

[54] ANTENNA ASSEMBLY FOR A
CAPACITANCE-RESPONSIVE SAFETY
DEVICE

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[58] Field of Search 317/DIG. 2, 258 B, 242,
317/246, 248

[56] References Cited

UNITED STATES PATENTS

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[57] ABSTRACT

An antenna assembly for a capacitance-responsive personnel safety device consists of an antenna formed by bending a ribbon of flat metal into a loop capable of defining a continuous capacitance field, the bending taking place across the width of the ribbon; a shield of the flat metal substantially coextensive with the antenna loop positioned in spaced relation with respect to the loop, the surface plane of the shield being perpendicular to the surface plane of the antenna ribbon; and a dielectric material such as an organic polymer embedding the antenna and shield and maintaining the spaced relation thereof.

5 Claims, 3 Drawing Figures

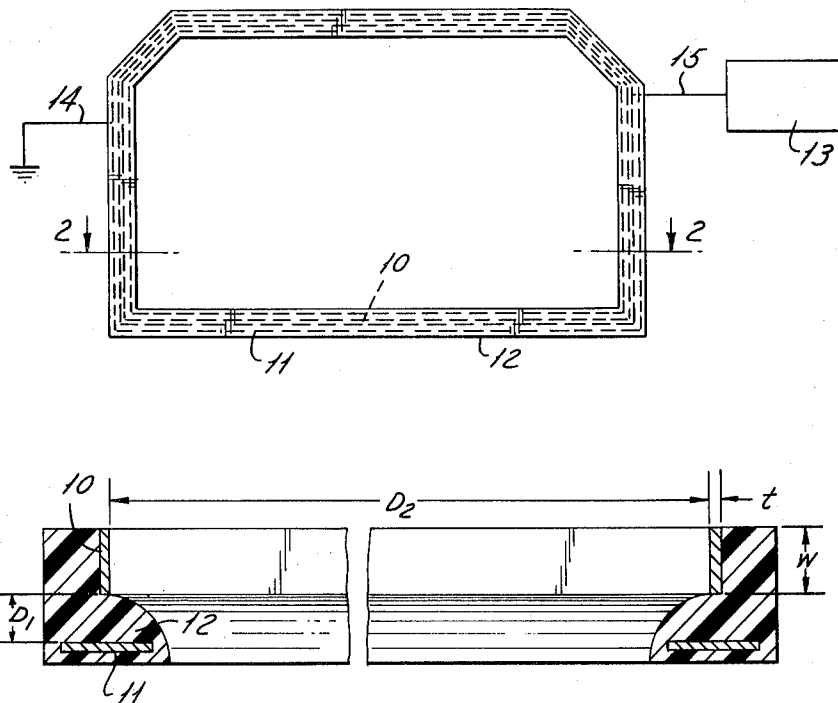


FIG. 1

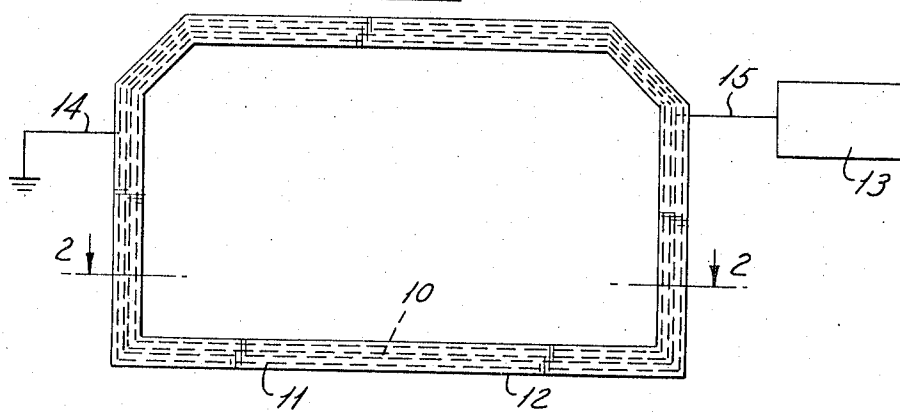


FIG. 2

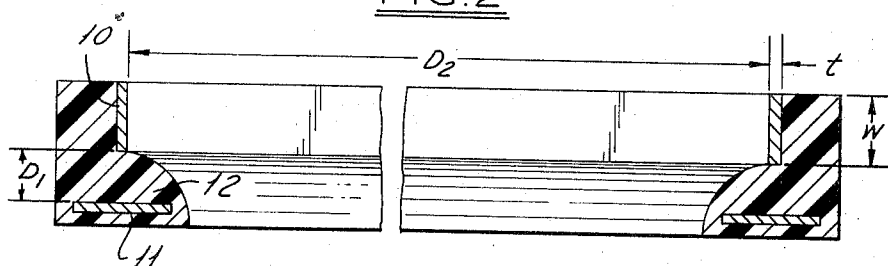
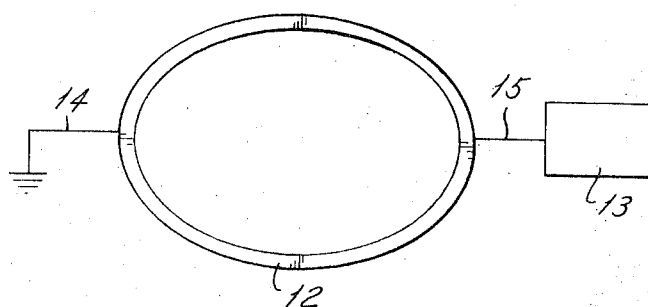


FIG. 3



ANTENNA ASSEMBLY FOR A CAPACITANCE-RESPONSIVE SAFETY DEVICE

BACKGROUND OF THE INVENTION

An operator of a punch press lacking a safety device faces considerable danger from the apparatus. It is necessary for the operator to insert a workpiece blank which it is desired to form in the press. The downward stroke of the punch effects the forming after which the punch is withdrawn and the operator removes the formed workpiece. A slight relaxation of concentration on the part of the operator can result in his hand getting caught in the path of the punch and sustaining a serious injury.

Various safety devices which have been developed for presses are described in the magazine "Machine Design" Jan. 11, 1973, pages 100-107. One form of safety device which has been used has been to give the operator control of movement of the punch. For example, in a single stroke press two knobs may be placed outside of the travel path of the punch, both of which must be pressed-one by the right hand and one by the left hand-in order for the punch to make a down stroke. While such safety means can be effective to reduce the risk of injury, the additional motions required of the operator reduce the production and efficiency of the machine.

A form of passive protection which has been used relies upon the effects of the grounding characteristics of the operator to arrest movement of the punch. In this system, the region through which the operator's hands must move in order to insert and remove workpieces is surrounded by an antenna formed of electrically conductive material. Such an antenna forms one component of a capacitance bridge. It is connected to a control box which contains the other capacitance bridge components including a balance indicator milliammeter and circuitry with manual dials for establishing the balance of the bridge and adjusting for sensitivity. Also included are relays which respond to imbalance in the bridge to shut down the press when the insertion of a hand, through the antenna loop during the portion of the stroke cycle when such action is dangerous, changes its capacitance. Such control boxes are well known in the art and are available on the open market.

Antennas for use with control boxes of the type described above are normally composed of EMT, which is an abbreviation for "electrical metallic tubing", the bendable tubing used as electrical conduit. Since EMT produces a rather large capacitance field both within the confines of the antenna loop and outside thereof a shield is sometimes used on the operator's side of the antenna in order to block the field and reduce the likelihood that the device will stop operation of the press when the operator is in no danger. Such a shield may be formed of thin gauge sheet metal substantially coextensive with the antenna loop and displaced a short distance therefrom and grounded. Because of the shape of the EMT the shield has to be placed a minimum of 4 inches away making it impractical for the operator to move his hands near the press.

The present invention is directed toward an improved antenna loop and antenna assembly having a restricted capacitance field producing a planar effect which enables the control box to be actuated to stop

movement of the punch only when the stoppage is needed, e.g., when the operator's hands are extended through the antenna loop at a time when such action is dangerous.

SUMMARY OF THE INVENTION

In the present invention an antenna loop for a capacitance-responsive safety device is formed of a wide ribbon of flat metal. A shield of flat metal substantially coextensive with the antenna loop is positioned in spaced relationship to the loop. The space between the antenna loop and shield is filled with an insulating material such as an organic polymer which serves to strengthen the assembly and to maintain the spacing between the antenna loop and shield. The distance separating the antenna loop from the shield is approximately directly proportional to the dielectric constant of the insulating material, the distance across the antenna loop, and the thickness of the flat metal of which the antenna is composed, and inversely proportional to the width of the metal ribbon of which the antenna is composed.

DESCRIPTION OF THE DRAWING

FIG. 1 is a front view of an antenna assembly made in accordance with this invention showing the control in block form;

FIG. 2 is a sectional view looking along the line 2-2 of FIG. 1;

FIG. 3 is a front view of an antenna assembly having an alternative configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The antenna assembly of this invention consists essentially of an antenna loop 10 (FIG. 2), a shield 11, and an insulating medium 12 which may also serve to lend structural support to the assembly. During operation of the assembly the antenna 10 becomes a charged capacitor through a conductor 15 connecting the antenna to the control box 13. As previously explained, the control box 13 is not a part of this invention as such boxes are well known in the art and available on the open market. The principal requirement of the control box 13 is that it be able to place a charge of sufficient magnitude on the antenna 10 that the capacitance field produced by the charge will occupy all of the space within the antenna loop and that the capacitance bridge balance be sufficiently sensitive for a relay to be triggered whenever a portion of the hand is thrust into the space encompassed by the antenna loop.

The shield 11 is shown grounded through a conductor 14. Grounding may be achieved by connection to the press (not shown) or control box 13, or both.

FIG. 2 best illustrates the positioning of the elements of the assembly. The shield 11 blocks stray capacitance flux from the antenna 10 and thus restricts the capacitance field to the space circumscribed within the antenna loop 10. The distance "D₁" separating the antenna 10 and shield 11 should be as small as possible commensurate with the structural strength needed for the assembly. We have discovered that the optimum distance D₁ varies according to "D₂", the distance across the antenna loop; the dielectric constant "a" of the insulating material 12; the thickness "t" of the metal ribbon forming the antenna loop 10; and the width "w" of the metal ribbon forming the antenna 10.

The distance D_1 varies directly as to the dielectric constant a , distance D_2 , and thickness t and inversely with the width w . Thus, the equation may be written: $D_1 = (a D_2 t/w)$

The dimensions used in the formula are marked on FIG. 2.

It was mentioned above that it is desirable to have the distance D_1 quite short. To achieve this the dimensions and dielectric constant in the numerator of the equation should be small whereas the width of the ribbon of metal should be large. However, the dimension D_2 is dependent upon the size of the area of entry to the press or other machine being protected. Normally this would range from about 6 inches to about 60 inches but these are not limiting dimensions. Further, it is desirable that the antenna assembly be able to withstand bumps and hard usage. Accordingly, the antenna loop should be strong and rigid. The thickness of the flat stock used will vary from about 0.1 inch to 0.25 inch depending on the length of the dimension D_2 . The dimension is normally of the order of one inch.

The thickness of the shield 11 is of importance only to the extent that the shield imparts structural strength and rigidity to the assembly. Sheet metal may be used for this purpose. As shown in FIG. 2 the shield may be completely encased in the dielectric material 12 to add structural strength to the assembly.

The dielectric material 12 is selected primarily on a cost and strength basis. Organic polymers such as polyurethane, polymethylmethacrylate, polypropylene, polyethylene, polystyrene, polycarbonate, nylon, polybutylene, and mixtures thereof, are satisfactory for use in the invention.

The embodiment illustrated in FIG. 3 provides a more uniform capacitance field than the embodiment of FIG. 1 but is more expensive to manufacture since the shield 11 is made from sheet material rather than a ribbon as in the case of the FIG. 1 embodiment. It illustrates the fact that the safety devices of this invention may be provided in a wide variety of shapes.

A safety device made in accordance with this invention using polyurethane as the insulating material 12 was found to have a very narrowly defined capacitance field. The exterior surface of the material 12 could be touched without triggering the device. It was only when

a portion of the hand protruded past the space circumscribed by the guard 11 that a relay within the control box 13 was triggered to cut the operation of the press on which the antenna assembly was mounted.

While the invention has been described with reference to certain embodiments thereof it is obvious that there may be variations which properly fall within the scope of the invention. Accordingly, the invention should be limited in scope only as may be necessitated by the scope of the appended claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An antenna assembly for a capacitance-responsive safety device comprising:

15 an antenna loop composed of a wide ribbon of flat metal, said loop surrounding and forming the perimeter of a continuous capacitance field;

20 a shield of flat metal substantially coextensive with said antenna loop positioned in space relationship thereto;

and means for maintaining the spaced relationship of said antenna and shield, said means avoiding direct electrical contact between said antenna and shield.

2. An antenna assembly as claimed in claim 1 wherein the antenna loop is formed by bending of the flat surface of the metal ribbon and the shield is formed with the plane of the surface of the flat metal perpendicular to the plane of the surface of the metal ribbon forming the antenna.

3. An antenna assembly as claimed in claim 1 wherein the spaced relationship between the antenna and shield is maintained by an organic polymer.

4. An antenna assembly as claimed in claim 3 wherein the organic polymer is a polyurethane.

5. An antenna assembly as claimed in claim 3 wherein the distance separating the antenna from the shield is approximately directly proportional to the product of the dielectric constant of the organic polymer, the distance across the loop of the antenna, and the thickness of the flat metal of which the antenna is composed, and inversely proportional to the width of the flat metal of which the antenna is composed.

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