

RELAYS

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RELAYS

General

Engineering requirements and specifications are becoming increasingly more exact in regard to the relays used in IBM equipment.

Relays of many varying characteristics have been designed and built by our engineering and manufacturing organizations. Extraordinary care enters into the development and production processes as well as into the selection and installation of relays. These units must perform definite functions within specified time limits. In order that trouble-free operation may continue after machine installation in the field, it is vitally important that these relay units be properly maintained by the customer engineering department.

This manual is intended to provide the customer engineer with a source of information regarding relays, their care and adjustment.

Types of Relays

There are several distinct types of relays used in IBM Electric Accounting Machines. They will be presented in the following order:

1. Duo circuit relay
2. Multi-contact relay

3. High speed relay (Collator)
4. Slate base relay
5. High speed relay (No. 202800)
6. Heavy duty relay
7. Wire contact relay
 - A. Wire contact relay testing device—Part 454199
8. Card counting dial relay

Relay Operating Speed

Several factors which affect relay operating speed in a circuit are the number and type of contacts, the voltage and current available, and the mechanical adjustment of the unit. Any deviation from prescribed standard adjustments, such as armature-core air gap, contact point adjustment and contact strap tension will affect the speed of the relay.

It is desirable to maintain a 100% safety factor in the operating speed of relays, that is, the impulse available to operate any relay should be at least twice as long as the rated operating time for that relay. The smaller the safety factor, the less dependable the circuit will be in operation.

It is strongly recommended that the dynamic timer be used wherever applicable to determine relay operating speeds and safety margins.

Milliseconds

Relay operating time is commonly expressed in milliseconds. A millisecond is 1/1000 second or .001 second and is abbreviated MS.

The formula for converting machine speed to milliseconds is as follows:

$$\frac{\text{MS}}{\text{Index Division}} = \frac{60,000}{\text{RPM} \times \text{No. of Index Divisions}}$$

CONVERSION CHART—MACHINE TIME TO MILLISECONDS

Type	Degrees or Cycle Points	RPM	MS/Index Division	RPM	MS per Index Division
*077	360°	240	.694		
078	360°	150	1.111		
079	360°	150	1.111		
080	16 pt.	450	.834		
089	360°	240	.694		
101					
Card Feed	16 pt.	450	8.33		
H. S. Acc.	11 pt.	450	12.42		
Print Cycle	20 pt.	130	23.08		
285	16 pt.	75	50.000	150	25.000
		120	31.250		
376	16 pt.	75	50.000	120	31.250
		100	37.500	150	25.000
402-403	360°	100	1.666	150	1.111
405	360°	80	2.083	150	1.111

Continued from preceding page.

Type	Degrees or Cycle Points	RPM	MS/Index Division	RPM	MS per Index Division
407	360°	150	1.111		
513	14 pt.	100	42.850		
514	14 pt.	100	42.850		
515	14 pt.	100	42.850		
517	14 pt.	100	42.850		
518	14 pt.	100	42.850		
519	360°	100	2.571		
520	14 pt.	100	42.850		
521	14 pt.	100	42.850		
551	16 pt.	75	50.000		
552	360°	60	2.777		
601	16 pt.	150	25.000		
602	360°	200	.833		
602A	360°	200	.833		

*Speed varies in parts of cycle.

DUO CIRCUIT RELAY

THE DUO RELAY, as the name implies, provides simultaneous control over several different circuits. It is used over a wide range of operating speeds and contact point combinations in most IBM machines. There are short and long frame relays; also one and two core relays. Various combinations of coils and contact points provide relays of large or small current drain, slow or fast pickup speed, and slow or fast drop-out speed. Suitable circuit combinations and relay design may provide for delayed action in either the pickup or drop-out time of these relays.

Figure 1 illustrates several types of duo relays.

- 1-A. Single coil, single core duo relay.
- 1-B. Two coil, single core duo relay.
- 1-C. Three coil, double core duo relay.

Duo Relay Adjustment

The function of a relay is the dependable opening and closing of circuits within given time limits. Proper adjustment is equally as important as proper design for successful operation.

Visual Inspection

Before adjusting any duo relay, a visual check should be made of the following items:

1. Core firmly secured to the frame.
2. Loose or burned contact points. Contact points which are loosely

held to the strap may cause bouncing and poor contact.

3. Contact point alignment. All contact points should be aligned vertically and horizontally, so that all points utilize the greatest contact area in both the de-energized and energized positions.
4. Contact pile holding screws tight.
5. Clean contact points.
 - (a) Remove loose dust with a brush.
 - (b) Remove caked or oily dust by moistening and flushing out with carbon tetrachloride. The carbon tetrachloride should be placed in a small container such as an accounting machine ribbon box and replaced when it becomes dirty. Dirty carbon tetrachloride will do more harm than good. Use a clean brush.
 - (c) Remove films by burnishing with the metallic burnishing tool. A burned deposit surface on silver contact points may be removed with a good quality contact file which should be followed by use of the burnishing tool. A flexstone should *not* be used on silver points.

A burned tungsten point should be cleaned with a flexstone after which a burnishing tool should be used to remove any residual abrasive. A chamois cloth or the finger dipped in carbon tetrachloride will serve to remove any

These relays are designed to operate in circuits of varying voltages as indicated in the chart (page 31).

GE Relay Adjustments

GE relays were used on IBM equipment in the past and are still to be found in many of the older machines in the field. When replacement is necessary, IBM unit relays are substituted.

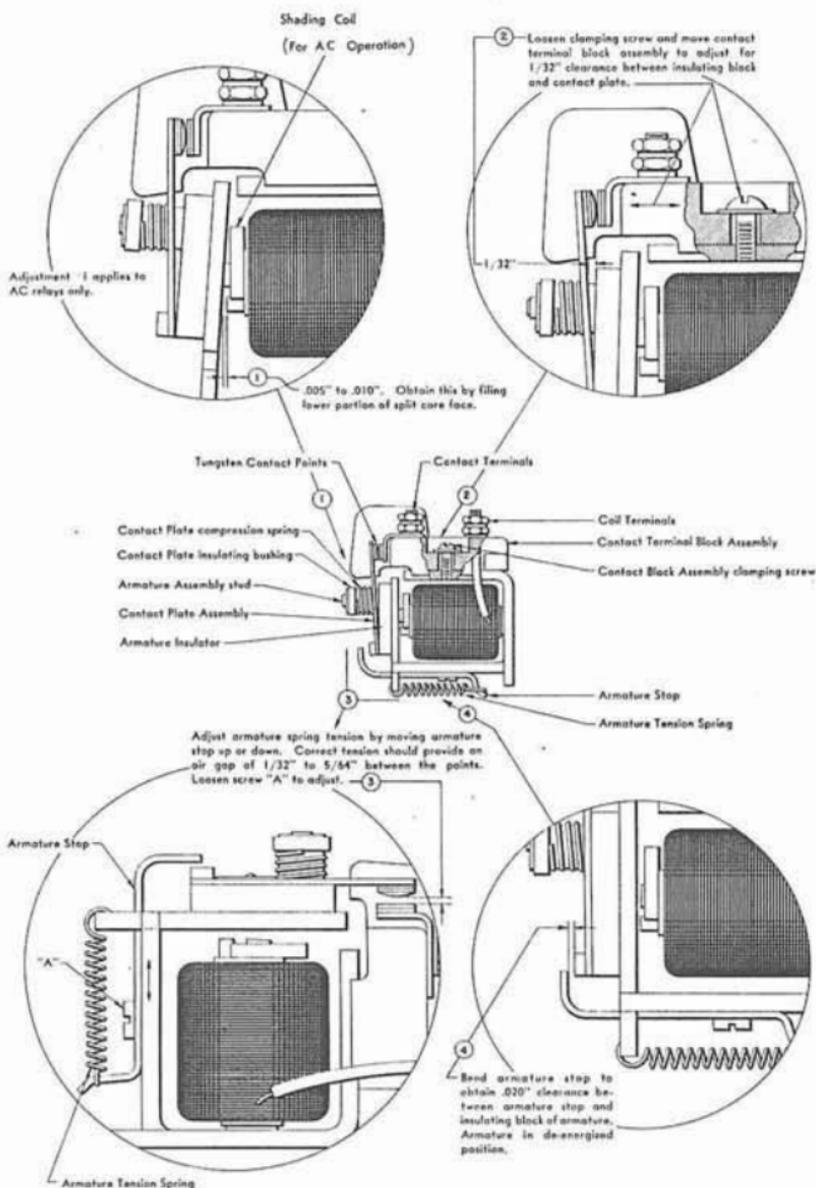
These relays should require very little adjustment other than to see that the armatures work freely and that the points are clean. The armature return spring should have sufficient tension to insure proper opening

of the points. A check should be made to be sure the points make squarely and simultaneously.

Unit Type Relay Adjustments

The following adjustments are recommended when the International Unit Type Heavy Duty Relays used on miscellaneous accounting machines are adjusted. Number of adjustment refers to sequence of adjustment and to Figure 14. Adjustment 1 is only made on alternating current unit type relays. Adjustment 2 through 4 refer to both alternating current and direct current unit type relays.

The adjustments are as follows:



1. On alternating current unit type relays there should be .005" to .010" clearance between the armature and the lower part of the split core face when the armature is fully attracted. This clearance is obtained by filing.
2. With the armature attracted there should be 1/32" clearance between the insulating block on the armature and the contact plate. Adjust by loosening clamping screw and moving the contact terminal block assembly. After getting correct lift of the contact plate, check to insure that the contacts close simultaneously so that the arc will be evenly distributed.
3. With the relay in a horizontal position the armature should balance with a contact air gap of 1/32" to 5/64". Adjust by loosening the armature stop retaining screw A and moving armature stop to obtain correct armature spring tension. A 100 to 150 gram weight applied at the point should seal the armature.
4. With the relay in operating position and the contacts fully open there should be a clearance no greater than .020" between the insulating block on the armature and the armature stop.

Note: When relays are used on alternating current, a characteristic hum is present under some conditions. However, the relay should not hum when proper current is applied. If the relay does hum, the armature is not seating flat on the yoke and the core. The upper part of split core face and the armature pivot points should be checked for burrs or foreign material.

Shading Coil (Figure 14)

Heavy duty relays operated from an AC voltage source are equipped with a *shading coil*. This coil consists of a heavy single, closed turn and is mounted in the split core (armature end) of the relay. Its purpose is to split the phase and thus produce a two-phase effect which will prevent the armature from dropping away from the core during the time that the alternating current in the relay coil circuit approaches and passes through the zero value of the sine wave. The tendency of the armature

to drop back to the de-energized position at zero time, followed by the re-energization of the relay coil as the current builds up in the opposite direction would cause a vibrating or chattering armature action.

During the cycle when the current is dropping from its maximum value to the zero value, the magnetic lines of force cutting across the shading coil cause an induced voltage in the shading coil. Current flowing in the single turn shading coil produces a magnetic field which will provide the necessary holding or sealing action for the armature, until the voltage and current builds up in the opposite direction to a point where the relay coil will again be energized. Thus, the shading coil functions to provide a continuous holding effect on the armature and overcomes the tendency of the armature to fall to its de-energized position.

Note: It is important that conditions in adjustment 1 be adhered to in order to eliminate a noisy chattering relay operation.

WIRE CONTACT RELAY

THE WIRE contact relay was developed to meet the need for a compact high speed relay for use on 40 volts DC. The unit is available in three sizes: 4, 6 and 12 transfer contact, single and double coil. The use of transfer contacts provides a flexible capacity which eliminates the need for several different relay assemblies having various contact combinations. The relay is pluggable, employing a terminal moulding connector which permits completion of wiring before relays are installed in a machine. The unit is readily removable for inspection or replacement and does not require removal of screws or wires. The wire contacts were not designed for circuit interruption, but the silver alloy now in use will stand some arcing. Figure 15 illustrates the component parts of a 4-position non-latch type relay.

Relay Terminal Wiring

The relay contacts are numbered from left to right facing the yoke end (Figure 15). When a holding contact is required, contact number one should be used. The common side of a wire contact relay coil is the side on which the high numbered contact is located. When wiring into the ter-

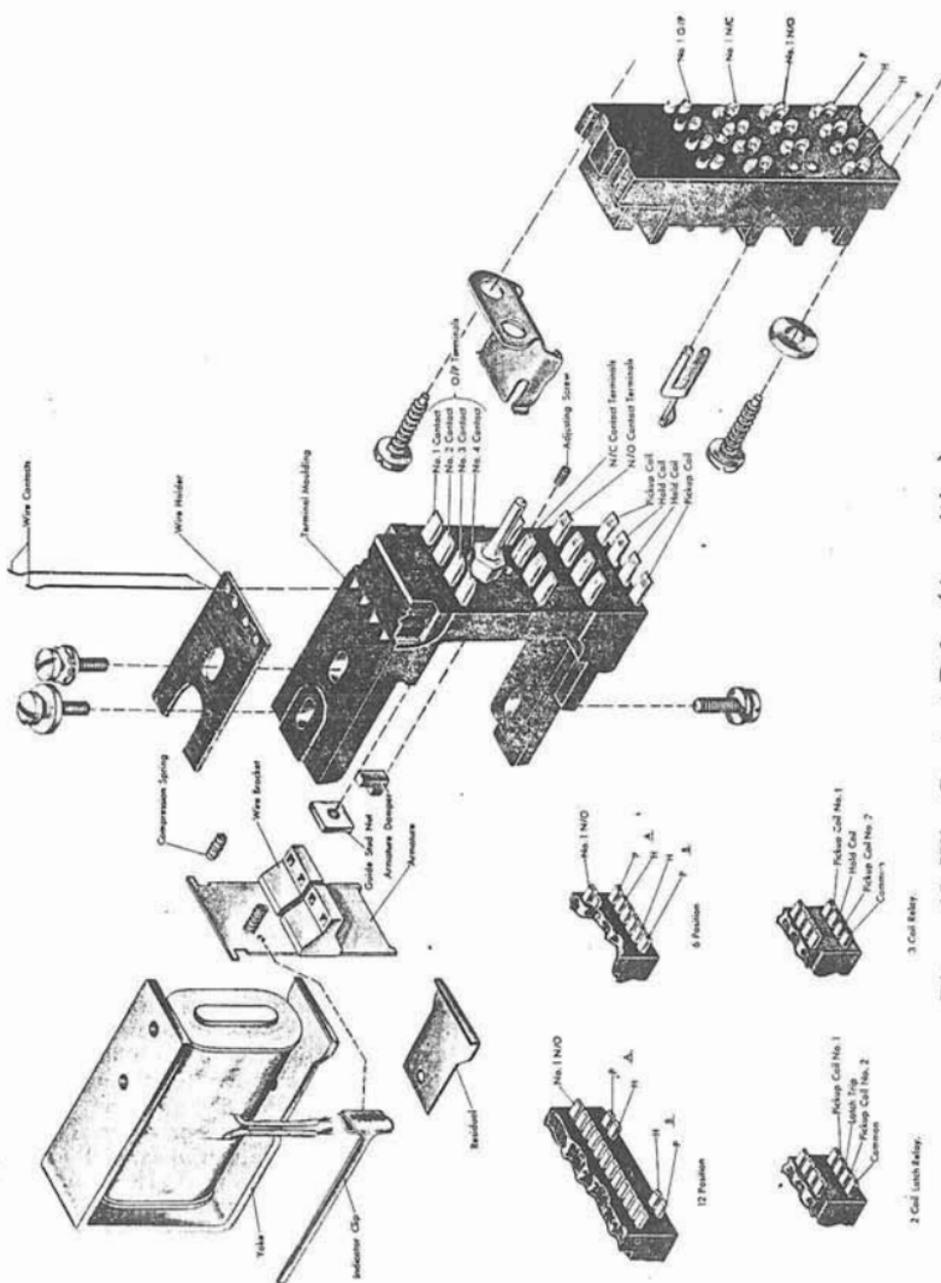


Figure 15. Wire Contact Relay (4-position).

minimal moulding, care should be exercised to prevent excessive pressure which may result in cracking or breaking the terminal moulding. The spacing between plugs in adjacent

contact positions is sufficient when the plugs are inserted straight and not bent to one side. No more than two wires may be wired to each terminal.

WIRE CONTACT RELAY CHARACTERISTIC CHART

Relay Part Number	Relay Size	Relay Coil Number	Coil Use	Coil Color *	PU Time M/S 40 Volts	Duty Cycle (Percentage)
196206	4	198881	PU		6.0	100
196207	4	198884	PU		6.0	100
196208	4	198887	PU		6.0	100
			HRH	red	8.0	100
104753	4	186693	HSPU	blue	4.5	50
			Hold		6.5	100
186696	4	186693	HSPU-1	blue	4.5	50
			186699	HSPU-2	blue	4.5
186256	4	186259	Hold		8.0	100
			PU		*6.0	100
			Hold		*8.0	100
186685	4	186260	PU-I	blue	*6.0	25
			186708	PU		6.0
186247	4	186707	Latch		6.0	50
			186249	PU-1		6.0
196196	6	198882	PU-2		6.0	50
			PU		6.0	100
			HRH	red	8.0	100
107558	6	107559	HSPU	blue	4.5	25
			107560	HSPU	blue	4.5
186686	6	186255	Hold		6.0	100
			PU		6.0	50
196186	12	198883	Latch		6.0	50
			PU		6.0	100
196187	12	198886	PU-1		6.0	100
			PU-2		6.0	100
196188	12	198889	PU		6.0	100
			HRH	red	8.0	100
107556	12	107557	HSPU	blue	4.5	25
108388	12	108389	HSPU	blue	4.5	25
			Hold		14.0	100

Note: The Drop-Out time for each of the above relays is to be considered as being 4 milliseconds, when a 40-volt potential is applied to the coils.

Legend

PU—Pickup Coil.

(Suffix 1 or 2 indicates PU coil 1 or 2)

PU-I—The pick coil is on the yolk for maximum isolation.

HRH—High Resistance Hold Coil.

Hold—Hold coil only.

HSPU—High Speed Pickup.

Latch—Unlatching coil.

*—Maximum pickup time listed above is for repetitive cycles of operation on the same coil. Increase the pickup time 3 MS if the coil receives single impulses, alternating from coil to coil.

Duty Cycle—Percentage of time the relay is designed to operate.

Non-Latch Type Relay Adjustments

The relay adjustments are listed in the order in which they should be made. They are given for the 4-position relay with an indication of the variations for the 6-position and 12-position relays. The test device should be used to check these adjustments as explained under *Use of Relay Test Device*.

- Figure 16. Contact air gap is machined to $.025" \pm .001"$ and should not be adjusted. Any attempt to change this gap will result in an out-of-parallel condition and prevent proper contact in all positions. Check for clearance of $.003"$ to $.005"$ between the armature and core with armature attracted. Adjustment for this clearance involves forming the center section of the armature. The residual must be flat against the face of the yoke, and the armature and core must be free of dirt or metal chips to insure good operation. Position the yoke to provide approximately $.050"$ travel at free end of armature. This is merely a starting point and may be changed to satisfy subsequent adjustments.
- Figure 17. With no wire tension on the armature, check the pressure exerted by the compression spring. This should be 7 to 15 grams, measured at the free end of the armature.
- Figure 18. The contact wires should be inspected to insure that they are positioned near the center of the contacts (Insert, Figure 18). Armature end shake must not permit the wires to reach the edge of the contacts, but the armature pivot must be free.
- Figure 18. Adjust tension on the contact wires by shifting the wire holder so that a 50-gram pressure applied at the center of the free end of the armature just moves the wires away from the contacts on the normally closed side. The 6- and 12-position relays require a 70 and a 130-gram pressure, respectively.
- Figure 19. Adjust the magnet yoke assembly so that with a $.010"$ thickness gauge between the armature and yoke at the free end of the armature, and the armature attracted, all con-

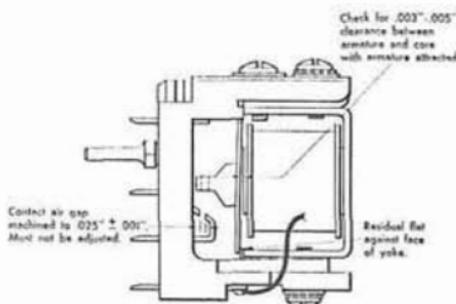


Figure 16

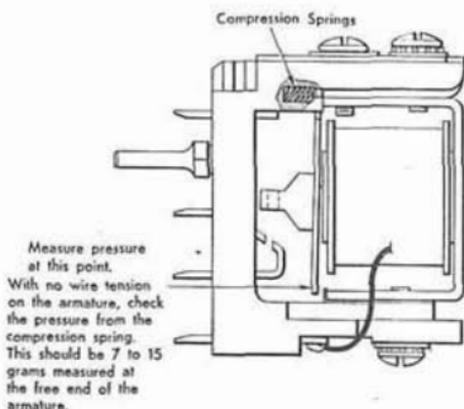


Figure 17

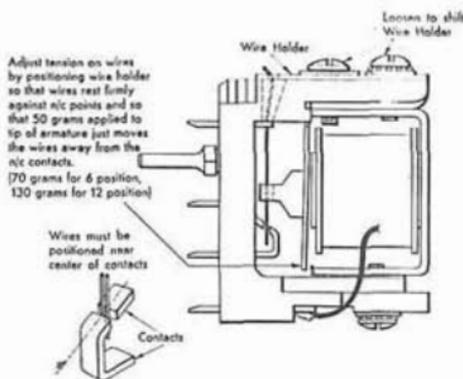


Figure 18

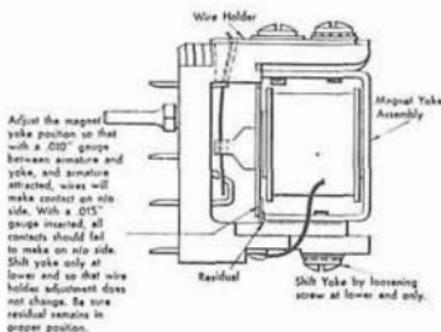


Figure 19

tact wires make contact on the normally open side. With a .015" gauge between armature and yoke and the armature attracted, none of the wires are to make contact on the normally open side. This adjustment is obtained by shifting the yoke assembly at the lower end only so that the wire holder adjustment does not change. If it is necessary to loosen the entire yoke to correct an out-of-parallel condition, the wire holder will have to be re-positioned for proper wire tension. Be sure the residual remains in the proper position.

- Figure 20. The damper screw should be adjusted to allow .003" to .005" movement between the vinylite damper and the wire bracket before the wire bracket can move any contact wire. If the screw is loosened, the vinylite damper must be pressed back into the moulding before checking the clearance between the damper and the wire bracket. Once adjusted at the factory, the damper screw is sealed with cement #198896.

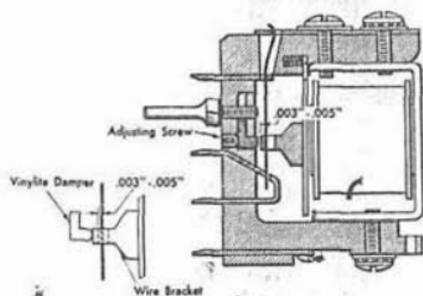


Figure 20

Latch Type Relay Adjustments

- Figure 21. Contact air gap is machined to $.024'' \pm .001''$ and should not be adjusted. Any attempt to change this gap will result in an out-of-parallel condition and prevent proper contact in all positions. Check for a clearance of .003" to .005" between the armature and core with armature attracted. Adjustment for this clearance forming the center section of the armature. The residual must be flat against the face of the yoke, and the armature and core must be free of dirt or metal chips to insure good operation. Position the yoke to provide approximately .050" travel at the free end of armature. This is merely a starting point and may be changed to satisfy subsequent adjustments.
- Figure 22. With the contact wires removed, the two relay armature pivot springs must exert 7 to 15 grams pressure against the relay armature at its free end.
- Figure 23. With the contact wires in place see that they are

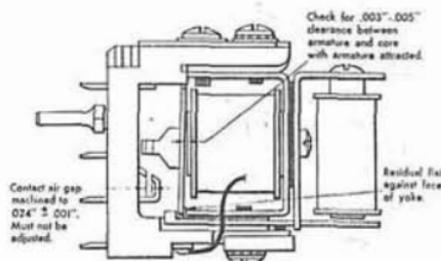


Figure 21. Adjustment 1

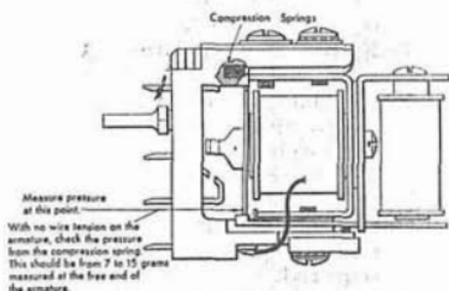


Figure 22. Adjustment 2

centrally located on the contact strap. Armature end shake must not permit the wires to move within $\frac{1}{84}$ " of the sides of the contact straps.

4. Figure 23. Adjust tension on the contact wires by shifting the wire holder so that a 45 to 55 gram pressure applied at the center of the free end of the armature just moves the wires away from the contacts on the normally closed side. The six position latch type relay will require 60 to 80 grams pressure.

5. Figure 24. Adjust the magnet yoke assembly so that with a .015" thickness gauge between the armature and yoke at the free end and the armature attracted, all contact wires make contact on the normally open side. With a .020" gauge between armature and yoke and the armature attracted, none of the wires are to make contact on the normally open side. This adjustment is obtained by shifting the yoke assembly at the lower end only so that the wire holder adjustment does not change. If it is necessary to loosen the entire yoke to correct an out-of-parallel condition, the wire holder will have to be repositioned for proper wire tension. Be sure residual remains in proper position.

6. Figure 25. The damper screw should be adjusted to allow .003" to .005" movement between the vinylite damper and the wire bracket before the wire bracket can move any contact wire. If the screw is loosened, the vinylite damper must be pressed back into the moulding before checking the clearance between the damper and the wire bracket. Once adjusted at the factory, the damper screw is sealed with cement #198896.

7. Figure 26. With the relay coil energized, there should be .003" to .005" latching clearance between the relay armature and the latch at the latching point. To change this adjustment, add or remove shims 186710 between the relay magnet yoke and the latch magnet yoke as required.

8. Figure 27. With the latch magnet energized, the latch armature should clear the relay

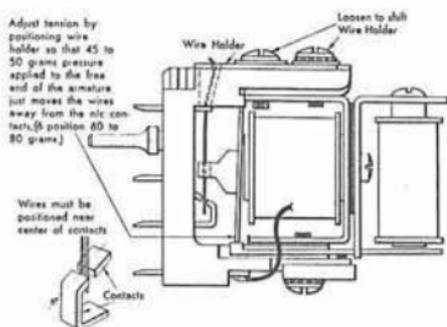


Figure 23. Adjustments 3 and 4

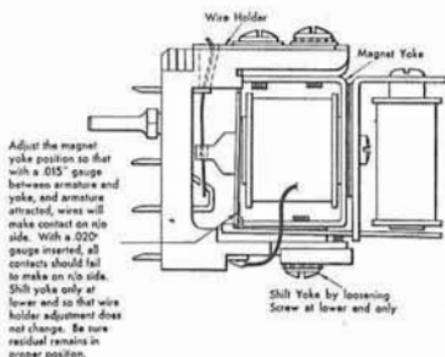


Figure 24. Adjustment 5

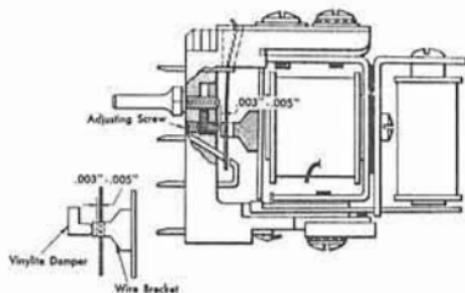


Figure 25. Adjustment 6

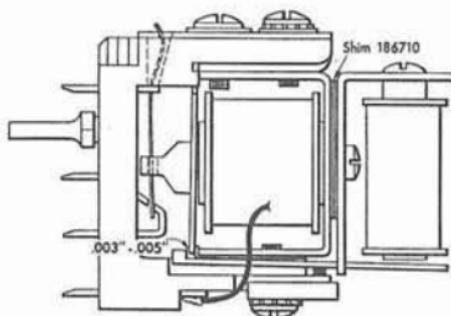


Figure 26. Adjustment 7

armature by .003" to .006" at the latch point. At the same time check for a minimum clearance of .010" between the bottom of the latch armature and the relay moulding as there should not be any interference with the movement of the latch armature at this point. If any change is necessary, form the latch armature at point A.

9. Figure 28. With the relay armature in the latched position, the point of contact of the latch should be at the 90° angle of the armature residual.
10. Figure 29. The latch should release the relay armature from its latched position when a pressure of 25 to 40 grams is applied to the extreme core end of the latch armature. The latch on the 6-position relay will require a pressure of 100 to 125 grams.

WIRE CONTACT RELAY TESTING DEVICE — PART 454199

THE WIRE CONTACT relay testing device is a small compact unit which provides the customer engineer with a means for testing the making and breaking conditions of all the contacts on a wire relay. The results of testing are indicated by two jewelled lights. One light labeled N/C, indicates by glowing when a N/C contact is made; the other light labeled N/O, when glowing, indicates that the N/O contact is made. The N/O light is equipped with a red jewel while a green jewel identifies the N/C light (Figure 30A).

By means of the light indications it is also possible to check visually the pickup and drop-out action of the relay when it is operated by each of the several coils. The contact points may be checked by manual operation of the relay or under power.

In addition to the above mentioned lights the device consists of a terminal receptacle which will accommodate the standard 4, 6 and 12 position, 1 or 2 coil relays. Three coil relays (4 position), including the latch type wire contact relay, may also be tested on the device.

When the 4, 6 or 12 position, one- or two-coil relays are to be tested, they must be plugged with #1 position

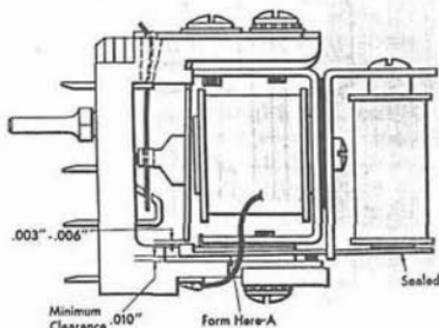


Figure 27. Adjustment 8

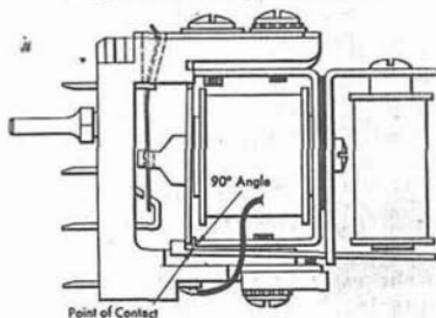


Figure 28. Adjustment 9

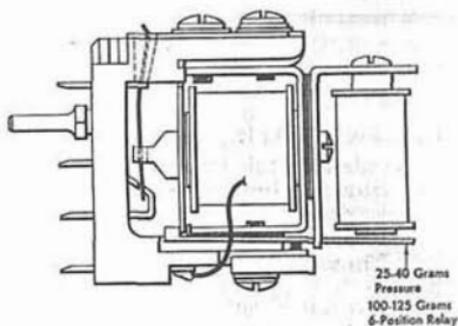


Figure 29. Adjustment 10

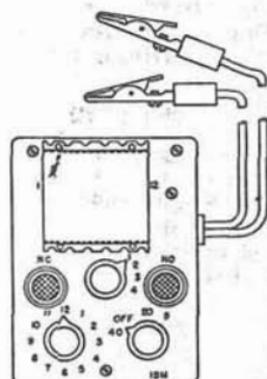


Figure 30A. Relay Tester

Test Objectives — Procedures — Adjustments

1. CHECKING NORMALLY CLOSED CONTACT POINTS

- a. Set dial switch (right) to OFF position.
- b. Insert relay, correctly, into connector receptacle.
- c. Using dial switch (left) select each contact position and check all N/C contacts. Green jeweled lamp should glow for each position selected when N/C point is made.
- d. Operate the armature manually and slowly toward the yoke. N/C (green) light should go out for each position before any of the contact wires have shifted to the N/O contacts, where the red lamp will glow. Then as the armature is released slowly, the same condition should be true in reverse with regard to the transfer indication from N/O to N/C contacts; great care should be exercised to release the armature so that the contact wires reach their N/C position slowly enough to detect faulty contacts because of excessive friction or insufficient tension. Proper use of the hand operation test provides an excellent means of determining proper alignment and contact tension. If the armature is operated and released too quickly, the purpose of the test is defeated. Repeat this hand operated test a number of times for each contact position to insure a satisfactory operating condition. Adjust or replace those contact wires when the test indicates improper alignment and tension conditions.

- e. 1. Insert a .015" thickness gauge between end of armature and yoke.
2. Energize the relay by setting dial switch (right) to the 40-volt position.
3. Center dial switch is set to 1 to energize 1 coil (2 position for three-coil relays).
4. With armature attracted, neither the N/C (green) nor the N/O (red) light should glow. Test every position by means of dial

switch (left). Run the finger lightly over the adjustable ends of the wires and if any lights come on, they should go out as soon as the finger leaves the wire. If the N/C light is on for a number of contact positions with a .015" gauge in position and the relay energized, adjust as follows: Loosen the screws holding the relay molding to the yoke side of the relay where contact adjustment is made and change the relation between the yoke and molding until light goes out for all positions. If a single wire makes, it may be malformed and should be replaced.

5. *Important*—Do not alter the position of the residual with respect to the magnet yoke nor disturb the contact wire holder.

2. CHECKING NORMALLY OPEN CONTACT POINTS

- a. 1. Insert a .010" thickness gauge between end of armature and yoke.
2. Set dial switch (center) to position 1 and dial switch right to 40 volts.
3. With gauge inserted and relay energized by power, the N/O (red) light should glow. Check each position by setting dial switch (left) accordingly. If the N/O (red) light does not glow for all positions, adjust by method indicated in 1e. With .010" gauge inserted and relay energized, run finger over wire contacts adjustable ends to make sure that when finger is removed the light is on for all positions.
- b. A relay may be considered to be in operating adjustment until the tester light indicates failure to make on the N/O (red light) side, in any position, with a .005" gauge inserted between armature and yoke.

3. TESTING ARMATURE PICKUP AND HOLD ACTION (ONE AND TWO-COIL RELAYS)

A check on armature pickup and drop-out action may be made with the

aid of the testing device by visually observing speed of light indications and armature actions (see High Resistance Hold Coils—HRH).

Testing PU and Hold Coil (except HRH)
— 40-Volt Test

- a. 1. Set dial switch (center) to position 1, 2 and 4 in turn.
2. Turn dial switch (right), to the 40-volt position. The armature should respond very speedily thus causing the N/O (red) light to glow immediately. Reset dial switch (right) to OFF. Armature should drop out immediately and rapidly. Remember that pickup time is 4-6 MS and drop-out time approximately 4 MS so armature action must necessarily be fast and positive.

Testing PU and Hold Coil (except HRH)
— 20-Volt Test

- b. 1. Set dial switch (center) to positions 1, 2 and 4 in turn.
2. Set dial switch (right) to the 20-volt position.
3. The armature should be fully attracted, although somewhat slower than with the 40-volt power source. It should be positively held by the 20-volt source.
4. While the armature is being held by the 20-volt source, turn the dial switch (right) to the 5-volt position. The armature should return to the de-energized position immediately with only 5 volts applied to the coil.

Note: the transfer from the 20-volt to the 5-volt switch position is accomplished by means of a sliding contact between these positions, thus preventing an open circuit during the switching operation.

4. TESTING PU, HOLD AND LATCH
TRIP COILS (THREE-COIL RELAYS)

Three-coil relays must always be plugged to the extreme right of the relay tester terminal receptacle.

At present there are two standard types of three-coil wire contact relays: the one type consisting of two pickup (PU1 and PU2) and a hold coil, the other known as the latch type and

consisting of two pickup coils (PU1 and PU2) and a latch trip coil.

(a) Non-Latch Type — 3-Coil Relay

To test PU1, PU2 and hold coils (except HRH) 40 volt test:

1. Set dial switch (right) to the 40 volt position.
2. To test the several coils set dial switch (center) as follows:
 - (a) No. 1 position connects PU2 coil.
 - (b) No. 2 position connects PU1 coil.
 - (c) No. 3 position connects the Hold coil.

The armature should be picked rapidly with power applied. Turn dial switch (right) to OFF position and the armature should return immediately and rapidly to the de-energized position.

(b) Latch Type — 3-Coil Relay

To test PU1, PU2 and latch trip —40 volt test:

1. Set dial switch (right) to 40 volt position.
2. To test the several coils set dial switch (center) as follows:
 - (a) No. 1 position to connect PU2 coil.
 - (b) No. 2 position to connect PU1 coil.
 - (c) No. 3 position to connect Latch Trip coil.

When power is applied to either PU1 or PU2 coils, the armature should be picked rapidly and latched in the energized position.

When the latch trip coil is energized, the armature should be unlatched and be restored to normal immediately.

(c) To test PU Hold and latch trip coils
(three-coil relay) — 20-volt test:

Three-coil relays, when tested under the 20 volt power source, should attract the armature and hold it to the core positively. As in the case of the two coil relays, the armature action will however be a great deal slower. Energizing the latch trip coil from the 20 volt source should unlatch the armature successfully. With the 5 volt power applied these relays should not pick, hold or unlatch.

High Resistance Hold (HRH)
Coil Relays

The #2 or hold coils of all standard relays are either of the same resistance as the pickup coil or of a higher value. These high resistance hold coils (HRH) are applied wherever a relay

may remain energized an indefinite length of time. They are used to prevent coil destruction.

(HRH) coils are not subject to the same voltage tests as applied to the standard coils in the foregoing test procedures.

A continuity check should be made on these coils by applying 40 volts. The armature should be attracted quite rapidly and positively held to the core. It has been found that by applying 20 volts to these coils the armature action is sluggish and in some cases it will not be fully attracted.

On machines leaving the factory after approximately May 1, 1949, these HRH coils may be identified by an orange or reddish coil covering.

CARD COUNTING DIAL RELAY

The card counting dial relay is a single position counting mechanism with a capacity of 1 to 9. At present it is applied in the circuits of the Collator Type 077 Counting Device and several special device circuits of the Type 405 machine.

Several of these dial relays may be coupled together (control panel plugging) in order to increase the counting capacity. For example, two coupled relays will provide a capacity of 1 to 99; three coupled relays, a capacity of 1 to 999; while coupling four relays will permit counting variables from 1 to 9999. These counter relays can add only unit impulses, and they can add only once during a machine cycle.

Each time the count magnet (Figure 31) is impulsed, the armature is attracted. The armature carries a pawl which engages a ratchet and advances the contact finger one position clockwise around a dial. This dial consists of ten contact segments corresponding to the characters 0 to 9. Thus, after a variable number of cards or unit impulses have been counted, the contact finger, having advanced one step for each impulse, will be positioned on the segment corresponding to the number of impulses counted.

The position of the contact finger, in relation to the dial contact segments 0 through 9, permits an electrical reading of the figure stored in the relay.

When the restoring magnet is impulsed, the tip of the armature which

serves as a detent releases the ratchet and allows the contact finger to return to its zero position.

Adjustments

1. The end play in the armature pivots should not exceed .005". Bend armature pivot ears to adjust.
2. There should be .004" clearance between the count magnet armature and the yoke when the armature is attracted. Adjust by loosening lock nut and moving armature pivot. Be sure armature is parallel with the yoke.
3. Bend stop arm under yoke for .020" to .024" armature core air gap on count magnet when de-energized.
4. The drive pawl should seat in the #9 tooth with .005" take up between the pawl and ratchet tooth when the contact wiper is resting against the stop pin. If this clearance is not obtained, bend contact wiper stop ear.
5. There should be a .004" clearance between the restoring magnet armature and the yoke when the armature is attracted. A .003" thickness gauge should go and a .005" should not go. Check as in paragraph 2.
6. There should be .008" to .010" clearance, preferably .008", between the restoring magnet armature and core when the magnet is de-energized. Adjust by bending armature at point indicated. With .008" air gap, the detent tip of the restoring magnet armature should clear the ratchet by at least .010" when the magnet is energized. This can be observed through a hole in the frame.
7. Bend the tip of the restoring magnet armature which serves as a detent for .005" clearance between the detent surface and the ratchet tooth when contact wiper arm is against the stop pin. Recheck adjustment 6.
8. There should be .005" overthrow of the ratchet beyond the detent. Bend end of count magnet armature to obtain this adjustment. Recheck adjustment 4 if this is changed.
9. Adjust the pawl stop by sliding in the elongated hole, for .005" to .008" clearance between the

- pawl and stop when the count magnet armature is attracted.
10. The contact wiper should seat on the center of the contact segment when detented. To position the contact finger, loosen hex locking nut and move the contact finger with a screwdriver. When tightening the hex nut, hold the stop arm against the stop pin and the break contact operating arm toward base of relay. The contact segment assembly may be moved through elongated holes for minor changes in this adjustment.
 11. Position shaft collar to allow .003" end play.
 12. The break contact should be made on the lower side with a clearance between the center strap and the contact operating arm when the step relay is in the 1 position.
 13. The tension on the flat restoring magnet armature spring should be sufficient to detent the ratchet properly without causing the armature to be sluggish on the pickup. With the coil de-energized, a scale reading of 50-100 grams should just lift spring away from stop pin.
 14. The tension on the flat count magnet armature spring should be just sufficient to overcome the tension of the feed pawl spring and to return the pawl away from the ratchet. Too much tension will cause counting. under. Keep a clearance between tension spring and end of armature. Adjust spring for 100-150 gram with coil de-energized.
 15. Tension on the contact finger should be sufficient to cause either strap to follow approximately $\frac{1}{8}$ " when the other strap is raised. This adjustment must be made with the contact finger beyond the segments.
 16. Both count and restoring magnets should operate in from 24 to 30 milliseconds.