected to a movable contact engageable with a second contact of a selected pair to close an electric circuit through a loop connected to the selected pair of contacts, and an electrically actuated signal connected in the circuit to indicate flow of current through the circuit.

5. A gyratory crusher having a concave crushing chamber lined with a replaceable wall having a wear surface and a back surface on a side of the wall opposite the wear surface, and a plurality of U-shaped loops of insulated electrically conductive wires partly within the wall, each of the loops having a pair of generally straight sections spaced apart and parallel with respect to each other and such sections of all other loops, each of the pairs being connected on one end to define the loop, each of the loop ends being within the wall and spaced different distances inwardly of the wear surface with the ends of the straight sections opposite the loop ends projecting through the back surface and said chamber to a location outwardly of the crusher to provide a pair of contacts for each loop outwardly of the crusher, a first contact of each of said pair being connected to a terminal of a source of electric current, another terminal of said source being connected to a movable contact engageable with a second contact of a selected pair to close an electric circuit through a loop connected to the selected pair of contacts, and an electrically actuated signal connected in the circuit to indicate flow of current through the circuit.

6. A gyratory crusher having a concave crushing chamber lined with a replaceable wall having a wear surface and a back surface on a side of the wall opposite the wear surface and defining an opening through said wall, a plug in said opening having a back surface and a wear surface flush with the wear surface of said wall,

and a plurality of U-shaped loops of insulated electrically conductive wires partly within the plug, each of the loops having a pair of generally straight sections spaced apart and parallel with respect to each other and such sections of all other loops, each of the pairs being connected on one end to define the loop, each of the loop ends being within the plug and spaced different distances inwardly of the wear surface of the plug with the ends of the straight sections opposite the loop ends projecting through the back surface of the plug and chamber to a location outwardly of the crusher to provide a pair of contacts for each loop outwardly of the crusher, a first contact of each of said pair being connected to a terminal of a

source of electric current, another terminal of said source being connected to a movable contact engageable with a second contact of a selected pair to close an electric circuit through a loop connected to the selected pair of contacts, and an electrically actuated signal connected in the circuit to indicate flow of current through the circuit.

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