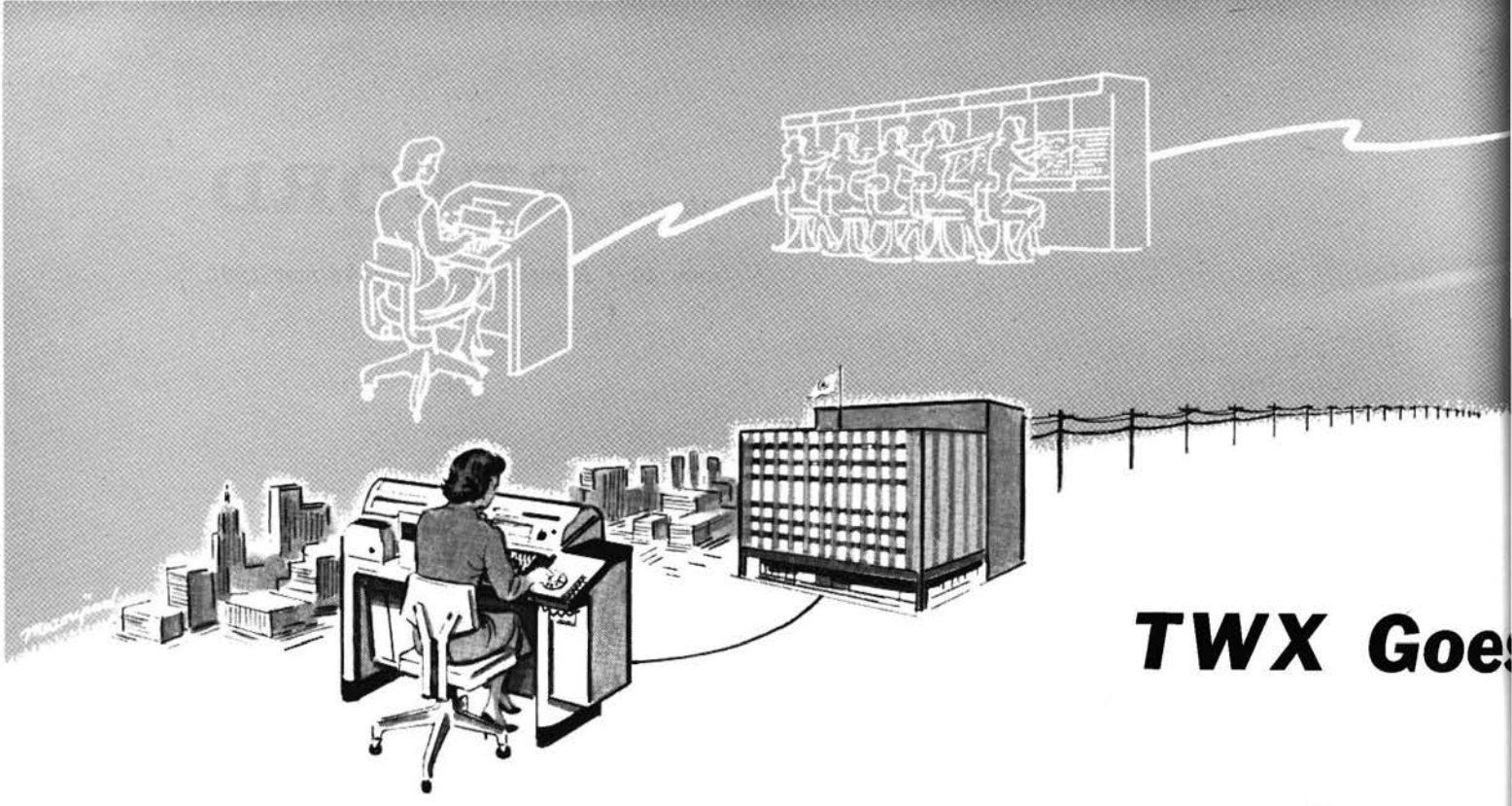


TWX Goes

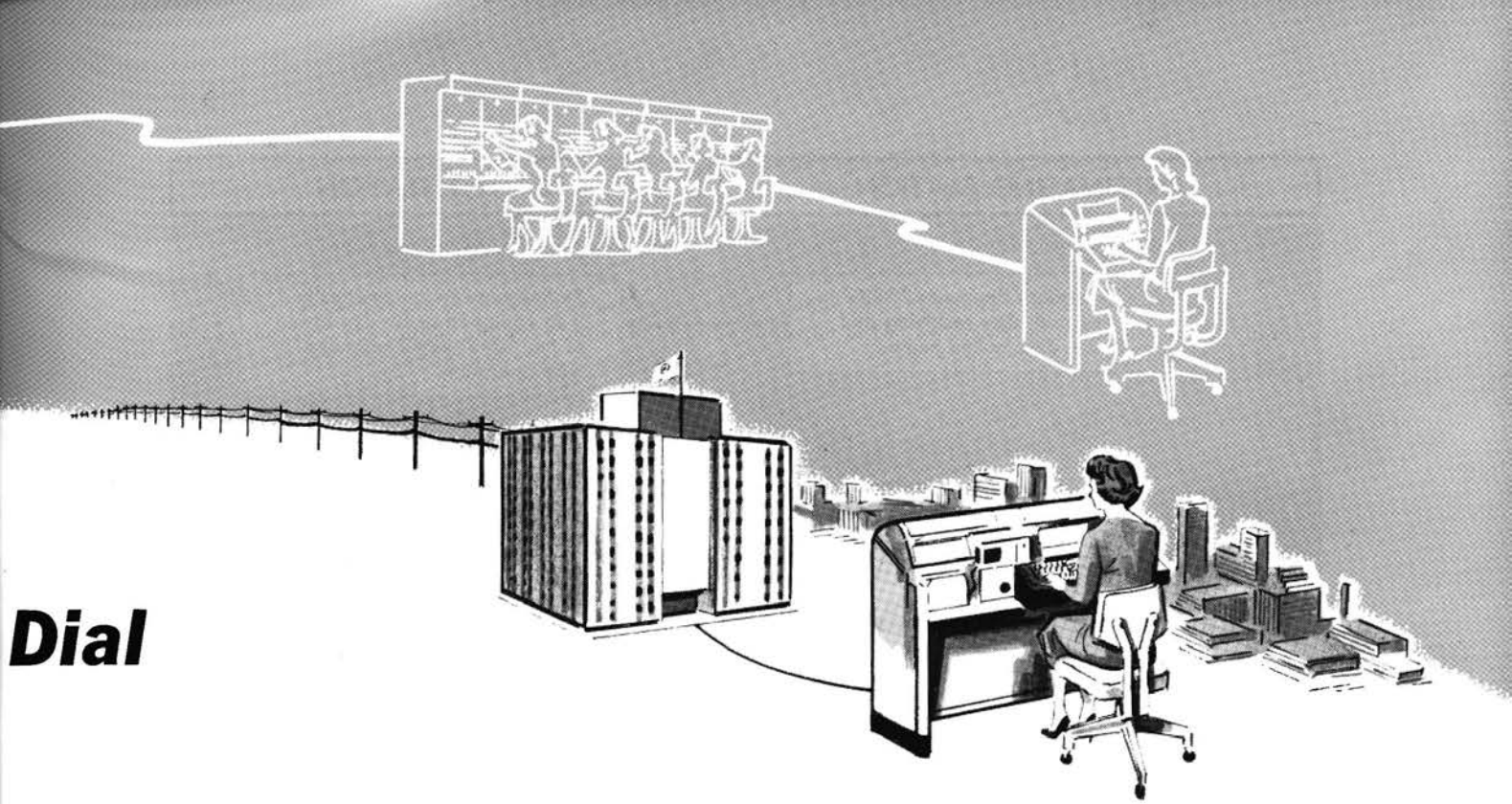
The first nationwide cutover in the history of telephony—one that will involve every operating company in the Bell System and many independent telephone companies—will take place on August 31, 1962. When it is accomplished, some 60,000 teletypewriter exchange (TWX) stations in the United States will begin to dial their calls over the Bell System's direct distance dialing (DDD) network. Almost 900 central offices will be switching centers for the TWX stations.

Since TWX service was started in 1931, its calls have been switched manually; at present 100 switchboard locations are needed to handle the traffic. Most of these have trunks to only 10 other locations in the network; none has trunks to all others. These limited trunking paths, and the fact that the average TWX call covers about 800 miles, results in a large number of multiswitch connections that must be handled by operators. Manual handling of calls is a costly procedure and it requires about two and a half minutes to set up a call. These and other considerations made it desirable to mechanize TWX service as soon as possible.

Tying TWX stations into the DDD network permits the telephone industry to convert them to dial operation in the minimum of time and TWX service will benefit in a number of ways. First, the DDD network will reduce the average time to set up a call to about one-half minute. Second, it will permit customers to place calls in the same manner as telephone calls. Thus, a minimum of customer training will be required. Third, it will reduce the interval from receipt of an order to service because ordinary telephone loops can be used rather than special telegraph loops.

Each TWX station will be assigned a ten digit telephone number. TWX stations will complete calls over the DDD network in much the same manner as telephone stations, but two-way voice communications with telephone stations or to other TWX stations will not be possible. Assistance, collect, conference and similar calls will be handled through switchboards recently designed at Bell Laboratories which will be located at 16 operating centers throughout the country (see the map on page 236), and reached from any TWX station by dialing a special seven digit number. There will also be one information center located in St. Louis, Missouri. All communication with TWX operators will be by teletypewriter machine.

TWX transmitting and receiving stations will



Dial

E. J. Tyberghein

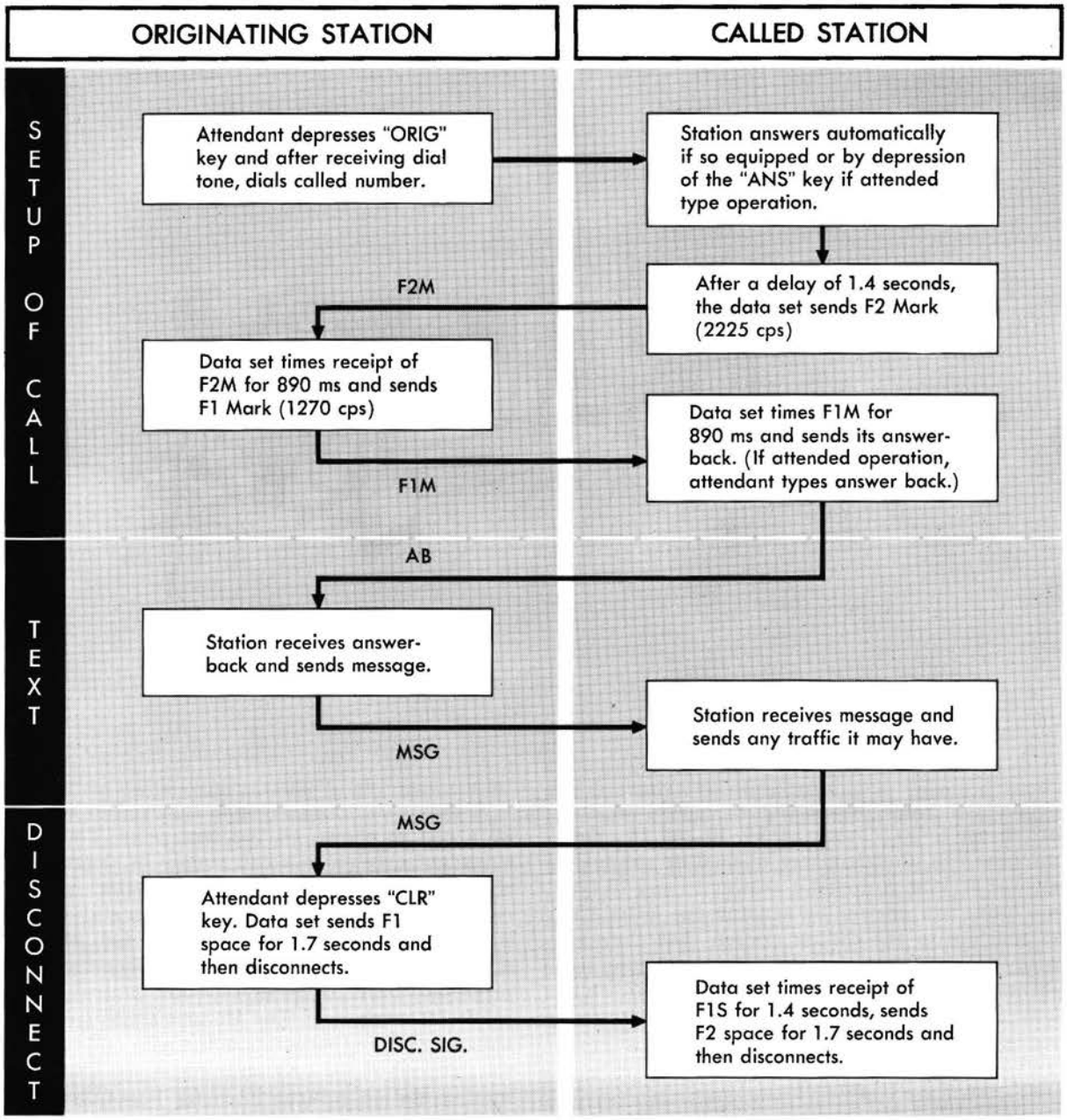
retain the same teletypewriter machines that are in use today: Types 14, 15, 19 and 28. Each machine will provide either manual or automatic answer service. Automatic answer 15 and 19 type machines will answer by sending the letter "V" to indicate to the calling station that they are ready to receive. Automatic answer 28 type machines will send a multicharacter answer which will identify the called station and indicate it is ready to receive.

New Station Equipment

A newly developed data set and an attendant set are intermediate equipment between TWX stations and their serving central office loops. Together, they will (1) convert the dc teletypewriter signals into mark and space carrier frequencies in the voice frequency band; (2) provide all necessary machine control functions; and (3) provide assurance that the transmission circuits are functioning. (If the signal in either direction is lost for approximately one second, both stations will be disconnected.) In addition, the attendant set will provide a means of dialing into the serving central office, and of listening to call progress tones such as dial tone, busy tone, reorder, etc.

A very natural sequence is followed in setting up a call as shown on the next page. The TWX attendant originates a call simply by depressing the ORIG key on the attendant set. Dial tone is returned, and the attendant dials the station she wishes. The called station answers and, after a slight delay to permit off-hook supervision to propagate back to the originating central office, sends F2 mark tone. The F2 tone (2225 cps) disables any echo suppressors in the path and enables the data set at the originating station. The originating station returns F1 mark tone (1270 cps) which enables the data set at the terminating station. When both stations are enabled, the called station sends its multicharacter or "V" answer-back. At this point, both stations are ready to send or receive messages in turn. The originating station always sends its data signals in the F1 band and receives in the F2 band. The called station sends in F2 and receives in F1. An attendant at either station can end the call simply by pressing a CLR (clear) key on the attendant set. For a disconnect signal, the originating station sends F1 space tone (1070 cps) and the called station sends F2 space (2025 cps).

TWX calls will continue to be billed on an



A call between teletypewriter stations will be set up in the steps shown in this drawing. When a teletypewriter console is unattended at a dial TWX *station, an answerback mechanism indicates automatically to the calling party that the station has answered and that it is ready to receive messages.*

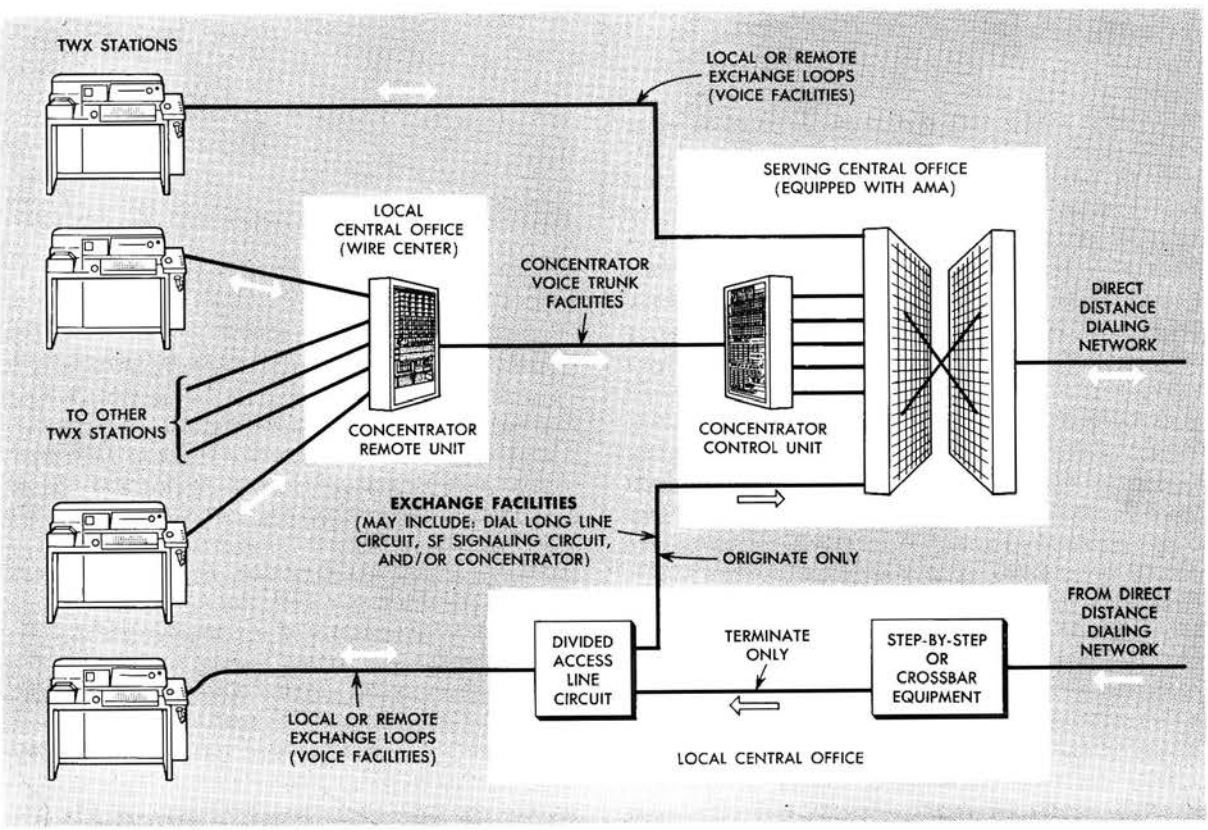
individual message basis and therefore automatic message accounting (AMA) records of all calls will be kept. Centralized AMA equipment with operator identification of the calling customer cannot be used because voice communication is not possible. No. 5 crossbar offices with local AMA are preferred for this service, but they do not exist in all areas serving TWX stations. Consequently, some step-by-step offices with automatic number identification (ANI) and CAMA, and some No. 1 crossbar offices with LAMA or ANI CAMA will be used.

The charge per message depends on the distance and duration of the call. Mileage is determined by the distance between the rate center areas in which the stations are located. In order

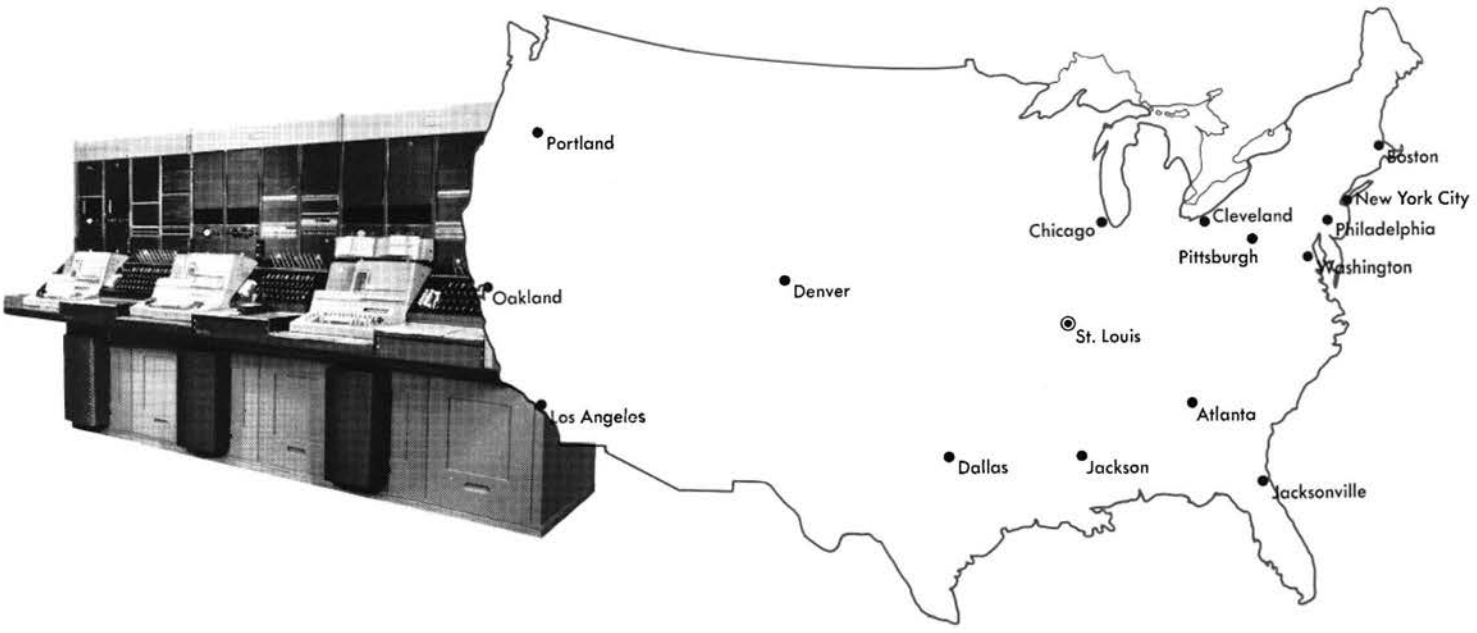
to keep message sorting at the various accounting centers to a minimum, it is desirable to assign a different central office code for each rate center involved. If separate codes are not assigned, it will be necessary to sort messages from TWX stations by the thousands or possibly even the hundreds digit of the called station's number. However, there are not yet enough AMA and ANI CAMA central offices; located in the right spots around the country. Hence, we cannot provide all the rate center codes we need.

To solve this problem, Laboratories engineers developed a divided access line circuit (DALC) which makes it possible for a TWX station to originate messages via one central office (having AMA or ANI CAMA) and receive incoming messages via a different central office which has the proper rate center code. Several typical line and trunking arrangements for serving dial TWX stations are shown in the drawing above. Only voice bandwidth loops are used; loop plant investments are kept to a minimum by using the 1A line concentrator with new arrangements that permit it to operate with carrier transmission trunks.

DDD central offices will be able to handle TWX traffic with the relatively few changes that have been outlined. Some changes also will be made in the interoffice trunk facilities. First, some trunk groups will be enlarged to accommodate the additional load. Secondly, all 2000 cps SF signaling units (a relatively small portion of the single frequency units in plant) will be replaced by 2600 cps SF signaling units. If this were not done, F2 frequencies (2125 ± 100 cps) would cause false operation of the 2000 cps SF receivers. Thirdly, because a receiving TWX station must be able to send a "break" or stop signal while the other station is sending, an echo suppressor disabler will be installed on every echo suppressor that



Shown here are typical line and trunking arrangements that will be used to serve the new dial TWX *stations. The divided access line circuit solves a problem of rate center codes by allowing* TWX *stations to place a call through one central office and to receive through a second central office.*



This assistance switchboard was developed at the Laboratories specially for dial TWX *service. These boards will be located in the cities shown on the map and will share a special seven-digit telephone number. An attendant at any* TWX *station who wishes assistance with collect calls, conference calls, etc., can dial this number and be connected with the switchboard assigned to serve her area.*

may be encountered by a TWX call.

The disabler was developed especially for data transmission over the DDD network. It works with the echo suppressor in the following manner: The echo suppressor monitors the signal energy present in both sides of a four-wire circuit (both directions of transmission) and introduces a high loss in the side that has the lower signal energy. It is the purpose of the disabler to remove this high loss when the circuit is used for data transmission. To accomplish this purpose, the disabler monitors each side of the four-wire facility for energy in two bands—the conditioning band (2000 to 2250 cps) and the guard band (the voice band outside of the conditioning band). Whenever the energy in the conditioning band is sufficiently in excess of the energy in the guard band for 350 milliseconds (±50 milliseconds), the echo suppressor is disabled; that is, the high loss is removed. If sufficient energy outside of the conditioning band is present on either side of the line, it will prevent the echo suppressor from being disabled. Thus, voice communication cannot disable the echo suppressor. After it is disabled by F2 frequency from the terminating station, the suppressor is kept disabled by energy in either band. A loss of signal for 100 milliseconds causes the suppressor to return to normal.

TWX customers will report trouble by telephone to their local operating telephone companies. A test desk man at the company will analyze the trouble reported and determine what course of action is required. Under his direction, the customer may dial up an automatic test line (ATL) and use it to determine the nature of the trouble. If an operating company craftsman is sent to the TWX station he may use the ATL to determine the trouble, or he may use his portable test equipment, or he may place a call to a manned test center. All test equipment, except for some standard transmission measuring test sets, was developed for the dial TWX system.

Automatic Test Line

The automatic test line permits one-man testing of the over-all operation of a TWX station. After it is reached through a dialed-up connection, it automatically sends standard teletypewriter test signals (the quick brown fox, etc. . . .) under various conditions of carrier signal level and distortion. The condition of the teletypewriter machine and that of the data set and loop is determined from the printed copy at the teletypewriter. After the station is thus checked for its ability to receive,

An attendant uses the new subscriber set on a teletypewriter console equipped for dial TWX *service.*

it gets a typed request from the ATL to transmit. Any distortion in transmission is automatically measured by the ATL and a "TRAN OK," indicating good transmission, or "OUT LIM," indicating a fault, is automatically typed back.

All the automatic features of the new system would be of little value to TWX customers if they did not assure an error performance at least as good as, and preferably better than, that of the present manual system. Field tests conducted jointly by the A.T.&T. Co., the operating companies, and the Laboratories indicate that there is a 99 per cent probability of sending a ten line message without errors due to transmission. Usually an error affects only one character; occasionally one will affect several characters. The rate of errors will vary depending on the kind of facilities a call is routed over and the number of links involved. Some customers will have a slightly higher rate, some lower.

Many customers will find dial-operated TWX service attractive for their data traffic. Customers with a very heavy traffic load will, of course, require much more sophisticated station equipment than has been offered in TWX service. In anticipation of this, new station equipment is being designed, so that, like dial-operated TWX, services can be offered with all the facilities customers may need.

Eastern Third of Blast-Resistant Cable System Nears Completion

The Bell System will complete the eastern third of its blast-resistant transcontinental cable system late this summer as part of its continuing program to insure the survivability of communications.

All the cable, amplifier stations and communications centers are being constructed underground, engineered to withstand any nuclear blast short of a direct hit. The system will be completed to the west coast by 1964.

The buried cross-continent system will transmit telephone calls, data and other communications and will interconnect with existing microwave and coaxial express routes. These criss-cross the nation and include bypass routes around potential target areas. The underground system, which also avoids large cities and major target areas, will represent a Bell System investment of about $200 million when completed.

The subterranean complex will include almost 4,000 miles of coaxial cables, more than 900 intermediate amplifier stations and nine communications centers linking the new route to conventional facilities. The cable is being buried deep underground, and all amplifiers and terminal equipment are housed in reinforced concrete buildings protected by thick earth cover. Manned stations are protected from radioactive fallout.

The communications centers, buried one to two stories deep, have reinforced concrete floors, ceilings and outer walls 18- to 24-inches thick. In emergencies, each center can generate its own power and has reserve water and fuel supplies. Food is stockpiled, and there are emergency living facilities for operators, technicians and maintenance men. Each center's ventilation system is controlled by a sensing device which would react immediately to nuclear blast. Blast valves in the underground buildings would close automatically, filtering equipment would cut in to prevent fallout from entering, and other equipment would constantly check radioactivity.

The only part of each building above ground is a small entrance structure. Personnel enter through a guarded two-door "entry lock" and pass through a fallout decontamination room before reaching the operations areas.

When fully equipped, the new transcontinental system will add about 9,000 telephone circuits to the 15,000 now spanning the country.