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J. B. MacNEILL ET AL
CIRCUIT INTERRUPTERS

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2 Sheets-Sheet 1

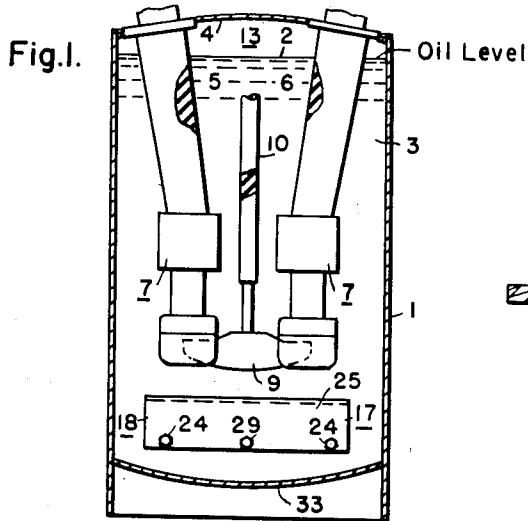


Fig. 5.

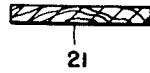
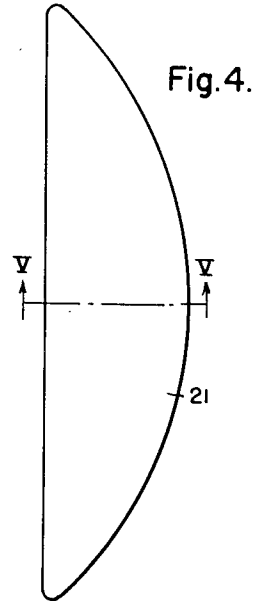
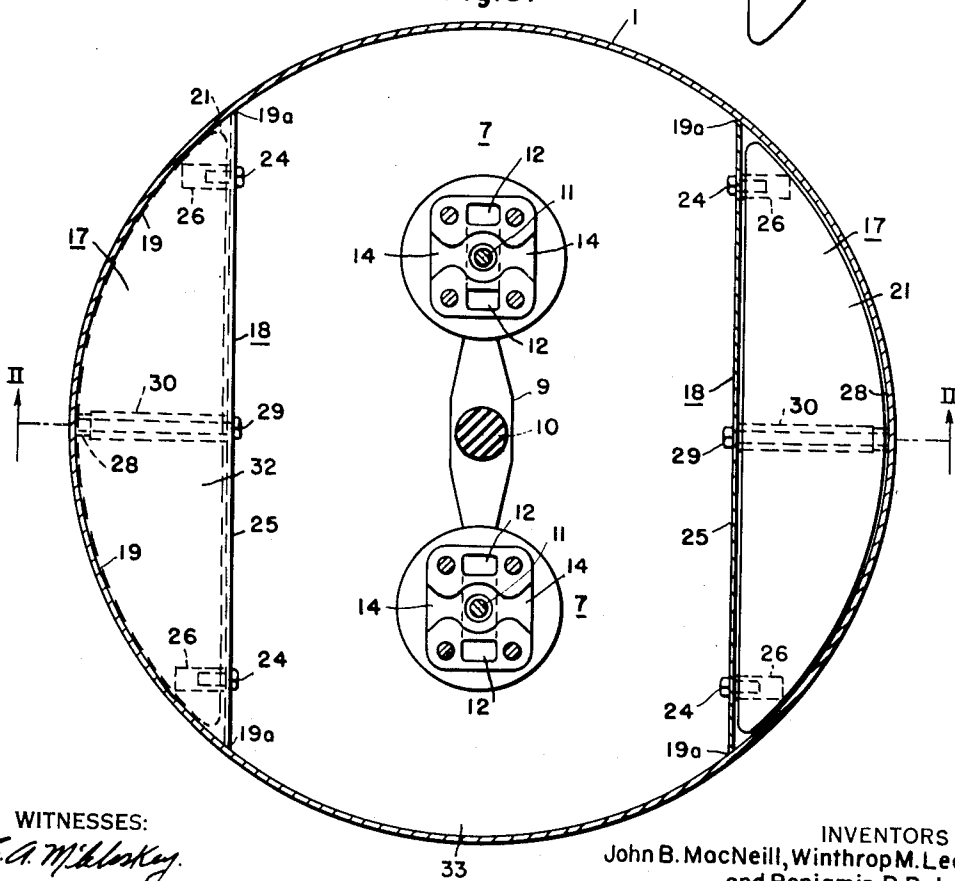


Fig. 3.



WITNESSES:

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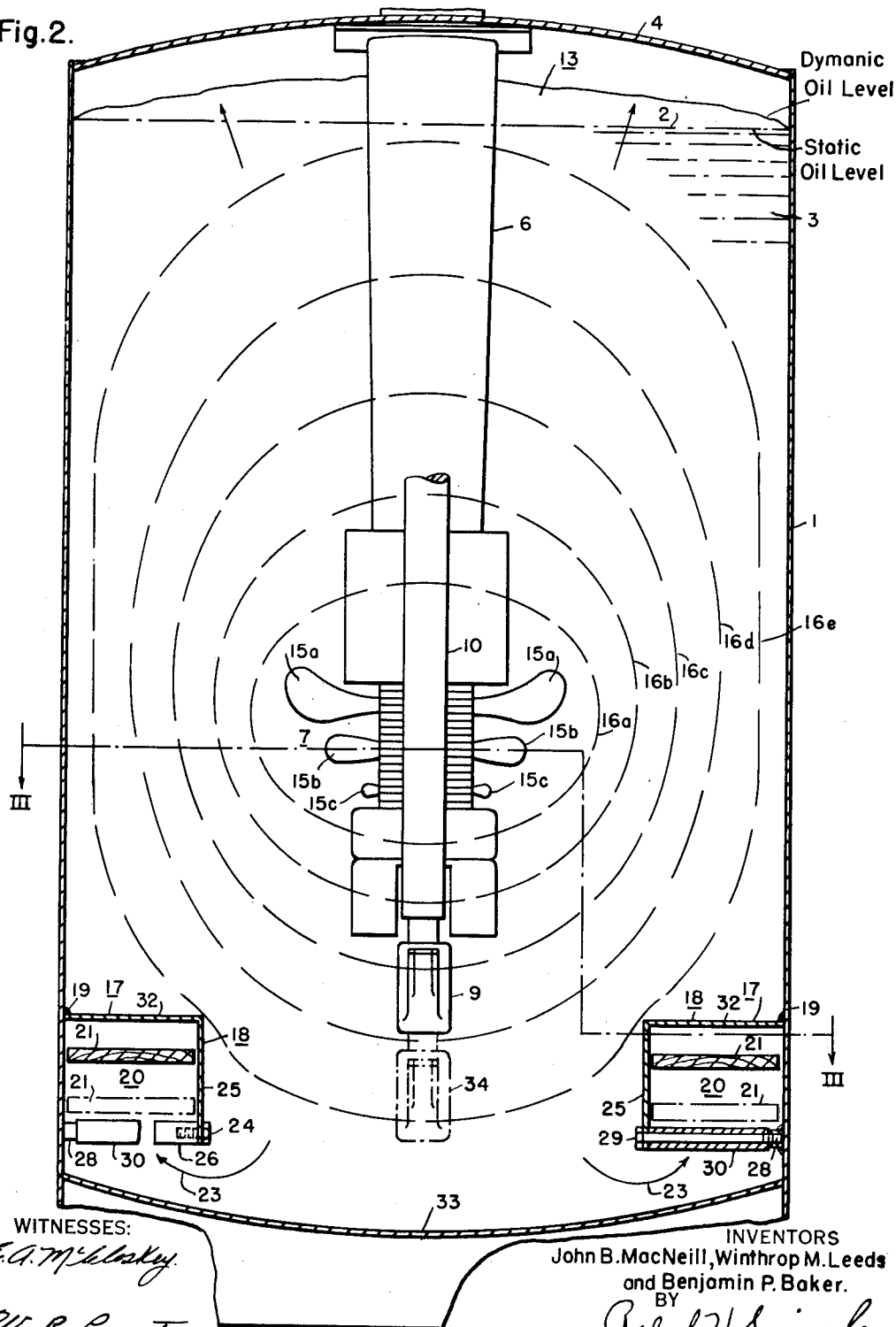
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Fig. 2.



WITNESSES:

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1

2,734,973

CIRCUIT INTERRUPTERS

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Application August 18, 1951, Serial No. 242,518

4 Claims. (Cl. 200—150)

This invention relates to circuit interrupters in general, and, more particularly, to shock-absorbing means for liquid break circuit interrupters of the tank type.

As the voltage and power requirements increase in long transmission lines, the energy which the tank-type circuit interrupter is caused to interrupt becomes such that high internal pressures within the tank are encountered. Thus, in heavy duty high-speed oil circuit breakers, the sudden release of arc energy in the interrupters causes a rapid generation of gas. This sudden creation of volume starts a shock wave which tries to force oil to move in all directions. That above the interrupters is free to move toward the top gas-filled portion of the breaker, and that below the interrupters tries to move downwardly but is restrained by the almost inelastic tank bottom. The oil above the interrupters, therefore, acts like a projectile, and the oil below the interrupters and also the tank respond similar to the recoil of a gun. The amount of travel is limited by the tank deflection. As a result of this deflection not being of an energy-absorbing character, the tank first moves down and then rebounds upwardly with such velocity and frequency that anchor bolts, bushings and connected bus work are sometimes damaged.

It is a general object of our invention to provide an improved energy-absorbing means to absorb the pressure shock wave which travels through the oil during interruption without damage to the tank or connected equipment.

A further object of our invention is to so dispose such shock-absorbing equipment that the overall dimensions of the tank will not be increased, and the shock-absorbing equipment is readily exposed for inspection and servicing if needed.

Another object is to provide means for preventing the gas cushion within the shock-absorbing chambers from being absorbed by the oil, or other liquid, within the circuit interrupting tank.

Still a further object is to so improvise and to so position such shock-absorbing equipment as not to interfere with normal operating movement of the conducting bridging member of the circuit interrupter when the latter moves to its fully open circuit disconnected position.

Further objects and advantages will readily become apparent upon reading the following specification taken in conjunction with the drawings, in which:

Figure 1 is a side elevational view, partially in vertical section, of a liquid break tank-type circuit interrupter embodying our invention with the contact structure being shown in the closed circuit position;

Fig. 2 is an enlarged vertical sectional view of the circuit interrupter of Fig. 1, taken substantially along the line II—II of Fig. 3, the contact structure being indicated in the partially open circuit position, and the fully open disconnecting position of the crossbar being indicated in dotted lines;

Fig. 3 is a broken plan view in section taken along the line III—III of Fig. 2, looking in the direction of the arrows;

Fig. 4 is a plan view of the diaphragm, or board, used

2

in preventing absorption of the gas within the gas-absorbing chambers; and

Fig. 5 is a sectional view taken along the line V—V of the diaphragm shown in Fig. 4.

Referring to the drawings, and more particularly to Fig. 1 thereof, the reference numeral 1 designates a tank filled to the level 2 with a suitable arc-extinguishing liquid 3, such as circuit breaker oil.

Depending from the cover 4 of the tank 1 is a pair of terminal bushings 5, 6, diagrammatically represented, to the lower ends of which is secured a pair of identical arc-extinguishing units 7.

Electrically interconnecting the interrupting units 7 is a conducting crossbar 9 vertically actuated, in a reciprocal manner, by an insulating lift rod 10. The lift rod 10 may be operated by any suitable mechanism of conventional type, which forms no part of our invention.

The specific contact structure provided in each arc-extinguishing unit 7 is not important for an understanding of our invention. It is merely necessary to know that the contact structure within the extinguishing unit 7 is separated to establish one or more arcs and to generate pressure within the oil. Reference may be had to United States Patent 2,462,733, issued February 22, 1949, to Gilbert J. Easley, and assigned to the assignee of the instant application, for a detailed description of a sequential contact break arrangement in which a pressure-generating arc and an interrupting arc are established in each interrupting unit 7.

Fig. 3, which is a sectional view taken through the interrupting units 7 indicates the lower movable interrupting contact 11, which corresponds to the contact 26 of the aforesaid patent. This contact 11 moves downwardly with the crossbar 9 during the initial portion of the opening operation separating from an intermediate contact, not shown, to establish an interrupting arc. As set out in the aforesaid patent, a pressure-generating arc may also be established by downward movement of crossbar 9.

The pressure-generating arc gasifies some of the oil within the enclosed pressure-generating chamber and forces oil to flow downwardly in two vertical flow passages 12 (analogous to the passages 21 of the aforesaid patent), as clearly shown in Fig. 3 of the drawings.

Suitable plate structure, described in the aforesaid patent, is provided including three pairs of vent passages 14, which permit the venting of the arc gases during the opening operation. The gas bubbles 15a, 15b, 15c indicate the exhausting of high pressure gas from the vent passages 14 during the interrupting operation. The formation of the gas bubbles 15a, 15b, 15c occurring during medium current interruption, together with actuation of the over-pressure exhaust valve, not shown, which may be disposed at the upper end of the extinguishing unit 7 during high current interruption, all result in sending out a shock pressure wave in all directions, as indicated somewhat diagrammatically in Fig. 2. The dash lines 16a, 16b, 16c, 16d and 16e denote successive positions of the shock wave during an interrupting operation.

If suitable absorbing equipment is not provided to relieve the shock upon the tank, as mentioned previously, damage may result to the anchor bolts, bushings and connected bus work associated with the interrupter.

We have discovered that if two chord-like gas cells 17 are provided adjacent the lower end of the tank 1, between which the crossbar 9 may move, the arc energy may be absorbed and the possibility of damage to the interrupter will be completely eliminated.

Referring more specifically to Figs. 2 and 3, each gas cell 17 includes an angle member 18, preferably of steel, which is welded, as at 19, along its longitudinal length, and at 19a to the vertical sides of the tank 1.

Thus, during the filling of the tank 1 with oil, gas will be trapped in each gas cell 17. This gas will be slightly compressed in the region 20 by the head of the oil between the gas cell 17 and the upper surface level 2 of the oil. When oil is exposed to air, it tends to absorb a certain amount of the air, and the amount absorbed is a function of the pressure. Therefore, if the air in the gas cell 17 is exposed to the oil at a pressure corresponding to one atmosphere plus the head of oil above it, and the same oil is exposed to the atmosphere at its top surface 2, there is a tendency for the oil to remove the air from the gas cell 17 and transfer it to the top where it is liberated to the atmosphere in the region 13. This process is accelerated by the thermal cycles normally experienced by a circuit breaker, which is exposed to weather changes and electrical load variations. Gas is absorbed as the temperature falls and given up by the oil as the temperature rises. In order to overcome this limitation, we reduce the amount of oil surface exposed to the air in the gas cells by providing a diaphragm which may take the form of a float 21, such as a varnished white pine board 21 (Fig. 4), which floats on the surface of the oil within each gas cell 17.

In the static or quiescent closed circuit position, or in the fully open circuit position of the interrupter, the diaphragm, or board, 21 will be disposed in the position indicated by the dotted lines in Fig. 2. During the opening operation, as indicated in Fig. 2, the shock pressure wave passing through the oil 3 will compress the gas within region 20 of each gas cell 17 so that the board or diaphragm 21 will rise to a position such as that shown in full lines in Fig. 2. The oil will enter the gas cell 17 as indicated by the arrows 23.

To prevent the board or diaphragm 21 from falling out of the gas 17 when the tank 1 is empty, we provide retaining means which may consist of a pair of bolts 24, which pass through the ends of each vertical section 25 of each gas cell 17. The bolts 24 have elongated nuts 26, which form stops for the ends of the board 21. Moreover, an apertured lug 28 is welded to the inside wall of the tank 1, as indicated in Fig. 3. A bolt 29 passes through the center of the vertical section 25 of each gas cell 17 and is threadedly secured to each lug 28. Preferably, a tubular spacer 30 is provided of substantially the same external diameter as the elongated nuts 26. Consequently, each board 21 has three stops which determine its lowermost position. When it is desired to remove the diaphragm 21, the bolts 24, 29 may be removed so as to permit removal of the nuts 26 and the spacer 30. The diaphragm 21 may then be removed.

With an application of our invention, the external demonstration even when interrupting short circuits equivalent to 10,000,000 kva. on a three-phase basis, is almost negligible.

From the foregoing description, it will be apparent that we have provided a pair of compressible volumes 20 suitably located in the vicinity of the source of gas generation, permitting the oil surrounding the growing gas bubbles to move in all directions with equal ease. The pressure shock wave is thus absorbed and deflected to prevent excessive applications of pressures to any given area of the tank 1. We have shown an application of our invention where the compressible volumes 20 are produced by using two inverted air cells 17 near the bottom of the tank 1. When the breaker interrupts high current, as indicated in Fig. 2, in effect, an explosion occurs in the region of the interrupters 7. The shock wave is produced and the oil starts moving in all directions. Portions of the shock wave strike the top 32 and the sides 25 of the air cells 17 in an out-of-phase relation with that which hits the bottom 33 of the tank 1. Also, oil is permitted to move down as well as up with little restraining action, in that it can flow freely into the air cells 17, compressing the gas as indicated by arrows 23. Since this area and volume are considerable, the motion of the

oil against the rising pressure of the compressed gas 20 within each air cell 17 absorbs a portion of the energy, and slowly returns a portion of it after the interruption is over.

From the foregoing description, it will be apparent that we have provided an improved pressure shock-absorbing means including the two gas cells 17 disposed at opposite sides of the crossbar 9. It will be noted that when the crossbar 9 is in its fully disconnected position, as indicated by the dotted lines 34 of Fig. 2, there is considerable clearance between the crossbar 9 and the side walls 25 of each gas cell 17. Moreover, it will be observed that the vertical height of the tank 1 is not increased by an application of our invention, since the crossbar 9 moves between the gas cells 17.

We have also disclosed the use of a diaphragm, to prevent absorption of the gas within each gas cell 17 by the oil 3. In addition, we have disclosed removable stops 26, 30 for the diaphragm 21 so as to conveniently permit its removal, and yet to serve as its lowermost limiting position when the tank 1 is empty.

Although we have shown and described a specific structure, it is to be clearly understood that the same was merely for the purpose of description, and that changes and modifications may readily be made therein by those skilled in the art without departing from the spirit and scope of the appended claims.

We claim as our invention:

1. A circuit interrupter including a tank containing liquid, means for establishing an arc within the tank to generate pressure therein, a gas cell disposed within the tank below the liquid level trapping gas for absorbing the shock pressure wave during circuit interruption, the liquid rising somewhat within the gas cell during circuit interruption, and a diaphragm on the surface of the liquid within the gas cell to prevent the gradual absorption of the gas by the liquid.

2. A circuit interrupter including a tank containing liquid, means for establishing an arc within the tank to generate pressure therein, a gas cell disposed within the tank below the liquid level trapping gas for absorbing the shock pressure wave during circuit interruption, the liquid rising somewhat within the gas cell during circuit interruption, and movable means positioned between the liquid and said entrapped gas to prevent the gradual absorption of the gas within the gas cell by the liquid.

3. A circuit interrupter including a tank containing liquid, means for establishing an arc within the tank to generate pressure therein, a gas cell disposed adjacent the bottom of the tank below the liquid level trapping gas for absorbing the shock pressure wave during circuit interruption, the liquid rising somewhat within the gas cell during circuit interruption, and a floating member on the surface of the liquid within said cell to prevent the gradual absorption of the gas by the liquid.

4. A circuit interrupter including a tank containing liquid, means for establishing an arc within the tank to generate pressure therein, a gas cell disposed within the tank below the liquid level trapping gas for absorbing the shock pressure wave during circuit interruption, the liquid rising somewhat within the gas cell during circuit interruption, and a wooden diaphragm on the surface of the liquid within the gas cell to prevent the gradual absorption of the gas by the liquid.

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