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## APPARATUS FOR DETERMINING AND RECORDING THE ECCENTRICITY OF LEAD SHEATHS OR OTHER CONDUCTING PIPE

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My invention relates to eccentricity detecting and/or recording devices and more specifically to an apparatus for determining, and where desirable, recording the eccentricity of the lead sheath and/or pipe as it is extruded on an electrical cable. Such sheath or pipe is extruded from a press and it is important that the thickness of the wall be uniform along the entire circumference. Variations of temperature in the extrusion block or other causes have the effect of making the lead thicker on one side than on the other and this condition is difficult to guard against. The present invention provides a method of detecting and measuring the eccentricity of the lead sheath or pipe continuously as it is extruded from the press.

In the practicing of my method an electric current is passed longitudinally through the lead pipe from a point at or near the die block to a point on the pipe somewhat removed therefrom. This current creates a magnetic field around the lead pipe, which field is concentric with the pipe, providing the current is disposed symmetrically around the pipe. If, however, by reason of eccentricity of the pipe, the current is disposed unevenly, the magnetic field around the pipe will show corresponding divergencies. By using alternating current, the field strength may be measured by noting the voltages induced in pick-up coils in any part of the field. If a pair of such coils is set on a diameter of the pipe, one on each side and equidistant from the pipe, any differences in the magnetic field on the two sides of the pipe may be detected and measured by the differences in the currents or voltages induced into the two coils.

By having two pairs of such pick-up coils set on diameters at right angles to one another, detection and measurement of eccentricities in either direction may be made.

I am aware that this general principle has been utilized by other inventors. Their inventions, however, do not give the results which I have been seeking. The present specification describes those changes which I have found it necessary or advisable to make, in order to render such a system operative.

It will be understood that my apparatus comprises four parts: 1. Means for circulating current through the pipe; 2. Pick-up coils and their supports; 3. Electrical circuits for combining the currents from the pick-up coils; 4. Detecting or recording instruments.

I have found it advantageous to use alternating current of about 100 cycles frequency, the density of the current being about 50 amperes per square inch of pipe. The current is introduced into the pipe by a permanent connection to the die block of the press and by a sliding contact with the pipe at a distance of about twelve feet from the press.

I have found it necessary to enclose pick-up coils in a magnetic and electrostatic shield, in order to prevent interference from outside electrical disturbances. This shield consists of iron pipe which encloses the pick-up coils and constitutes the framework of this part of the system whereby it is supported. I have found the most advantageous arrangement consists of two pairs of pick-up coils, one set on a horizontal, and one on a vertical axis. In order to keep the pick-up coils centered, a pair of rollers is used in connection with each pair of coils, which holds the cable and pick-up coils in their proper relative positions. The pick-up coils and rollers are linked together so that they all make simultaneous contact with the pipe as it is being extruded regardless of its diameter. This whole system is supported in such a way as to follow the pipe in the course of any swaying to which it may be subjected.

The third part of my apparatus consists of two circuits, one for each pair of pick-up coils, each circuit comprising, in addition to the one pair of pick-up coils already described as a transformer, a variable inductor, a variable resistor, an amplifier and a rectifier. The circuit is completed by the instruments to be described under part 4. The variable inductor and resistor are for the purpose of balancing the phase and magnitude of the opposing induced currents. This feature I have found to be essential to the proper operation of the apparatus. A capacitor might be used in connection with balancing of phases but I have not found this to be necessary.

The fourth part of my apparatus consists of a pair of graphic recording instruments, each with its chart drive geared to operate synchronously with the flow of the pipe so that the chart travel is directly proportional to the length of extruded pipe. The rectifier described under part 3 enables me to use D. C. milliammeters of high sensitivity. By this means I am able to make records of the horizontal and vertical eccentricity of pipe.

The foregoing and other features of my invention will now be described in connection with the accompanying drawings forming part of this specification in which I have shown diagrammatically a preferred way in which my method