

KNOW YOUR TELEPHONE SYSTEM

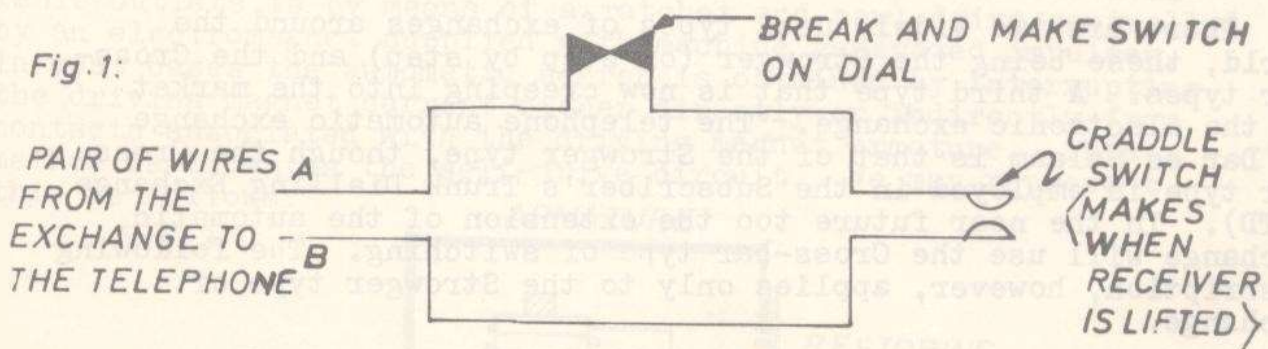
By: A.J. Fernandes & L.M.N. Ijumba*

1. Introduction

Though a lot many of us use the telephone day in and day out, a few of us really think as to how we get through to the other side. The account given here is to try and explain how the telephone exchange works and also to clear up some of the myths that are associated with the exchange. For example, we have found that quite a number of people have the idea that there is a light for each telephone in the main exchange, that it lights up everytime a person makes a call and that it indicates whom he is ringing up and for how long or things of that nature. We also hope that by reading this article the reader will understand just what may be wrong when he fails to make a successful call and in so doing may not lose his head easily.

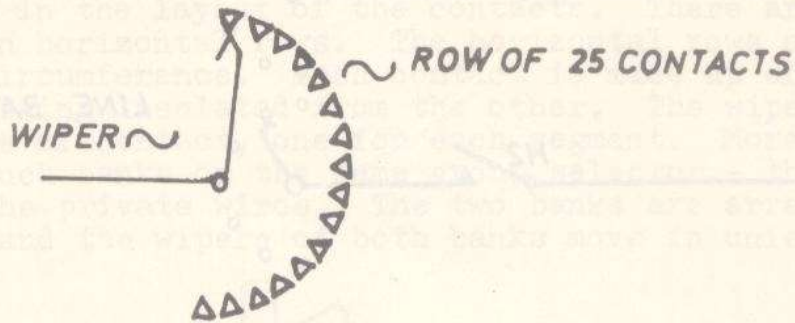
2. The Process

One of the best ways of trying to understand how the telephone system works is by tracing a call from one subscriber (hereafter referred to as the sub.) to another, via the telephone exchange. So let us assume that person A who has a private telephone, wishes to converse with person B over the telephone. When person A lifts his receiver, he completes a circuit which links his telephone to the exchange. As soon as he gets a dialling tone, he proceeds to dial. Dialling involves the breaking and making of the already completed circuit thereby sending 'pulses'. The number of pulses sent correspond to the number dialled; i.e., if 7 is dialled then seven pulses are sent. These pulses are sent at a rate of ten per second; ten pulses corresponding to the '0' on the dial. Very simply we may represent this circuit as in Fig.1.



* Third Year Students, Electrical Engineering Department.

sub. A, let us see what happens within the exchange as he tries to establish a call. As soon as he lifts his receiver he operates a uniselector. Each sub has his own uniselector. These uniselectors are connected in groups or twenty four, the connections being in parallel. These groups of twenty four uniselectors are in turn wired to a group of ten 1st group selectors. What happens when a sub lifts his receiver is that he sets his uniselector hunting for a free 1st group selector. A uniselector consists basically of a wiper and twenty five stationary contacts that are arranged on a circumference. In side view, the uniselector may look as shown.

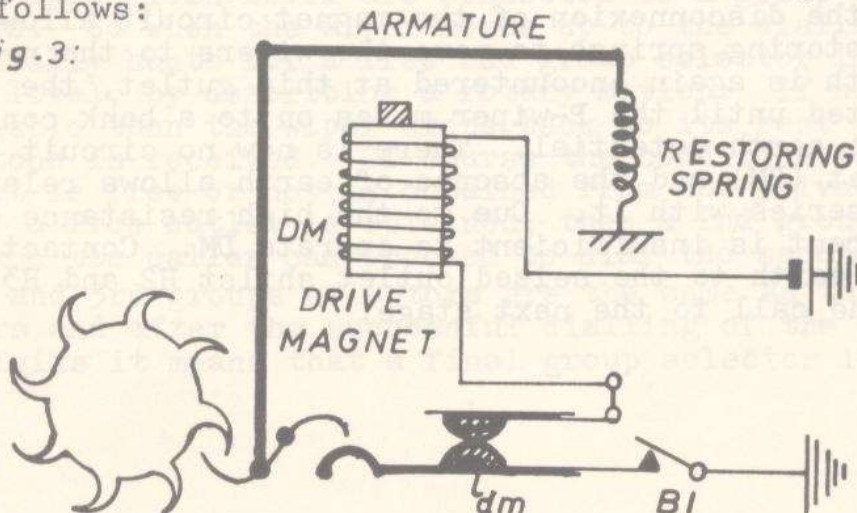


The wiper makes contact with each of the contacts as it rotates about its axis. Each uniselector may have four or even eight rows of contacts. Two rows are for the sub's line and a third is for the private wire. The rest maybe put to a number of other uses. Whenever a sub's line is engaged an earth condition is established on his private wire and this is extended to all the other uniselectors in his group because of the parallel connexion. Now whenever the wiper encounters an earth condition on any contact, it steps forward automatically to the next one because this means that the one with earth is engaged.

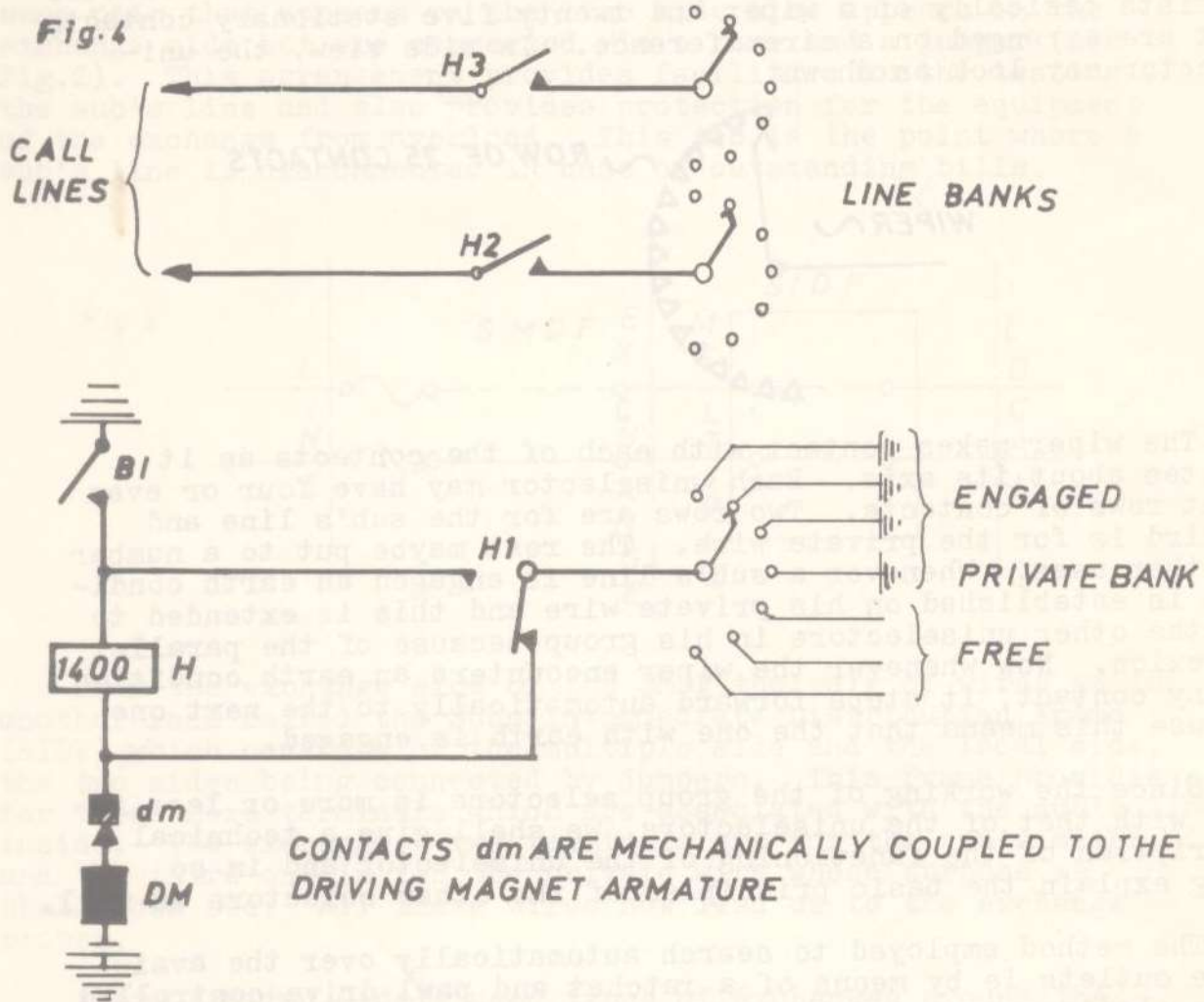
Since the working of the group selectors is more or less in line with that of the uniselectors, we shall give a technical description of the functioning of the uniselector and in so doing explain the basic principles of the other selectors as well.

The method employed to search automatically over the available outlets is by means of a ratchet and pawl drive controlled by an electromagnet supplied with machine generated impulses. In most cases the automatic search is obtained by interrupting the driving magnet current either directly or indirectly from contacts associated with the driving magnet armature. This method is known as the self-drive circuit. We may represent this as follows:

Fig. 3:



However, from the above representation we can see that this simple circuit will not suffice because once the contact B1 is operated the ratchet will continue to be turned. For this reason, therefore, a combined self-drive and earth testing circuit is used. The circuit shown in Fig. 4 provides for automatic search over engaged outlets and to switch a call only when a free trunk has been found.

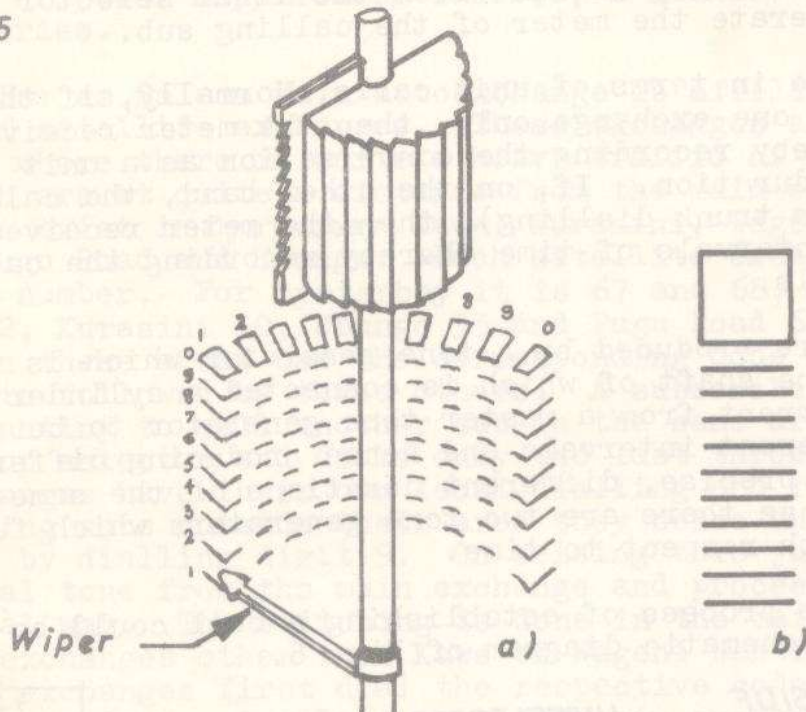


The driving magnet is energized from the earths encountered on the P-bank contacts. When earth is encountered on the P-bank, the magnet is energized to this via H1 and dm. Towards the end of the forward stroke of the armature, the interrupter springs (dm) break, and the disconnection of the magnet circuit allows the mechanism restoring springs to move the wipers to the next contact. If earth is again encountered at this outlet, the process is repeated until the P-wiper moves on to a bank contact where there is no earth potential. There is now no circuit for the driving magnet (DM) and the absence of earth allows relay H to operate in series with it. Due to the high resistance of relay H, the current is insufficient to operate DM. Contact H1 extends guarding earth to the seized outlet whilst H2 and H3 switch through the call to the next stage.

If no free outlet is available, then a busy tone is sent automatically to the calling sub. If, however, a free outlet is seized then a dialling tone is received by the calling sub, and he proceeds to dial. At the same time, the circuit of the sub's meter is prepared for the registration of the call when, at a later stage positive battery is applied on the private-wire from the final selector!

When the sub dials the first digit, it is dealt with by the 1st group selector. Though in principle the working of the group selectors is the same as that of uniselectors, they differ from the latter in the layout of the contacts. There are ten vertical and ten horizontal rows. The horizontal rows are arranged on a circumference. (Each contact is made up of two segments, each being insulated from the other. The wiper likewise has two surfaces of contact, one for each segment. Moreover, there are two such banks on the same group selector - the second one being for the private wires. The two banks are arranged one atop the other and the wipers of both banks move in unison.

Fig. 5



When a person dials the first digit, maybe 2, then the wiper moves vertically to the level dialled, in this case 2. Now the contacts in a given level are connected to a group of 2nd group selectors. So when the wiper moves up to the dialled level it automatically hunts for a free 2nd group selector in that particular level, by describing a rotary motion. If no free outlet is available then the wiper drops back to its rest position and a busy tone is received. Of course the condition as to whether a contact is free or not is obtained from the private bank. If, however, a free outlet is obtained, then a 2nd group selector is seized and the caller can proceed to dial the second digit.

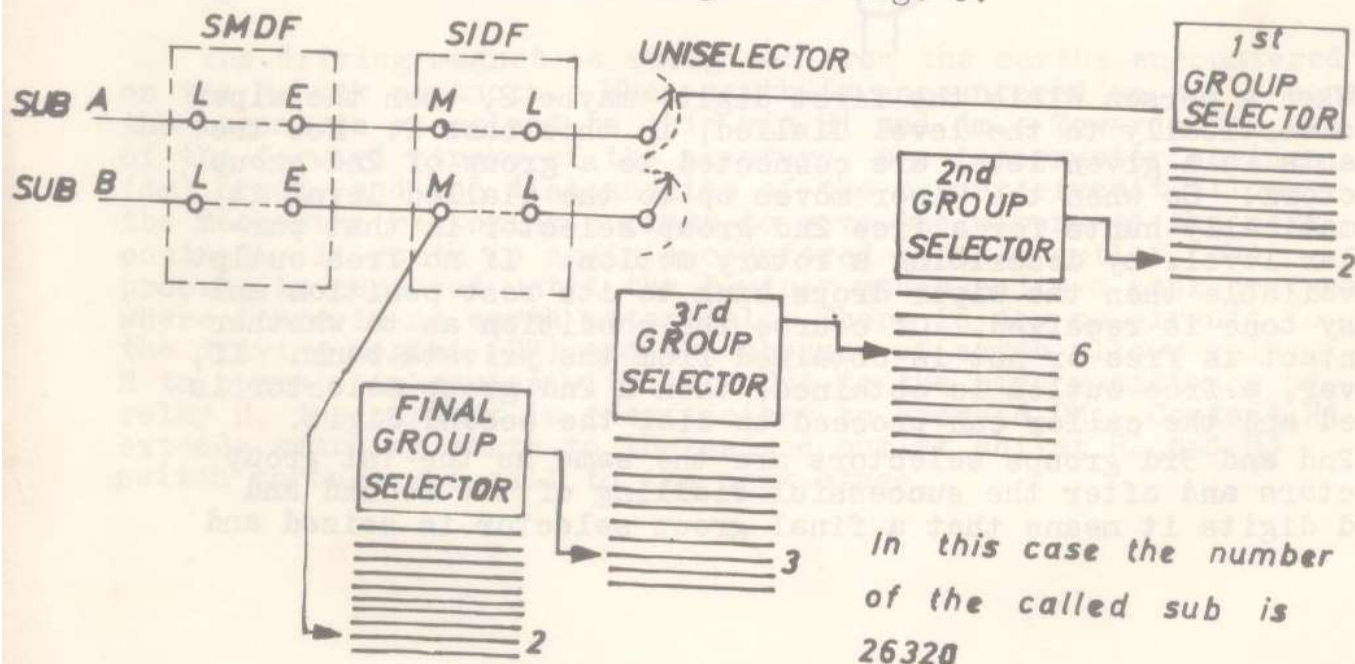
The 2nd and 3rd groups selectors are the same as the 1st group selectors and after the successful dialling of the second and third digits it means that a final group selector is seized and

is ready to receive the last two digits. The final group selector differs from the others in that the sub lines are directly connected to the contacts of the bank. Thus when the fourth digit is dialled, say 8, then the wiper steps up to that level and stays put, i.e., there is no automatic hunting over the horizontal contacts as was the case with the previous selectors. Only when the last digit is dialled will the wiper move horizontally to the number of contact corresponding to the dialled digit, e.e., if 7 is dialled then the wiper will move in to the seventh contact, of course it still being on the level of the fourth digit that was dialled. It is thus at this point that the physical connexion between the calling sub and the called sub is made. If the called sub is engaged then the caller receives an engaged tone. Similarly if the called sub's line has been disconnected then a N.U. (number unobtainable) tone is received. If however the called sub is free, then a number of things happen at the final selector. Firstly a ringing current is sent to the called sub's telephone bell circuit. Simultaneously a speech circuit is engaged. The moment the called sub lifts his receiver then a 50V positive battery is sent from the final selector back on the P-wire to operate the meter of the calling sub.

Metering is done in terms of unit calls. Normally, if the call passes through one exchange only, then the meter receives only one pulse thereby recording the conversation as a unit call no matter what the duration. If, on the other hand, the call is an STD (subscriber's trunk dialling), then the meter receives pulses at pre-set intervals of time thereby recording the call as several unit calls.

All the tones are produced by a tone generator which is simply a motor on the shaft of which is connected a cylinder that enables the current from a master tone generator to be interrupted at different intervals and hence producing different tones or to be more precise, different durations of the same tone. At the exchange there are two tone generators which function alternately with respect to time.

The whole of the process of establishing a call could be represented by the schematic diagram of Fig. 6.



Faults may show up electrically, i.e., they give some alarm which in most cases is either the ringing of a bell or the lighting of a bulb. Such alarms can be caused by a power failure for instance. Other alarms may show up because of blown fuses or because a selector fails to release even when the call is ended. At the end of a conversation all the selectors release after the calling sub replaces his receiver. If, however, the calling sub fails to replace his receiver even though the called sub has done so, then an alarm will come up. This means that the called sub has no access to the exchange for making his own calls. Some of these alarms are prompt, such as the power failure alarm, whereas others occur after a time lapse, as is the 3 minute time lapse for a called sub held alarm.

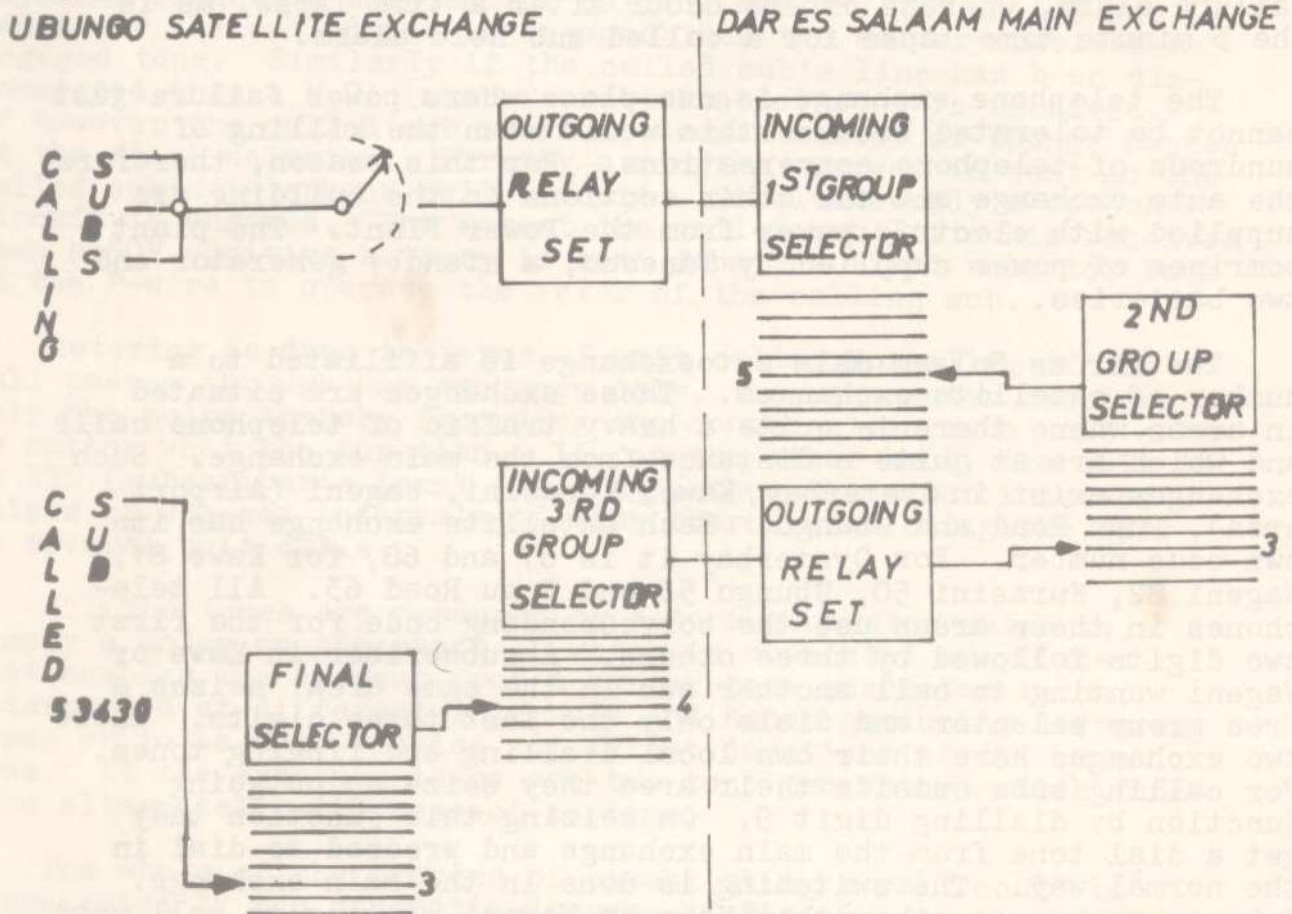
The telephone exchange is one place where power failure just cannot be tolerated because this would mean the killing of hundreds of telephone conversations. For this reason, therefore, the auto exchange and the other sections in the building are supplied with electric power from the Power Plant. The plant comprises of power supplied by Tanesco, a standby generator and two batteries.

The Dar es Salaam main autoexchange is affiliated to a number of satellite exchanges. These exchanges are situated in areas where there is quite a heavy traffic of telephone calls and which are at quite a distance from the main exchange. Such exchanges exist in Oysterbay, Kawe, Kurasini, Wageni (Airport area), Pugu Road and Ubungo. Each satellite exchange has its own code number. For Oysterbay it is 67 and 68, for Kawe 81, Wageni 82, Kurasini 50, Ubungo 53 and Pugu Road 63. All telephones in these areas use the corresponding code for the first two digits followed by three others. A subscriber in Kawe or Wageni wanting to call another sub in the same area, seizes a free group selector and dials only the last three digits. These two exchanges have their own local dialling and ringing tones. For calling subs outside their area they seize an outgoing junction by dialling digit 9. On seizing this junction they get a dial tone from the main exchange and proceed to dial in the normal way. The switching is done in the main exchange. Subs in exchanges other than Kawe or Wageni wanting to call subs in these exchanges first dial the respective code numbers of the exchange required. A selector in the main exchange seizes a group selector called exchange. The calling sub then receives a dialling tone of that exchange and he then proceeds to dial the last three digits.

For the subs in the remaining exchanges the calling process differs a bit. These exchanges provide each sub with a uni-selector and has outgoing relay sets, incoming 3rd group selectors and final selectors. The missing links of the system, i.e., the incoming 1st group selectors, 2nd group selectors and the outgoing relay sets exist in the main exchange. Such a sub wanting to call a sub who is connected to the main exchange first seizes an outgoing relay set which puts him through to a 1st group selector in the main exchange. The rest of the process remains the same. If, however, this sub wants to call a sub that exists on a similar satellite exchange then the sub just

seizes an outgoing relay set through his uniselector on lifting his receiver. This set then seizes a free incoming 1st group selector in the main exchange. Through a free outlet, a free 2nd group selector is seized. In turn, the 2nd group selector seizes a free outgoing relay set which puts the call through to the incoming 3rd group selector in the called satellite exchange. The last two digits dialled are handled by the final group selector and thus the call is put through. The trunking diagram of such a system is shown below in Fig. 7.

Fig. 7:



Another interesting feature in the telephone system is that of barring. Barring involves either the placing of a short circuit across a given pair of terminals or the placing of a resistor of a specific value. Of course the method used depends on the manufacturers of the exchange. Barring provides a telephone with three different kinds of facilities:

- 1) it allows for an extension to dial to the main exchange without the aid of an operator.
- 2) it allows for STD calls to be made without the aid of the operator.
- 3) it disallows an extension to dial to the main exchange without the aid of an operator. These barring facilities are very often used for extensions that exist on some private automatic branch exchange (P.A.B.X.).
