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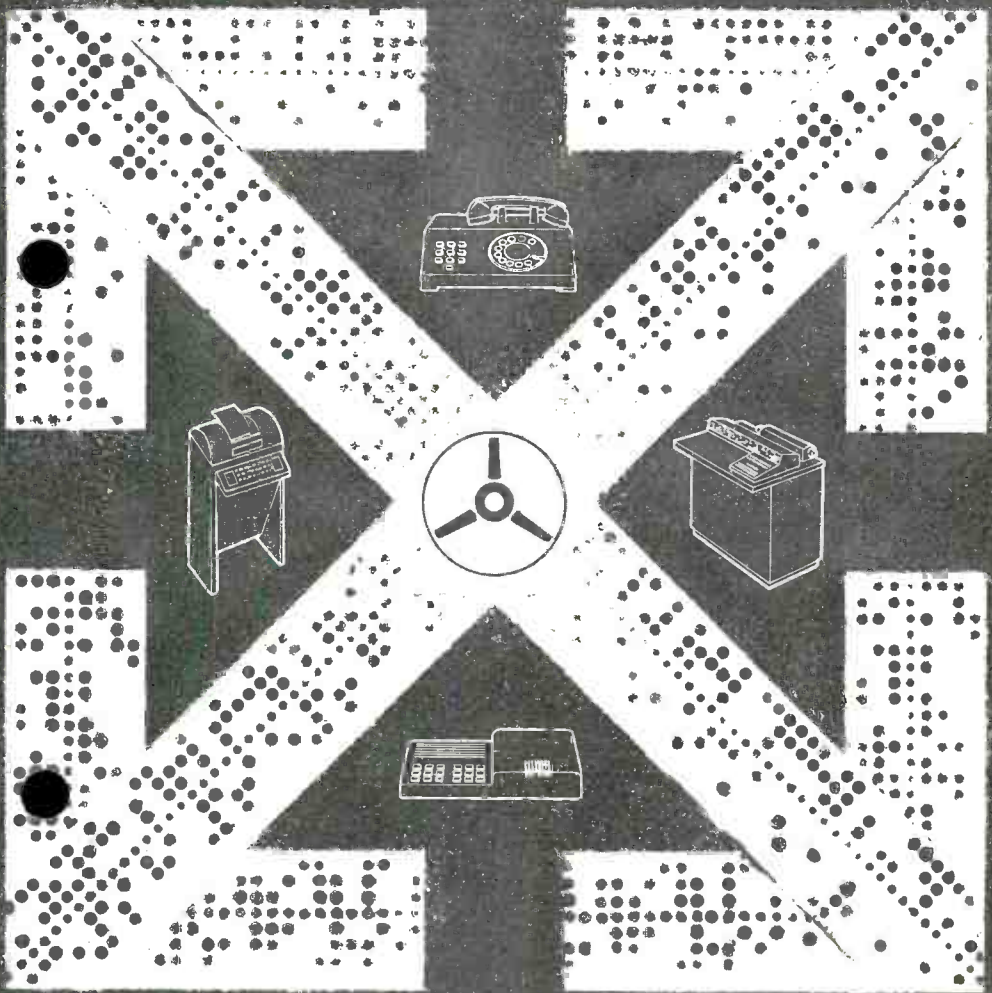
The Lenkurt DEMODULATOR

USES OF LOW SPEED DATA



With the growth of knowledge and the expansion of both business and government has come a need to provide timely and effective communications to widely separated but integrated organizations. The most obvious way to meet this need has been to increase communications speeds and expand the capacities of existing communications systems.

In this article, the Demodulator *explores some of the ways that low speed data transmission is expanding communications capacity.*

Explosions occupy an increasing amount of space in today's literature. Populations are exploding and information, aided and abetted by stories about itself, continues to explode.

At present rates, the volume of information is doubling every five years. A few years ago this took ten years and a century ago the body of knowledge available doubled at the leisurely pace of once every 50 years. Needless to say, the effective dissemination and use of all the facts and fancies coming into circulation today poses a staggering problem.

Perhaps the most promising solution to this problem is data communications —the use of machines and machine languages to transfer information from place to place by electrical means. Although the present tendency is to define telegraph and data communications separately, the two have similar transmission requirements and for the purposes of this discussion will be included under the general heading of data communications.

A typical data communications system consists of an input, modulator, transmission link, demodulator, and data sink. The input can be anything from a highly sophisticated computer to a simple business machine. The data sink might be nothing more than an output device. More often, the data sink is a depository, such as the memory bank of a computer, for the data being communicated.

The modulator and demodulator, often referred to as data sets, interface the input or output equipment with the transmission link. It is the function of the modulator to make input signals suitable for transmission. The demodulator converts the transmitted signals to their original form before sending them to an output device.

Two Categories

By using different combinations of input devices and data sinks, a remarkably comprehensive data communications system can be evolved. In general most systems fall into one of two cate-

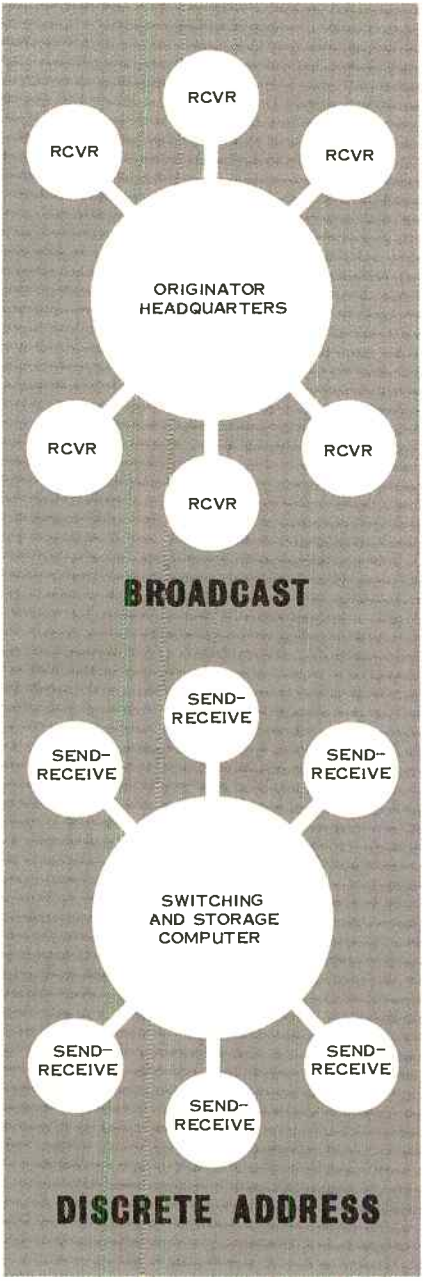


Figure 1. Data communications systems fall into one of two general categories. One is essentially a receive-only system while the other has stations with a send and receive capability.

gories. The simplest employs a number of receive-only terminals connected to a single data source. It is often compared to a radio broadcast. This procedure serves mainly to distribute information which is perishable—information intended to be used only once and then immediately.

Another procedure uses discrete addresses. The majority of the stations in this system have a send as well as a receive capability, although there are monitoring systems with send-only remote terminals which update computer information. Each remote terminal can be called by the use of addresses and any remote terminal can address other terminals in the system. More often than not this configuration uses a data sink to store information for future use.

As might be expected, data communications systems can be flexible enough to integrate both methods in a single system. For example, the broadcast method can be designed so that more than one station on the network can originate traffic to all or some of the subscribers. On the other hand the discrete address method can, by using preassigned address calls, broadcast information to several subscribers simultaneously.

New Economies

Recent changes in communications regulations have made low speed data communications more economical. Many systems use leased line circuits for transmission. These lines have been leased for specific purposes and, in the past, have had to terminate in telephone company interface equipment. Now a new tariff filed with the Federal Communications Commission makes it possible for a customer to install his own data set to interface on certain leased lines.

This change has given users the option of choosing interface equipment

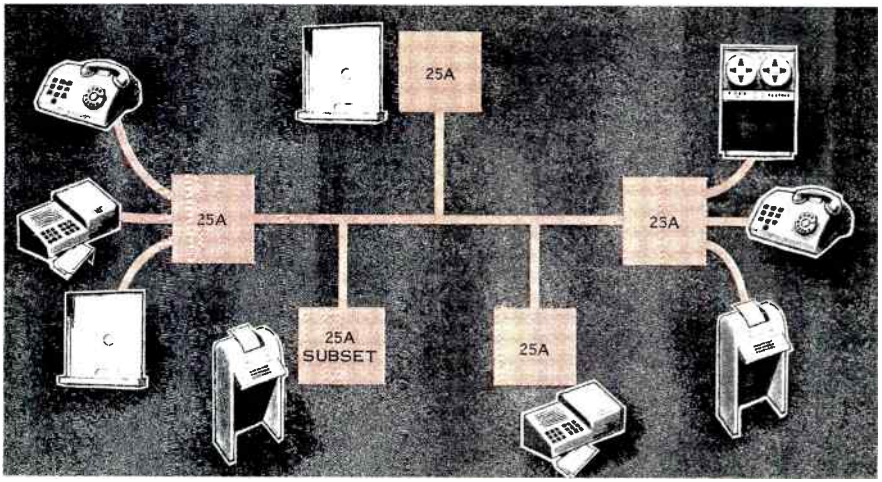


Figure 2. The Lenkurt 25A data transmission system makes it possible to use one voice circuit for a number of data channels. The 25A operates between 75 b/s and 200 b/s with a maximum of 25 channels per voice circuit.

which makes the most efficient use of a leased line. Individual users can now employ equipment which derives a number of channels from a single, leased voice-frequency circuit. From a user standpoint this enables him to satisfy several requirements—depending on the characteristics of his system—with only one voice circuit.

Speed of transmission is one system characteristic which influences the number of channels which can be derived from a single circuit. Direct computer-to-computer operations, for instance, run at extremely high speeds. Computers talking to each other under the most ideal circumstances can exchange bulk information in nanoseconds (a nanosecond is one billionth of a second). But high speed exchange requires wideband transmission paths which minimize impulse noise and delay distortion. Such considerations raise the cost of leased services.

Lower transmission speeds can use narrower bandwidths and less ideal circuit conditions. Data at rates up to 9600 bits per second has been carried on an equalized voice circuit. With even lower speed input equipment, sharp filtering can split a voice-frequency circuit into a number of separate channels. With the remote ends of each channel serving a different terminal, the over-all traffic volume can be increased without increasing circuit costs.

Increasing Efficiency

Making the most efficient use of data communications is not merely a matter of getting the maximum number of channels on a voice circuit. The computer must be protected against having to wait for all data from one channel before calling for inputs from another channel. With data coming at 200 bits per second or less, for instance, a computer capable of receiving information at 1.5+ million bits per second would be wasting time. On the other hand, allowing only one terminal at a time to have access to a computer would

in effect turn a multi-channel voice circuit into a single channel circuit. To avoid such inefficiency each communications channel feeding a computer normally terminates in a buffer unit which uses store and forward techniques to accumulate data from many sources and send it to the computer at higher and more suitable speeds. The buffer acts as an intermediate storage device which compensates for the difference in the rate of flow between input and computer.

The buffer is not an essential component of a data transmission system. With it, however, a large number of remote terminals can communicate with a single computer. The buffer collects incoming data at relatively low bit rates and literally spits groups of bits into the computer in hunks called "bytes".

Accuracy

Of course, moving data at high speeds is of no avail if the material is not received accurately. This is especially critical in a system which passes large amounts of numerical or encoded data. With numbers and random letters an end user has a much more difficult task interpreting garbles than he would if plain language were being received. Obviously, data which goes directly into a computer or other business machine must be essentially error free.

Some sources of error, such as those introduced by malfunctioning equipment or operating personnel, are easily identified and can be corrected—at least temporarily. Others, which also affect the accuracy of a transmission, are not so easily dealt with. These depend on a number of variables including speed of transmission, noise and propagation characteristics.

Low speed data transmissions tend to minimize these sources of error because the signals exist longer and can more readily withstand disrupting influences. Although any given system will exhibit its own peculiarities regarding error rates, one test over leased lines found an error rate of from one to eight characters per 100,000 transmitted. At this rate an error occurred as often as every half hour and as infrequently as once every four hours. In terms of a 100 word per minute system, 144,000 characters could be sent between errors.

Nationwide

Both the Associated Press and United Press International are installing Lenkurt 25A data transmission systems to take advantage of the vast voice-frequency network already available in the United States. The 25A can derive as many as 25 channels from one voice circuit. This gives each wire service its own private broadcast network. To provide, say, 20 different news services a wire service only needs one voice circuit. Two channels might carry hard news, another feature stories, a fourth general sports news, and a fifth horse racing news. Other channels might have financial news, state news or special services such as news edited and processed prior to transmission so that a tape received along with the teletypewriter copy can be used to set type. Finally, other channels might be reserved for communications between bureau offices and wire service headquarters.

The ordinary news service subscriber, either with a data subset at his terminal or via local service from a data interface point at the wire service bureau office, receives only the channels contracted for. On the other hand the bureau office, in addition to terminating the desired news channels, can originate news traffic on certain channels. With a channel of its own, a bureau can provide the wire service with fast coverage of local events. For example, a flood story in the Midwest can be sent by the nearest bureau office to the news service head-

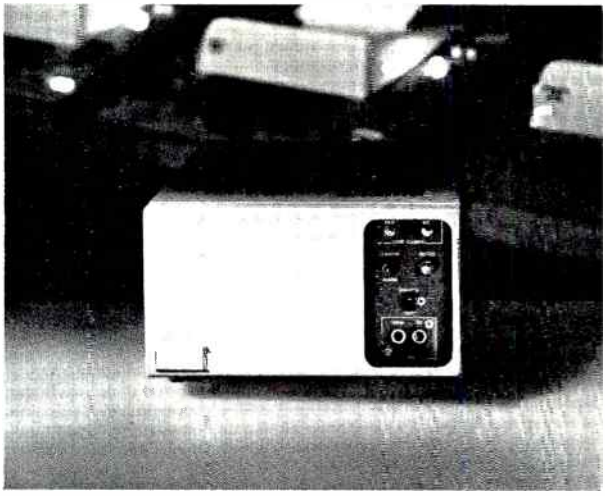


Figure 3. Lenkurt 25A data transmission subsets are being used by news service subscribers. Each subset is tuned and set to the channel contracted for by the subscriber.

quarters and to all subscribers on that channel.

Certain designated offices can block local delivery of channels on the backbone trunk. By blocking local delivery a bureau gains a free channel for broadcasting local news to regional subscribers. A bureau in the Southwest, then, can originate its own broadcast of news about the Southwest for local subscribers.

Wall St.

The nationwide brokerage firm of Paine, Webber, Jackson & Curtis is using Lenkurt 25A equipment to connect its 51 offices with a computer in New York City. The resulting data communications system represents a non-broadcast or discrete address network. As with the wire services, voice-frequency circuits serve as the backbone for a system which makes it possible for branch offices to feed data directly to a computer which acts as a message switching system.

Since installing its data communications system, Paine, Webber has more than doubled its communications capacity and has reduced the handling time of an execution order by as much as 20 or 25 minutes. With the new system an order for the New York or American stock exchange travels over one of the 22 two-way teletypewriter channels to the company's computer where it is directed to the correct booth on the exchange floor. The data communications system gives branch offices access to the firm's over-the-counter trading, institutional, bond, research, and underwriting departments. Copies of an order and its execution are also printed in the firm's bookkeeping office to speed billing and crediting customers' accounts. The entire transaction is also recorded on magnetic tape for record-keeping purposes.

Although the system is oriented toward handling orders, conceivably it could be put to such other uses as price quotations, reporting customer accounts or handling other information which is needed on a real time basis. Essentially it is an on-line, real time system. Each remote user is on-line with the computer continuously, guaranteeing an immediate or real time response from the computer. Where data must be processed outside the system, as would be

the case on the stock exchange floor, response time will depend on the quickness of floor traders in handling an order.

Near and Far

Banks are making use of low speed, on-line data communications systems to link their branch offices to a central computer containing balance information on all customers' accounts. If a customer wishes to cash a check at the bank, a teller can query the computer on a push button intercom and receive a verbal response from the computer in about 20 seconds. By using a computer the bank has a single information retrieval system for all its branch offices.

A national radio-television network is using an information retrieval system to determine instantly the status of the air time it has for sale. By querying a computer any salesman can find out what air time is available. In addition, the network management has on call an up-to-the-minute report on all time sales. Of course, data communications also provides a means of keeping the computer updated on the status of sales.

Data communications is also helping create firms which offer computer services to a number of subscribers. This timesharing concept gives various unrelated organizations, many of which would not lease their own, a computer 24 hours a day. Each user has his own code, can store information, and can run his own programs. Several colleges offer timeshare services to other colleges and business firms as well as to their own students and faculty. Some companies and computer manufacturers are also sharing computer time with outside users.

Tymshare, Incorporated in California sells time on its computer to users as close as a local phone call and as far away as Colorado and New Mexico. At present all customers—remote and local—have access to the computer through data sets transmitting directly to the computer over ordinary dialed telephone circuits. In the future, however, remote users will be able to communicate with the computer by dialing a local number which interfaces with a leased line. The leased line, terminating in Lenkurt 25A equipment, will serve

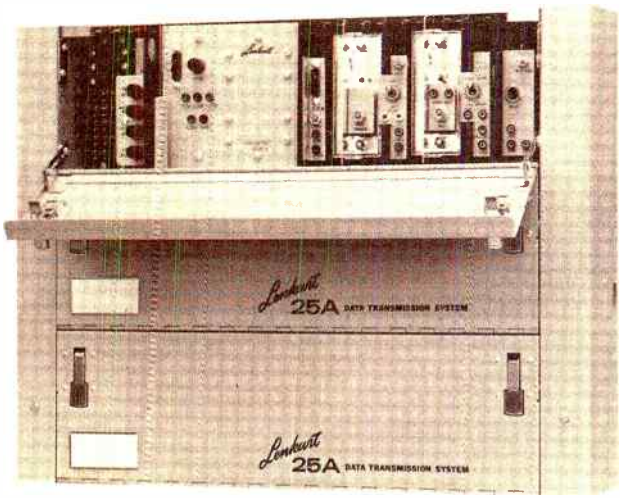


Figure 4. The Lenkurt 25A is an economical, highly reliable data transmission system which uses sharp filtering to transmit up to 50% more information than conventional systems.

as a trunk, able to handle several calls at once. This timesharing application allows users to run engineering and scientific computations or develop programs on a real time, on-line computer. It provides customers with simultaneous access to a computer with a maximum response delay of three seconds.

The Railroads

Railroads, many of which own their own communications networks, are one of the oldest users of data communications. By installing data transmission systems railroads have been able to increase their communications capacity at minimal cost. The increased capacity has in turn made it possible for the railroads to account for every car and train in their system on a real time basis.

Each car is represented by a data card and each train is represented by a stack of these cards—one for each car plus cards for the locomotive and caboose. As a car moves from yard to yard, its card, along with the other cards for cars in the train, is transmitted over data circuits to the next yard. This gives personnel at the next yard timely information for handling the incoming train.

At the same time this information is relayed to a computer to update its record of each shipment in progress. The computer, accessible from many sources by data communications, allows the railroad to make immediate replies to inquiries about a shipment.

Freight offices which book shipments are linked by teletypewriter to the communications system so that a shipping order can be processed immediately. A single message from the freight office provides the accounting department with billing information, the freight department with car requirements and the computer memory with a record of the transaction. From that point on the progress of the shipping order and the subsequent shipment can be recorded by relatively short inputs direct to the computer.

Railroads also use data for administrative traffic and train safety. One line has centralized its payroll accounting by sending timecard information over its communications system directly to a central office. At present the checks are drawn up and mailed back to the station submitting the timecards, although the processed information could be returned on a data circuit and printed directly onto check blanks.

For train safety, railroads are using a specially developed Lenkurt 960A journal data transmission system. This unit converts analog sensor signals received from heat detectors to tones which can be transmitted over standard communications facilities. Overheated journals have been cited as contributing to railroad accidents costing millions of dollars annually. The 960A, linked to a transmission system, is helping to reduce the number of these accidents.

Immediate Response

Airlines use on-line, low speed data communications to handle their passenger reservations, freight operations and aircraft maintenance schedules. During non-peak hours the airlines use the same communications to handle bulk jobs such as payroll and inventory. Pipeline and utility companies have joined their far flung operations with data communications also. The pipeline companies monitor such operational details as flow rate, pump pressure, suction, and fluid viscosity. Utility companies exercise load control by using data communications to connect substations and switching points. In both cases distant operations can be adjusted in response to variations as they occur.

Large business concerns which would not be immediately associated with a need for real time communications are using data communications to enhance

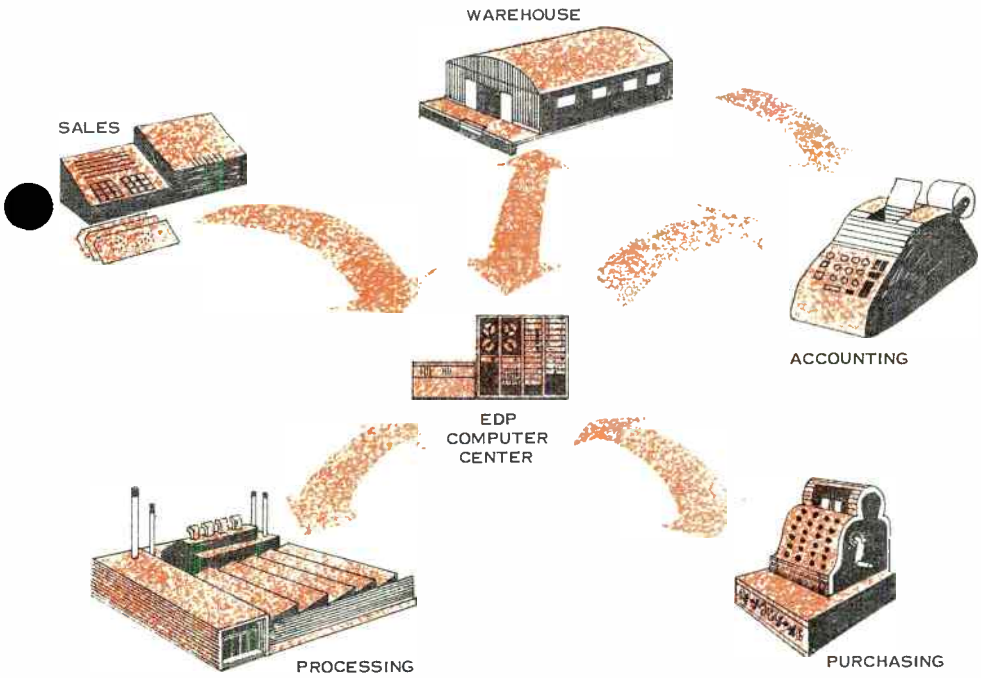


Figure 5. Management information systems can use data communications for their sales offices, manufacturing plants, and planning and support departments.

management information systems. Leased voice-frequency circuits connect central computers with warehouses, sales offices, processing plants, and accounting and purchasing departments.

With such an installation, a salesman booking an order at one of the sales offices sends that order via a data channel to the firm's computer. The computer determines which warehouse is best situated to fill the order and routes it there. At the same time the computer informs accounting that the customer's account should be billed for the item. If necessary and if programmed to do so, the computer will also inform production and purchasing of the order so that these departments can take action. If necessary, the warehouse can update the computer's inventory record.

Orders by data communications gain time—they can be filled within a few hours. Users claim that the time between writing and delivering an order can be less than twenty-four hours.

Supermarket chains with their own warehouses have used this method for restocking and inventory control. A large company which supplies consumer items to gas stations claims that orders placed by mid-afternoon can usually be on their way to the customer the next morning. Even at the slowest transmission rates information gets from place to place much faster than by conventional means. One company found that using data communications to process its daily sales spread the work load evenly over the week. Before switching to a data system, over 40% of its orders

arrived on Monday and all orders spent at least two days in the mail.

Data communications can bring widely separated parts of an organization into closer coordination. Within seconds an order can be available at any number of user stations. If a computer is part of the system and is used for record keeping, the order is on file instantaneously. At the same time the computer can perform whatever accounting computations it is programmed to do.

Operating data from outlying points can be made available daily. Management then has timely and accurate information on which to base production schedules and sales promotion plans. Management also has for its immediate use information that can influence the purchase of basic commodities, the location of plants, and the regulation of cash flow.

Such interwoven systems reduce errors and paper work. A shipping invoice on a customer's order need be written only once. After that, all copies are either transmitted directly to users or are on call from a computer memory. In addition, records stored in the computer are updated automatically by direct inputs—no formal reports to be hand delivered by messenger.

More to Come

These examples only touch the more prosaic possibilities of data communications. What lies ahead depends more on man's imagination than on his technology. There has been speculation that houses might have a home learning center connected to a teacher-computer by data links.

A few public utility companies are testing data systems which, by sending information directly to the billing office, could replace meter reading. At the same time these real time readouts could warn a control center of potential system overloads.

A data input device interconnecting retail stores with banks could eliminate money. On payday an employee's bank account would be credited by a deposit from his employer. The employee could draw on that deposit by inserting his personal money-card into a remote data terminal. The remote terminal would transmit information from the money-card, along with the amount required for the transaction, to the bank. The bank in turn would compare that amount with the balance of the account in question and, if there were sufficient funds, okay the transaction and debit the account.

Coming even sooner than the money card scheme is a data communications system to give customers immediate access to hundreds of theater and sporting event tickets. By using a special terminal device in supermarkets and banks a customer can select tickets to a ballet in London, a football game in New York, and a play in Los Angeles within a few seconds. The customer's order is transmitted from the supermarket to a computer which searches for the tickets to the event and in the price range and area desired. When the seats are found, the computer causes the remote terminal to print the tickets for the customer who pays for them at the supermarket .

Data communications is bringing widely spread operations into more immediate contact and in so doing increasing the coordination between separate parts of large organizations. It is also keeping the right people informed in spite of ever increasing amounts of information. Hopefully, it will prove to be an effective solution to the problem of handling the exploding amounts of information becoming available.

An Invitation . . .

During the year Lenkurt exhibits its diverse product line at over 25 conventions. By participating in these shows Lenkurt has an opportunity to exchange ideas with communicators in many, varied industrial and governmental fields. This fall and through the final quarter of 1967, Lenkurt will have booths at several conventions. You are cordially invited to drop in on us.

Data Systems Division Association of American Railroads	**Houston**	**Sept. 11-13**
Rocky Mountain Independent Telephone Association	**Albuquerque**	**Sept. 11-13**
New England Independent Telephone Association	**Dixville Notch**	**Sept. 10-13**
North Carolina Independent Telephone Association	**Pinehurst**	**Oct. 2-3**
Communications & Signaling Division Association of American Railroads	**Chicago**	**Oct. 8-13**
United States Independent Telephone Association	**Las Vegas**	**Oct. 9-12**
Virginia Independent Telephone Association	**Hot Springs**	**Nov. 12-15**
Fall Joint Computer Conference	**Anaheim**	**Nov. 14-16**
Florida Independent Telephone Association	**Jacksonville**	**Dec. 7-9**

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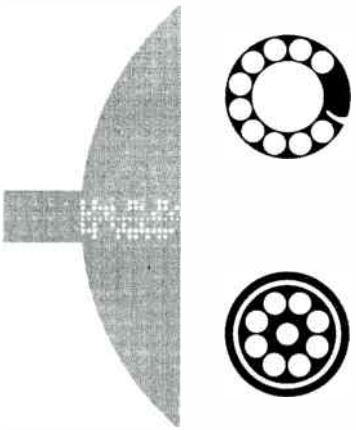
A WORD ABOUT THE LENKURT DATA FAMILY



Look to the growing Lenkurt Data Family for your data needs. Lenkurt specializes in highly stable, easily maintained and flexible data transmission systems. They are accurate and uncomplicated—and can increase the capacity of almost any communications system. For data on voice circuits, the 25A covers the range up to 200 b/s. Above that range is the 26C, a Duobinary-Datatel™ system capable of 2400 b/s. The 970A handles data on wideband or multiplex systems. Lenkurt's Data Family also includes such specialty items as the 960A journal transmission system for railroad "hot box" detection and a speech plus data panel for speech and data transmission over a single voice circuit. For more information on any or all of these systems write Lenkurt, Dept. B720.

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