HZ-E High Voltage Bridge Cable Fault Locator
User Manual

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Application of High Voltage Bridge in Cable Fault Location

I. Summary

This paper briefly introduces the principle and application of high voltage bridge, and introduces the experience of using the cable main insulation and high voltage cable metal sheath fault location.

Warning

1. When testing, "high voltage input" "high voltage output A" "high voltage output B" are in a high voltage state, and they are strictly prohibited personnel touch (including high voltage test connection).
2. Because the inside of bridge is under the high voltage situation when using HZ-E. So please check the box and make sure it is in good condition before use every times. If the box is damaged or crack, please stop using.
3. It is strictly prohibited to plug all the wiring when power on. Removing the wiring must be confirmed in a fully discharged state.
4. The instrument can withstand the input voltage: $\leq 30$KV; input current: $\leq 50$mA;
5. Because the bridge is used to test the cable's small resistance, so the terminal short contact resistance must be small, otherwise it will increase the test error or cause the incorrect test results.
Overview

Power supply system always think that the cable fault location is more difficult. As the progress of the instrument, cable fault location become more convenient. In practice, choosing a reasonable instrument and experience is still important.

Typically, the power cable fault location is carried out in four steps

1. judge the type of fault
2. select the appropriate method and the corresponding equipment
3. rough measurement pinpoint
4. precise pinpoint

There are two kinds of methods: bridge method and wave reflection method. The wave reflection locator is more popular. But there are several cable failure is difficult to find with wave reflection method: For example, high-voltage cable jacket insulation defects, PVC cables, short cables, some high resistance damp failure.

The use of fault wire on both sides of the cable core resistance and proportional resistance constitute Murray bridge, is the traditional, classic cable fault location method, its application is almost synchronized with the use of cable, a hundred years of history. Positioning bridge equipment is low prices and simple operation, China has been widely used in the past. At present, a large number of applications of cross-linked polyethylene cable, after the breakdown, it is difficult to form a conductive area, breakdown point resistance is high, and even high voltage, flashover type breakdown. In the country to maintain the largest QF2-type bridge, the rated test voltage is only 500V, can not be high resistance fault location. And because of advances in electronic technology, wave reflection method has been popularized, so that the application of bridge method is gradually reduced, not known for new cable users, so the bridge method is almost forgotten.

HZ-E cable fault test bridge is to solve the power of the bridge to the high sensitivity of the interference problem. Measuring cable is dedicated high-voltage cable, the measurement principle is the method of four-terminal resistance, positioning accuracy of the bridge placed on the high side, and the operation of safe grounding. Completely solve the bridge method for high resistance positioning limitations, so that the bridge
without dead zone, accurate and convenient features to play. This paper summarizes some of the applications of HZ-E cable fault test bridge positioning cable insulation and sheath defects experience for the majority of peer reference.

II. the principle and equipment

The bridge method is based on the core (or shield) resistance is proportional to the length. Figure 1 is a typical usage:

Sample is the three-core steel armored power cable, length L, B-phase core of the steel strip in the L1 breakdown. Supply the A-phase core as the auxiliary line. Use low resistance wire short-circuit N, Y ends of the core. L1 section cable core resistance for the R1, L2 cable and A-phase cable core resistance R2. And the positioning bridge constitutes a Murray bridge circuit. The circuit principle shown in Figure 2,

Figure 2: Circuit diagram of bridge positioning

In the figure, r is the proportional potentiometer r, r1 + r2 = r
After balancing:

\[
\frac{r_1}{r_2} = \frac{R_1}{R_2} = \frac{L_1 + L_2}{L_1 + L_2} \]

The proportional potentiometer is adjusted by 10 turns, and the resistance ratio

\[
\frac{L_1}{2L} = \frac{r_1}{r_2} = \phi \%
\]

P can be read by the scale disc, so:

\[
L_1 = 2 \cdot \phi \% \cdot L_2
\]

Thus, as long as the bridge has a certain sensitivity and can balance, electricity Bridge method is simple and accurate.

Figure 3 shows the HZ-E cable fault test bridge

Technical indicators are as follows:
- the maximum input voltage of 30KV
- Short circuit current 50mA
- positioning ratio accuracy ± (0.2% · L + 1) m
- Weight 5Kg
- Volume 327 × 282 × 218
- Work power: power frequency 220V ± 10%

III. the measurement steps

The actual wiring is shown in Figure 4:
Figure 4: Actual wiring of the bridge

1. With a multimeter or megger or other withstand voltage equipment to confirm the cable breakdown state, record the core of the insulation resistance or breakdown voltage and other values.

2. Record the length of cable to be measured, model, cross-section and other parameters, to check the underground cable along the cable laying path, leaving one person in the remote monitoring in the remote short-circuit fault cable and auxiliary cable outlet terminals, so as not to hurt due to the high voltage.

3. Wiring. According to the above diagram reliable connection test line, high-voltage output A-side (black clip) reliable connection in the fault cable core, high-voltage output B-side (red clip) reliable auxiliary cable core. High voltage connections are overhead and away from testers.

4. Power AC220V, turn on the power switch, power indicator light.

5. Bridge zero. Rotate the zero button (if the pointer is left, clockwise, the pointer is right, counterclockwise). Let the zero indication refer to zero.

6. Boost high voltage. "DC high voltage source" rose to the appropriate voltage. Clockwise slowly rotating the high pressure adjustment knob, observe the "DC high voltage source" voltmeter and "HZ-E cable fault test high voltage bridge" ammeter, until the ammeter more than 5mA. If the current is unstable, can continue to raise the voltage, keep a period of time to form a stable arc or conductive area, so that the test process current stability. ("DC high voltage source" detailed operation with reference to its instructions)

7. Balance adjustment. Turn the sensitivity button clockwise to gradually
increase the sensitivity to the galvanometer has a significant deflection but not excessive rotation of the dial, so that the galvanometer gauge zero (if the pointer left, clockwise rotation, the pointer is right, counterclockwise rotation).
Gradually increase the sensitivity, so that the pointer deflection on the %o knob can be sensitive to minor adjustments.
8, write down at this time %o dial reading P1 %o, should be P1 ≤ 500.
9, drop the voltage, turn off the power, discharge, and confirmed by another person. Will measure the clamp exchange position, (return the ground clip does not have to replace the position). Repeat steps (4) through (9) to get another reading P2, which should have P1 + P2 = 1000. The process can avoid the readings and errors in the use of the pliers, P1 + P2 does not have to be completely equal to 1000. Between 990 and 1010 is normal. In the high-voltage closing, no current output, the current sensitivity file repeat zero can get a more accurate ratio.
10, calculation. Location of the point of failure
\[ X = 2 \times L \times P1 \% \]
Special attention should be paid to "2" in the formula because the auxiliary cable doubles the cable involved in the calculation.

V, the use of experience
In addition to the typical usage, the bridge has other uses:
1, multi-point defect location
Here, it is necessary to distinguish whether the defect point is a low resistance point or a breakdown point. The positioning ratio points is point to the center of gravity of the multiple leakage currents, so theoretically the bridge method cannot locate multiple fault points. the fault over-voltage surge occasionally can cause multiple weaknesses of the cable breakdown on live cable, resulting in multi-point breakdown. But the breakdown of the situation is very difficult, consistent with the DC voltage, the weakest point of the first breakdown, through the vast majority of current, according to the proportion of the location is very close to the point, remove the point, a little. The actual situation is rarely that more than two points flow through the larger current at the same time, it can be said that the impact of multi-point penetration led to the probability of not allowed, so do not worry about the bridge is difficult to locate multi-click wear.
No breakdown of the low resistance point, with the voltage rise, most of the conversion into the breakdown point.

2, intermittent puncture positioning

The difference from the previous example is that the current should flow back through the other wire to the bridge, so that the other core of the intervening breakdown should be connected to the bridge. In practice may be: inter-phase breakdown and phase with the shield breakdown coexistence, may wish to other core and shield are grounded, the results are mostly: phase breakdown and phase with the shield breakdown is the same point.

3, single-core cable insulation defect point positioning

Single-core cable is usually 35KV and above the high-voltage cable, positioning wiring as follows:

The biggest difference with the multi-core cable is that the external interference affects the possibility of bridge balance increases, shorted M, X and N, Y point of the metal jacket is very effective. High-voltage cable spacing is large, it should be choose large length short circuit wiring.

4, the positioning of overhead cables

Overhead cable is usually a single core, only the insulation layer; positioning method and the same as the fourth.

5, high voltage cable sheath defect point positioning

High-voltage bridge is the most effective way to locate the cable sheath defect, wiring as shown below.
V. positioning examples

1. 110KV high-voltage cable outer jacket defect point:
High-voltage cable sheaths are scratched during traction. The following figure shows one of the damage points, positioning excavation, plus DC voltage, damage at the creepage and smoke.

2. Polyvinyl chloride (PVC) Insulation cable positioning:
Polyvinyl chloride insulation medium loss is great, the attenuation of the high-frequency pulse is obvious, often do not see the reflected wave. Bridge method positioning is preferred. The following figure for a case of polyvinyl chloride (PVC) insulation cable breakdown point:
VI conclusion

Compared with the wave reflection method, HZ-E bridge method locator is particularly suitable for:

1. After the laying of the cable after the high resistance to breakdown point, in particular, is difficult to burn low resistance linear high resistance breakdown point, such as cable intermediate connector, the linear high resistance breakdown.

2. The bridge method only requires uniformity of the wire core resistance. And poor wave characteristics of cable, such as dielectric loss of PVC power Cable; no good conductor back to the cable, high-voltage cable metal sheath defect point positioning, only steel armored cable. These cable fault just choose the HZ-E high voltage bridge method to check.

3. Not yet breakdown, but the resistance of low defects, such as the use of megger to find the cable resistance is low, but the operating voltage does not breakdown the insulation point.