Chapter 5

THE PILOT WIRE

The Pilot wire is a mean of transmitting the communication signals along the telephone lines, which are usually in the form of multicore cables. This method is the simplest form oftelemetering and supervisory control system for circuit breakers, switchgears and associated equipments. The pilot wire is economical for the distances up to approximately one mile from the centrol point.

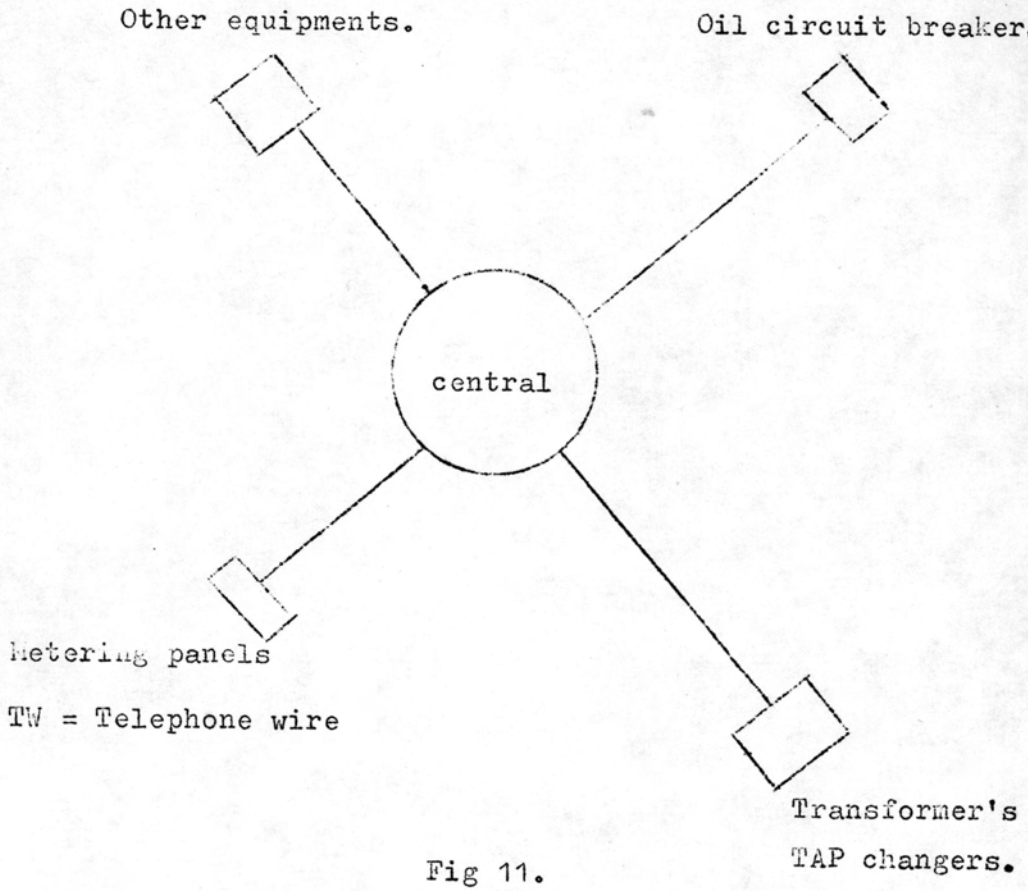


Fig 11.

The single line diagram of telemetering and superisory control system using pilot wire method.

The simple telemetering and supervisory control system using Pilot Wire method is shown in Fig 11. In this case the pilot wires from the central to the oil circuit breakers, transformer's tap changers and other equipments are used for supervisory control purposes. The controlled signals are sent along the telephon wires to close or trip the oil circuit breakers, to change the taps of the power transformers in order to maintain the level of operating voltage etc. The pilot wire from the control to the metering panels is used in telemetering the readings of load such as :

1. Kilowatt
2. Kilovar
3. Volt
4. Ampere etc.

which are in the forms of voltage and current signals will be converted into pulse codes before transmitting along the telephone line back to the central.

The type of the multicore pilot cable which is used as the transmission path depends mainly upon the local conditions and upon its proximity to other electrical circuits. In general, it is a paper insulated,

lead or aluminium sheathed type, with steel tape or wire armouring where such additional protection is warrented, and having small gauge conductors that go along with the low voltages and current required by the apparatus.

5.1 Pilot line Network.

In cases where the control has to be exercised over relatively long distances, the direct wire schemes are are protribitive due to the high cost of providing and laying the necessary multicore cables. One answer to the problem is to restrict the number of cores to an absolute minimum and to carry out all signalling over these few wires by means of a system of coded impulses. Another solution is to use separete frequency channels superimposed on the existing power lines.

On supply system where coded impulse methods are employed, much saving in cost may be obtained by interconnecting the substations in order to use the pilot wire as economical as possible. The actual choice of such a pilot line depends on.

1. Local conditions
2. The layout of the substations
3. The extent of the supervisory control system.

Consideration must also be given to the geographical layout and in the case of existing undertakings to any pilot wires which may already be available.

Typical methods of linking remote substations to the control station or center are divided into 4 methods such as:

1. <u>The radial system</u>.

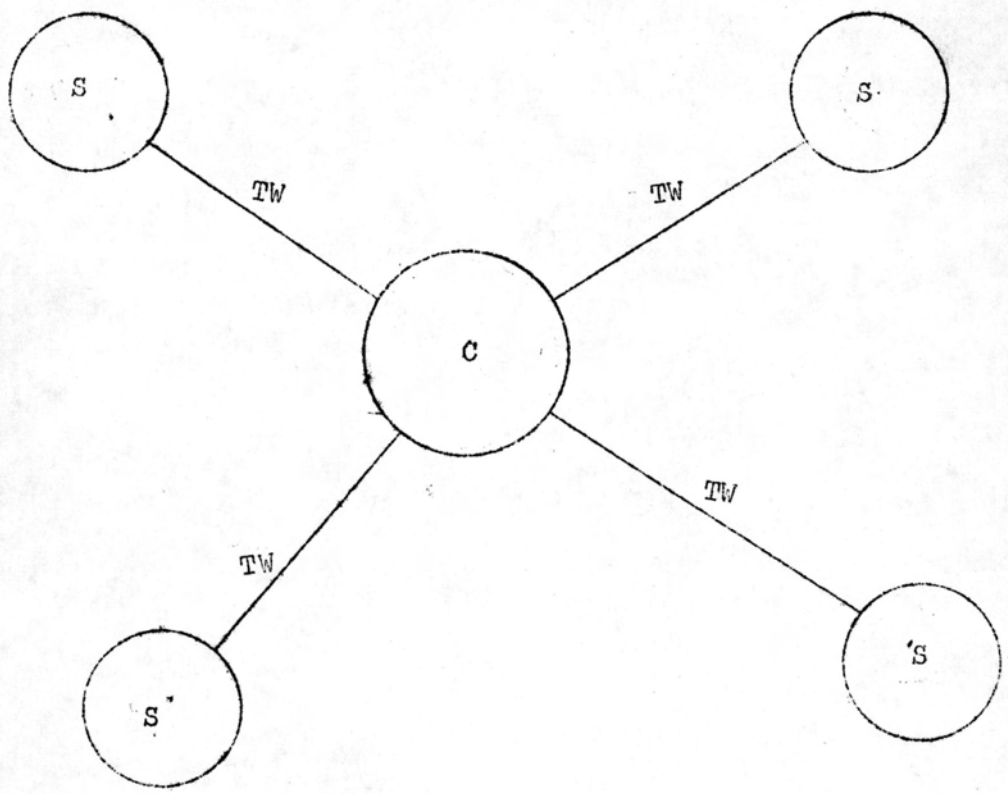


Fig 12.

The Single Line Diagram of the Radial System.

C = Control station.

S = Substation.

TW= Telephone wire.

The redial system is the system in which the control station is situated centrally, with separate pilot lines linking redially to the other substations as in Fig 12. By this method the signals can be transmitted directly from the central to the distant substations, no delays occur. But a lot of multicore cables must be used for this purpose.

2. Tandem or group center system.

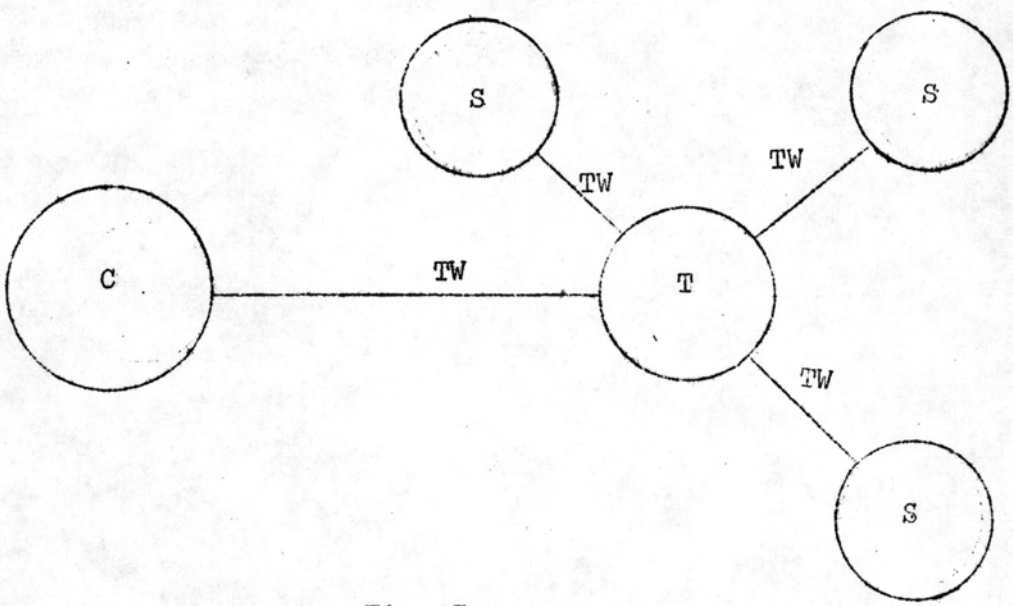


Fig 13.

The Single Line Diagram of the Tandem System.

C = Control station

T = Tandem station

S = Substation

TW = Telephone wire

This method, the control station is connected to a tandem station from which further lines radiate to the distant substations as in Fig 11. In this case the signals from the control station must pass through the tandem station before reading the terminal substation. This causes more delay in control but fewer used of multicore cables compare to the radial method.

3. Radial-Tandem system

The radial - tandem system which is shown in Fig 14. is a combination of the radial system and tandem system as previously described. This method is economical in conductors between the tandem and control station, particularly in large schemes involving very many stations, but may result in slight delay of the signals to the central point if more than one substation in any one group wishes to signal at the same time.

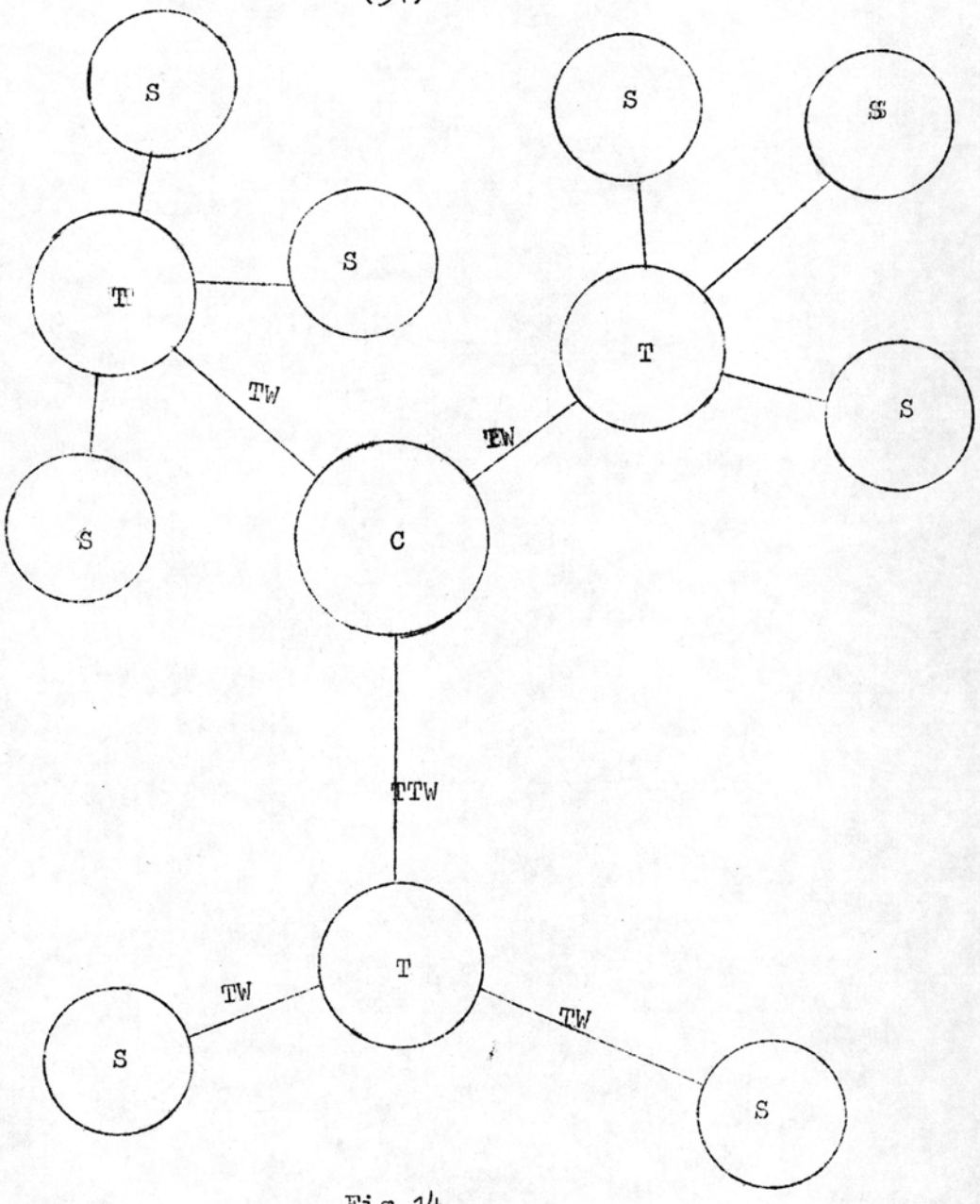


Fig 14.

Radial-tandem Method.

C = Control station T = Tandem station

S = Substation TW = Telephone wire

4. The Omnibus or Party line system.

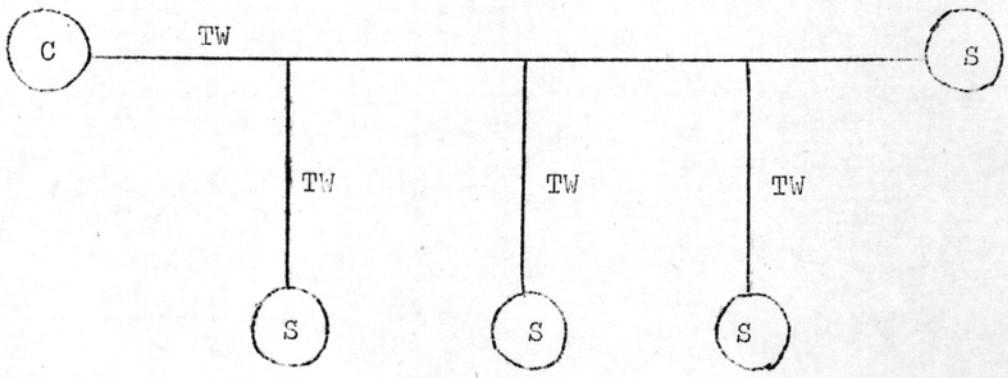


Fig 15. The Party Line system.

This system differs from the other arrangements of the pilot wire method, it consists of a common line called a party line which serves a number of related substations as shown in Fig15. This method is also economical in conductors, but the reliability is not satisfied. If the common line is damaged by accidents or other causes, all substations will be out of reach.

The pilot lines refered to above comprise one or more pairs depending on the overall scheme and a variety of circumstances. Where conditions warrant it, one pair of conductors between adjacent stations can provide all services comprising control, back indication, telephony and telemetering. On the other hand, additional conductors, if available, enable schemes to be simplified and the final choice in any

selected case can only be made when all the salient factors have been carefully assesed.

For relatively long distances, where lines connecting distant load centres are vented from the postal administration, it is especially necessary to cater for all the services over the minimum number of wires, and for such needs specially disigned sehemes have been evoled. In loss well developed areas,where longer distances separate the vasion load centres but economical or technical considerations warrant the use of such control and telemetering schemes, resort can be made to equipment by employing a tele graph carrier superimposed on the high voltage power lines serving the electric network. Here the main consideration is the cost of the terminal equipment, particularly at the higher voltages, since this must be specially designed to must the exact requirements of the carrier current circuits, and also to suit the insulation level of the power line. There fore this method may be justified only in a relatively for casess.

When the method of pilot wire in telemetering and supervisory control for MEA. system is to be used. Each type of network must be considered effectively and economically. The types of networks which are described previously may be

compared to suit the MEA. system as follow.

1. The Radial mathod this type composes of a center and the satellites substations, which may be arranged by using Watlieb substation as a center and other substations as as the terminals of the radial lines. This is the most direct way in controlling, no delay occurs in this system. But it is almost impossible to accept because.

1.1 The pilot wires must be hoisted along the transmission posts, under the high voltage transmission lines. This method is economic and time saving. Because we need not install the new posts for hoisting the pilot wires.

At present, none of the transmission lines are radiated from Watlieb substation, if we use the radial network system for the signals path, the first necessary thing to do is to install a great deal of transmission posts in order to hoist the pilot wires only, which mean a lot of money and time to waste in this operation. This is not one of practical methods.

2. <u>The method Tandem or group center</u> This method is suit for substations that are located in the nearby areas. But, from the 69 kv. single line diagram (route), the substations are scattering in the large plane from the center. If we use this method in MEA system the same problems as the

radial method will occure.

3. The radial-tandem This method composes of one center and a lot of tandems which is the most suitable for scattering substations. The substations Θ which are used as the tandems must have the transmission paths to other substations.

For the MEA system, we can arrange all the substations into radial-tandem system as follow.

Center = Watlieb.

Tandems = - North Bangkok
- Bangkapi
- Sam rong
- Bangkok Noi

and the remaining substations as the terminals of the radial lines.

NS. 809 — 230 KV. (LINE 230KV. FROM NAKORNSAWAN)
NS. 807 — 230 KV. (LINE 230KV FROM NAKORNSAWAN)

BANGPOOD
BD6911

RUNGSIT-1
RUNGSIT-2
40.7KM.
36.5KM.
6038
GOOD YEAR
6039
THAI TEXTILE
THAI TEIJIN
NS. 801 — 230 KV.
NS. 804 — 230 KV.

6034
DONMUANG
D6911
D6907
D6521

NONTHABURI
NR6025
NR6907
NR6015

N-693
6045
6016
THAI SYNTHETIC
THAI BLANKET INDUSTRY
B-691
6018
N-693
RT6911
RAMINTRA

NORTH BANGKOK TERMINAL
BANGSUE
BS6911
6030
6029
N-694
M6911
M6907
MT6921
MOCHIT
B-691

6011
S6929
S6907
S6921
S6911
SAMSEN
6001
6002
SAMSEN WATER WORKS
6003
U6911
LARD PRAO
NS. 804 — 230 KV.
NB 802 — 230 KV.

6051
BY6911
BANG-YEE-KHAN
6012
THONBURI WATER WORKS 6014
6013
NS 801 — 230 KV.
6033
6047
MS6911
MS6907
6035
MAKASAN
6032
6043
SANSAB
6004
6005
6044
SAPANDAM
P6907
SD6908
SD6909
6041
PATUMWAN
PM6911
PM6909
W6931
W6909
W6907
WATTHEB
L6911
L6907
L6931
LUMPINI
6026
6027
6028
6050
BANGKAPI EAST TERMINAL
B-694
B-693

T6919
T6907
T6931
T6929
T6921
6018
THONBURI
BANGKOK NOI WEST TERMINAL
5010
K-693
K-692
K-691
6025
6007
6006
PRAKANONG
P6907
P6921
6037
MM6921
MM6907
MM6911
MAHAMEK

U.S. SUMMIT
6023
BANGNA
6040
B-693
SR-697
K-691
RN6907
6008
RASBURANA

THAI INDIA STEEL Co.LTD
6042
FIRE STONE
6020
SR-695
AJINOMOTO
6036
6053
TONGKUNG
6022
SR-693
6021
SAMRONG
BANGKOK STEEL INDUSTRY
G.S. STEEL
THE BANGKOK IRON & STEEL WORKS
6024
SK-693
6049
SK-696

Q6921
Q6907
Q6911
6017
6054
PHRA PRADAENG
THAI DURABLE TEXTILE
THAI ASAHI CAUSTIC SODA
SOUTH BANKOK TERMINAL
R6911
R6907
PAKNAM

NOTA 23 KV. (BANGKOK NOI — SOUTH BANGKOK)

LEGEND —

- SWITCHING STATION
- Y.E.A. TERMINAL STATION 230/69KV
- M.E.A. DISTRIBUTION SUBSTATION 69/12KV (ENERGIZED)
- M.E.A. DISTRIBUTION SUBSTATION 69/12KV. (TEMPORARY)
- M.E.A. DISTRIBUTION SUBSTATION 69/12KV. (DE ENERGIZED)
- PROPOSED M.E.A SUBSTATION 69/12KV (DE ENERGIZED)
- INDUSTRIAL SUBSTATION 69/12KV. (ENERGIZED)
- INDUSTRIAL SUBSTATION 69/12KV. (PROPOSED)
- Y.E.A 230KV. LINE
- 69KV M.E.A. SYSTEM (ENERGIZED)
- 69KV. M.E.A. SYSTEM (DE ENERGIZED)
- 69KV. M.E.A SYSTEM (PROPOSED)
- GANG OPERATED SWITCH
- 69KV M.E.A. LINE BUNDLE
- 69KV. M.E.A SYSTEM (TEMPORARY)
- 69KV. LINE BREAK
- VACUUM BREAK INTERRUPTER
- 115KV. MEA SYSTEM (PROPOSED)

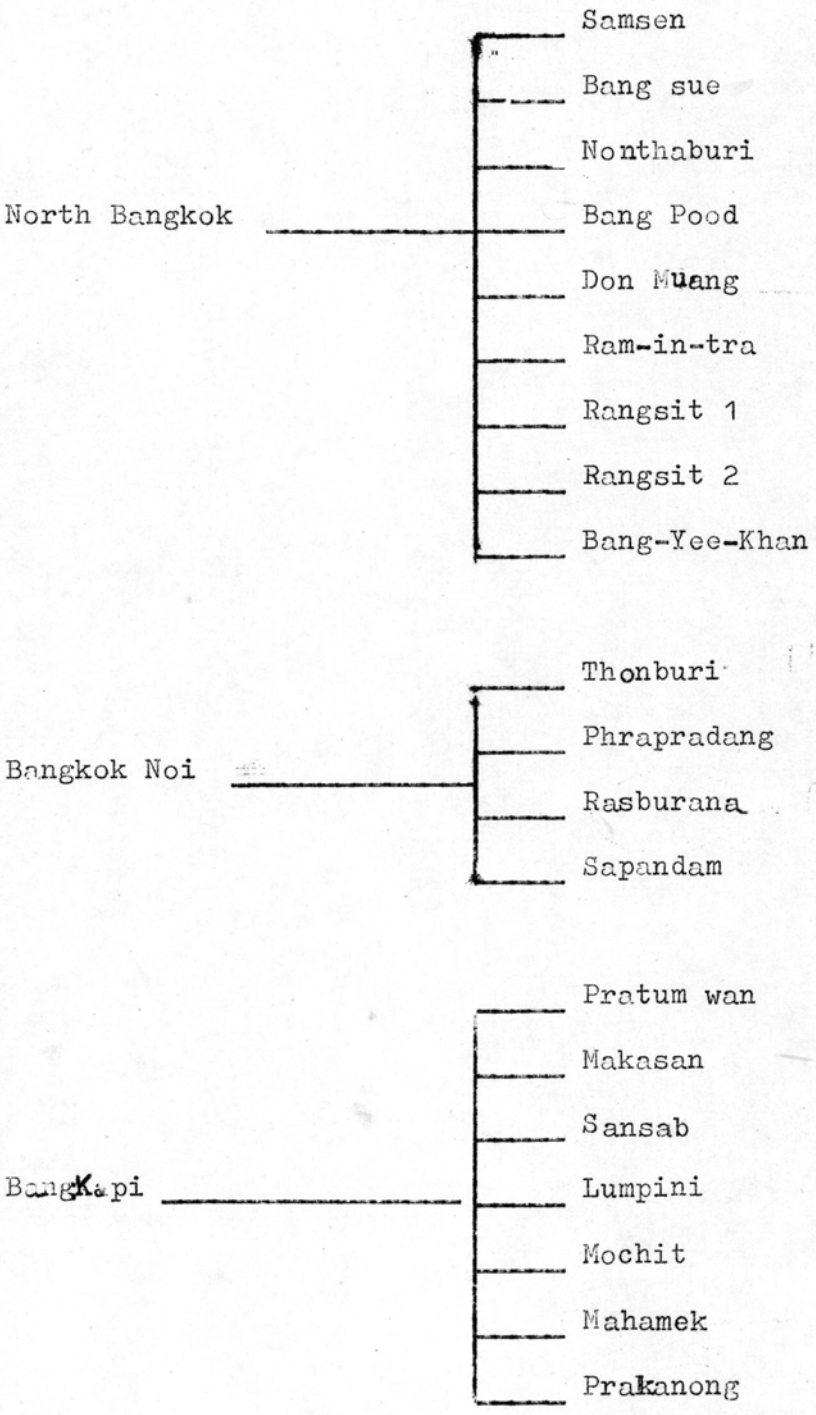
10.A.W.2515

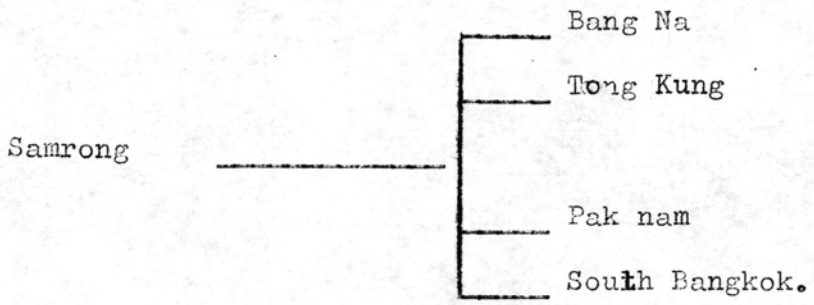
METROPOLITAN ELECTRICITY AUTHORITY

SUBSTATIONS & TRANSMISSION LINES MAINTENANCE DIVISION

DRAWN E. Khuchuay	GEN. MGR.	DATE 23-6-70
CALCULATED	SINGLE LINE DIAGRAM 230-69KV. SYSTEM (ROUTE)	SCALE
CHECKED		SUPERSEDING
CHF. OF DIV.		SH. No. OF
EX. MGR.		DRAWING No. STM-23069-0001
DEPT. GEN. MGR.		

We can arrange as follow.





By using the radial-tandem method. The necessary thing to do is only the wiring of the telephone wires from center to tandems and from tandems to the other substations This is done easily because there are already the transmission paths which may be used as the paths for pilot wires. This method is very advantageous for required by the new transmission paths need not be installed as the radial system.

The party line This method depends on one main line which links all the substations to the center. It is good in construction and economic point of view, But the reliability is not acceptable. The reason is that when the main pilot wire is damaged by accidents, all the substations which are linked to the broken line are no longer in control.

5.2 The Telephone line

The other wire that can be used in pilot wire communication is the telephone line.

A telephone pair is simply a pair of wires, normally ranging from AWG#19 to AWG#26 in size. Then wires, furnished by the local telephon company, pass through over head cables, underground cables, through junction points, and switch-boards. To the user, Howere, they may be considered a simple pair of wires. Equipment that is designed to operate with such a pair should have nominal impedances of 600 . A telephone pair will normally have a maximum length of about 12 miles before amplification is added by the telephone company to make up for line losses. This loss is a direct function of the length of the line, and varies with the wire size used. As an example, with AWG# 19 wire, a distance of six miles may be covered before one-half the input voltage of a 1,000 tane is lost. With AWG# 26 wire, only two and one-quarter miles may be covered before one-half the input voltage is lost: Line losses as high as 30 DB can be toterated in - operating a transmitter from the centrol censol, but such high losses should be avoided whenever possible. Although the telephone pair is fairly well belanced, some noise will be induced into the line, expecially if an unshielded has to be made in a fluorescent lighted building.

5.3 Disadvantages.

The disadvantages of the pilot wire may be classified as follow:

1. The construction of pilot wire, this requires a lot of money and man-hour, because if we use this method as a control medium; wiring the multi-core cable throughout the metropolitan area become necessary.

2. The damage of the pilot wire caused by accidents at the posts lines because of being hoisted along the transmission posts, means the control system will be also interrupted.

3. The delay in signals transmission, as deseribed previously, if the radial-tandem method as the medium is used. The signals from the center must pass through the tandems before going to the substations this causes the delay of transmission.

4. The pilot wire is economical for distance up to approximately one mile only which is not good for large area of MEA distributive network.