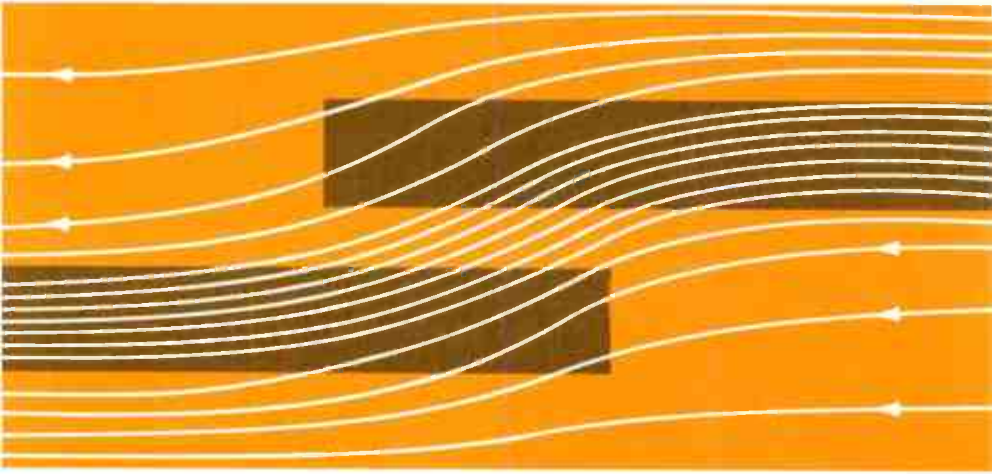
GTE LENKURT
DEMODULATOR
JUNE 1974



Basics of Telephone Relays

The relay is one of the first electromagnetic devices developed and used for communications. It was an essential part of the old telegraph networks, and its name is derived from the function it performed in those networks.

In the early days of electrical communication, attempts to transmit signals over longer and longer distances met with little success. The dots and dashes of Morse Code became too weak to operate any kind of sounding device, after being transmitted over miles of wire. The problem could be corrected by increasing the power of the transmitted signals, but this was only a partial solution and ultimately proved to be impractical.

Figure 1 shows a direct telegraph communication circuit between two stations. If stations A and B are connected by a line whose loss characteristics are such that only 1/1000th of the original signal power transmitted from A arrives at B, and the sounding device at B requires a minimum of 1 watt to operate, then A will have to send a 1000 watt signal to be heard at B. If it is later necessary to expand the network by installing station C (see Figure 2), and the line connecting C to B is of the same length and characteristics as the line connecting B and A, and the sounding device at C also has a 1 watt power requirement, then for B to communicate with C, 1000 watts of power is necessary. For A to directly communicate with C, 1,000,000 watts is required, since to receive the necessary 1 watt at C there would have to be 1,000 watts at B. The total requirement would thus be 1,000,000 watts from A. The use of such large quantities of power could be avoided by having station A send a message at 1000 watts, and have an operator at B send the message on to C at an additional 1000 watts. This solution, however, still requires excessive power. In addition, the human repetition involved is a source of error and introduces a definite delay factor. The development of the relay produced a device that was used to great advantage in solving the early problems of electrical communications.

The relay is an electromagnetically operated switch used to open and close electric circuits. It changes electric action to mechanical action. The essential parts of a relay are shown in Figure 3. When current flows through a coil wound on a soft iron core, the

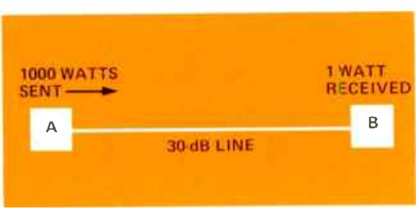


Figure 1. A direct telegraph communication circuit between two stations.

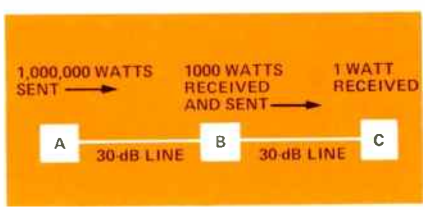


Figure 2. The expansion of a telegraph line necessitates an increase in power.

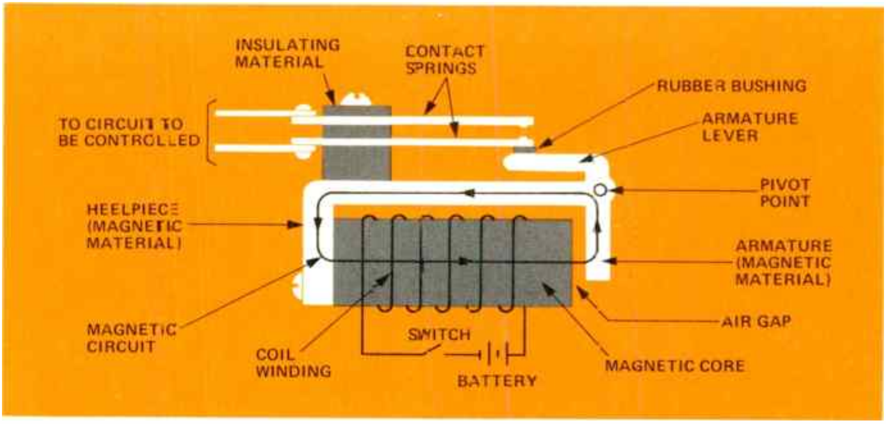


Figure 3. Current flowing through a relay coil magnetizes the core, which then attracts the relay armature.

core becomes magnetized. The magnetizing action of a weak current may be increased by increasing the number of turns on the core. For example, a relay coil may be wound so that it will operate with one milliwatt (1/1000th of a watt) of power. The core of the relay may then generate a magnetic field that is strong enough to attract the movable armature, the motion of which causes the contact springs to close. This closing of the springs may then be used to complete a circuit that can generate larger amounts of power. When the magnetizing current is removed, the core is demagnetized, and the armature is returned to its normal position by the spring action of the contact springs.

By utilizing relays in the hypothetical communication network of Figure 4, not only can the power requirement be reduced, but the human repetition can also be eliminated at the relay point. If this relay is capable of operating on 1 milliwatt, telegraph messages are sent from station A to station B on only 1 watt of power. If station A wishes to communicate directly with station C, a switch is provided as shown in Figure 4, and the relay at B controls a 1 watt sender instead of the telegraph sounder (a relay-type device that produces audible clicks when its armature moves from one position to another). To send messages from A to B. only 2 watts are required, one watt for transmission and one watt to operate the sounder. Communication between A and C requires 3 watts.

Modern Relay Uses

Today, relays are used primarily as switches and control devices. In this capacity they perform various functions that are required in the orderly and logical operation of complex communication networks. The relay is one of the most important components used in telephone switching, since nearly all telephone circuits depend upon one or more relays for operation. Relays also perform an important role in the remote control of certain operations, and in controlling the time of operation such as when:

(a) a weak or variable signal must have positive control over a local circuit,
(b) one circuit must cause changes in several other circuits,
(c) it is necessary to effect time delays or sequential operations or both,
(d) events which must occur simultaneously or in a certain sequence must change another circuit.

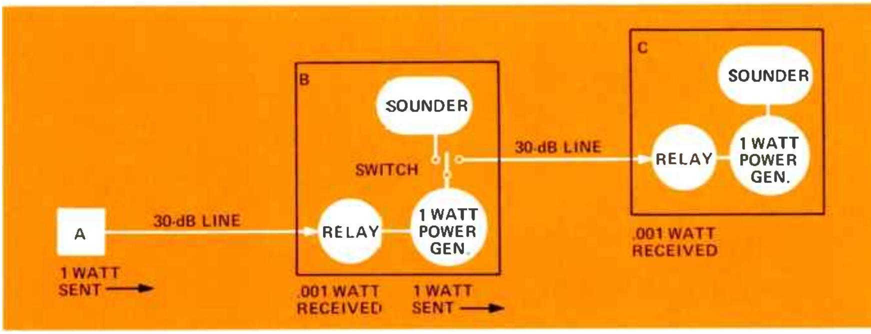


Figure 4. The use of relays in a communication network reduces power requirements as well as the possibility of human error.

Slow-Acting Relays

In today's automatic switching circuits, slow-acting relays are used to momentarily delay certain circuit operations. Slow-acting relays may be separated into two categories: the slow-operating relay and the slow-releasing relay. The slow action of these relays is accomplished by the use of a copper collar mounted around the coil core of the relay, which momentarily delays the operation of the relay armature (see Figure 5). The relay is made to both close and release slowly when the collar is on the armature end of the core. A slow-release-only action takes place when the collar is located on the heel end of the core. A copper sleeve around and along the entire core length also makes a relay slow to operate, and very slow to release. Slow-acting relays are mainly used when it is necessary that the relay contacts remain closed while the coil circuits are repeatedly interrupted for short periods.

Slow-Operating Relay

The slow operating relay is slow to attract its armature after the control circuit has been closed. The copper collar mounted on the armature end of the relay (see Figure 6) causes a delay in the attraction of the armature. To more easily visualize the action that takes place, the relay winding might be considered the primary of a transformer and the copper sleeve a short circuited secondary winding consisting of a single turn having a very low resistance. When a voltage is initially applied to the terminals of the winding, the current tends to build up and establish a magnetic field in the relay core. The instant the lines of force cut through the copper collar, a voltage is induced, causing a current to flow in the collar in the opposite direction from that in the winding. The current in the copper collar sets up a field in the same magnetic path, which opposes the field being built up by the current in the relay winding. Gradually the field in the copper collar dies away and the magnetism due to the winding builds up until it reaches a maximum value and attracts the relay armature.

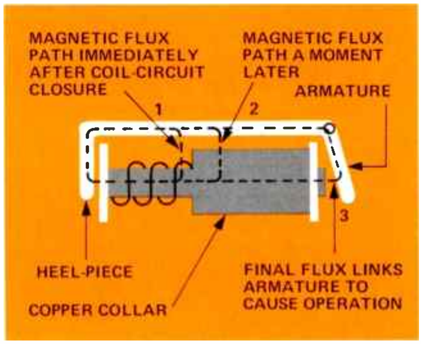


Figure 5. Magnetic flux paths in an armature-end collar relay.

Slow-Releasing Relay

The slow-releasing relay holds its armature momentarily, after the control circuit to the relay has been opened. The copper collar of the slow-releasing relay is mounted on the heel end of the relay (see Figure 7). When the circuit to the coil is broken, the magnetic field, in collapsing, sets up a current in the copper collar, which flows in a direction that attempts to maintain the existing magnetism. But, since this current itself is dependent upon the decreasing magnetism, both the field in the copper collar and in the relay, gradually die away. This action delays the release of the armature.

Correed Relay

An advancement beyond that of the conventional relay came with the development of the correed relay. The complete correed relay assembly consists of a core on which the operating coil is wound, and within which are one or more "reedcapsules." The reedcapsule is a hermetically sealed glass tube containing two flat ferromagnetic metal reeds, each supported at the ends and overlapping at the center of the capsule (see Figure 8). When the operating coil is energized, the magnetic field tries to follow the path of least resistance. The field will assume the

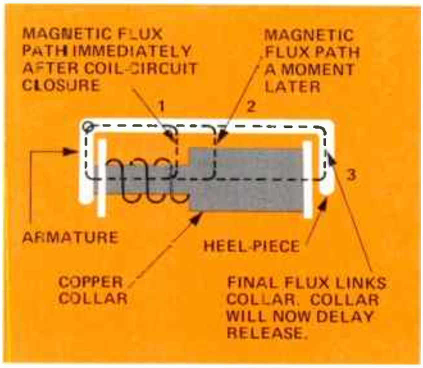


Figure 6. Magnetic flux paths in a heel-end collar relay.

shape and proportional distribution shown in Figure 9. The contact points magnetize with the indicated polarity and attract each other. When the coil is de-energized, spring action causes the reeds to separate. Some of the advantages of correed relays are lightness of weight, economy, and dependability. They may be constructed to contain several sets of contacts, as do other types of relays. Because of their compactness and excellent operating characteristics, correed relays find numerous applications in many of today's electronic switching systems.

Telephone Ringers

Telephone ringers usually operate in conjunction with some type of relay action. Ringers announce incoming

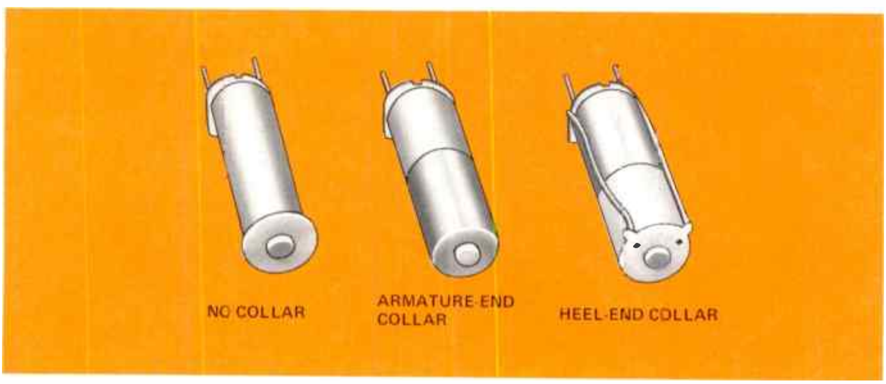


Figure 7. Typical relay coils.

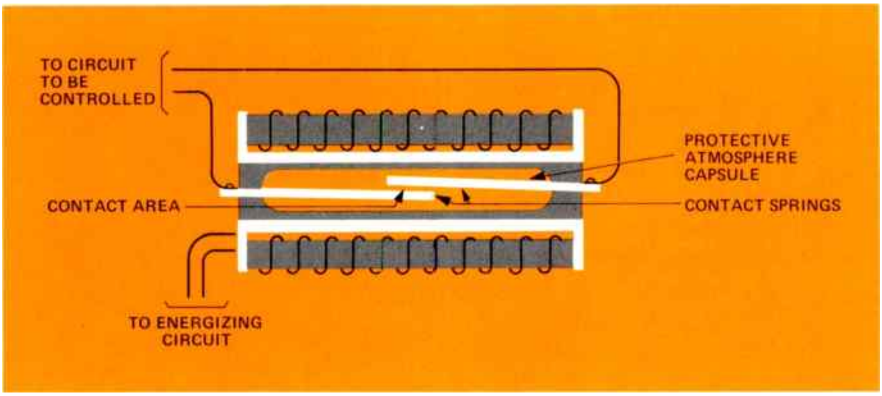


Figure 8. A correed relay.

calls. The working parts of a telephone ringer are shown in Figure 10; they consist of two electromagnetic coils, a permanent magnet, a pivoted armature with hammer, and two gongs. Except for a difference in size and physical arrangement, the operating principle of the ringer in Figure 10 is the same as the operating principle of the polarized telephone receiver (see the May, 1974 Demodulator). With no current in the ringing coils, the ends of the armature are of one polarity, and the ends of the coil cores are of the opposite polarity. Because of the equal attraction of the armature ends by the two coil cores, a relatively small bias spring force will hold the armature against one pole. With the ringing current (ac) applied to the coils, the magnetic balance is disturbed. Each half cycle causes first one, then the other electromagnet to attract its respective end of the armature with greater force. When the right-hand core shown in Figure 10 attracts the right-hand end of the armature, no action takes place; the armature remains in the position where it is normally held by the bias spring. When the left-hand core attracts the left-hand end of the armature, the bias spring force is overcome. The armature swings and the hammer (clapper) strikes the right hand gong. At the end of the half-cycle, the armature swings back to its normal neutral position, and the whip of the clapper rod causes

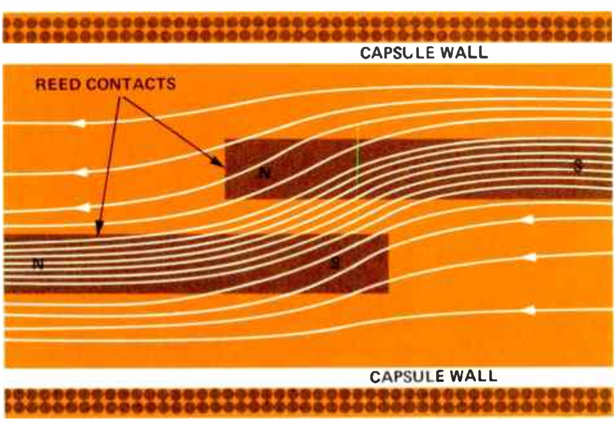


Figure 9. Magnetic lines of force in a correed relay.

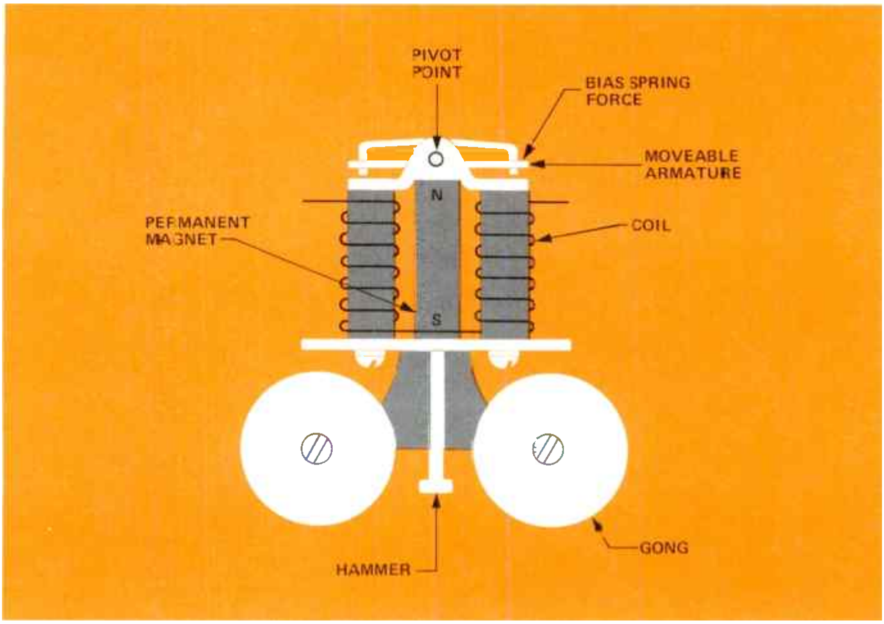


Figure 10. Typical telephone ringer arrangement.

the clapper to strike the left-hand gong. Since a biased ringer is not affected by one polarity of current in its coils, it can be connected to prevent bell tapping during dialing, or used with a cold cathode tube for full selective superimposed ringing.

A relay is essentially a switch that is operated by an electromagnet. The uses for this device run the gamut from simple local switching of a large current, to selecting and operating complex functions from a central point many miles away. In recent years, high-speed, solid-state devices have come into use in switching circuits where relays formerly dominated. However, where high-speed operation is not essential, the relay is often the choice, not only because of economy, but also because relay contacts and coils can better withstand those voltages and currents inherent in customer lines and trunks.

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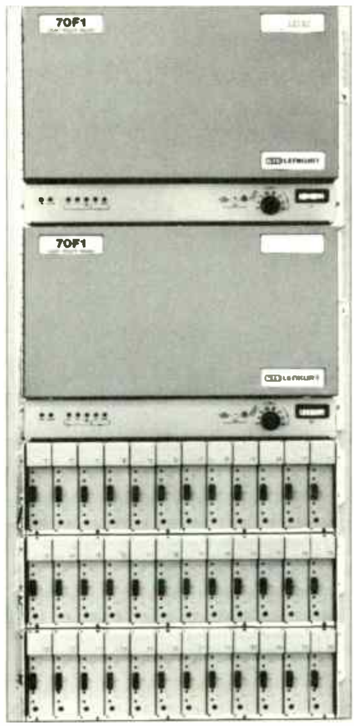

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