## Chapter 4

## REPRESENTATION OF THE SUBSTATION OPERATORS BY THE TELEMETERING AND SUPERVISORY CONTROL SYSTEM.

Although the substation operators can do the work in the power transmission system rather completely, the ability limitation and error of the human being may cause some delay, confusion and damage in the system.One example of this condition may be illustrated as follow.

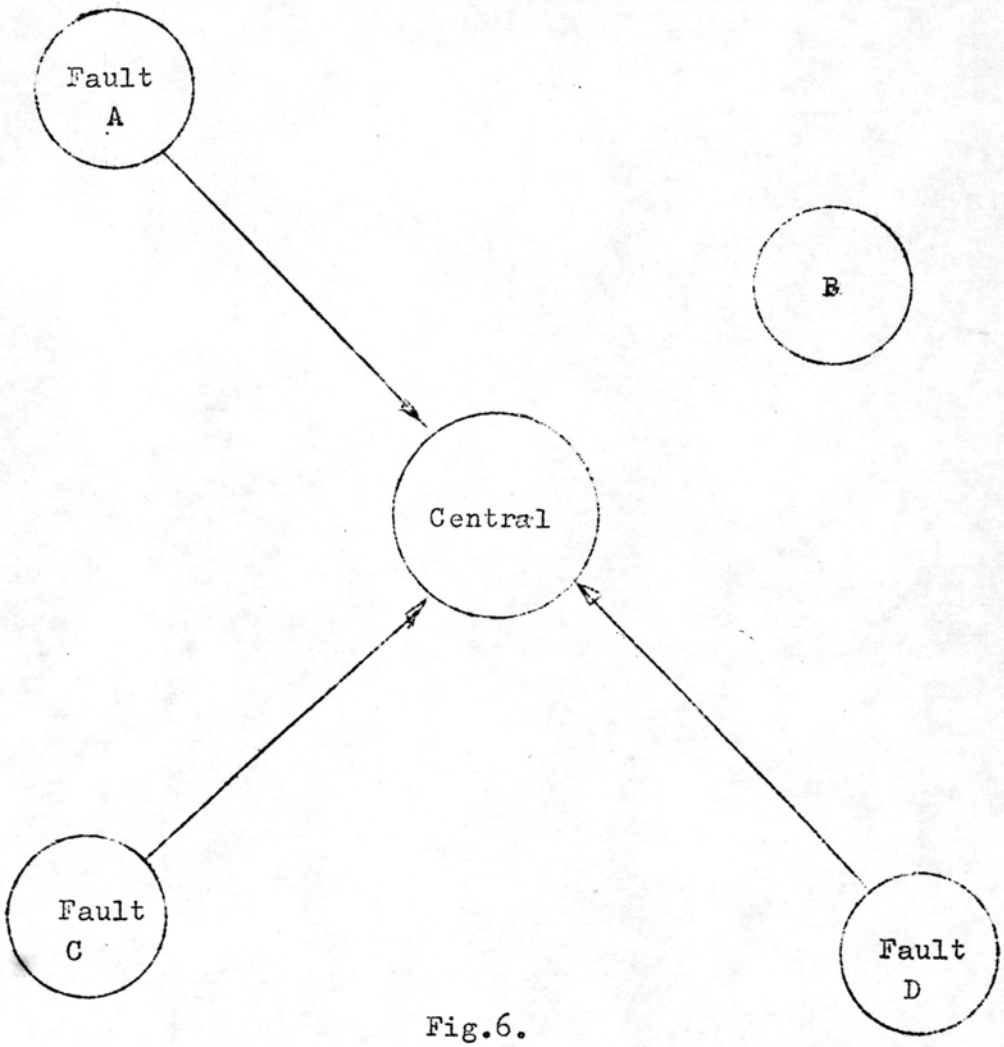


Fig.6.

The faults occur simultaneously at three substations.

In Fig 6. is the case of faults occur instanteneously at three substations, A, B, and C, the operators at these substations must spend the time in checking the faults' details before reporting to the load dispatching center. At present, the VHF links is the only mean of communication system between substations and the load dispatching center, so the reporting of faults must be done in sequence, A first and then B and C or B first and so on while the first substation is reporting it's faults, the remainders(other 2 substations) have to wait, if the faults occur severely during the waiting time, the damage of the high voltage equipments is also severe.

In order to get rid of.

1. Time in load reporting.
2. Confusion and trouble in switching operation.
3. Damage due to the faults.
4. The delay of old fashion VHF links.

The new automatic control system is introduced. the one that satisfies the previous objects is the telemetering and supervisory control system. The most important function of this system is the protective relaying. Relaying system must have an extremely high order of availability dependability, and security.

An occasional failure or extra pulse in a telemetering or teletype cirurit is not unespected and is not considered serious. In a relaying application, failure to operate when being called upon or to receive response to a noise generated signal can cause a serious interruption to the power system.

Application of supervisory control system for protective relaying can be divided into two categories:-

1) Transformer and circuit breaker failure protection: this application is termed "direct transfer tripping" the media systems such as pilot wire, power line carrier, VHF, UHF and Microwave function as the communication link to extend the relay tripping circuits to remote circuit breaker locations.

2) Transmission line Protection: the media described previously function as the communication medium for pilot and transfer-trip pilot relaying schemes. The transfer trip pilot schemes include underreaching, permissive-underreaching and permissive overreaching protection. pilot relaying schemes are directional comparison and phase comparison.

It is the transformer and circuit breaker failure applications (direct transfer trip) which have the greatest

difficulty in meeting the relay security requirements. Direct transfer tripping cannot have fault-detector supervision and the security against undesired tripping rests solely with the media system. Tripping with line protective schemes can be made dependent on line relay and fault - detector relay operation.

## 4.1 Transformer and Ciruit Breaker Failure Protection.

Direct transfer tripping over media systems has been used extensively for transformer protection where high-voltage breakers have been omitted or for breaker backup protection where system arrangement places a backup brecker at a remote location. The operation of the media system for remote clearing is described as follows.

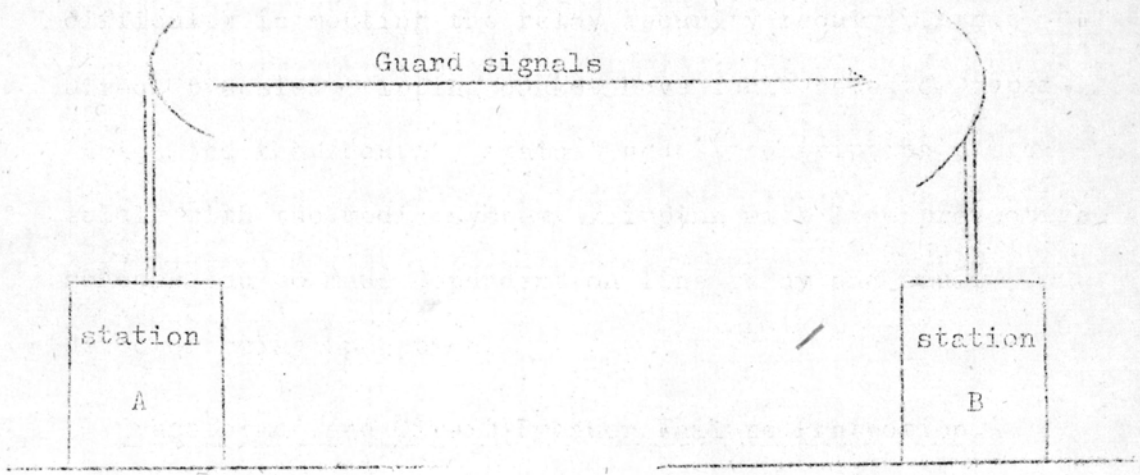


Fig 7

Normal condition of direct transfer tripping.

At normal conditions Fig 7, guard signals are transmitted continuously. Receipt of the guard signal by the receiver produces blocking of the breaker trip circuit at station B. At the same time, the guard signals provide continuous monitoring of the communication system.

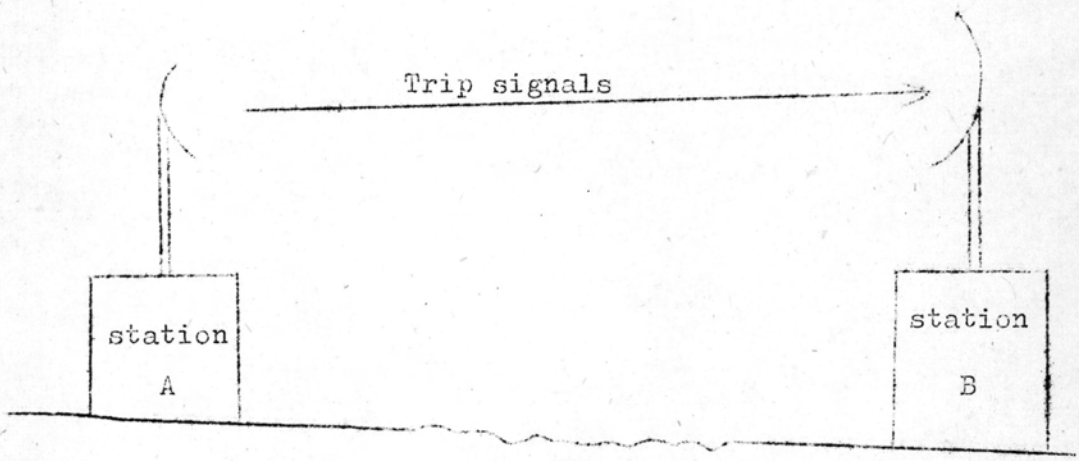


Fig 8

Fault Condition of direct transfer tripping.

When the protective relays detect abnormal operation, they initiate removal of the guard signals and transmission of the trip signals as in Fig 8. The loss of guard frequencies and the reception of the trip frequencies constitutes a valid trip signal to effect remote clearing.

## 4.2 Transmission Line Protection

The transmission lines may have two or more terminals each with circuit breakers for disconnecting the line from the rest of the power system. All of the relaying systems discribed can be used on two-terminal or multiterminal lines. These relaying system program the automatic operation of the circuit breakers during power system faults.

1) Direct Underreaching.

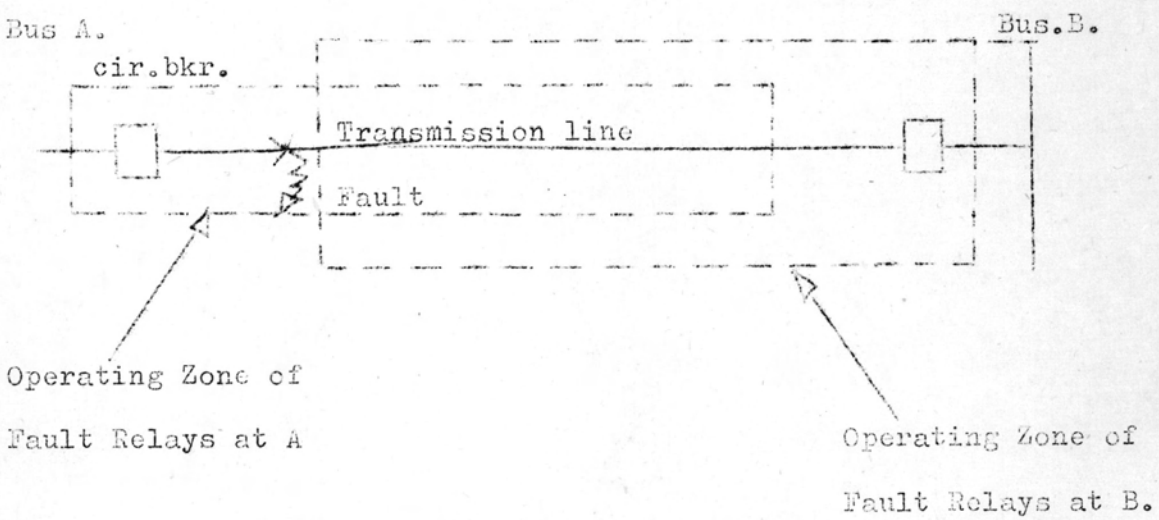


Fig 9.

The single line diagram of transmission line Protection, direct underreaching method.

Fault relays at each terminal of the protected line sense fault power flow into tne line. Their zones of operation

must overlap but not overreach any remote terminals in Fig 7. The operation of the relays at any terminal initiates both the opening of the local breaker and the transmission of a continuous remote breakers. For example, in Fig 9, for a line faultes near the bus A, the fault relays at A. open (trip) the breaker A directly and send a transfer - trip signal to B. The reception of this trip signal at B. trips breaker B.

2) The Permissive Underreaching.

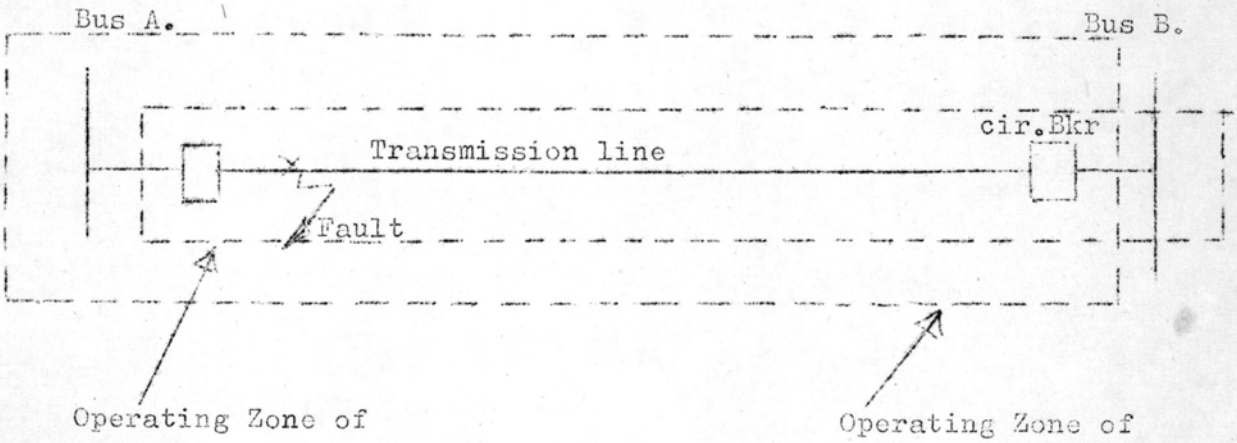


Fig 10.

The single line diagram of transmission line protection, the permissive underreaching method.

The operation and equipment for this system is the same as the direct underreaching system with the addition of fault-detector units at each terminal. The fault detectors must

overreach all remote terminals. They are used to provide some additional security by supervising remote tripping. These the fault relays operate as shown in Fig 9.and the fault detectors as shown in Fig 10. For an example, a fault occurs near the point A. in Fig 9. the fault relays at A trip the breaker A directly and sends a transfer trip signal to B. The reception of the trip signal plus the operation of the fault-detector relays at B (Fig 10) trips the breaker B.

3) The Permissive Overreaching.(Fig 10.)

Fault relays at each terminal of the protected line sense fault power flow into the line with their zones of operation overreaching all remote terminals. Both the operation of the local fault relays and a transfer-trip signal from all of the remote terminals are required to trip any breaker. Thus in the example of Fig 8. for the line fault near A, fault relays at A operate and transmit a trip signal to B. Similarly the relays at B. operate and transmit a trip signal to A. Breaker A. is tripped by the operation of the fault relay A plus the remote trip signal from B. likewise, breaker B. is tripped by the operation of fault relay B. plus the remote trip signal from A.