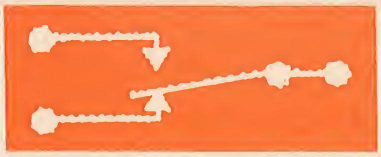


Which relay is right for you? . . . Here's help in deciding

Zero in on the relay for your design by knowing the salient characteristics of the major types.

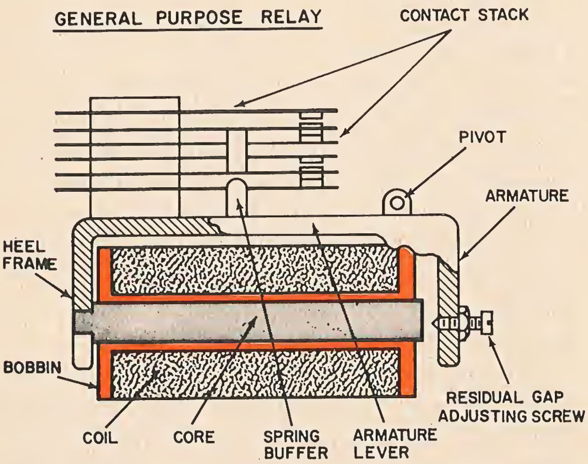
IF YOU WANT to find the best relay to do a particular job, here is a handy guide. It takes a fast look at 22 primary relay types and stresses the salient characteristics of each. There is also a relay chart on p 64 that names the manufacturers of all of the different types of relays. Titles alone aren't always the perfect guide to choosing the best relay. So let's examine the types one by one:

1. General Purpose

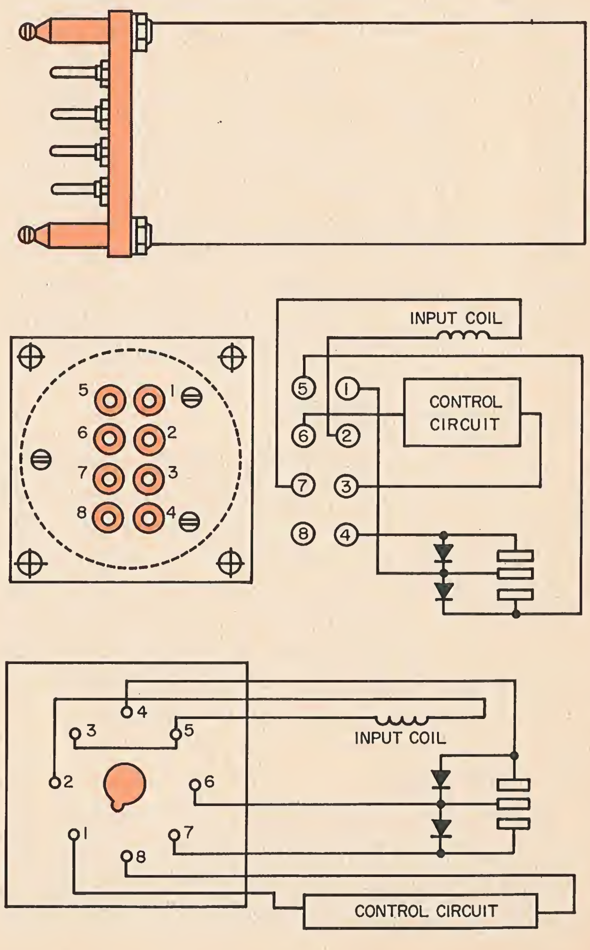
This broad category takes in many different kinds of relays that have one thing in common: They have multiple rather than specific applications. While general-purpose relays are often thought of as clapper relays, they can be of almost any type, depending, of course, upon the industry in which they are being used.

2. Frequency Sensitive/Selective

These are more properly classified as resonant-reed relays. They have an electromagnetic coil, arranged so that its flux, when energized, drives a vibrating reed. The reed, carrying a movable contact, acts as the armature and only responds to a given frequency. When a specific frequency, corresponding to the mechanical resonant frequency of the reed, is impressed on the coil, the reed will vibrate. This causes its contact to touch a stationary contact and thereby close a circuit one time for each electrical cycle. Variations are obtained by biasing the reed with a permanent magnetic or by employing more than one resonant reed, each with a different frequency response.

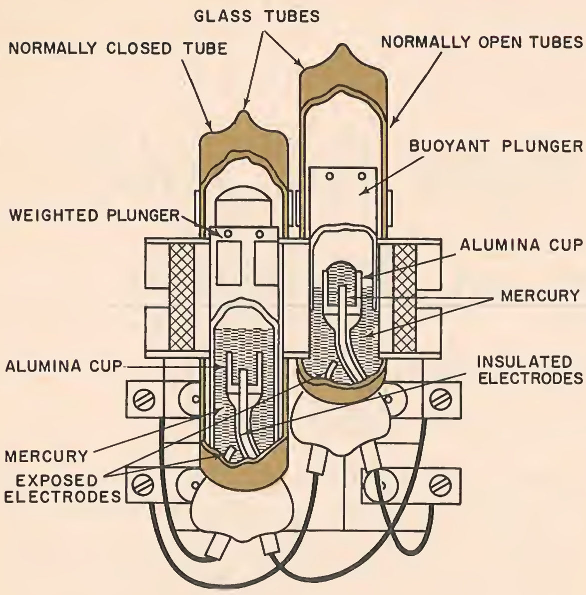


HIGH-SPEED RELAY



This article is a condensed version of material extracted from Section VIII of the forthcoming NARM Engineers Relay Handbook.

MERCURY RELAY



3. High-Speed

High-speed refers to the response of a relay when its coil is energized. Representative of this group are dc-operated relays that can close a contact in less than 1.0 msec.

From a design standpoint, high speed is obtained through the use of a low moving mass, low travel and a minimum of eddy currents. The design may use a polarized magnetic structure. High operating speeds can sometimes be obtained by overdriving the coil—applying abnormally high coil voltage or current. This presents no problems where limited duty and pulse-type energization are called for. In the case of longer coil energization periods, overdriving may cause damage. In these cases, a current-limiting resistor should be placed in series with the coil. High-speed ac relays that operate within less than half-cycle time are also available.

4. High-Voltage

In general, high-voltage relays switch up to 10,000 volts at 1 ampere or less ac and 0.2 ampere or less dc. These relay types are recommended for operation at a high reference potential. Coil power requirements are comparatively high—in the area of 5 watts dc or 25 volt-amperes ac—with solenoids quite common. Vacuum relays are used to accommodate the highest rating needs.

5. Latching

Broadly, latching relays are available in two types: magnetic latching and mechanical latching. Magnetic latching relay types usually employ permanent magnets to make them magnetically bi-stable. Thus their armatures are magnetically held in the operated position after the coil power has been removed. Reset is accomplished by either applying a voltage of proper polarity to a separate reset coil or by employing the same coil for both latch and reset, but reversing the polarity of the voltage for each function.

Mechanical latching relays are of two basic styles: mechanical reset and electrical reset. Mechanical reset types employ a coil and armature mechanism, plus a mechanical reset device. The latter locks the armature in the operated position after the coil has been de-energized. Rest is accomplished by manually tripping the locking mechanism or by some means other than electrical. Electrical reset types employ a second coil and armature to trip the latch mechanism and allow the relay to reset to its original position.

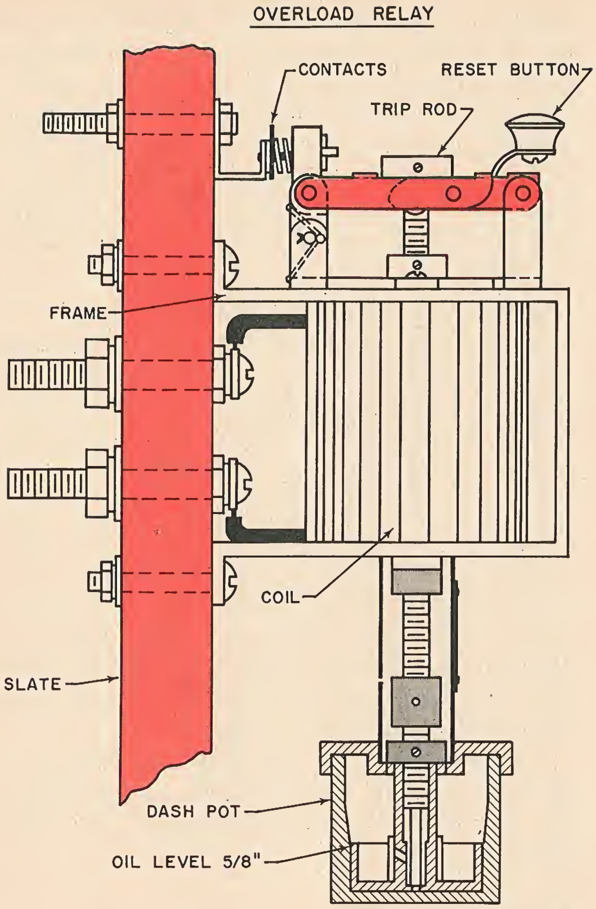
6. Mercury-Wetted Contact

The mercury-wetted contact relay is a special form of reed relay. It consists of a glass encapsulated reed, with its base mounted in a pool of mercury and the other end arranged so as to move between two sets of stationary contacts. By capillary action, the mercury flows up the reed to coat the movable and stationary contact surfaces, thus assuring mercury-to-mercury contact during MAKE.

There are two basic types. One, whose moving element is a magnetic, spring-biased armature, has platinum-tipped contacts. These contacts will typically carry a maximum current of 5 amperes, have a maximum voltage rating of 500 and a maximum switching load capacity of 250 volt-amperes.

In the second type, which features a smaller package size than the former, the armature consists of a magnetic alloy reed, which is not spring biased and is adjusted to a neutral position between the stationary contacts in the unbiased position. The movable reed is biased by means of a permanent magnet or magnets. These contacts have a maximum load capacity of 100 volt-amperes, limited by a maximum current capacity of 2 amperes and a maximum voltage rating of 500. Permanent magnets may be used with both types of capsules to provide single-side-stable, bi-stable or chopper operation.

Mercury-wetted contact relays are extremely fast in operation, have relatively good load carrying capacity, extremely long life and excellent low-level load characteristics. They also are free from contamination and bounce. But they have poor resistance to



shock and vibration, and are position-sensitive. Both types must be protected with suitable arc-suppression devices.

7. Miniature

This is a relative term (not recognized by NARM). It refers to a package size that is smaller than the general types and larger than the subminiature types. It does not describe any particular relay but is sometimes defined as one whose length is not less than one inch and not more than two inches, exclusive of terminals.

8. Motor-starting/armature

This term is usually applied to two different functions performed in starting motors. One is the "across-the-line" starter, usually nothing more than a power relay that, when energized, connects the line to the motor terminals.

The other is designed to open the motor-start winding circuit as the rotor approaches rated speed. This is achieved by sensing either voltage or current. In the voltage-sensing method, the relay coil is connected in parallel with the start winding of the motor. As the motor comes up to speed, the voltage generated in the start winding increases, causing the relay to pickup, thereby disconnecting the start winding.

The current sensitive relay types are connected in series with the motor winding. The initial "locked rotor" current energizes the relay and causes the contacts to close, thus placing the start winding in operation. When the motor reaches its operating speed, the line current finishes and allows the relay to drop out, thereby permitting the contacts to reopen.

9. Overload

An overload relay is an alarm, or protective, device. It is designed to operate when its coil current or voltage reaches a predetermined, or unsafe, value above normal. Such relays are often, but not always, mechanical latching types. A time-delay function may be included to permit short-duration overloads.

10. Plunger (Solenoid-Actuated)

Solenoid-actuated relays are generally used where a relatively large movement of the contacts is desirable or where considerable contact pressure is required. Because the solenoid provides relatively high pull in the open position and even higher pull in the closed position, it is an ideal method for actuating contacts that carry high power loads. It also is used in multiple contact systems. The majority of contactor designs use solenoid-actuated relays.

Plunger (Mercury)

This is a specialized form of solenoid-actuated relay in which a magnetic plunger displaces mercury. The mercury is moved relative to a contact system and thus makes or breaks a circuit. The mercury plunger and contacts are hermetically sealed in a glass or metal envelope, which is placed inside the actuating coil. Both normally open and normally closed contact forms are available. Mercury-plunger relays are position sensitive and are not useful for severe shock and vibration environments. They are suitable for heavy load applications and, being hermetically sealed, are excellent under environmental conditions that produce dust and humidity. A unit featuring a time-delay capability is also available.

11. Polarized

Polarized relays vary in size and design, depending upon the control application for which they are used. Their styles include Telegraph, Crystal Can, Ferreed, Dry Reed, Mercury-Wetted Contact and Armature with a remanent core. They usually employ one or more permanent magnets to provide the polarizing magnetic flux, which normally can flow in either of two symmetrical paths. The relay armature aligns itself according to the forces produced by the two flux paths.

Utilization of permanent magnet flux permits greater efficiency for a given size, when compared with non-polarized electromagnetic relays. This added efficiency is often used to make the relay more sensitive, to increase its operating speed, or to improve its vibration and shock resistance. For magnetic-latching (bi-stable) applications, this relay has the added advantage of consuming no power after contact transfer. Depending upon the design, polarized relays may be operated by a series of high-speed pulses (as encountered in telegraph and pulse-code equipment) or by infrequent ON-OFF signals, or by slowly varying signals (as found in controls and instrumentation circuits).

12. Power

This is a general term that varies from industry to industry, but usually it denotes relays capable of switching loads above 15 to 25 amperes at either 28 volts dc or 115/230 volts ac. They encompass a wide variety of styles—armature, solenoid actuated or rotary balanced armature.

13. Rotary

Rotary relays are defined as those whose armatures move in a rotary motion to close the gap between two or more pole faces. By far the great majority have balanced armatures and are used primarily under conditions of shock or vibration. They are manufactured in a very wide variety of sizes and shapes, from the smallest of microminiature to large relays designed to withstand very severe shock.

14. Radio-Frequency

These relays are designed to switch radio-frequency currents from one circuit to another with a minimum of losses. Of the broad range of shapes and sizes available, all use dielectric materials selected for their insulating qualities and for low losses at frequencies up to 150 Mc or higher. Large contact gaps and long dielectric leakage paths are employed to withstand the high voltages that are often encountered.

15. Dry-Reed

Dry-reed relays consist of one or more capsules containing contact mechanisms that are generally surrounded by an electromagnetic coil for actuation. The capsule consists of a glass tube with a flattened ferro-magnetic reed sealed in each end. These reeds, which are separated by an air gap, extend into the tube so as to overlap. When placed in a magnetic field they are brought together and close a circuit.

When the magnetic field is removed, the spring tension in the reeds causes them to separate. Multiple-contact systems employ as many capsules as required within the magnetic actuating field. Contact rating is dependent upon the size of the reed and the type and amount of plating. It ranges from low-level to 3 amperes. Effective contact protection is essential in most cases. The contacts have the advantage of being hermetically sealed and thus are impervious to atmospheric contamination. They are also fast-operating and have long life when operated within their load limits.

Vacuum types are available for high-voltage applications. Form A and form C operating types are common to most dry reed switches.

16. Sensitive

Sensitive relays require small amounts of power to be applied to their coils to cause them to operate—usually 100 mw or less. They encompass a very wide variety of styles: clapper, crystal can, dry reed, instrument, mercury-wetted contact and polarized, among others.

17. Snap-Action

Snap-action usually refers to the storing of energy during the initial motion of an actuating member, until a point is reached at which the contacts snap to a new position of equilibrium. This can be mechanically achieved by over-center devices, armature pre-travel or by circuitry designed to store energy from a sliding current source, triggered and applied to the relay for rapid contact transfer.

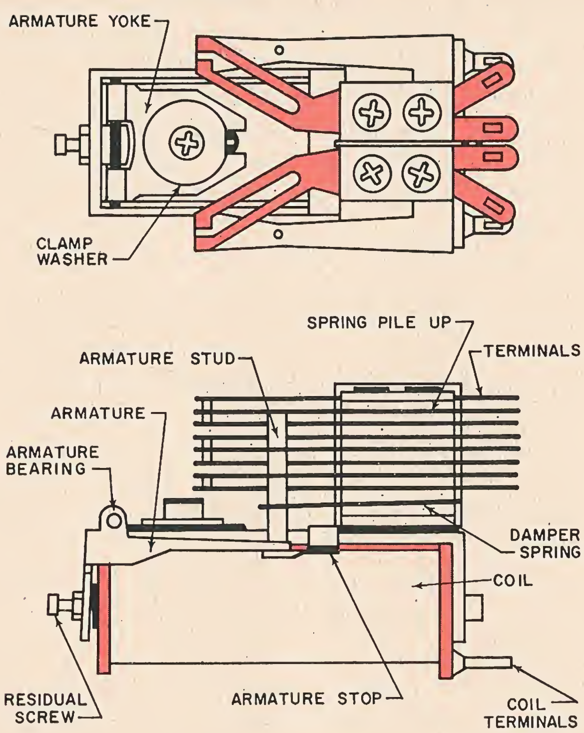
18. Subminiature

This is a relative term (not recognized by NARM) describing any sort of relay smaller than miniature but, presumably, not as small as microminiature. It is occasionally found on specification sheets. One definition in usage is that of a relay whose length (independent of terminals) is less than one inch.

19. Stepping Switches

There are many switching devices on the

TELEPHONE RELAY



market that are operated by a series of pulses and that perform sequential switching. Many are devoted to specific applications. Two types are available: commercial and rotary (telephone).

Two means of driving mechanisms are used in stepping switches: indirect and direct, with the former enjoying wider usage. When the armature-pawl combination acts directly on the ratchet under the magnetic attraction generated by the electromagnet, the stepping switch is said to be directly driven. The indirect type is a spring-driven stepping switch that is considered more consistent in performance, with longer life, greater efficiency and faster stepping than the directly driven device.

Commercial Stepping Switches

These are primarily intended for use in applications other than the telephone or communications industry. The basic design incorporates an electromagnetic driving mechanism that causes a contact-wiping mechanism to rotate over a series of contacts, arranged in a circle. A rather wide variety of contact and driving mechanism combinations is available. Some are bi-directional, having two coils and ratchet mechanisms so arranged that the wipers rotate in one direction when one coil is energized and in the opposite direction when the other coil is energized. Other types rotate the wiper mechanism against a spring that returns the wiper to a home position when a pawl is released. Some are designed so that pawl can be released electrically; others release manually. The electromagnetic driving mechanism may be a clapper type or solenoid. The number of steps available varies considerably.

Telephone Stepping Switches

The basic design is quite similar to that of the commercial type. The switches may be either simple rotary or two-motion selectors. They usually feature an electromagnetically operated mechanism, having one or more wiping spring sets fixed on a shaft that is moved and controlled by a pawl engaging a ratchet.

This moves the rotor (wiper assembly) one step per pulse and causes the attached wipers, successively, either to contact or break contact with a semi-circularly arranged row of contacts, called a bank level. The basic wiper contact forms of the stepping switch can be either of the make or break variety. The make form is commonly used and may be arranged to cause either "break before make" contacting (nonbridging) or "make before break" contacting (bridging). Bank contact levels are available in various switch types from different manufacturers, with 10, 11, 20, 22, 25, 26, 30, 33, 50, and 52 contacts per level.

20. Telephone Relay

This is a misnomer, as the use of this type is not confined to the telephone industry. Moreover, that industry does not often make use of the term.

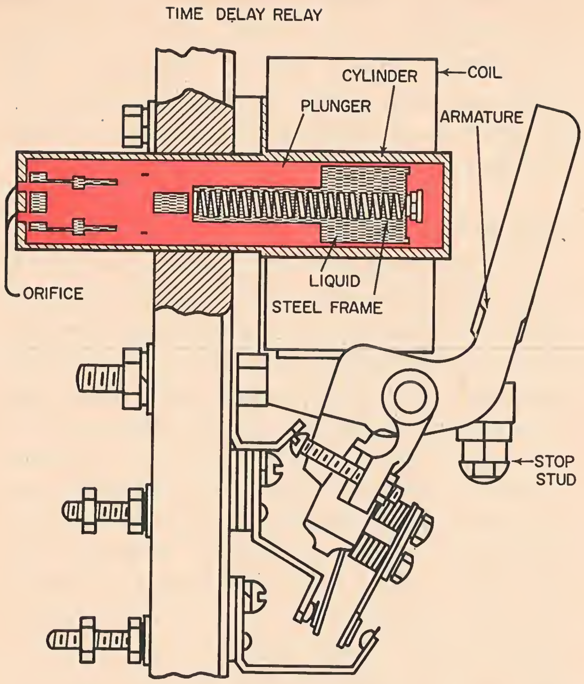
Commonly the telephone relay has a relatively long coil compared with the relay's diameter. Both dc and ac types are available. Slight time delays on pick-up or drop-out can be obtained on the dc units. These relays offer a very wide choice of contact forms and have relatively long lives.

21. Time Delay

When current is supplied to the coil or heating element in this relay, the contact mechanism doesn't move until the pre-set time-delay period has elapsed. A time delay can also be provided between the moment when the coil or heating element is de-energized and the contact mechanism is released.

Dashpot

In its earliest form the dashpot time-delay relay consisted of a plunger relay on which the armature or plunger was connected to a dashpot. The relatively slow transfer of air volume in or out of the cylinder regulated the



movement of a piston, which in turn controlled the movement of the armature or plunger, thus producing a time delay when the relay was energized or de-energized. However, variable friction between the cylinder and the piston tended to cause erratic performance. This difficulty was overcome by replacing the dashpot with a flexible bellows. Further refinements included passing the air from one chamber to another through an adjustable orifice, thus reusing the same air or gas without introducing contaminants that might clog the orifice.

Other modifications of the dashpot principle are now used. One device employs a closed hollow tube that is extended through the coil and some distance through the heel piece or frame. Inside this hollow tube is a movable magnetic core, held away from the face of the tube and armature by a spring. The hollow tube is filled with a liquid that surrounds the movable core. When the coil is energized, the armature of the relay does not immediately close, because the magnetic path is insufficient to produce the necessary flux. When the flux path is sufficient, the armature closes. Various time delays can be obtained by using liquids of different viscosities and by varying the clearance between the magnetic core and the inside of the tube.

Most dashpot relays operate on dc or rectified ac, although a few versions operate directly on ac.

Delay Slug

A time delay can be produced on dc relays by placing one or more shorted turns around the magnetic circuit (usually the core) in such a manner as to produce an opposing flux. This flux delays the regular flux build-up on energization and sustains the flux present when de-energization occurs. This shorted turn (or turns) is called a slug. It usually consists of a copper collar on the core of the relay.

This method of time delay is applicable to any dc relay that has sufficient physical space to accommodate the slug. However, it is most commonly used on long telephone types of relays that have comparatively long coils. For maximum delay on pull-in, the slug is placed on the armature end of the coil. For a delay on drop-out, the slug is placed on the heel end of the core. This location minimizes the effect on pull-in.

Pull-in delays up to 120 msec and drop-out delays to 500 msec can be achieved.

Hot-Wire

Hot-wire relays are a form of linear expansion relay in which the longitudinal expansion of a wire, when heated, provides the mechanical motion to open or close contacts. The time required to heat the wire constitutes the delay.

Thermal

Most thermal relays have a heating element of some type to provide the necessary temperature differential for mechanical expansion. This provides the movement to actuate the contacts. Since time is required for the heating element to attain the desired temperature and to transfer this heat to the expansion element, these devices are often used as time-delay relays. They are available in both fixed and adjustable types.

22. Vacuum

Vacuum relays have contacts sealed in a high vacuum. They range from the simple dry-reed, single-pole, single-throw device through small, multi-pole relays and on to rather large switching devices capable of carrying thousands of amperes at thousands of volts. The small, dry-reed type makes contact from an externally provided magnetic field in the same manner as the gas-filled dry reed does. Other vacuum relays have their contacts actuated mechanically by an exernal source. The moving element is a flexible member mounted in glass or a rigid member supported by a metal bellows, thus allowing sufficient movement to provide contact actuation while still maintaining the necessary vacuum. Vacuum relays tend to be more expensive than conventional relays. ■ ■