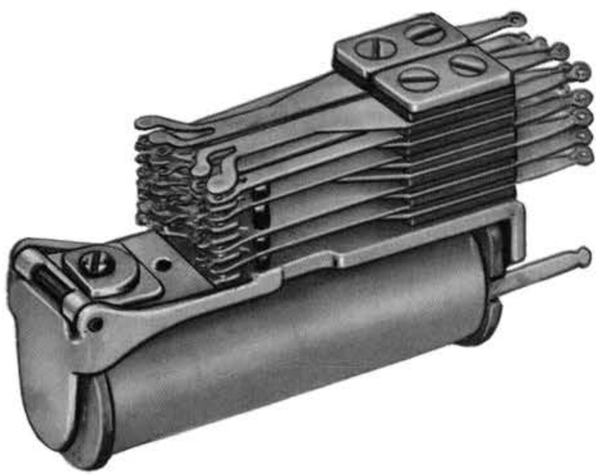
RELAYS

CLASS B AND CLASS C

(TYPE 57-A AND TYPE 58-A)



Technical bulletin 961-537

AUTOMATIC ELECTRIC
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

Factory, development laboratories, and general office at Northlake, Illinois, U.S.A.

AUTOMATIC ELECTRIC COMPANY is an organization of designing, engineering, and manufacturing specialists in the fields of communication, electrical control, and allied arts. For more than sixty years the company has been known throughout the world as the originator and parent manufacturer of the Strowger Automatic Telephone System. Today Strowger-type equipment serves over 75% of the world's automatic telephones. The same experience and technique that have grown out of the work of Automatic Electric engineers in the field of telephone communication are also being successfully applied on an ever-increasing scale to the solution of electrical control problems in business and industry.

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Community Automatic Exchanges—Unattended automatic units for small rural or suburban areas, with facilities for switching into attended exchanges.

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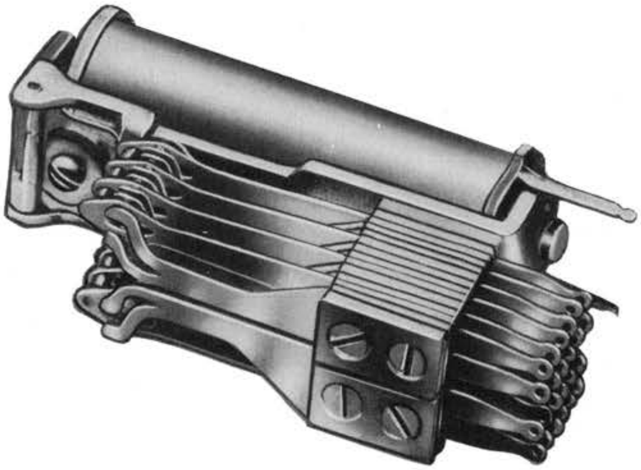
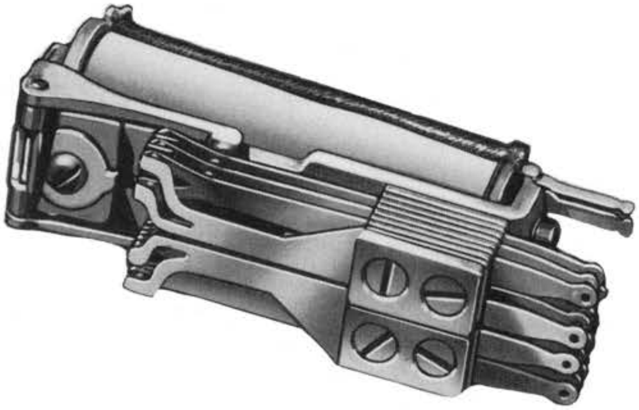
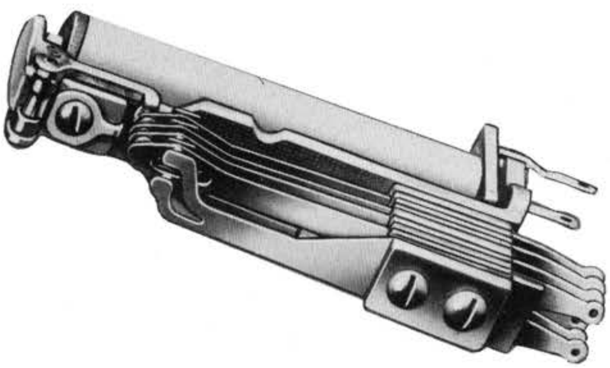


Class B relay with short-lever armature



Class B relay with long-lever armature
(most widely used)



Class C relay

Frontispiece.
Typical class B and class C relays.

CLASS B AND CLASS C RELAYS
(TYPE 57-A AND TYPE 58-A)

1. INTRODUCTION

The Class B and Class C relays are general-purpose telephone-type relays of the most modern design, for horizontal or vertical mounting. Both classes have many identical features, the main difference being that the Class C relays are approximately half the size of Class B relays and thus mount in much smaller space. There are several different types available in each class and these will be discussed in §3. With so many different types available and with the choice of many design features (see §2) it is possible to obtain a relay engineered to meet the requirements of almost any particular application.

Some of the general advantages of Class B and Class C relays are: small mounting area, high sensitivity, independent twin-contacts, centered dome-type spring buffers which obviate "wearing-in", sturdy armature arms, simple and permanent adjustment, heavy-duty armature bearing and yoke, self-cleaning contacts, adjustable or fixed residuals, and (particularly Class C) space-saving compactness.

1.1 Physical description

1.11 Class B relays: Class B relays extend 3 17/32" beyond their mounting (see figure 3) and the over-all length is 4 3/32".* The width of the relay depends, of course, on the number of

*Approximately 1/3" less if there is no residual *screw* (*i.e.*, if welded-disc residual is used). *Disc* residuals are furnished unless residual screws are specified.

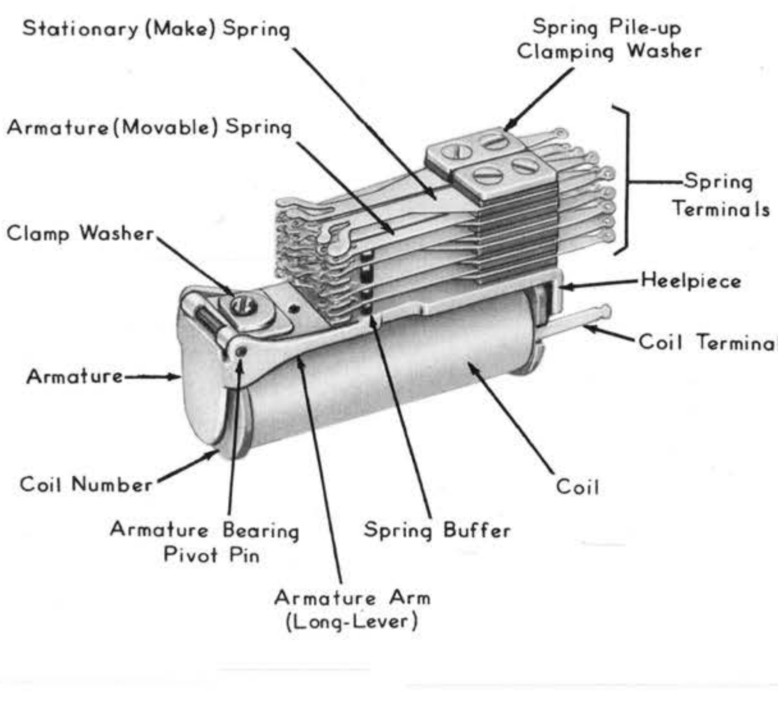


Figure 1. Typical class B relay.

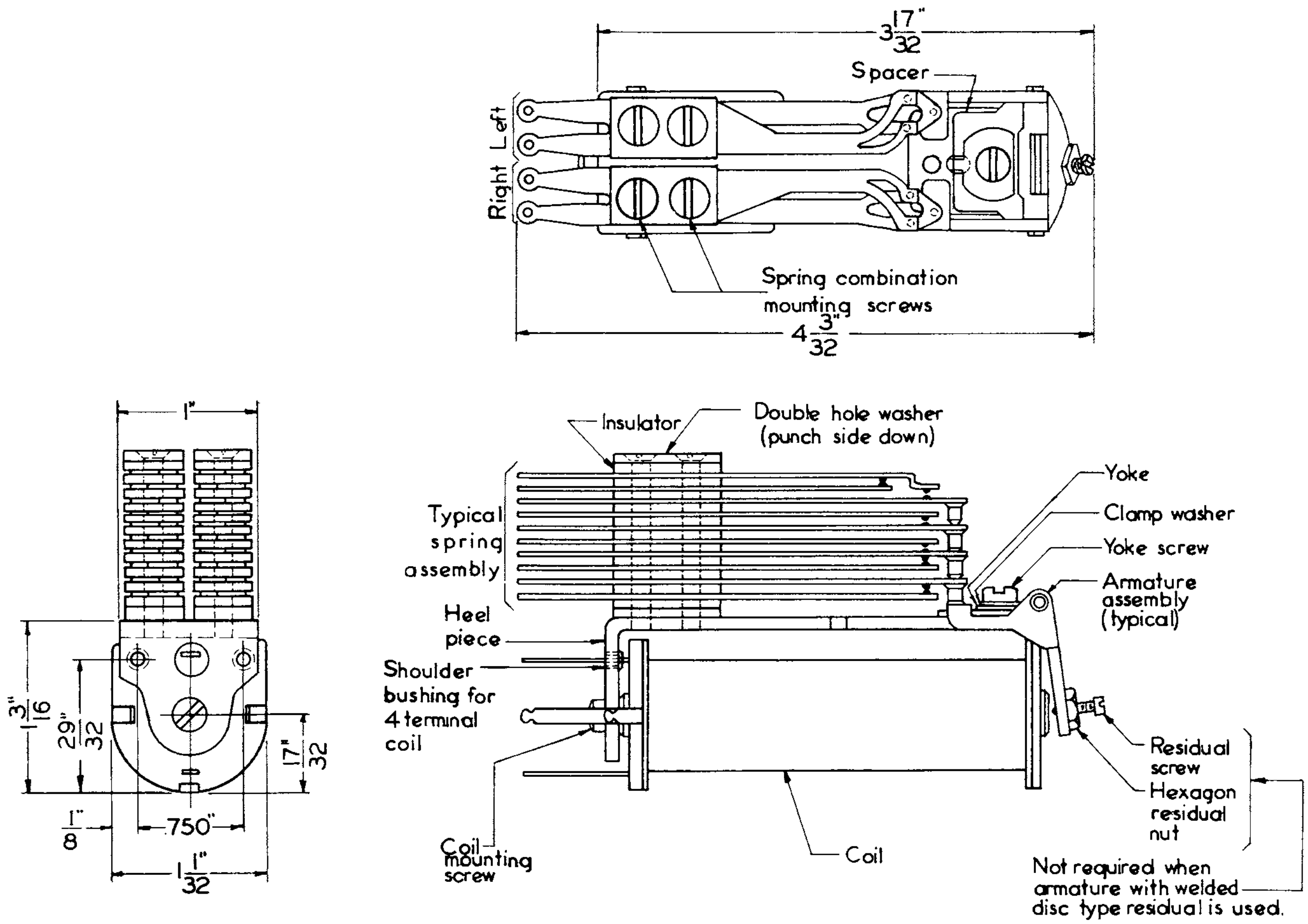


Figure 2. Typical class B relay with short-lever armature.

contact springs, being 1 9/16″ minimum (2 springs) to 2 27/64″ maximum (13 springs). The height of the relay is 1 1/32″ which permits $1\frac{1}{4}$″ mounting centers. The maximum number of springs on the Class B relay without a cover is 13 springs in each pile-up. With a standard size cover the maximum is 8 springs in each pile-up. For industrial applications a special cover accommodating a maximum of 13 springs in each pile-up is available.

<u>1.12 Class C relays:</u> Class C relays are of essentially the same length as Class B relays, namely 3 15/32″, and the over-all length is 4 1/32″.* The width of the relay is a minimum of $\frac{3}{4}$″ for two springs and a maximum of 2 1/32″ for 13 springs. The height is 21/32″ (see figure 4).

*Approximately 1/3″ less if there is no residual *screw* (*i.e.*, if welded-disc residual is used). *Disc* residuals are furnished unless residual screws are specified.

1.2 Applications

Because of their superior design and long-wearing qualities, Class B and Class C relays may be used for a wide variety of applications. Class B relays are used primarily for telephone circuits, calculating machines, power supervisory equipment, electronic control circuits, coin-operated devices, and many other such applications. Class B relays are used where high sensitivity, extremely dependable performance, freedom from frequent maintenance, and long wear are required. Class C relays incorporate the same characteristics as Class B relays but are approximately only half the size and thus can be utilized for the same applications where space saving and weight reduction are important.

1.3 Things to consider when ordering

When our relay engineers know as much as possible about your requirements, they can

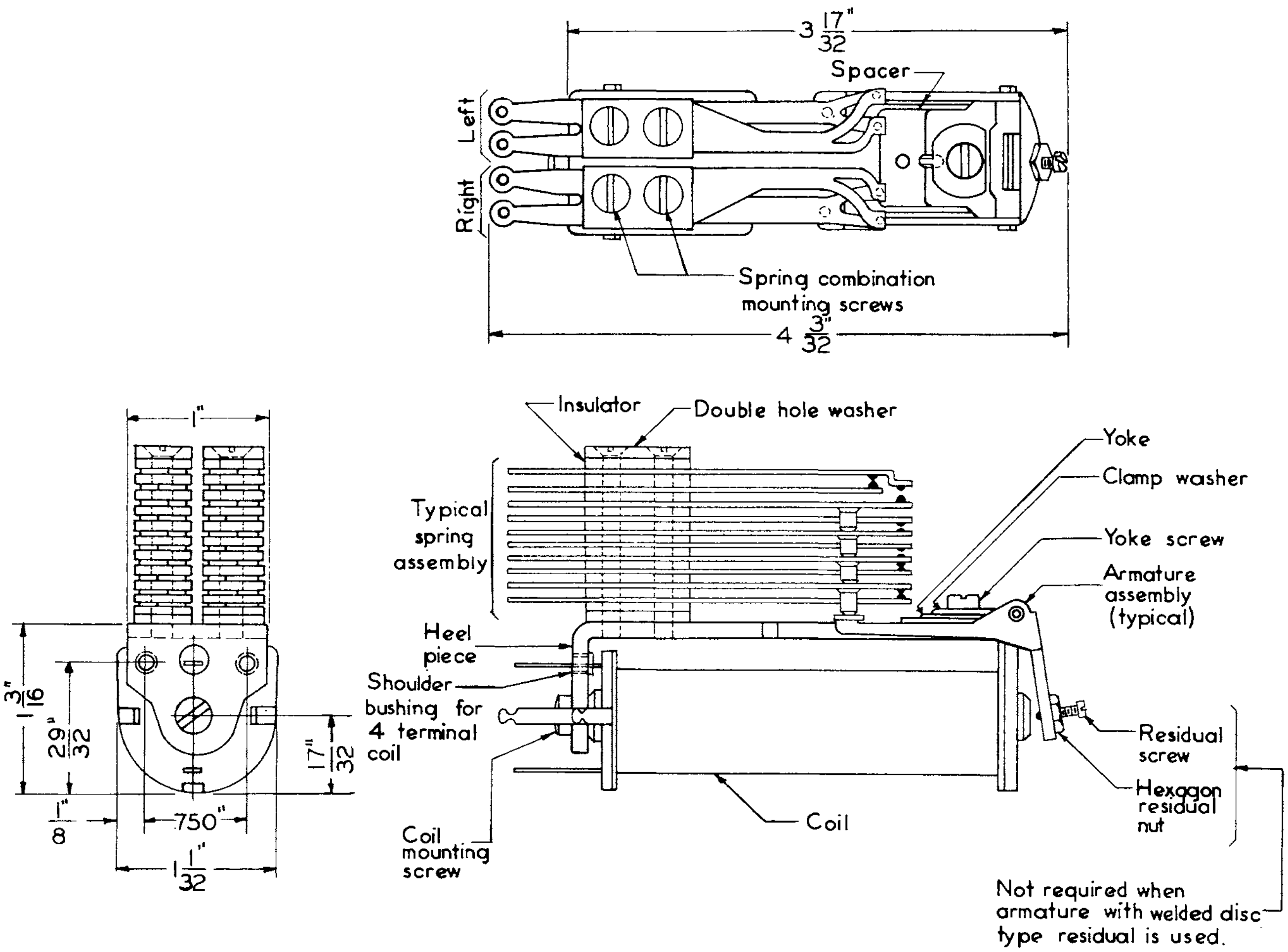


Figure 3. Typical class B relay with long-lever armature.

select the best relay for each particular application and circuit condition. It is advisable to give us complete information about your circuit and its operation, avoiding too narrow specifications, which may be neither necessary nor commercially practicable. Where limits are specified they should be in the nature of either tolerable maximums or tolerable minimums, not both.

In ordering a relay, specify the following:

a. Class of relay desired (Automatic Electric Company Class B or Class C).

b. Operating coil voltage (nominal) a.c. or d.c. If voltage is unstable, what is the minimum to which it falls? The maximum, that might produce over-heating?

c. Operating current (maximum or minimum milliamperes available in the circuit), only if critical. If current is not critical, our relay engineers will select an economical coil for the voltage available, and should not be hampered in selecting an ideal coil by having current limitations imposed.

d. Spring combination (see figure 5).

e. Contact load (see figure 7).

f. Type of contact load -- whether inductive, resistive, or capacitive; voltage a.c. or d.c.

g. Timing requirements only if critical. (Relays typically operate in less than 25 milliseconds.) If timing is critical, specify only a maximum or only a minimum rather than a range; e.g., "not over 20 milliseconds," rather than "10 to 20 milliseconds".

h. Frequency of operation, i.e., approximately ______ operations per day or year.

It usually is not desirable to specify minimum contact pressure because this introduces gram-gauging operations during production, which increases the price and slows delivery. All our relays are designed to provide adequate contact pressure, providing reliable operation for years.

2. DESIGN AND CONSTRUCTION

Class B and Class C relays are general-purpose relays which are manufactured in many different standard assemblies from which one can select to meet each particular application. The types available in each class are discussed in §3. The spring pile-ups can be arranged in almost any form, order or combination required by the circuit. This flexibility in contact-spring arrangement and contact material and form, combined with proper coil characteristics, required adjustment, choice of two armature ratios, and choice of right-hand, left-hand, or double-arm armature enables you to obtain a relay "custom tailored" for each specific application.

2.1 Contact assembly

The most important part of a relay is, of course, the contact assembly; the contacts must make and/or break as required by the circuit in which the relay is used. To insure perfect contact at all times, each of the twin contacts on each spring of Class B and Class C relays is independent and self-cleaning. The springs have diverging tips that are widely separated to simplify adjustment, and to insure independent operation of each contact. This design has been found to be remarkably free from contact "bounce" and "chatter", and such bounce and chatter of the contacts as does exist is largely masked by the different length, stiffness, and vibration frequency characteristics of the disimilarly shaped spring tips. Elimination of this much of unwanted spring contact opening is helpful in critically timed circuits, and reduces contact wear from mechanical rubbing, with resultant increase in contact life. Electrical arcing is also reduced by the improved contact stability. The tips of the springs are free to adjust to the slightest pressure exerted on the

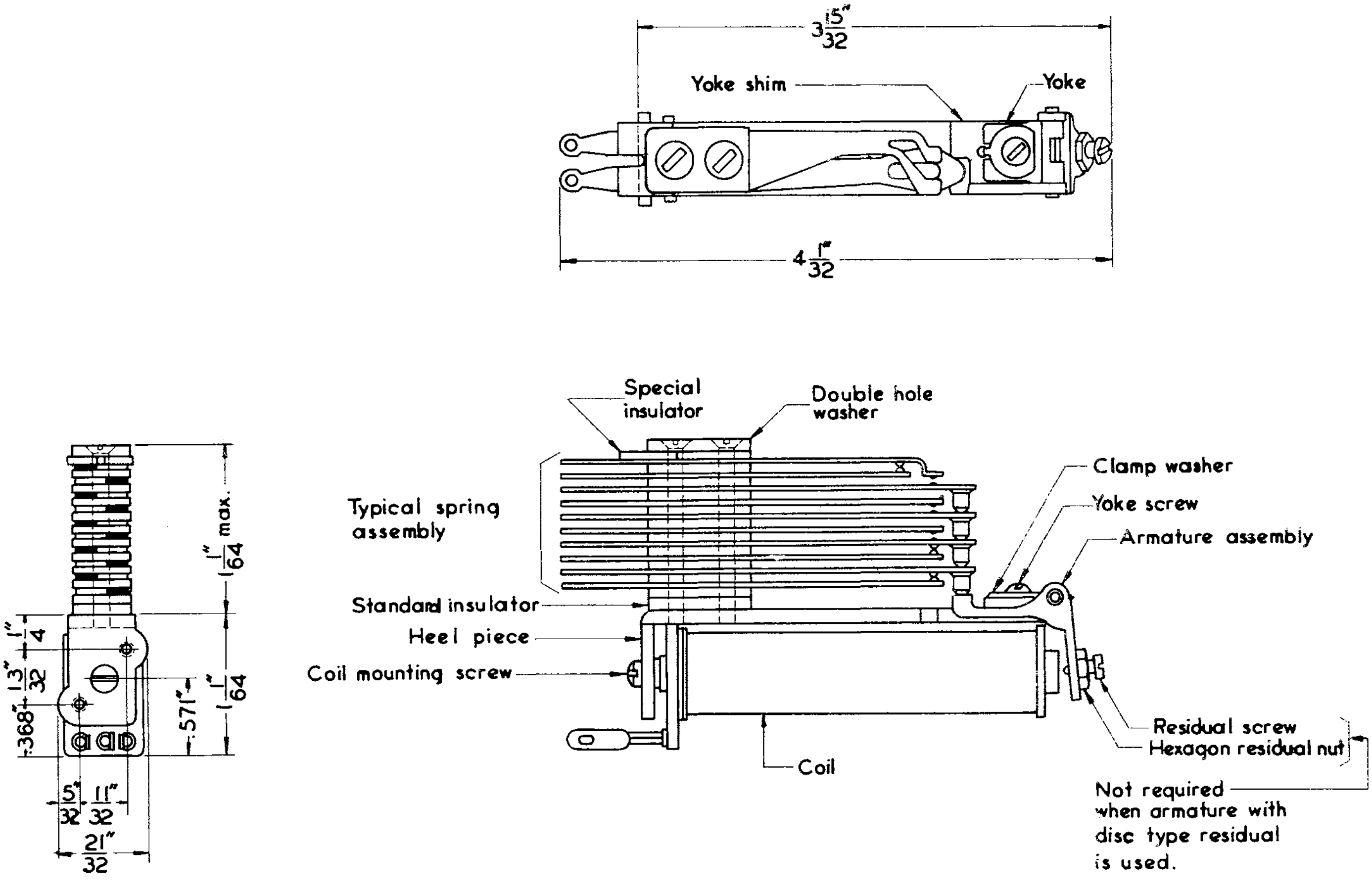


Figure 4. Typical class C relay.

spring. The circuit is thus completed through one contact if the other contact should be held open by dust or foreign matter. The twin contacts also somewhat increase the current-carrying capacity of the relay.

2.11 Self-cleaning contacts: The armature (moving) spring and the break or make (stationary) spring of each contacting pair are made of different shapes and thicknesses and have different flexing lengths. This difference in flexing lengths means the path of movement of the armature-spring contacts is on a different radius than that of the stationary-spring contacts. This difference in the direction of movement makes the contacts rub or wipe sufficiently to break through a film of dust or dirt without excessive mechanical contact wear. This self-cleaning action insures positive circuit contact. The dome shape of the contacts also aids in the self-cleaning action. This dome shape is also more resistant to mechanical wear. (Other contact shapes may require consideration of polarities and thus handicap circuit design.) Contacts on Class B and Class C relays are welded to the spring which also adds to the sturdy construction and long-wearing qualities of these relays.

2.12 Basic contact arrangements: The basic contact arrangements (figure 5) are shown in their normal positions. These can be arranged in almost any order or combination. Unless otherwise specified the contact arrangement will be supplied per the standard order of assembly (figure 6). The code letters "A" to "D" are used to describe the basic contact arrangement or "form". The number of forms required is indicated by a number preceding the "form" letter. They should be specified in the order in which they are assembled starting from the heelpiece. For example, the spring pile-up shown in figure 6 would be ordered "1B1C1E1A1D".

The Class B relay can have a maximum of 26 springs (13 in each pile-up). The maximum number of springs obtainable with the Class C relay is 13 (right-hand pile-up only). Class B relays with the long-lever armature can have only one "D" combination in each pile-up and it must be on the outside of the spring pile-up. If two or more "D" combinations (in each pile-up) are necessary, use the short-lever armature.

2.13 Selecting the contact: Although considerable progress has been made in the development of

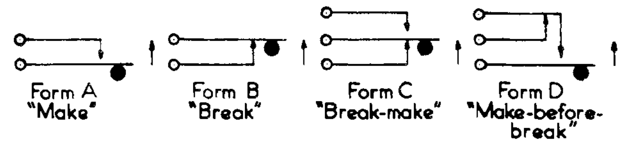


Figure 5. Basic contact forms.

new alloys and in broadening the uses of some contact materials, there is no all-purpose contact material which both works well in, and is economical for, all applications. Many variables influence contact life and performance. Materials like silver have excellent conductivity but are subject to filming, transfer, and pitting. Tungsten on the other hand is highly resistant to mechanical wear and arc erosion but requires relatively high contact pressure and applied voltages.

Selection of a relay contact material therefore involves choice of a material which will give good performance despite its inherent disadvantages. The information requested in §1.3f and §1.3h enables us to best select suitable contacts.

One contact material may work fine in one application and not in another. Over a period of years Automatic Electric Company has tested and used many different contact materials. Figure 7 lists materials normally used and recommended for Class B and Class C relays. Code 0-18 is supplied unless the information under §1.3f indicates another material will be preferable.

2.14 Springs: The springs on Class B and Class C relays are of identical design (see figure 8). The armature springs and break or make springs are of different shapes and thicknesses of nickel silver. They are assembled, then tightened and secured under pressure which

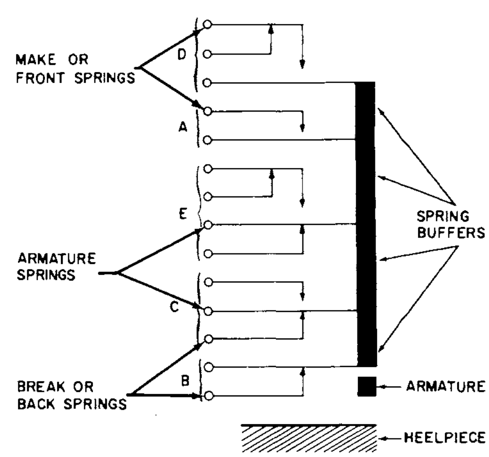


Figure 6. Contact-spring standard arrangement.

CODE	DIAMETER	MATERIAL	BREAK OR MAKE LOAD	WILL CARRY LOAD	RECOMMENDATIONS
0-18	0.067″	50% silver 50% palladium	135 watts (max. 3 amp)	150 watts (max. 3 amp)	To be used for all ordinary applications. Resistant to tarnish and non-microphonic.
3-18	0.067″	85% gold, not more than 15% alloy	50 watts	150 watts	To be used for low-level or for "dry" circuits. Reliable. Short life, subject to mechanical wear, high metal transfer.
9-18	0.067″	96% platinum 4% ruthenium	135 watts (max. 3 amp)	150 watts (max. 3 amp)	Very resistant to mechanical wear – hence long life.
Tungsten *	0.125″	Tungsten	450 watts (max. 2 amp)	450 watts (max. 2 amp)	Recommended for highly inductive, low-current circuits. Available with single contacts only.
Silver tungsten *	0.1875″	Silver tungsten	450 watts (max. 4 amp)	650 watts (max. 6 amp)	Available with single contacts only.
Silver tungsten *	0.25″ **	Silver tungsten	575 watts (max. 5 amp)	1150 watts (max. 10 amp)	Available with single contacts only.

* When these heavy-duty contacts are required, the short-lever armature is recommended.

** When 0.25″ diameter contacts are employed it may be advisable to use special highly conductive springs to minimize heating to prolong spring life.

Figure 7. Contact materials.

results in a very stable spring combination. The springs do not protrude beyond the edge of the heelpiece. The reduced over-all height of the relay saves mounting space.

The number of springs or "spring load" affects the operating and release time of the relay since the relay does not operate until the magnetic flux has had time to build up. Fast release is aided in part by mechanical loading. Many factors contribute to the operate and release time of a relay (see §3) but if operate time or release time is critical, it may have to be considered when a particular spring pile-up is selected.

2.15 Spring buffers: Because spring buffers on Class B and Class C relays are subject to mechanical wear, they are made from mandrel-wound phenolic rod. This material will not dust, wears down only imperceptibly during the life of the relay, and withstands very high temperature conditions without distortion. The top of the spring buffer is domed or rounded off rather than flat. The pressure falls on a small point in line with the center of the spring and is evenly distributed between the independent twin contacts. This dome shape eliminates "wearing-in". As the contacting spring flexes, it always rolls over the same point, thus it doesn't change the shape of the buffer or cause unnecessary wear, which makes relay readjustment infrequent. On Class B relays with long-lever armatures, the buffers are mounted on the center line of the armature (moving) spring near the bifurcation of the spring. On Class C relays, and on Class B relays with short-lever armatures, the spring buffers are mounted on the center line of the armature springs on the free end of the spring (see figure 8).

2.2 Armature

Class B relays are available with two armature ratios. For the long-lever armature, the ratio of buffer travel to armature travel is approximately 1.65 to 1 (figure 9). This leverage ratio for Class B relays with short-lever armatures and for Class C relays is approximately 1.15 to 1. Class B relays are available with either long- or short-lever armatures, each of which is available in right-, left-, or double arm. Class C relays are available only with the right-hand short-lever armature. Both are available with either a welded (fixed) residual or a screw (adjustable) residual.

The working ends of the armature arms are formed inward so they lie over the back of the heelpiece but are kept from contact with it by a non-magnetic metal shield to prevent magnetic freezing of the armature arm. Thus no backstop, no backstop adjustment, and no field replacement due to breakage are required.

Class B and Class C relay armature bearings are of the pin type, greased to give long life under all conditions. The armature, the bearing pin, the yoke, and the bearing plate are assembled on the relay with a clamping washer. This makes the armature suitable for both light- and heavy-duty applications.

2.21 Short-lever versus long-lever armature: No more work can be obtained from a system of levers than is put into it. If a long lever lifts a weight, the small force travels a great distance. The choice of length is governed by the available force or by the distance through which the force may go to produce the required work. In the case of relays, the choice of length is governed by required operate and release times, load, and available power.

The movement and force ratios in these two armature-lever lengths are shown in figure 9. The dimensions along the armatures show the simple ratios of the arms themselves. A spring can be considered as a lever where the fulcrum is at the insulator, the load is at the contact, and the force is applied at the buffer.

The two small sketches at the bottom in figure 9 show an additional point: in a relay with long-lever armature, the contact moves farther than the buffer, but in a relay with short-lever armature the contact moves less than does the buffer. Thus, the long-lever armature relay with an air-gap-to-buffer-movement ratio of 1:1.65 has an air-gap-to-contact-movement ratio of 1:2.4. The short-lever armature relay with an air-gap-to-buffer-movement ratio of 1:1.15 has an air-gap-to-contact-movement ratio of 1:1.

Short-lever armatures are recommended for relays that are to be slow to release, such as d-c relays with release-delay requirements too long for long-lever armatures, a-c relays, and relays operated from $\frac{1}{2}$-wave-rectifier power.

The short-lever armature ratio gives contact springs less leverage to restore the armature; i.e., gives the relay coil greater leverage to hold the relay operated. Advantages of the short-lever armature in special situations are:

a. Prevents chatter in an a-c relay, by giving the shading-coil flux mechanical advantage.

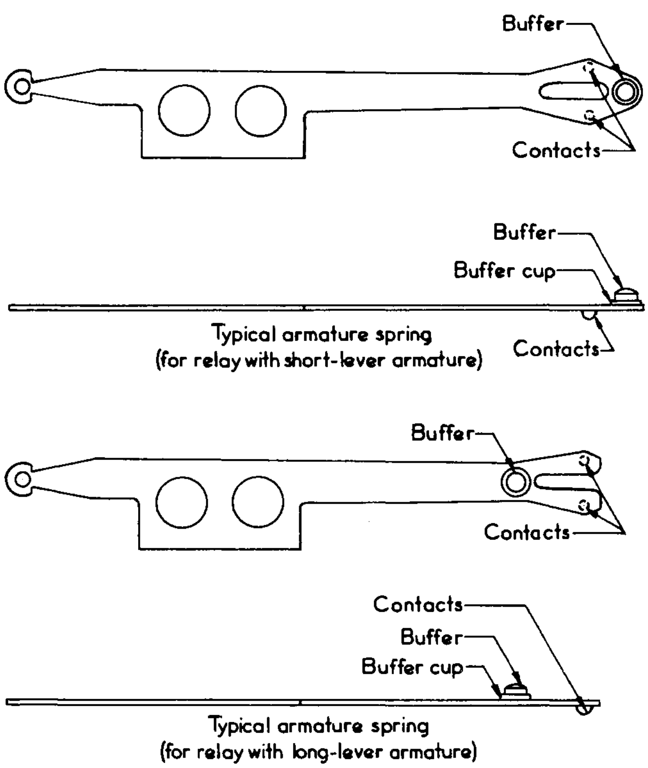


Figure 8. Typical armature springs.

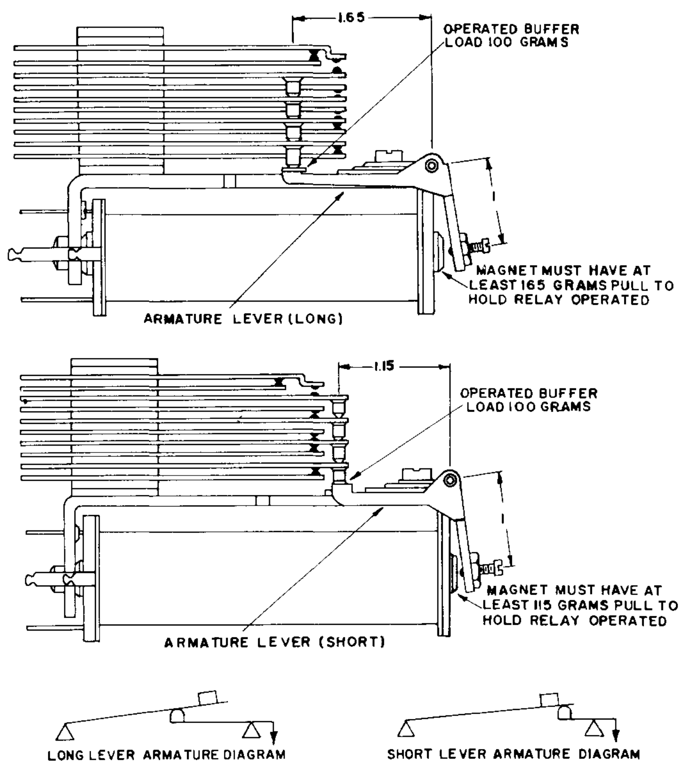


Figure 9. Comparison of leverage ratios of long- and short-lever armatures.

CLASS B	TYPICAL OPERATING TIME SECONDS	TYPICAL RELEASE TIME SECONDS	MAXIMUM COIL VOLTAGE	MAXIMUM NUMBER OF CONTACTS
Quick-acting BQA	0.003-0.030	0.002-0.050	250 dc	26 springs
Slow-operating BSO	0.040-0.120	0.025-0.350	135 dc	26 springs *
Slow-releasing BSR	0.015-0.035	0.035-0.600	135 dc	6 springs **
Slow-acting BSA	0.020-0.055	0.035-0.600	250 dc	6 springs **
Quick-acting a-c BFA	0.010-0.025	0.008-0.020	230 ac	26 springs
Snap-action BMS	0.010-0.030	0.015-0.050	250 dc	20 springs & 2 form "C"

* Up to 0.600 second release time with not over 6 springs.

** More contacts can be accommodated at a sacrifice of operating speed and release time delay.

CLASS C	TYPICAL OPERATING TIME SECONDS	TYPICAL RELEASE TIME SECONDS	MAXIMUM COIL VOLTAGE	MAXIMUM NUMBER OF CONTACTS
Quick-acting CQA	0.005-0.035	0.005-0.025	100 dc	13 springs
Slow-acting CSA	0.010-0.040	0.015-0.200	100 dc	13 springs
Snap-action CMS	0.010-0.035	0.010-0.050	100 dc	1C snap-action switch only

Figure 10. Typical operating and release times.

b. Enables a-c relays to hold firmly operated a heavier spring load than would be possible with a long-lever armature. Make contacts of some a-c relays might otherwise flatten after relatively short service due to imperceptible fluttering, which would wear away the contact faces. This is eliminated in well-designed relays having short-lever armatures.

c. A slow-release d-c relay, with a short-lever armature, will remain operated longer after de-energization than will a similar relay with the same spring load and a long-lever armature, thus providing longer and better controlled release time.

d. A short-lever armature provides a required release time for a heavily loaded slow-release d-c relay with a larger "residual" setting than is possible with a long-lever armature. Armature "sticking" from residual magnetism is prevented. If an adjustable residual is used, the relay will need little if any readjustment during its entire life. Slight wear or flattening of the residual disc or screw therefore will affect release timing only slightly because the residual gap was larger originally. Before the widespread use of the short-lever armature, release time was adjusted through the residual gap. Without a short-lever armature a too small residual gap is often unavoidable. With a short-lever armature and a well-designed relay, a large residual gap is always possible.

The short-lever armature is not advantageous for all relay applications. The long-lever armature travels less to actuate the contact springs, so is faster acting (an especially desirable feature if frequent short pulses must be followed rapidly). For all ordinary purposes – where there is no actual need for a short-lever armature – use a long-lever armature.

2.3 Heelpiece

Class B and Class C relays have very sturdy heelpieces to give the spring pile-up great stability of adjustment. The heelpiece is made of heavier-than-usual zinc-plated magnetic iron, which results in great flux-carrying capacity. This heelpiece is engineered to minimize magnetic leakage for greater sensitivity (all the flux generated links the armature, doing useful work). When the release time of a fast-acting relay is very critical and must remain constant even under conditions of varying magnetic saturation and age, most Class B and Class C relays can be supplied with nickel-iron heelpiece and coil core.

3. DIFFERENT TYPES

Several different types are available in both Class B and Class C relays. There are various types in order to meet different timing requirements (see figure 10). Many factors affect the timing of the relay. If timing is critical, you may wish to consider the following before ordering a relay:

a. Contact spring load

The relay armature does not operate until the magnetic flux has had time to build up to the required value, and this time varies (other factors being constant), with the mechanical loading. A light contact spring load may decrease the operating time and increase the release time; a heavy contact spring load may increase the operating time and decrease the release time.

b. Armature stroke

A shorter armature stroke tends to decrease the operating time; a longer stroke to increase the operating time.

c. Residual gap

Increasing the residual gap tends to decrease the release time, and decreasing the residual gap tends to increase the release time. Since, for a standard stroke, an increase in the residual gap will require an increase in the distance of the armature from the core at the start of its stroke, it also tends to increase the operating time. Where release timing especially is critical, a screw-type residual is recommended.

d. Inductance of the coil

Increase of coil inductance will increase the operating time, other factors remaining constant. A relay which gets its required ampere-turns from a coil with a few turns and relatively high current will operate more quickly than one with many turns requiring less current (other effects being equal). Increase in circuit voltage decreases operate time. The effects of inductance can be lessened by use of a non-inductive resistor in series with the relay coil.

e. Spring gauging

Increasing the make-contact gauging increases the armature restoring force and will tend to decrease the release time, and, conversely, decreasing the make-contact gauging will tend to increase the release time.

f. Copper collars and sleeves on coils

When the core of a relay is encircled by a solid ring of copper, any change in the flux produced by the current flowing in the coil winding will tend to be opposed by momentary current in the copper collar or sleeve (Lenz' law). The extent to which the flux change will lag behind the primary-coil current change increases with an increase in the amount of copper in the collar or sleeve. Various size collars and sleeves are used by the relay engineer to achieve the required operate and release time (see figure 11). A copper collar on the heelpiece end of the coil core has just a small effect, causes a slight delay, on the operate time of the relay; it causes a greater delay in the relay release time. A copper collar on the armature end of the coil core or a copper sleeve the full length of the coil core both have the effect of making the relay slow to operate and slow to release. The copper sleeve the full length of the

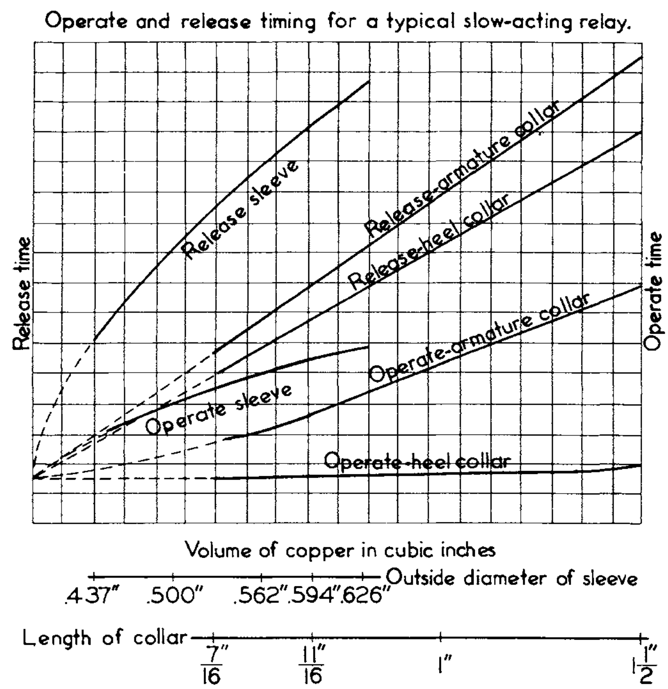


Figure 11. Operate and release timing of a typical slow-acting relay.

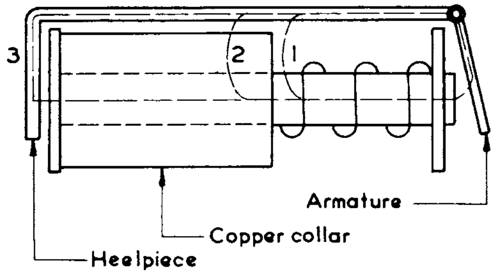


Figure 12. Effect of heel-end collar.

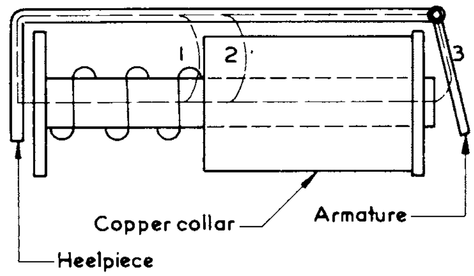


Figure 13. Effect of armature-end collar.

core has the greatest effect on both the operate and the release delay times - per unit of copper. However, since the maximum amount of copper that can be used in a sleeve is limited to approximately one-half the amount usable in an armature-end collar, maximum operate and release delay times are obtained by use of the armature-end collar. Heel-end collars have the advantage of producing a significant release delay time, but delay the operate time only slightly.

If both a.c. and d.c. flow in a circuit, the combination of a sleeve and an armature-end collar on relays intended to operate on d.c. only, will make them so sluggish they will not respond to a.c. (ringing-cut-off relays in telephony, for example).

g. Nickel-iron coil core and heelpiece

A standard relay ordinarily will have a ratio of release to operate power of approximately 50%. For quicker release, nickel-iron alloy is recommended for the coil core and heelpiece. When a relay must release on a value of current as close to the operate value as possible, other nickel-iron parts are used. Sometimes a circuit of nickel-iron is employed throughout, even in the armature. A ratio of release to operate power of 75% is attainable under ideal conditions (one back contact and not to exceed 5 springs).

h. Armature ratio

For normal operating and release time, the long-lever armature is most efficient. For slow-to-release or a-c-operated relays, the short-lever armature is usually used. It permits employing a larger residual gap, and delays release longer on d.c., or provides quiet operation on a.c.

Since some factors that speed operation also retard release, careful balancing of all factors is necessary in critical timing applications.

3.1 Quick-acting relays

Quick-acting relays are available in both Class B (series BQA and BFA) and Class C (series CQA). Series BQA may be used for normal operating- and release-time requirements; also fast operation and marginal operation. These relays can be supplied with multi-wound coils, fixed or adjustable residuals, and 1 or 2 pile-ups with a maximum of 13 springs in each pile-up. A long-lever armature and fixed residual are standard on series BQA relays.

The series CQA relay is recommended for use as a general-purpose relay to mount in minimum space. These relays use a single- or double-wound coil, 1 pile-up with a maximum of 13 springs, and a short-lever armature. They may be supplied with an adjustable residual, but a fixed residual is standard.

The series BFA is a quick-acting relay for a-c operation. It is provided with shading coils to prevent fluttering, and the short-lever armature and fixed residual are standard.

3.2 Slow-releasing relays

The slow-releasing relay (series BSR) provides a large release-time delay with little delay in operating time. These relays have a copper collar around the heel-end of the coil core, small residual gap, and a relatively light contact load. The copper collar retards the collapse of the magnetic field once it has been established, thus providing a release time delay. Figure 12 shows how the effects of the counter e.m.f. of the heel-end collar result in early linkage of the armature but, after the circuit has been maintained for a fraction of a second, the flux soon links the collar steadily. On de-energization, the counter e.m.f. of the collar maintains the flux long enough to produce a release-time delay of 0.035 to 0.600 second. An example of a coil with a heel-end collar is shown in figure 14. Where greatest possible delay is desired, or where permanence of the timing adjustment is very important, a short-lever armature is recommended. It is advisable to limit the spring pile-up to not over 6 springs. More springs may be added but at a sacrifice of release delay. Because of slow contact separation and consequent tendency to arc, these relays (BSR) are not recommended for use in breaking heavy current or highly reactive loads.

3.3 Slow-operating relays

Slow-operating (series BSO) relays use a copper collar on the armature-end of the coil core to retard magnetic field build-up. With the collar on the armature-end of the coil spool (figure 13), the flux first leaks inside the collar when the coil winding is energized. Later the transient effect of the collar allows the flux to build out until it acts upon the armature. This time interval, during which the collar is effective to prevent magnetic attraction of the armature, is referred to as "operate time delay". It varies (depending on the length and thickness of the copper collar) from 0.040 to 0.120 second. After the magnetic flux is established in full linkage with the collar, the counter e.m.f. of the collar also delays the collapse of the magnetic field when the coil winding is de-energized. The armature-end collar, therefore, delays both operation and release. These relays may be used with a heavy contact load; in fact a heavy contact load helps delay operation. These relays can have 1 or 2 pile-ups with a maximum of 13 springs in each pile-up.

3.4 Slow-acting relays

Slow-acting relays are available in Class B (series BSA) and Class C (series CSA). Slow-

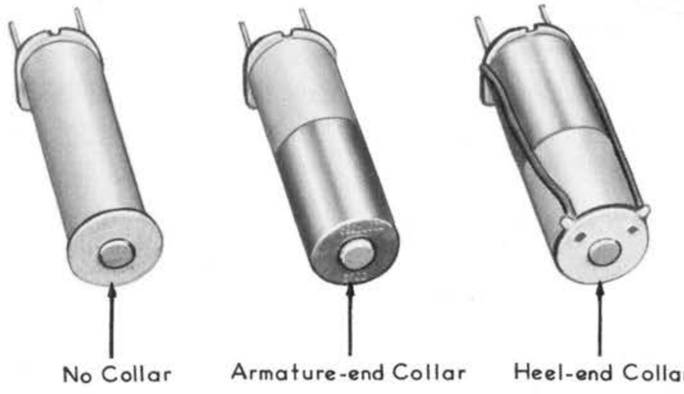


Figure 14. Typical relay coils.

acting relays employ coils with a copper sleeve around the full length of the coil core to reduce effective inductance of the winding and to provide both operate- and release-time delays. However, the operate-time delay is not so great as in the series BSO. The short-lever armature and the adjustable residual are recommended for use with series BSA and series CSA relays.

3.5 Snap-action relays

Snap-action relays (for contact loads greater than can be handled normally on open contacts) are available in Class B (series BMS) and Class C (series CMS). These are sensitive relays designed for switching heavy a-c loads. They may be used in locations subject to sudden jarring, vibration, or tilting for which mercury contacts are not suitable. Series BMS relays are furnished with one snap-action switch over each pile-up of up to ten springs; series CMS are furnished with only one snap-action switch over the sole pile-up of up to ten springs. Depending on the number of snap-action switches, the combinations are known as "1C" or "2C".

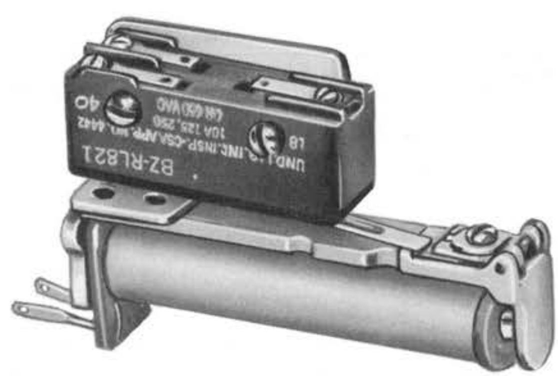


Figure 15. Typical snap-action relay. (The one shown is a class C.)

3.6 Special features

Many special features are available for both Class B and Class C relays. These special features include:

a. Hermetic sealing

See §5.4.

b. Impregnated coils

Impregnated coils are recommended to protect coil windings from excessive vibration. Coils are impregnated with phenolic varnish and have protective coverings.

c. "High-pot" coils

Our standard test potential is 500 volts r.m.s. Any voltage above this is "high-pot". We test our "high-pot" relays at 1,250 volts; ordinarily they withstand surges up to 1,500 volts. High-pot coils have extra insulation around the core, and phenolic fillets rounding corners between core and spool head.

d. "High-pot" relays

Where both coils and springs must withstand peak voltages in excess of 500 volts a.c., high-potential-insulated coils and specially insulated spring pile-ups are recommended.

e. Humidity treatment

Relays to be used where conditions of extreme humidity will be encountered are equipped with impregnated coils, and the spring pile-ups are moisture-sealed.

f. "Tropical" and "semi-tropical" treatment

For use in tropical climates or salt-spray atmospheres, relays are supplied with fully impregnated coils and are given fungicidal treatment.

g. Double spring insulation

Class B and Class C relays can be supplied with two insulators instead of one, placed between the springs. This reduces capacitance and increases the insulation resistance between the springs, but not between the springs and heelpiece.

h. Spring insulating tubes

Phenolic tubes slipped over the pile-up assembly screws provide added insulation between the springs and the heelpiece.

i. Marginal or close differential operation

The coils, the springs, and the adjustments of Class B relays can be properly coordinated to make the relay release in response to a drop in coil current or voltage, even though the coil circuit is not opened. Where the "drop out" voltage is half or less than half the operating voltage, a standard relay with proper adjustment can be used. Where the difference between operating and "drop out" voltages is less than half, "marginal" operation can be provided by relays that have nickel-iron alloy heelpiece and coil core (see page 12) and large residual and isthmus type armature.

j. Low-resistance springs

Low-resistance springs can be supplied to improve current-carrying capacity.

k. Electrostatic spring shielding

Because adjacent contact springs are of different shapes, capacitance effects are lower than with straight springs. However, where desired, relays can be equipped with electrostatic shields between the two springs of each contacting pair, between contact forms in one spring pile-up, or between two spring pile-ups.

l. Chromium-plated coil core

In very-heavy-duty applications such as computers, a residual screw or stud tends to indent the end of the coil core unless a hard mechanical protective coating is employed. Chromium plating provides this extra wear- and impact-resisting surface on the end of the coil core for very-heavy-duty applications.

4. ORDERING REPLACEMENT PARTS

With Class B and Class C relays it is very easy to replace coils or complete spring assemblies. Occasionally it may become necessary to change the spring assembly because of an accident or

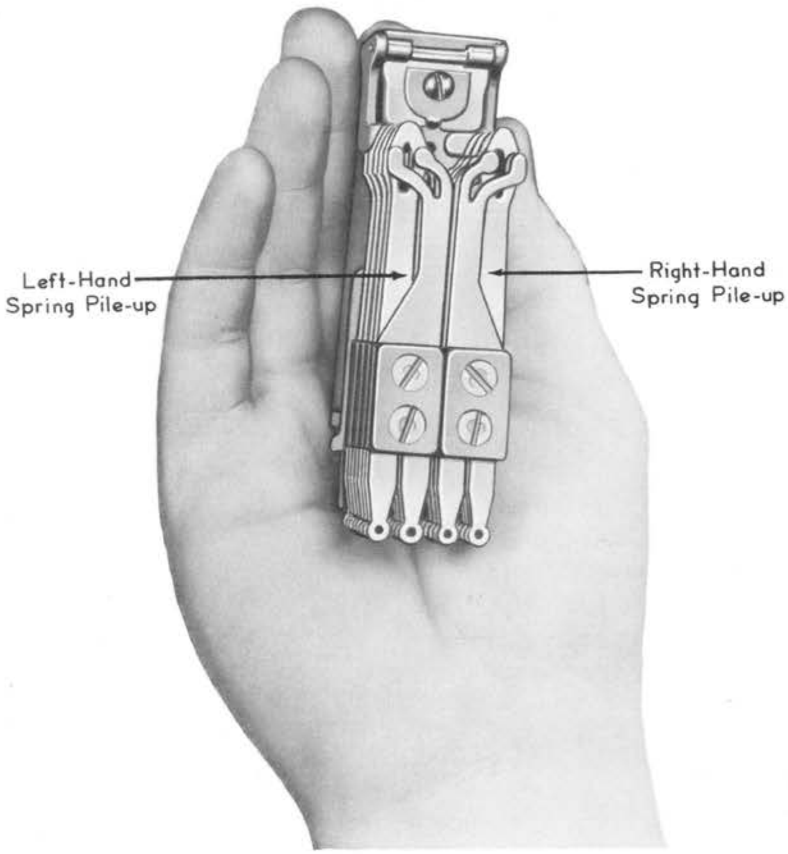


Figure 16. Left- and right-hand spring pile-ups.

changes in circuit requirements. Replacement of the spring assembly saves the cost of a complete relay.

Individual springs cannot be replaced in the contact spring pile-up in the field. At the factory the insulators are baked to remove any moisture and unwanted volatiles. While "hot and dry", they are assembled in the contact spring pile-up by special jigs. With the spring pile-up under heavy pressure, the high-tensile-strength screws are tightened by power-driven screwdrivers to the correct torque and then the squeezing pressure is released. In this way the spring pile-ups are permanently tight and "cold flow" shifting is avoided. For this reason, when a new spring combination is needed, a complete spring assembly (less the coil and armature) should be ordered.

There are two ways to order a spring assembly. When the same spring combination is to be replaced, look for the relay factory number on the inside edge of the heelpiece. Order by this number less the coil designation but add the letter "X". For example, if the relay number is PG-25003-B11, order PG-25003-X. You will receive a complete spring assembly on the heelpiece, unadjusted.

If a different spring combination is required, it is best to make a sketch using the basic contact forms shown in figure 5. On Class B relays be sure to specify either the long-lever or short-lever armature and either right-, or left-, or double-arm. (The Class C relay is available only in the right-hand short-lever armature.) As explained in §2.15 and shown in figure 8, the location of the spring buffers on the long-lever and short-lever armatures is different. Therefore, it is necessary to specify which is required, or provide the identifying number of the relay.

4.1 Explanation of right- and left-hand pile-ups

Visualize the relay held with the armature at the top and the springs toward you (figure 16). The springs on the right are the right-hand pile-up and those on the left are the left-hand pile-up.

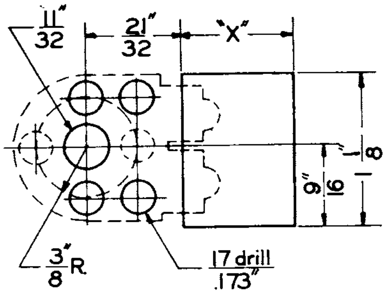


Figure 17. Mounting dimensions for series BQA, BSO, BSR, BSA, and BFA relays.

4.2 Coils for replacement

Coils may also be ordered for replacement purposes. The coil number (usually D-28____-A) is stamped on the spoolhead at the armature end of the coil. The coil may be ordered by this number or if the number is obscured specify the relay number. For example: coil for relay PG-25003-B11.

5. MOUNTING

Class B relays mount with two #8-32 screws and project 3 7/16″ above the mounting surface and 9/16″ below. Dimension "X" (figure 17) will vary with the number of contact springs per pile-up, being 13/32″ for a relay with two springs, 7/8″ for a relay with 8 springs per pile-up, 1 9/32″ for relay with 13 springs per pile-up (maximum). The two holes shown dotted are required only for relays having four coil terminals.

The series BMS relay (figure 18) also mounts with two #8-32 screws, and projects 3 7/16″ above the mounting surface and 9/16″ below.

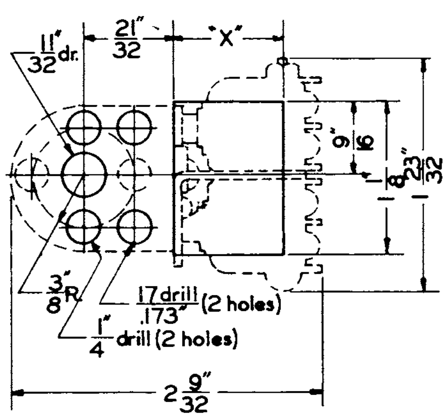


Figure 18. Mounting dimensions for series BMS relays.

Mounting parts required for one Class B relay are:

1 phenolic plate insulator D-440181-A for single-arm relays or D-440179-A for double-arm relays

2 bushings D-75321-A

2 #8-32 × 9/32″ W.H.I.M. screws

Class C relays mount with two #5-40 screws and project 3 9/16″ above the mounting surface and 7/16″ below. Dimension "X" (figures 19 and 20) will vary with the number of contact springs, being 5/16″ for a relay with 2 springs and 1″ for a relay with 13 springs (maximum).

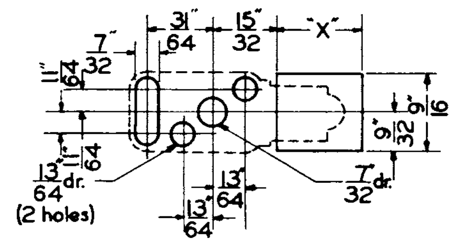


Figure 19. Mounting dimensions for series CQA and CSA relays.

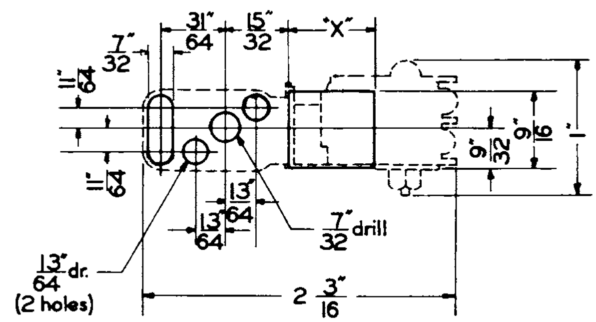


Figure 20. Mounting dimensions for series CMS relays.

Mounting parts required for one Class C relay are:

1 triple-hole metal washer D-17563-A

1 triple-hole insulating washer D-440253

2 #5-40 × 5/16″ R.H.I.M. screws

5.1 Individual mounting bracket and covers

Mounting bracket D-73934 will mount one Class B relay. It is supplied complete with phenolic insulator, bushings and screws as shown in figure 21.

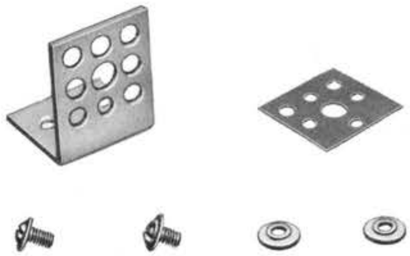


Figure 21. Individual mounting bracket and hardware.

5.2 Mounting strips

There are horizontal mounting strips in various widths and lengths to mount 5 to 24 class B relays or up to 36 class C relays. There are also vertical mounting strips to accommodate 10 to 25 class B relays or up to 50 class C relays.

5.3 Plug-in mountings

Class B relays (except series BMS) may be plug-mounted where it is necessary that the relay be removed and replaced quickly. Plugs and sockets are available for 8, 9, 12, and 20 external connections. If individual covers are used with plug-in relays, the maximum number of springs per pile-up is 8 (see figure 22).

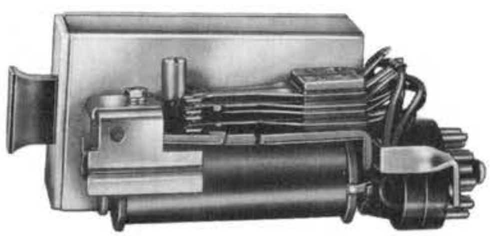


Figure 22. Plug-in mounting; relay cover in background.

5.4 Relay covers

Individual slip-on covers are available for Class B relays; these come in various sizes to accommodate relays having different pile-ups. Covers protect the relays from dust and from mechanical injury; they also provide magnetic shielding, when desirable, between adjacent relays. If covers are to be used this should be specified when the relay is ordered so that guide posts can be installed during manufacture; field installation of guide posts makes re-adjustment of the relay necessary. Group relay covers can also be provided for all horizontal group-mounting strips.

5.5 Hermetically sealed relays

Relay operation often is affected by the surrounding atmosphere. High humidity tends to corrode the relay mechanism. Airborne dust and fungi collect, clogging its moving parts. Acid and salt, carried in moisture particles, corrode its surfaces. Extreme variations in air pressure can change contact ratings and thereby can cause failure of even a new relay.

Class B and Class C relays can be protected from these injurious forces by hermetically sealing them. The relay atmosphere is controlled, relay enemies are shut out, and the relay is tamper-proof. Several different enclosures are available.

<u>5.51 AE 700 enclosure:</u> This enclosure will hold one Class B relay with either one or two pile-ups, or one Class C relay, each with a maximum of 9 springs per pile-up. A flange is provided for mounting the enclosure.

Figure 23 shows an AE 700 enclosure having a single octal base type multiple header with eight pins. This enclosure is also available with other type headers: screw-on connectors etc.,

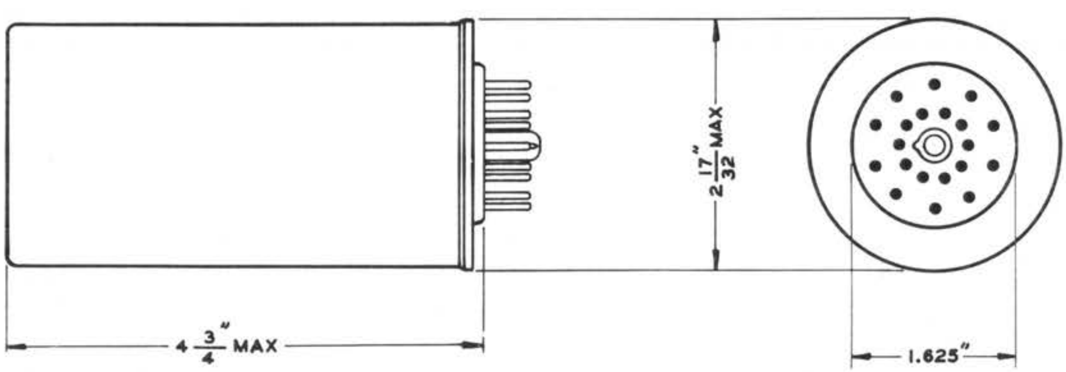


Figure 23. Enclosure AE-700 for hermetically sealed relays.

and with other styles of pins: straight pins, and hook pins for solder connections, and with various sizes and numbers of these pins.

5.52 AE 600 enclosure: This enclosure will hold two Class C relays having a maximum of 11 springs each, or one series CMS relay, or one Class B relay with either one or two pile-ups, and having a maximum of 11 springs per pile-up. (Class B relays with larger pile-ups require the use of the larger, AE 6100, enclosure; see below.) Four #8-32 X 5/16″ mounting studs are standard.

Figure 24 shows an AE 600 enclosure having three 14-contact (14 conductor), straight-pin, multiple headers. This enclosure is also available with other type headers: octal base, screw-type, etc., and/or with similar type headers having a different number of pins, and/or different sized pins, and/or pins with a different shape to provide different means for terminating or connecting the wires.

5.53 AE 6100 enclosure: This enclosure is similar to the AE 600, above, but is slightly larger and may be used to hold Class B and Class C relays having larger pile-ups than can be accommodated in the 600 enclosure. Other combinations of relays and some rotary switches may also be mounted in this enclosure.

Figure 25 shows an AE 6100 enclosure having three 28-contact, hook-pin, multiple headers. This enclosure is also available with a variety of pins and headers similar to those previously mentioned.

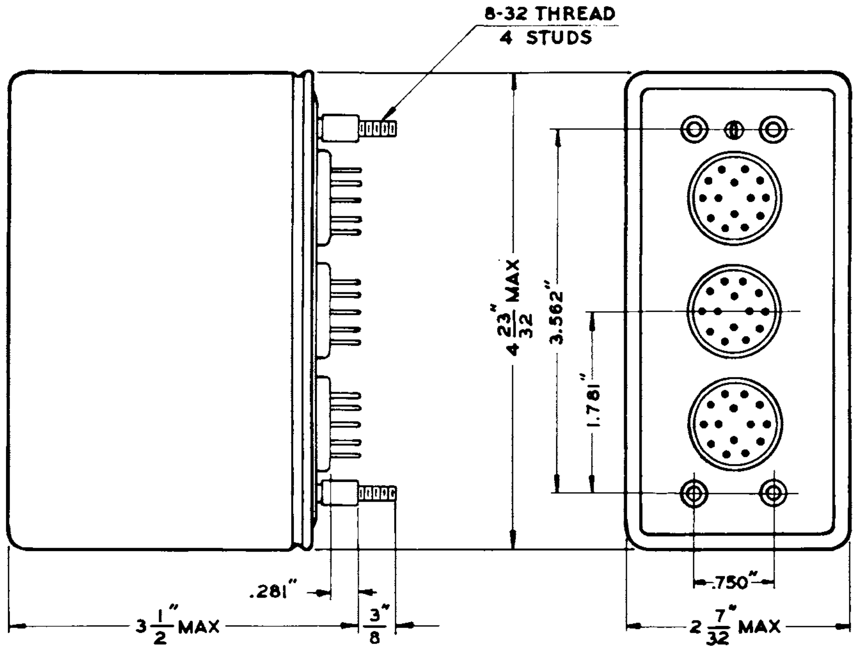


Figure 24. Enclosure AE-600 for hermetically sealed relays.

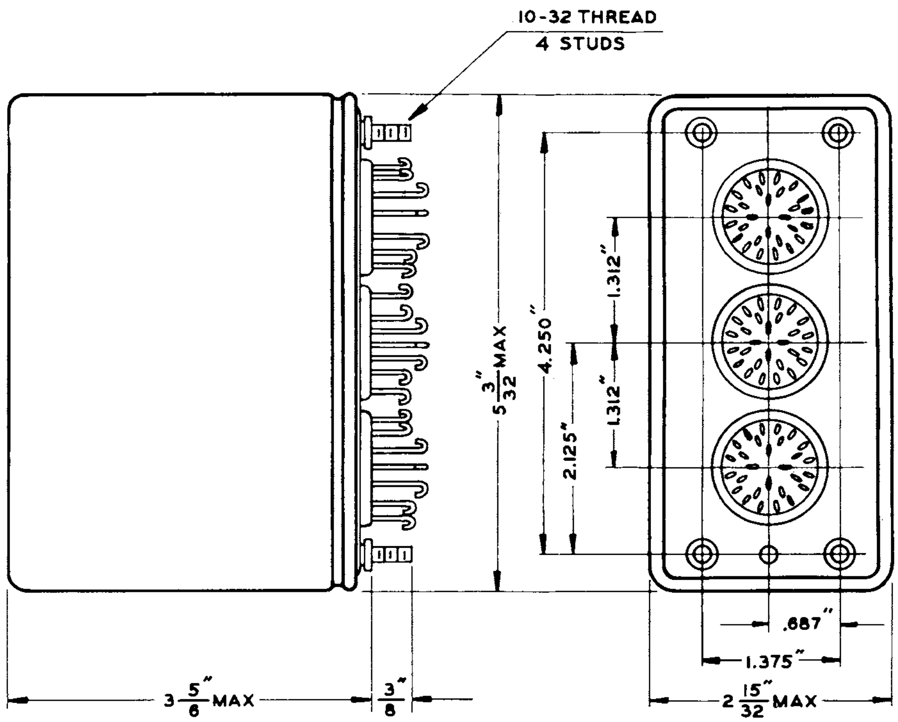


Figure 25. Enclosure AE-6100 for hermetically sealed relays.

6. MAINTENANCE

Class B and Class C relays are as maintenance-free as a relay can be. The main problem will be to keep the relays clean (dust covers will help). All bearing pins are heavy duty and are packed with grease and should never require relubrication. Relays should be readjusted as recommended in Automatic Electric Company bulletin 538. It is recommended that after the relay is mounted it be checked for proper adjustment. Class B and Class C relays are easily readjusted without removal of any parts (other than dust covers, if used).

NOTES

NOTES

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