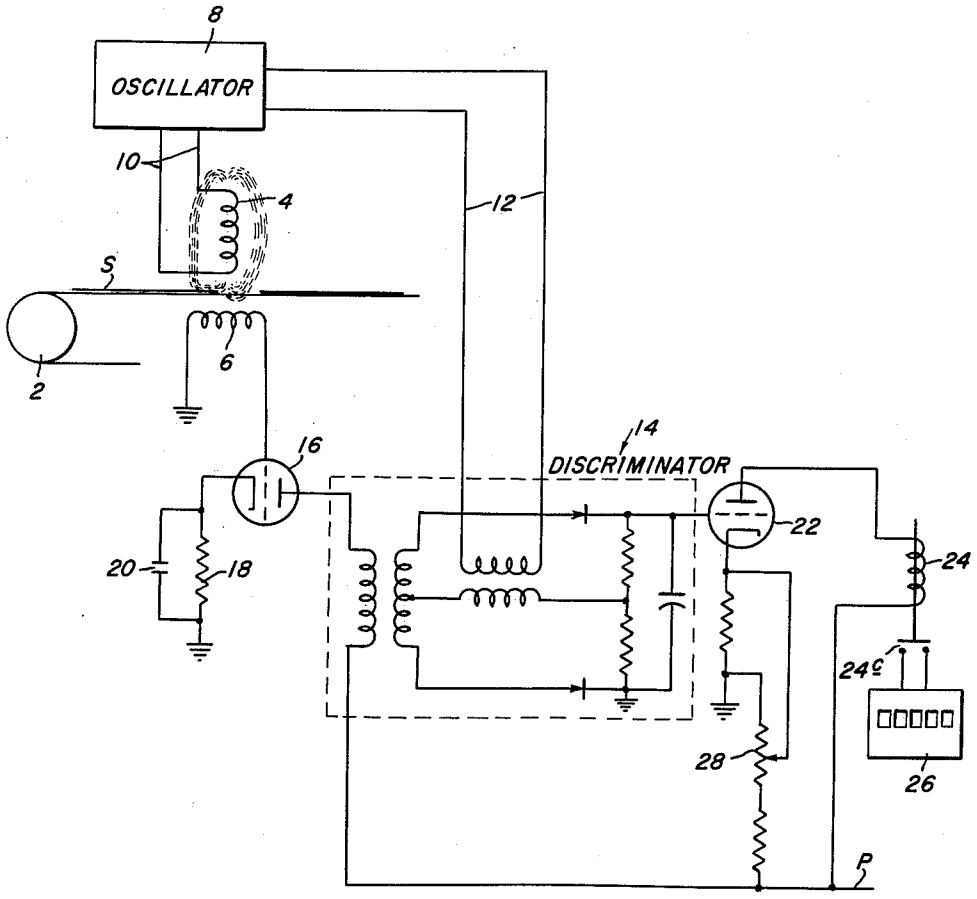
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COUNTING APPARATUS

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COUNTING APPARATUS

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This invention relates to apparatus for counting electrically conductive objects and more particularly to such apparatus wherein there is relative movement between the object and the apparatus such as steel sheets moving along a conveyor. Various counters have previously been used such as shown in my co-pending application, Serial No. 630,570, filed December 26, 1956. The apparatus disclosed therein is accurate and suitable for this purpose under all conditions. However, I have found that the apparatus of my co-pending application is more sensitive than necessary when used as a counter. Other counting devices such as that shown in Buccicone Patent No. 2,751,150 are dependent upon the presence of a mass of material, particularly magnetic material, rather than the presence of an edge of an electrically conductive object. These devices are quite sensitive to vibrations of the object and hence do not function properly when the objects being counted are subject to vibrations.

It is therefore an object of my invention to provide an inexpensive and rugged counter.

This and other objects will be more apparent after referring to the following specification and attached drawings, in which:

The single figure is an electrical diagram showing the counter of my invention as used in counting sheets.

Referring more particularly to the drawings, reference numeral 2 indicates a belt conveyor for conveying sheets S. Located on opposite sides of the path of travel of sheets S are transmitter coil 4 and receiver coil 6. The axes of coils 4 and 6 are arranged at an angle to one another with the axis of coil 6 extending in the general direction of sheet travel and part of the turns of coil 6 on the entry side of the axis of coil 4 and part on the exit side. The arrangement of the coils 4 and 6 is such that the number of turns of coil 6 on the entry side of the axis of coil 4 times the average magnitude of the flux linking these turns is equal to the number of turns of coil 6 on the exit side of the axis of coil 4 times the average magnitude of the flux linking these turns. The simplest way to accomplish this is to arrange the axis of coil 4 substantially normal to the surface of sheet S and the axis of coil 6 generally parallel to the surface of sheet S with the number of turns of wire on the entry side of the axis of coil 4 being substantially equal to the number of turns on the exit side. The same result can be obtained by tilting the axis of coil 4 with respect to the direction of sheet travel and arranging more turns of coil 6 on one side of the axis of coil 4 than on the other side to compensate for the resulting non-symmetrical fields or by so tilting coil 4 and tilting coil 6 so that the axes of the coils are in planes transverse to sheet travel and substantially normal to one another. In the latter case the number of turns of coil 6 must be substantially equal on each side of the axis of coil 4. For best operation the diameter of coil 4 is small in comparison with the length of sheets being counted. The coils 4 and 6, with or without the other apparatus to be described hereinafter, may be placed in a protective steel box or may be exposed. However, the coils must not be shielded so as to weaken their fields. The coil 4 is connected to an oscillator 8 by means of leads 10. The oscillator 8 is a conventional low frequency oscillator operating at about 15,000 cycles per second. Choice of power and frequency of operation of the oscillator is not critical. The oscillator 8 is connected by means of leads 12 to a phase discriminator 14. The discriminator 14 may be of a well known type such as that described on page 368 of Active Networks, Prentice-Hall, New York, 1954. The coil 6 is connected to the grid of a triode amplifier tube 16. The cathode of tube 16 is connected to ground through a resistor 18 and condenser 20 connected in parallel. The output of tube 16 is connected to the discriminator 14. The output of discriminator 14 is connected to the grid of a triode tube 22. Other biased switching devices operable from a voltage signal such as a transistor or magnetic amplifier may be substituted for the tube 22. A relay coil 24 is connected to the plate of tube 22 and is provided with contacts 24C for operating a counter 26. A potentiometer 28 is connected to the cathode of tube 22. The potentiometer 28 provides the means for controlling sensitivity of the system by varying the fixed bias on the relay tube 22. A positive direct current is supplied to the system by lead P.

The operation of the counter is as follows:

The circulating currents passing through coil 4 produce an alternating magnetic field that centers over receiver 6, thus inducing equal voltages into the entry and exit end of coil 6. These voltages are applied to the amplifier tube 16. When there is no sheet in the system the output of amplifier tube 16 will be zero. When the end of a sheet S passes receiver coil 6 the entry half of the coil and the exit half thereof are shielded in sequence and an unbalanced voltage occurs at amplifier tube 16. In this manner a signal is obtained from the receiver circuit when the leading or trailing edge of the sheet passes. This difference in voltage is amplified by amplifier tube 16 and the amplified signal is applied to the discriminator 14 which compares the signal with the reference signal from the oscillator 8 to determine the direction of unbalance. Since there is a 180° phase difference between the signals due to the leading and trailing ends of the sheets S the discriminator 14 will cause tube 22 to conduct at one end but not at the other, depending upon the phase of the reference signal. Firing of the tube 22 energizes relay coil 24 closing its contacts 24C to operate counter 26.

While one embodiment of my invention has been shown and described it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. Apparatus for counting moving electrical conductive objects comprising means for moving said objects along a path of travel, a transmitter coil located on one side of said path of travel with its axis arranged at an angle to said path of travel, a receiver coil located on the side of said path of travel opposite said transmitter coil with its axis extending in the general direction of object travel and with the number of turns of wire on the entry side of the axis of the transmitter coil times the average magnitude of the flux linking these turns being substantially equal to the number of turns of wire on the exit side thereof times the average magnitude of the flux linking these turns, a counter, means for obtaining a signal from said receiver coil when the leading edge of each object passes adjacent thereto, means for obtaining a signal from said receiver coil when the trailing edge of each object passes adjacent thereto, and means for impressing the signal from only one of said edges on said counter.

2. Apparatus for counting moving electrical conductive objects comprising means for moving said objects along a path of travel, a transmitter coil located on one side of said path of travel with its axis arranged at an angle to said path of travel, an oscillator, leads connecting said oscillator to said transmitter coil, a receiver coil

located on the side of said path of travel opposite said transmitter coil with its axis extending in the general direction of object travel and with the number of turns of wire on the entry side of the axis of the transmitter coil times the average magnitude of the flux linking these turns being substantially equal to the number of turns of wire on the exit side thereof times the average magnitude of the flux linking these turns, an amplifier connected to said receiver coil, a phase discriminator, means connecting the output of said amplifier to said phase discriminator, leads connecting said discriminator to said oscillator, a counter, said discriminator generating an output signal of one polarity when the leading edge of each object passes adjacent said coils and an output signal of opposite polarity when the trailing edge of each object passes adjacent said coils, and means permitting passage of signals of only one polarity from said discriminator to said counter.

3. Apparatus for counting moving electrical conductive objects comprising means for moving said objects along a path of travel, a transmitter coil located on one side of said path of travel with its axis substantially normal to said path of travel, an oscillator, leads connecting said oscillator to said transmitter coil, a receiver coil located on the side of said path of travel opposite said transmitter coil with its axis extending in the general direction of object travel and with the number of turns of wire on the entry side of the axis of the transmitter coil times the average magnitude of the flux linking these turns being substantially equal to the number of turns of wire on the exit side thereof times the average magnitude of the flux linking these turns, an amplifier connected to said receiver coil, a phase discriminator, means connecting the output of said amplifier to said phase discriminator, leads connecting said discriminator to said oscillator, said discriminator generating an output signal of one polarity when the leading edge of each object passes adjacent said coils and an output signal of opposite polarity when the trailing edge of each object passes adjacent said coils, a triode tube having a grid, plate and cathode, means connecting the output of said discriminator to said tube, a relay coil in the plate circuit of said tube, said triode tube being so biased as to permit passage of signals of only one polarity from said discriminator to said relay coil, a counter, and means operable by said relay coil to actuate said counter.

References Cited in the file of this patent

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