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PRESSURE RELIEF DEVICE

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My invention relates to a pressure relief device for an enclosing casing of electrical apparatus, and to a device for rupturing a frangible diaphragm upon the occurrence of an abnormal operating condition, such as excess pressure.

Electrical apparatus which are totally enclosed in a casing are usually susceptible to relatively high pressures being developed in the casing under certain conditions, such as when a fault occurs in the apparatus inside the casing. It is customary, therefore, to provide pressure relief devices including frangible diaphragms which will rupture and relieve the high pressure whenever such an abnormal pressure condition obtains within the casing. It is sometimes difficult to provide a frangible diaphragm which will withstand normal pressures indefinitely and which will consistently release pressures which would damage the tank and electrical apparatus. In order to overcome this difficulty spring operated plungers have been provided which are released for operation when an abnormal pressure obtains within the casing, the plunger being forced against the diaphragm to rupture it. Such a structure is described in Patent 1,670,697, Treanor, which patent is assigned to the same assignee as this present invention.

It is therefore an object of my invention to provide an improved device for rupturing a frangible diaphragm upon the occurrence of an abnormal operating condition.

Another object of my invention is to provide an improved device for rupturing a pressure relief diaphragm which is placed in the casing of an electrical apparatus.

Further objects and advantages of my invention will become apparent from the following description referring to the accompanying drawing, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawing, Fig. 1 is a side elevation in partial section of a transformer casing which is provided with an embodiment of my invention; Fig. 2 is a side view of the diaphragm rupturing device of Fig. 1; Fig. 3 is a top view of the device of Fig. 2; Fig. 4 is a side view of the diaphragm rupturing device taken along the lines 4—4 of Fig. 3; Fig. 5 is a perspective view of a portion of the operating mechanism of the device in Figs. 1 to 4; Fig. 6 is a sectional side elevation of the operating mechanism of Fig. 5; and Fig. 7 is a sectional side elevation of a portion of the device after operation in response to an

abnormal operating condition, such as an abnormal pressure.

Referring to Fig. 1 of the drawing, I have illustrated a casing 10 for any apparatus, such as a transformer having a core 11 and windings 12. Such apparatus usually has an insulating fluid, such as oil, partly filling the casing and with a gas above the oil. At the top of the casing there is provided a suitable frangible diaphragm 13 which is adapted to be ruptured by my improved device upon a predetermined abnormal condition, such as pressure obtaining within the casing 10. The diaphragm 13 may be supported in any suitable manner such as being attached to a collar 14 which is in turn attached to the top of the casing 10. Inside the transformer casing and suitably positioned with respect to the diaphragm 13 is placed my improved device indicated generally by the numeral 15. This device has a plunger 16, as will be seen more clearly in Fig. 2, with a sharp point 17 in the end thereof. The plunger 16 is normally held with its point 17 away from the diaphragm 13. However, upon the attainment of a predetermined abnormal pressure the plunger 16 is released so that the sharp point 17 will be forced against the diaphragm 13 with sufficient pressure to rupture it and relieve the excess pressure within the tank 10. Since the diaphragm is ruptured by a sharp point at the desired pressure, the diaphragm may be made of any strong material, such as tempered glass.

In order to mount the plunger 16 in suitable relationship with respect to the diaphragm 13, a base plate 18 is provided having openings 19 (see Fig. 3) for bolting the base plate to the inside portion of a collar member 20 which is suitably attached to the inside of the transformer casing 10. The base plate is also provided with a bearing portion 21 having an opening 22 within which the plunger 16 is supported and longitudinally movable.

In order to hold the plunger 16 in a first position or in a position with the point 17 away from the diaphragm 13 as is illustrated in Figs. 1 to 6, I provide an arrangement including a shaft 23 which is rotatably mounted at its ends 24 and 25 in suitable holes in the base portion 21. In order to hold the plunger 16 in the position illustrated in Figs. 1 to 5, the plunger and shaft 23 are each provided with cooperating stops or surfaces. This may be accomplished in any suitable manner, such as by providing a cutout portion 26 on the plunger 16 and a cutout portion 27 on the shaft 23, the plunger and shaft being so situated with

respect to each other that relatively small surfaces or edges on the cutout portions 26 and 27 cooperate to hold the plunger 16 in its first position, as is illustrated clearly in Figs. 2 and 6. It will also be seen that shaft 23 extends transversely with respect to the axis of the plunger 16 so that a relatively slight rotatable movement of the shaft 23 will move the surface 27 out of contact with the edge 26 so that the plunger 16 will no longer be held in the position as illustrated in Figs. 1 to 6.

In order to bias the plunger 16 to a second or cutting position there is provided a biasing arrangement including a spring 30 which has one end supported by an end portion 31 of the base member 21, the other end being supported by a stud 32 near the point 17. It will be seen that when the plunger is in the position illustrated in Fig. 2 the spring 30 will be under compression. Thus, when the surface 27 moves away from the surface 26, the spring 30 will force the plunger 16 toward the diaphragm 13 to rupture it.

In order to support the shaft 23 in the position so as to hold the plunger 16 in its first position, I provide a second shaft 33 substantially parallel with the shaft 23, the connection between the shafts being made by an arm 34 which is rigidly attached at one end to the shaft 23. The opposite end 35 of the arm is held by an edge 36 of the shaft 33. The shaft 33 is mounted for limited rotatable movement in a portion 37 of the base member 21. It will be noted particularly that the shaft 33 has a relatively small surface which contacts the end 35 of the arm 34. This is accomplished by cutting a portion of the end of the shaft 33 so as to provide the half round portion 36. As will be seen clearly in Figs. 2 and 6, a very small rotation of the shaft 33 will move the half round portion 36 so that the end 35 of the arm 34 will be left unsupported. This will in turn allow the shaft 23 to move which will in turn allow the spring 30 to force the plunger 16 to its second position.

In order to accomplish the slight rotation of the shaft 33 so as to trigger the device, the opposite end 40 of the shaft 33 is attached to a longitudinally movable rod 41 which moves when the predetermined abnormal condition of pressure obtains. This may be accomplished in any suitable manner such as by connecting the rod 41 to a Sylphon bellows 42, the bellows being attached to the base member 21 at 43. A connection is made between the rod 41 and the shaft 33 through connector member 44. The connector member 44 is biased by a spring 45 so as to bias the shaft 33 for rotatable movement in a counterclockwise direction when looking at Fig. 2.

So that the bellows member 42 may be substantially unaffected by changes in temperature within the transformer casing 10, the bellows having a suitable opening 46 (see Fig. 3) is heated to expel the air. The bellows in this condition is also compressed so as to further accomplish the expelling of the air, and while in this condition the hole 46 is closed in any suitable manner, such as by placing a lump of solder 47 over the hole 46. In order to prevent collapse of the bellows, since it is partially evacuated, a suitable spring 48 (see Fig. 4) is placed inside, the spring being suitably calibrated so that it will allow the bellows to contract sufficiently upon a predetermined abnormal con-

dition of pressure obtaining within the tank enclosure 10.

Operation of my device is as follows. When a pressure of a predetermined amount obtains within the tank 10, the Sylphon bellows 42 will collapse, thus causing movement of the rod 41 toward the bellows. Through the link member 44 this will cause the shaft 33 to rotate in a clockwise direction (see Fig. 2) until the end 35 of the arm 34 is no longer supported by the end 36 of the shaft 33. Since the plunger 16 is biased to move toward the diaphragm 13, the pressure of the spring will now force the stop surface 27 by rotating the shaft 23 until the surface 27 is out of contact with the surface 26. The plunger 16 will then be free to move until a stop or nut 50 and washer 51 on an end of the plunger contact the space member 21, this position being illustrated in Fig. 7. The shaft 23 will rotate until the end 35 of the arm 34 contacts a stop member 52.

As will be seen in Fig. 6, the flat surface 27 of the shaft 33 is placed at a slight angle with respect to the flat surface 26 of the plunger 16 so that the point of contact 53 may be as close to the center line 54 of the shaft as is practical. With this construction it will only take a relatively small force between the end 35 of the arm 34 and the edge 36 of the shaft 33 so as to hold the arm 34 in the position illustrated in Fig. 6.

The device may be easily reset by removing the damaged diaphragm 13 and pushing the plunger 16 to its first position and resetting the stop surfaces. In order to adjust the predetermined abnormal pressure which will operate the device I provide an adjusting mechanism including a nut 55 on the end of the rod 41. By backing off the lock nut 56 and displacing the link 44 with respect to the rod 41 it will be seen that the predetermined pressure at which the device operates will be raised.

Although I have shown and described a particular embodiment of my invention, I do not desire to be limited to the particular embodiment described, and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

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

1. In a device for rupturing a frangible diaphragm, a plunger biased for movement from a first to a second position, means for holding said plunger in said first position including a rotatable shaft extending transversely of said plunger, said plunger and shaft having stops with relatively small engaging surfaces so that a slight movement of said shaft will release said plunger, an arm connected to said shaft, means for holding said arm against movement including a second shaft, and means for moving said second shaft upon the occurrence of a predetermined abnormal pressure so as to allow movement of said first shaft and disengagement of said stops.

2. In a device for rupturing a frangible diaphragm, a plunger biased for movement from a first to a second position, means for holding said plunger in said first position including a rotatable shaft extending transversely of said plunger, said plunger and said shaft having cutout portions presenting cooperating surfaces, an arm connected to said shaft, means for holding said arm against movement including a sec-

ond rotatable shaft substantially parallel with said first shaft, and means for rotating said second shaft upon the occurrence of a predetermined abnormal pressure so as to allow movement of said first shaft and disengagement of said cooperating surfaces.

3. In a device for rupturing a frangible diaphragm, a plunger biased for movement from a first to a second position, means for holding said plunger in said first position including a rotatable shaft extending transversely of said plunger, said plunger and said shaft having cutout portions, an arm connected to said shaft, means for holding said first shaft and arm against movement including a second rotatable shaft having an edge engaging an edge of said arm, and means for moving said second shaft upon the occurrence of a predetermined abnormal pressure so as to disengage said edges and allow movement of said plunger.

4. In a device for rupturing a frangible diaphragm, a plunger biased for movement from a first to a second position, means for holding said plunger in said first position including a rotatable shaft extending transversely of said plunger, said plunger and said shaft having cutout portions, said plunger contacting a radial surface of said shaft relatively close to the longitudinal axis of said shaft, an arm connected to said shaft, means for holding said first shaft and arm against movement including a second rotatable shaft having an edge engaging an edge of said arm, a pressure responsive means, and means for connecting said pressure responsive means to said second shaft including an adjustable means for regulating the pressure at which said second shaft will move out of engagement with said arm.