The Lenkurt® Demodulator

NEWS FROM LENKURT ELECTRIC

VOL. 5 NO. 11 NOVEMBER, 1956

A Program for

CARRIER EQUIPMENT MAINTENANCE

Manufacturers, through equipment design and factory services, can help reduce the maintenance burden of the operating company.

This article discusses Lenkurt's role in the reduction and simplification of maintenance and routining.

New equipment developments, the rapid expansion of plant facilities and the impact of nation-wide toll dialing have given new emphasis to the need for more comprehensive maintenance programs throughout the telephone industry. The large-scale use of electronics in recent years has greatly increased the number of knobs to be turned, tubes to be tested and measurements to be made.

Maintenance is an important part of the cost of operating the modern telephone plant. Because of this, operating companies are constantly seeking to reduce and simplify equipment maintenance. Repair facilities, spare parts systems and plant facilities are being improved. And many companies have started training and refresher courses for their maintenance personnel.

The equipment manufacturer has a definite place in the over-all maintenance picture. He has in his hands a very valuable tool for maintaining his equipment—the knowledge accumulated in the development and production of it. By sharing his experience, the manufacturer can help make the operating company's maintenance program more efficient and effective.

At Lenkurt, a four-point program for the reduction and simplification of equipment maintenance is available for all users of Lenkurt equipment: (1) equipment is designed with maintenance in mind; (2) factory repair and replacement services are available to the equipment user; (3) a fully-equipped training school with full-time instructors is available; and (4) special equipment maintenance instruction material is provided.

Equipment Design

From a maintenance standpoint, equipment design is of considerable importance. A long, trouble-free life

Copyright 1956, Lenkurt Electric Co., San Carlos, Calif.

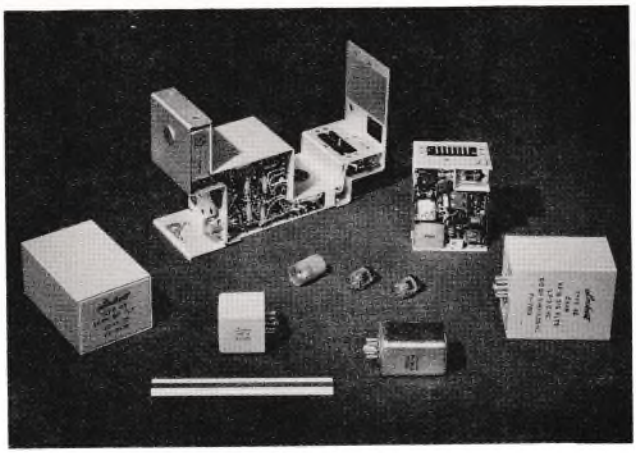

FIG. 1. Type 45A channel unit with plug-in sub-assemblies shown removed.

for equipment can be achieved by careful detailed planning in the early development stages. In the carrier and microwave equipment field, such advantageous features as long-life components and plug-in units are the result of planning for easy maintenance on the part of the manufacturer.

Miniaturized components and the subsequent reduction in size of the overall equipment contribute greatly to savings in space. Small, compact units and sub-assemblies facilitate repair and handling and require less space in spare parts storage.

The compactness and reduced size of components led to application of the plug-in concept for carrier and microwave equipment. Plug-in units divide the system into smaller, more convenient assemblies and sub-assemblies. For example, a Lenkurt Type 45A carrier system terminal is divided into channel units, group units, regulator units and frequency supply units—all of which plug into the terminal rack. The various units are in turn divided into smaller plug-in sub-assemblies. The Type 45A channel unit, shown disassembled in Fig. 1, illustrates the practice.

The plug-in concept is an important step towards minimizing equipment outage and troubleshooting time. Formerly, a circuit could be out of service for hours while a maintenance man searched for a defective component within a unit. Through the use of plug-in units, an inoperative circuit can be restored to service within minutes by substituting a good spare unit for one suspected of being faulty. In addition, less repair equipment is needed and a saving in maintenance time can be obtained by maintaining central repair shops to trouble-shoot the faulty units.

Test points are conveniently located to assist maintenance men in rapidly localizing equipment troubles. On Type 45A equipment, test points, test panels and jackfields are provided for rapid testing of system operation. By use of test points, faulty circuits can be located without the necessity of random substitution of spare components and units.

Figures 2 and 3 illustrate the application of miniaturized plug-in units to Lenkurt equipment. A Type 45A carrier system terminal, shown in Fig. 2, is in

the process of being installed. All channel, group, supply and associated units are placed in rack shelves to complete the terminal. Completely assembled Type 45A terminals and associated equipment are shown in Fig. 3.

Factory Service

An important phase of Lenkurt's program for ease of maintenance is the provision for service after a system has been engineered and installed. Factory repair facilities are available to all equipment users for post-installation service needs. This service provides the customer with fast and dependable repair or replacement of equipment sent to the factory.

The factory service facility provides a convenient central repair station for the operating company. Equipment received from the customer is sent to the factory repair facility where technicians, specially trained for factory service, can effect quick repairs.

In addition to equipment repair, a unit replacement service is available to the customer for emergencies. A faulty unit can be exchanged for a new or fully-guaranteed reconditioned unit which is normally shipped within 24 hours after receipt of an order. Factory replacement service helps the equipment user from the standpoint of speed of service restoration when an equipment failure occurs in a unit not carried in spare parts.

When special problems arise, field engineers and technicians can be sent to the user's plant. Arrangements for this service can be made through Lenkurt representatives or distributors. Whether the user needs factory or field service, the freeing of customer personnel for other activities represents an advantage to the equipment user.

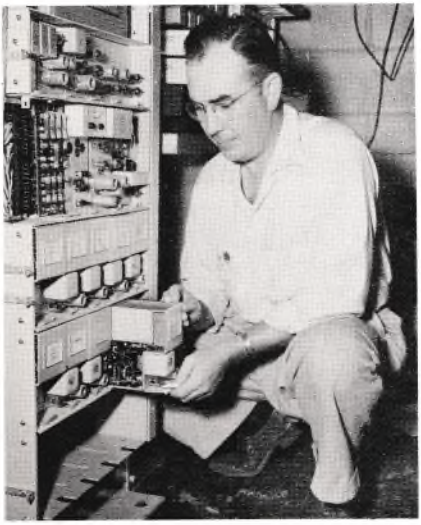

FIG. 2. Type 45A carrier system channel unit is shown being placed into position.

Technical Training School

With the complexity of modern telephone equipment, specialized training of maintenance personnel is needed to keep equipment functioning at its best.

An organized training school with full-time instructors is operated by Lenkurt for training in installation and maintenance of carrier and microwave equipment. The courses are conducted by engineers with experience in both the theoretical and practical aspects of equipment operation. Classes are offered at certain field locations as well as at Lenkurt plants in San Carlos, Vancouver and Mexico City. Classroom facilities include complete working systems, test equipment, drawings and

technical publications. A typical training school class is shown in Fig. 4.

Technical training schools serve a number of functions. First, the equipment user's maintenance personnel are provided with the background necessary to keep the equipment operating at peak performance. Second, the school serves as a gathering place for customer recommendations on improvement of instruction material and equipment, as well as a source of the latest in maintenance techniques.

The training school also can be coordinated with the equipment user's own training program. Training aids are available to help the customer organize his own training program. In addition, a number of companies have sent men to the training school so they can return to the company and start a similar training course. In this way, the customer can provide a greater portion of his maintenance personnel with training.

Equipment Drawings and Publications

To coordinate the entire program for maintenance, Lenkurt provides publications and drawings that help users to apply, understand and maintain their equipment.

An effort has been made to make the publications as clear and concise as possible. Wherever necessary, illustrations, photos and tables are used to clarify the subject matter. Since modern equipment is often technically complex, maintenance manuals and equipment prove invaluable to maintenance men when troubleshooting and lining up the equipment.

Maintenance publications covering Lenkurt products are generally divided into two categories: (1) detailed instructions and (2) condensed instructions. The detailed instructions are divided into step-by-step lineup, test and maintenance sections. Schematics, block diagrams, test points and other data are included in the detailed sections. For more complex assemblies, this material is generally divided into separate books with separate groups of drawings.

Condensed instructions include lineup, testing and maintenance information, but are briefer than the detailed sections. Tables containing test point voltages, continuity checks, etc. for each major assembly are placed on a single sheet to aid the maintenance man in rapid troubleshooting. If more comprehensive information is required, the detailed instructions can be consulted.

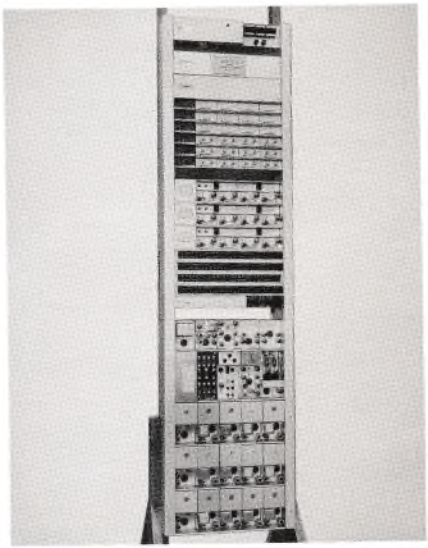

FIG. 3. Type 45A carrier terminal showing plug-in units mounted in position on standard rack assembly.

FIG. 4. A technical training school class in session. Problems worked by students are checked on equipment operating under simulated field conditions.

Lenkurt drawings and publications are always furnished as part of the equipment order and are also available to customers through the Equipment Drawing and Publication Information Service Department. This service, furnished on the basis of an annual subscription plan, provides the equipment user with a master index of all Lenkurt drawings and publications.

Monthly change supplements list all new drawings and publications for equipment developed after the publication of the master index. All other changes are also noted on the supplement. The price and description of each individual drawing or publication is listed in both the supplement and the master index.

The drawing and publications service enables an operating company's engineering office to maintain up-to-date files of instruction material, maintenance manuals, equipment specifications and drawings. This is especially important for the planning of maintenance programs or the expansion of plant facilities.

Conclusion

With the significant advances that have been made in the field of telephone equipment in recent years, the need for rapid comprehensive maintenance programs has become evident. A great number of operating companies have responded to this need by instituting preventive and corrective maintenance routines and training courses for their employees.

To assist operating companies in their maintenance programs, Lenkurt is offering equipment that requires less maintenance attention and is providing various technical services designed to reduce and simplify the operating companies' equipment maintenance.

CARRIER LEAK

In Carrier Telephone Systems

Most toll carrier systems use a method of suppressed-carrier, single-sideband transmission. By this technique, the original voice-frequency signal and the carrier are suppressed in the modulator and one of the two sidebands is eliminated by a filter. The intelligence to be transmitted is contained in the remaining sideband. (See Lenkurt *Demodulator,* Nov. 1955 and Jan. 1956.)

Suppressed-carrier, single-sideband transmission offers several distinct advantages over methods which transmit the carrier and both sidebands. Among these are the economies realized in power and bandwidth. But unless the modulator and the sideband filter do an effective job of suppressing the carrier, some carrier energy may find its way into the system and interfere with its proper operation. This unwanted energy is called *carrier leak.*

A typical "ring" modulator for suppressed-carrier transmission is shown in Fig. 1 and the carrier current paths for opposite halves of a cycle are shown in Fig. 2. Under ideal conditions, the carrier current paths through the transformers and diode pairs have identical electrical characteristics on both halves of the cycle. The carrier current then divides evenly at the center taps of the transformers and the net voltage induced in the secondary of the output transformer becomes zero. Ideally then, no energy at the carrier frequency can find its way into the output of the modulator.

In practice, however, such perfect balance cannot be achieved. The effects of temperature, shock, and individual differences in component characteristics can cause slightly uneven division of current at the center tap or slight differences in carrier current flow on opposite halves of the cycle. This small net current through the output transformer primary induces a carrier-frequency voltage across the secondary and constitutes carrier leak.

Since the carrier is introduced into the modulator at a much higher level than the signal, unbalance may make the level of carrier leak much higher than the sideband level at the modulator output. Even though this carrier leak is then attenuated by the sideband filter, it may still get through at a level high enough to overload the amplifiers of the carrier terminals and repeaters. Since the system is designed to handle only the sideband power, amplitude distortion results.

Carrier leak can also adversely affect the operation of alarm and regulator circuits in some types of carrier systems. Where alarm circuits are designed to

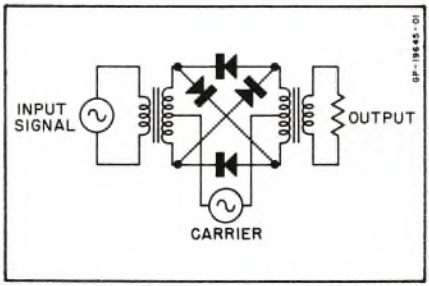

FIG. 1. Modulator which suppresses both signal-frequency and carrier-frequency. Output contains only upper and lower sideband frequencies.

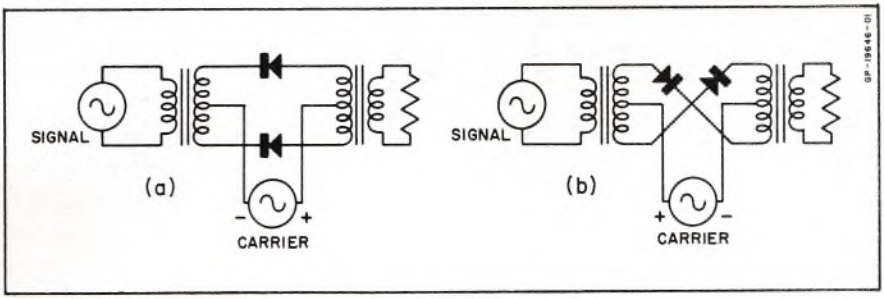

FIG. 2. Effective current paths through modulator of Fig. 1 on opposite halves of carrier-frequency cycle.

operate on an energy-sensitive principle, carrier leak power can sometimes simulate signal strength and prevent the alarm from sounding—even after a complete loss of signal. Similarly, carrier leak also can act to upset the regulation of a terminal or repeater when regulation depends on the level of total received power, or when the frequency of the carrier coincides with a regulator pilot tone.

In view of the damaging potential of carrier leak, its control is important in the design and construction of modulators for suppressed-carrier operation. Since perfect balance cannot be achieved, a workable compromise is to match components and approach the ideal as closely as practicable. The careful choice of diodes and accurate winding of transformers are key procedures. Precisely balanced modulators then combine with sharp cutoff filters to keep carrier leak to a tolerable level.

At Lenkurt, the choosing of diodes for modulators is a two-stage process. The diodes are pre-tested by impressing a voltage across them and measuring the forward current. In the first stage of testing, a relatively low voltage is used and the diodes which pass the same current within a narrow specified range are separated into groups. In a second stage of testing, the diodes from each of these groups are subjected to a higher voltage and the diodes within each group which pass the same current within another specified range are sorted into final groups. These final groups comprise diodes with very closely matched transfer characteristics. The four diodes for each modulator are then selected from one of these final groups.

This method of testing achieves a high degree of balance by limiting the minor inconsistencies inherent even among individual diodes of the same type and from the same production batch.

The accurate positioning of the center taps on the transformers is also an important step. Both input and output transformers of Lenkurt modulators are bifilar (parallel) wound to obtain equal electrical characteristics on both sides of the center tap.

Such careful modulator balancing, followed by effective filtering, insures that very little carrier-frequency energy reaches the output of the system terminal. The adverse effects of carrier leak are thus avoided and full use can be made of the advantages of suppressed-carrier, single-sideband transmission.

Lenkurt Electric Co.
San Carlos, Calif.

Sec 34.66, P. L. and R.
U. S. POSTAGE
Paid
San Carlos, Calif.
Permit No. 37

W. F. CRUESS, DESIGN ENGR.
WESTINGHOUSE ELECTRIC CORP.
SWITCHBOARD ENGINEERING DEPT.
EAST PITTSBURGH, PA.

Form 3547 754 20
REQUESTED

A Recently Issued Publication

A new bulletin, **Engineering Considerations, Lenkurt Line Filters,** consolidates in one reference source pertinent information on the various line filters manufactured by Lenkurt. This bulletin contains brief descriptions of the different types of line filters, tables and curves of their electrical characteristics, and block diagrams showing their typical applications. Additional closely related material covers phantom and two-wire repeater balancing, special filters as adjuncts to carrier system operation, and other supplementary information.

The new bulletin is designated as **LF-ENG.** Copies are available on request from Lenkurt or its distributors.

Lenkurt® ELECTRIC CO. SAN CARLOS, CALIF. VANCOUVER, B. C.

Automatic Electric Company and International Automatic Electric Corporation, Chicago, and their affiliates are distributors of Lenkurt products.

The Lenkurt DEMODULATOR is a monthly publication circulated to individuals interested in multi-channel carrier, microwave radio communication systems and allied electronic products. Permission to reproduce material will be granted upon request.

LITHO IN USA