that an over current relay having a current setting of 150% is connected to a supply circuit through a CT of 500/5A. The rated secondary current of CT is 5 A and, therefore, the pick-up value will be 1.5 x 5i.e., 7.5 A. It means that with above current setting, the relay will actually operate for a relay current equal to or greater than 7.5 A.

Similarly for current settings of 50, 100 and 200% the relay will operate for relay currents of 2.5A, 5 A and 10 A respectively. Adjustment of current setting is made by inserting a pin between the spring loaded jaws of the bridge socket at the tap value required. When the pin is withdrawn for the purpose of changing the setting value while the relay in service, the relay automatically adopts higher setting, thus the CT's secondary is not open-circuited.

The disc spindle carries a moving contact which bridges two fixed contacts (trip circuit contacts) when the disc has rotated through a preset angle. The angle can be set to any value between 0° and 360° and there by giving desired time setting. This adjustment is known as time-setting multiplier. Time multiplier setting is generally in the form of an adjustable back-stop which decides the arc length through which the disc travels, by reducing the length of travel, the operating time is reduced.

The time setting multiplier is calibrated from 0 to 1 in steps of 0.05. These figures do not represent the actual operating times but are multipliers to be used to convert the time known from the relay name plate curve (time-PSM curve) into the actual operating time. Thus if time setting is 0.2 and the operating time obtained from the time-PSM curve of the relay is 5 seconds, then actual operating time of the relay will be equal to 0.2 x 5 i.e., 1 second.

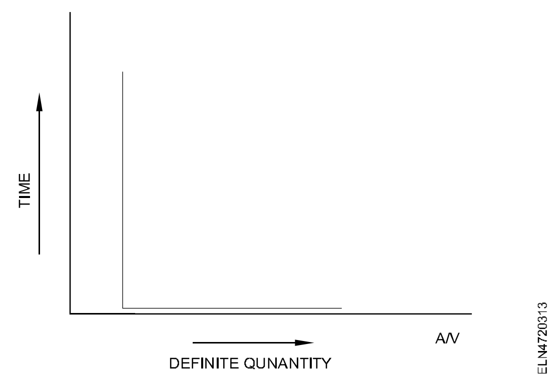
Since the time required to rotate the disc through a preset angle depends upon the torque which varies as the current in the primary circuit, therefore, more the torque lesser will be the time required. So the relay has inverse-time characteristic.

Relay Time setting characteristics

1 Instantaneous over current/voltage relay

Definite current/voltage (over or under) relay operate instantaneously when the fault quantity reaches a predetermined value. (Fig 3)

Fig 3

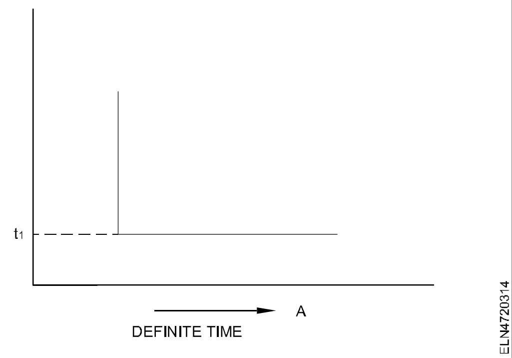


- Operates in a definite time when fault quantity exceeds its pick-up valve.
- Its operation criteria is only fault quantity magnitude
- Operating time is constant
- No intentional time delay
- These are varies with position of the fault occurred because of the difference in impedance between the fault and the source
- It can operates in 0.1s or less.

2 Definite time

Two conditions must be satisfied on the fault quantity continued to be present up to the time setting of the relay. (Fig 4)

Fig 4

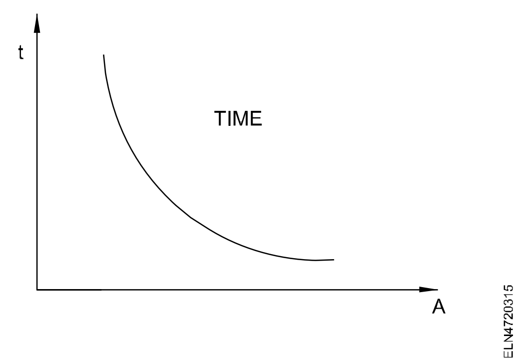


- Its operating time is constant
- Its operation is independent of the magnitude of the fault quantity
- It has time dial settings; Time delay can be varied
- Tripping time independent on fault location.

3 Inverse time

Operating time is inversely changed fault quantity. So, high the fault quantity will operate relay faster than lower ones (Fig 5). There are few more settings also in practice, They are;

Fig 5



- Standard inverse
- Very inverse
- Extremely inverse

Discrimination by both time and fault quantity, the relay operation time is inversely proportional to the fault quantity.

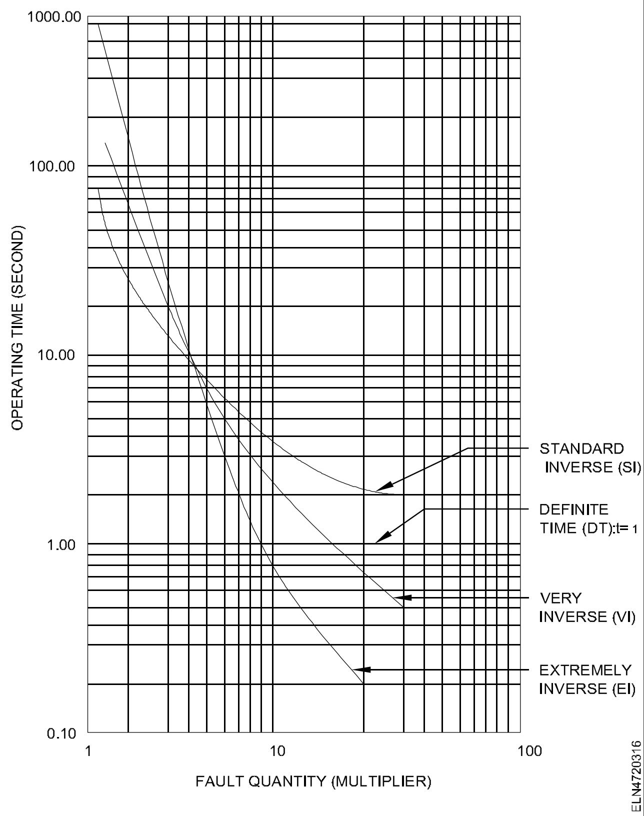
Inverse time relays also referred as Inverse Definite Minimum Time (IDMT) relays.

The operating time of relay can be moved up (made slower) by adjusting the time dial setting. The lowest time dial setting (fastest operating time) is generally 0.5 seconds and the slowest is 10s.

Silent features of inverse time settings

- Operates when fault quantity exceeds its pick-up value.
- Operating time depends on the magnitude of the fault quantity
- It gives inverse time current characteristics at lower values of fault quantity and definite time characteristics at higher values.
- An inverse characteristics is obtained if the value of plug setting multiplier is below 10, for values between 10 and 20 characteristics tends towards definite time characteristics. Fig 6 shows the different inverse types. Based on the inversness it has three different types of curves shown in Fig 6.

Fig 6



Normal Inverse Characteristics

The accuracy of the operating time may range from few percentage of the nominal operating time. The uncertainty of the operating time and the receiving operating time may require a grading margin of less than one seconds.

Normal inverse time over current relay is relatively small change in time/unit of change of current

Very inverse time characteristics

- Gives more inverse characteristics than that of IDMT
- Used when there is a reduction in fault quantity, as the distance from source increases
- Effective with ground faults because of their steep characteristics
- Suitable where the fault distance from the power source increase
- Particularly suitable if the short circuit fault current drops rapidly with the distance from the substation
- The grading margin may be reduced to very low time (0.1 second) in this characteristics
- Used when fault quantity is dependent on fault location

Extremely inverse time characteristics

- It has more inverse characteristics than that of IDMT and very inverse characteristics
- Suitable for protection against over heating
- Operative time approximately inversely proportional to the square of the fault quantity
- It makes possible to use short time delay in spite of high switching in current
- Used when fault quantity is dependent on fault location
- Suitable for protection of feeders, with peak current on switching (refrigerators, pumps water heaters etc) and also for alternator transformers and expensive cables.

Long time inverse characteristics

This characteristics is used as back up earth fault protection as the time inversely proportional to the intensity of fault quantity.

Over voltage and under voltage relays

This electromagnetic relays are working on the same principle of induction type disc type relays. The sensor used in this relay input is from PT (potential transformer) where output generally kept on 110v AC.

When the fault occurs the PT output produces a voltage which in turn energise the disc mechanism to rotate. As the fault continue to represent; and the trip time settled, the relay disc rotates and make the trip coil to activate in the trip mechanism in the breakers. The tripping time settled as per the characteristics selected. The pick up voltage has to be verified with the plug setting value of fault voltage which can be selected in different fault voltages in both over/ under voltage relay. Time Multiplier Setting (TMS) shorten the trip time if necessary on the fault quantity is more as the case may be.

Time multiplier setting

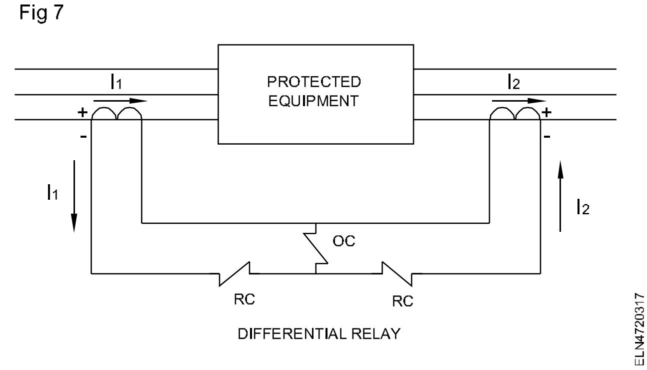
This setting is helps the relay to shorten the time selected without change of any other settings made in the relay. Time multiplier helps the relay to activate fast the breaker in case the fault quantity is more than 50% of the fault quantity selected by the tap setting.

Differential protection relay

Differential protection is a very reliable method of protecting generators, transformers, busbar and transmission lines from the effects of internal faults. In normal operating conditions the current through the CTs is the same. So the relay sense no differential current. This is also the case for external faults. Differential protection can be used for protecting generators from faults to ground. Differential protection of busbars in substations uses one CT for each incoming line. All incoming currents are added up and compared to the sum of all out going currents.

General schematic diagram of differential protection relay is in Fig 7.

Fig 7

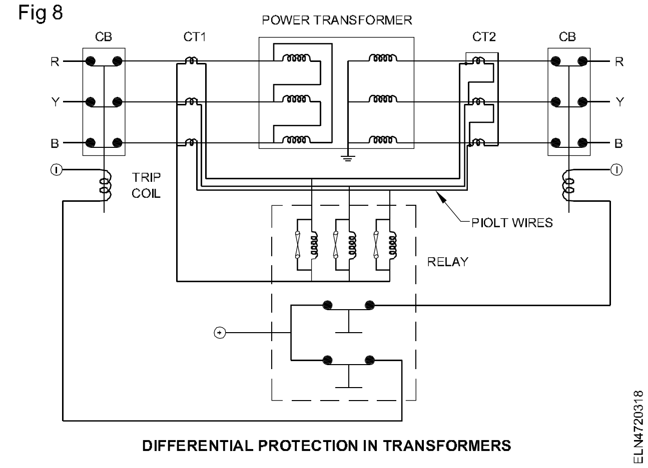


The installation of differential relay for protection of power transformers used in transmission line is in Fig 8.

Distance relays / Admittance relay

The impedance of a transmission line is proportional to its length, for distance measurement it is appropriate to use a relay capable of measuring the impedance of a line up to a predetermined point (the reach point) Such a relay is described as a distance relay and is designed to operate only for faults occurring between the relay location and the selected reach point thus giving discrimination for faults that may occur in different line sections

Fig 8



Reactance relays (or) Shaded pole type non directional relay

The reactance relay is a straight line characteristic that responds only to the reactance (X_L) of the protected line . It is non directional and is used to supplement the admittance relay as a tripping relay to make the overall protection independent of resistance. It is particularly useful on short lines where the fault arc resistance is the same order of magnitude as the line length.

The relay serves an important part in switchgear protection. The electromagnetic relay is the first generation of protective relays and it has many moving parts and working in the principles of induction. Electromagnetic relay can carry one function ie., over current, over voltage or under voltage at a time. This draw back is overcome by the use of static or digital relay which can use for multi function, as well as more accurate than electromagnetic relays.