

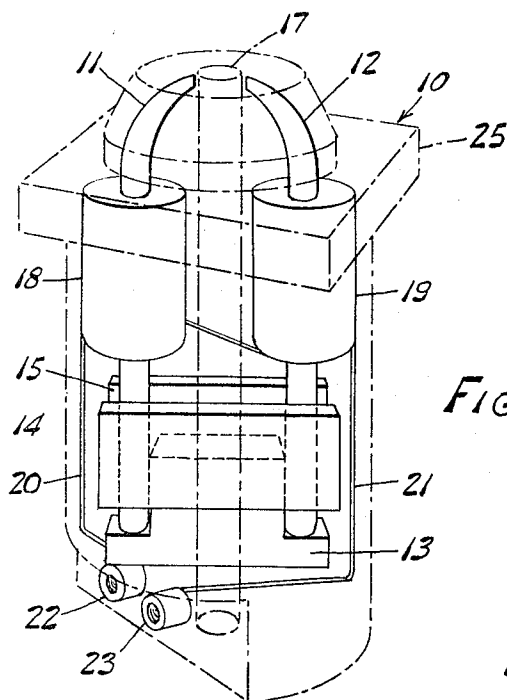
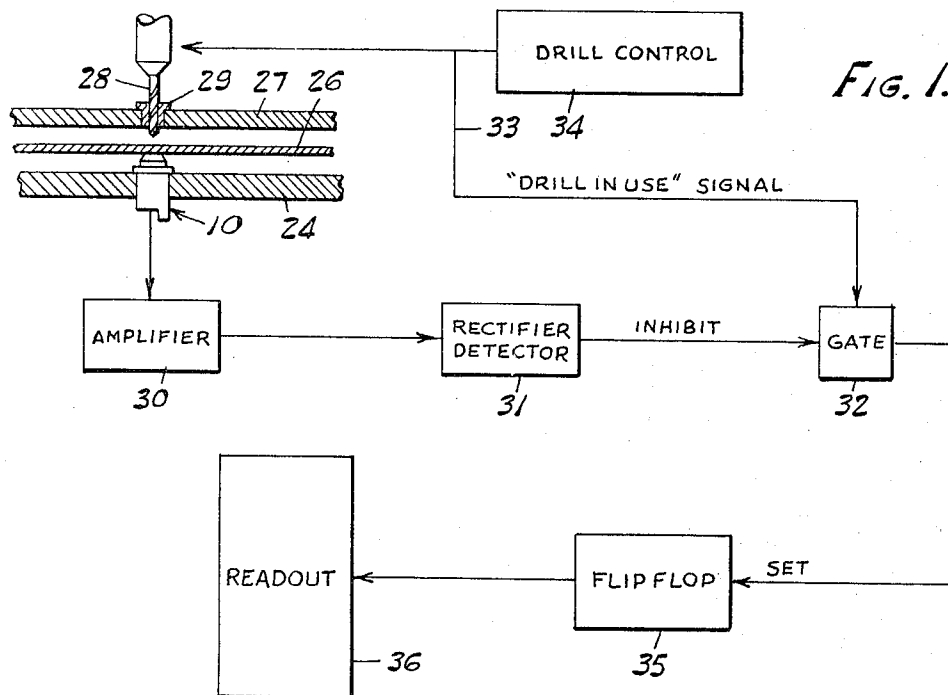
March 21, 1967

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3,310,796

DRILL INDICATOR

Filed July 31, 1964



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1

3,310,796

DRILL INDICATOR

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Filed July 31, 1964, Ser. No. 386,524

9 Claims. (Cl. 340-271)

This invention relates to apparatus for detecting and signalling the presence of an abnormal condition of a drill in drilling apparatus, such as a drill which has broken, or ceases rotation for any other reason, or a drill which is of improper size or which is not operating at proper speed, due to wear or any other abnormality.

The present invention provides means which indicates an abnormal condition whenever a drill bit or the cutting end thereof ceases to rotate, as when the drill bit breaks or becomes loose in the drill chuck. The detecting means of the present invention may also be employed to signal a worn cutting edge, which slows the rotation of the drill, and may also be employed to detect a drill of improper diameter and to indicate the relative axial position of the cutting end of the drill. This detecting apparatus is particularly useful in the case of gang drilling or in various automatic or semi-automatic drilling machines or in any case where the drill is not ordinarily under the direct and immediate surveillance of an operator.

Speaking generally, the present apparatus employs electrical phenomena in detecting and signalling the condition of the drill so that there need be no mechanical contact or intervention between the drilling and the detection portions of the apparatus. Conventional drills in transverse cross section exhibit circumferentially spaced lobe formations formed by the helical flutes formed in the side walls of the drill body. In ordinary twist drills there are two flutes and accordingly two such lobes, although the number may vary in special cases.

The detection portion of the present apparatus comprises means producing a magnetic field arranged in such proximity to and oriented with the drill element in such manner that the lobes of the latter, upon rotation of the drill in the magnetic field, generate an alternating current impulse in output winding means associated with the magnetic field means when the drill is rotating. The cessation of this alternating current impulse is caused to produce a signal indicating an abnormal condition, usually a broken drill. Similarly, a slowing of the frequency of the generated impulse may be employed to indicate a worn drill and the intensity or amplitude of the generated impulse may be employed to indicate the size of a drill.

In the form of the present invention shown herein by way of example, the probe element of the apparatus establishes a magnetic flux circuit by means including and defining an air gap in which a drill normally rotates. The aforesaid lobes of the drill cause a continuous variation in the reluctance of the air gap and thus induce an alternating current flow in output windings disposed in inductive relation to the magnetic circuit means, preferably by disposition about a conductor of the magnetic circuit means. If the drill stops rotating the alternations in the magnetic flux stop and the current flow in the output windings likewise ceases. This cessation or absence of output current comprises a signal which is employed to indicate to an operator the abnormal condition existing at the particular drill.

Since drills generally operate intermittently, it is desired that the abnormal signal be transmitted only when a drill ceases to rotate or otherwise is subject to an abnormality during a period when it is supposed to be in operation. Accordingly, gate circuit means are provided as between the foregoing indicator output and the drill control circuit, so that an abnormal indication is trans-

2

mitted through the gate circuit only during periods when the drill control circuit is energized.

While a single specific embodiment of the principles of the present invention is illustrated in the accompanying drawing and described in detail in the following specification, it is to be understood that such embodiment is by way of example only and that various mechanical modifications may be made without departing from the spirit of the invention, the scope of which is limited only as defined in the appended claims.

In the drawing:

FIG. 1 is a schematic illustration of one form of the broken drill detection apparatus of the present invention; and

FIG. 2 is an enlarged perspective view of one form of the sensing element or probe of the apparatus of FIG. 1.

In the drawing like characters of reference denote like parts. As shown in FIG. 2, a drill sensing probe assembly designated generally by the numeral 10 comprises a pair of ferro-magnetic pole pieces 11 and 12 connected magnetically at one end by a ferro-magnetic pole piece holding block 13. In the present instance a pair of permanent magnets 14 and 15 are disposed against opposite sides of the pole pieces 11 and 12 and holding block 13, thus forming a permanent horseshoe magnet.

The attraction of the magnets 14 and 15 will hold the foregoing assembly temporarily in assembled position and the whole is embedded in a synthetic resin block 16 such as epoxy resin, for instance. The other ends of the pole pieces 11 and 12 are directed toward each other and are spaced to define an air gap in the magnetic circuit which is slightly greater across than the diameter of the drill which is being monitored thereby. A central bore 17 is formed in block 16 to permit the passage of a drill and the ends of the pole pieces 11 and 12 face each other across bore 17. The ends of the pole pieces may be exposed at the surface of bore 17 or not, as desired.

A pair of series connected inductive windings 18 and 19 are disposed about medial portions of the pole pieces 11 and 12 and leads 20 and 21 extend therefrom to a pair of terminal sleeves 22 and 23 which comprise output terminals from the probe 10.

Referring now to FIG. 1, the numeral 24 designates a lower anvil or support plate which is drilled to receive any desired number of probes 10 to match a particular pattern of multiple drilling. The probe body 15 has a flange 25 which rests on the upper surface of lower anvil 24. Thus the upper faces of the several probe bodies receive a work piece 26 thereon.

An upper anvil 27 is movable downwardly against the work piece to clamp the same against the probe surfaces and the numeral 28 designates a drill which moves downwardly through upper anvil 27 to drill the work piece 26 and, in passing through the same, enter the bore 17 of the probe. The upper anvil 27 may be provided with a drill guide bushing 29 for each drill 28. It is to be understood that the alternating current signal set up in the windings 18 and 19 by rotation of the drill 28 does not require that the drill be directly within bore 17. Rotation of the drill in the area approaching bore 17 will sufficiently vary the reluctance of the magnetic circuit to produce a measurable alternating current flow in windings 18 and 19.

The remaining portion of FIG. 1 comprises a block diagram which illustrates a representative arrangement for producing a signal to indicate a broken or non-rotating drill. It is to be understood that the illustrated electrical arrangement is merely by way of example and that various means may be employed for converting the failure of alternating current in the probe to a sensible readout signal.

As shown in FIG. 1, the alternating current signal from the probe is amplified and rectified, as at 30 and 31, re-

spectively, and is applied to a gate circuit device 32. A conductor 33 from a drill control circuit 34 leads by way of the gate circuit device 32 to a flip-flop 35 and thence to a readout indicated at 36 in FIG. 1. When an alternating current of sufficient minimum intensity flows from the probe 10 through amplifier 30 to rectifier 31 the direct current output from the rectifier is applied to gate 32 and inhibits current flow through gate 32 from the drill control circuit 34 to the flip-flop 35 and readout 36. However, if the current from the probe fails due to a broken or non-rotating drill gate 32 is open to current flow and a readout signal is produced.

The readout signal may be employed in various ways, such as to energize a lamp, an audible device, an indicating meter, or a relay. In the latter case the relay may act to stop the drilling machine or otherwise control the operation.

I claim:

1. In combination with drilling apparatus comprising work holding means and rotatable drilling means including a fluted drill bit of ferro-magnetic material wherein said two means are relatively movable toward and away from each other along the drilling means axis, drill sensing probe means disposed in coaxial relation with respect to the drilling axis, said probe means comprising a pair of magnetic poles at opposite sides of said drilling axis, electrically conductive winding means in inductive relation with respect to said magnetic poles, and readout means responsive to alternating current induced in said winding means by rotation of said fluted drill bit in proximity to said probe means.

2. In combination with drilling apparatus comprising work holding means and rotatable drilling means including a fluted drill bit of ferro-magnetic material wherein said two means are relatively movable toward and away from each other along the drilling means axis, drill sensing probe means disposed in coaxial relation with respect to the drilling axis, said probe means comprising a pair of magnetic poles at opposite sides of said drilling axis, electrically conductive windings disposed about said magnetic poles, and readout means responsive to alternating current induced in said windings by rotation of said fluted drill bit in proximity to said probe means.

3. In combination with drilling apparatus comprising work holding means and rotatable drilling means including a fluted drill bit of ferro-magnetic material, drill sensing probe means disposed in coaxial relation with respect to the drilling means, said probe means comprising a pair of magnetic poles at opposite sides of the drilling axis, electrically conductive winding means in inductive relation with respect to said magnetic poles, and readout means responsive to alternating current induced in said winding means by rotation of said fluted drill bit in proximity to said probe means.

4. In combination with drilling apparatus comprising work holding means and rotatable drilling means including a fluted drill bit of ferro-magnetic material, drill sensing probe means disposed in coaxial relation with respect to the drilling means, said probe means comprising a pair of magnetic poles at opposite sides of the drilling axis, electrically conductive windings disposed about said magnetic poles, and readout means responsive to alternating current induced in said windings by rotation of said fluted drill bit in proximity to said probe means.

5. Drilling apparatus comprising a rotatable drill and means for supporting a workpiece to be drilled thereby, said supporting means including a drill sensing probe disposed coaxially with said drill, a pair of magnetic pole members terminating at opposite sides of said drill axis whereby the drill may pass freely through the gap therebetween, means establishing a magnetic circuit which includes said pole members and said gap, and readout circuit means including an inductive winding about said pole members, whereby rotation of said drill in the vicinity of said gap produces a variable reluctance in said magnetic

circuit and an alternating current response in said winding for controlling said readout circuit means.

6. Drilling apparatus comprising a rotatable drill and means for supporting a workpiece to be drilled thereby, said supporting means including a drill sensing probe disposed coaxially with said drill, a pair of magnetic pole members terminating at opposite sides of said drill axis whereby the drill may pass freely through the gap therebetween, means establishing a magnetic circuit which includes said pole members and said gap, and readout circuit means including means in inductive relation to said pole members, whereby rotation of said drill in the vicinity of said gap produces a variable reluctance in said magnetic circuit and an alternating current response in said inductive means for controlling said readout circuit means.

7. In combination with drilling apparatus comprising work holding means and rotatable drilling means including a fluted drill bit of ferro-magnetic material wherein said two means are relatively movable toward and away from each other along the drilling means axis, drill sensing probe means disposed in coaxial relation with respect to the drilling axis, said probe means comprising a pair of magnetic poles at opposite sides of said drilling axis, electrically conductive winding means in inductive relation with respect to said magnetic poles, a drill controlling circuit and readout means connected therewith, said winding means having a gate circuit connection between said drill controlling circuit and said readout means and adapted to interrupt said connection when rotation of the drill bit induces alternating current in said winding means, said gate being adapted to close said connection upon failure of said induced alternating current whereby said readout means is connected to said drill controlling circuit to indicate that the latter is energized but the cutting end of said drill bit is not rotating.

8. In combination with drilling apparatus comprising work holding means and rotatable drilling means including a fluted drill bit of ferro-magnetic material, drill sensing probe means comprising magnetic circuit means including a pair of magnetic poles defining an air gap in proximity to said drill bit whereby rotation of the fluted drill bit varies the reluctance of said magnetic circuit means, electrically conducting winding means in inductive relation with respect to said magnetic circuit means, a drill controlling circuit and readout means connected therewith, said winding means having gate circuit connection between said drill controlling circuit and said readout means and adapted to interrupt said connection when rotation of the drill bit induces alternating current in said winding means, said gate being adapted to close said connection upon failure of said induced alternating current whereby said readout means is connected to said drill controlling circuit to indicate that the latter is energized but the cutting end of said drill bit is not rotating.

9. In combination with drilling apparatus comprising work holding means and rotatable drilling means including a fluted drill bit of ferro-magnetic material, drill sensing probe means comprising magnetic circuit means including a pair of magnetic poles defining an air gap in proximity to said fluted drill bit whereby rotation of said drill bit varies the reluctance of said magnetic circuit means, electrically conductive winding means in inductive relation with respect to said magnetic poles, and readout means responsive to induced alternating current in said winding means.

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