COMMUNICATIONS DIVISION
WEBSTER ELECTRIC COMPANY, INC.
Racine, Wisconsin 53403

telecom systems

service and routining trouble shooting and telephone terminology

bulletin TC4-1 volume 2

JULY 68

TABLE OF CONTENTS

LIST OF FIGURES

VOLUME I INCLUDES: Introduction, Theory, Preliminary & Installation Procedure

A STA-RITE INDUSTRY

Litho in U.S.A.

5. SERVICING AND ROUTINING:

5.1 PREVENTIVE MAINTENANCE:

Dial switchboard equipment's operation depends on a large quantity of electrical contacts made up as precision relays and stepping switches. Keeping this equipment operating at top efficiency is best accomplished by an intelligent **Preventative Maintenance Schedule.** This schedule is a systematic series of service operations performed at regular intervals established to prevent major breakdown of the equipment. This service is routine in nature and is simply a periodic inspection to detect signs of wear, dirt accumulation, overheated or damaged parts, and broken wires or connections. These conditions may not have interfered with the operation of the switchboard, however, correcting them will prevent the eventual breakdown of equipment.

5.1.1 Routining Schedules:

The actual frequency of the schedule depends on the equipments location, its type and age, and the average daily use of the equipment.

1. It is not always possible to install the board in an ideal location and as dirt and dust is the major cause of contact failures, a routine cleaning schedule is all important. Dust and dirt in the switchboard area eventually filters it's way inside the cabinet and it must be periodically removed. In problem area, cleaning and routine testing should be performed every 90 days. In relatively clean areas this can be reduced to 180 days.
2. The type and age of the equipment should be considered when setting up this schedule for the following reasons:
   a. Available linkage (conversation paths) in the one, two, and four link boards can greatly affect the normal function of the owners business activity, consequently routine testing should be performed more frequently on the smaller boards. Routine testing is simple and the time spent is well worth the effort.
   b. Each additional year of equipment use will increase the possibility of wear and component failure. The cleaning routine will not be affected but the routine inspection and testing schedule after each year of operation should be increased.
3. Information concerning the average daily use (traffic) through the switchboard is necessary in setting up the lubrication schedule for the stepping switches. Each switch requires the application of specific lubricant after a given number of operations. This is the best insurance for long trouble free switch life.

5.1.2 Cleaning:

The cleaning operation starts **before** the equipments access panels are removed or doors opened. Wipe the exterior of the cabinet, top and all sides, with a lint-free cloth to remove accumulated dust and dirt. Do not use any wax or cleaning material that is likely to generate fumes -the slightest chemical film on relay contacts renders them inoperative. This will make the job more time consuming and more than likely introduce future problems. Try to avoid introduction of dirt and fumes when the cabinet is opened for the interior cleaning operation. Carefully clean the interior of the board so as not to damage relays, switches, and parts. A small tank type vaccum cleaner is ideal for removing accumulated dust and dirt on or around wiring and parts. Relay and switch assemblies can be cleaned with a camel hair brush, being careful not to change their adjustments.

Examine and clean all recesses in the switchboard and especially between connecting terminals. Any foreign matter should be wiped clean from connections and joints to prevent corrosion.

After the interior of the equipment has been cleaned, examine all cable and equipment entrance holes, reseal these if necessary. Also, check the gasket around the panels or doors, replace the gasket if it shows signs of wear or damage.

5.1.3 Power Checks:

Proper operation of the relays and switches of a switchboard is dependent upon the output of the power supply. If the operating voltages are not of the proper value, satisfactory operation cannot be expected.

The quickest method for checking the operating voltages is to connect the positive lead of a D.C. voltmeter to any terminal having a red wire and the negative lead to any terminal having a white wire. This voltage should measure -52 volts D.C. under no load condition. With the negative lead of the voltmeter connected to a terminal having a black wire the reading should be between -60 and -65 volts D.C. If the voltages are not within these prescribed limits, check the line voltage and the primary tap adjustment of the power transformer. Power supply adjustment should be made for the average line voltage condition and not for low or peak conditions. If power supply adjustment does not provide D.C. voltages of the proper value, refer to section 7.2.3, covering trouble shooting of power equipment.

5.1.4 Adjustment Check:

Routine adjustment checks of relays and stepping switches is done visually by observing contact operation. It is basically routine and intended to prevent future problems, and problems of the intermittent nature. During routine or preventative maintenance the importance of cleanliness has been pointed out, but in the case of relays and switches this is difficult to observe unless contact operation is checked. Any obstruction such as dirt, corrosion, or foreign material between the relay's armature and pole piece can give the relay's contact operation the appearance of misadjustment. Always keep in mind that relays and switches seldom need adjustment and then only after considerable use.

a. Visual check of relays is made by manually pushing in on the armature and observing

contact operation. Pay attention to the following:

1. Excessive load or binding as the armature is pushed in. This can be caused by dirt or foreign material obstructing armature action, or possibly by worn or damaged armatures and related parts.
2. Look for any dirt or foreign material across or between contact springs. Clean the springs and contacts with a clean nylon tooth brush to remove dirt.
3. If the relay or switch operation indicates the necessity for adjustment, carefully follow instructions in Section 5.3, 5.4 and 5.5.

b. Visual check of the rotary stepping switches can be made by observing the following:

1. Operation of the various type of rotary and two-motion stepping switches can be checked by being thoroughly familiar with its function. The preselect and connector switches will return and stop on the home, or normal position, with all telephones hung up. Finder switches will remain where last used.
2. The wipers of the switches should line up with the contacts of the banks. This should be checked for one complete rotation of the wipers.
3. Check for signs of wear which is evident by fine metal particles deposited between the contacts of the banks. This must be cleaned out with a bank cleaning brush. Excess signs of wear can be an indication of misaligned wiper assemblies, or damaged, worn, or bent mechanical parts.
4. Check to see that the interrupter and off-normal spring contacts are operating properly. There should be no excessive sparking in the interrupter springs. If the sparking is quite visible, check the spark suppression capacitor in the link assembly.
5. Check for visible signs of dirt and dust accumulation around the moving mechanical parts of the switch. This should be cleaned with a bristle brush.

c. Check the RI and BI relays on the tone and interrupter assembly. These relays should be pulsing automatically on the DA series boards, however, on the earlier D series they will only pulse when the handset is removed from the hook switch. Check to see that the three tubes (12BH7A) are inserted firmly and that they are operating. The heaters are connected in series, therefore, an open heater in one will affect all three.

Exercise care when cleaning contacts on the RI and BI relays. Dust or foreign material should be removed with relay paper, do not use a bristle brush or burnishing tool.

5.1.5 Functional Testing:

The purpose of this test is to check electrical operation as well as the mechanical operation of each link. This can best be done by use of a test telephone at the switchboard location. The operation of each link can be tested through the test phone and at the same time relay and switch operation observed. Two telephones will be needed for this functional test. If a telephone is available near the switchboard, only one instrument need be connected directly to the line terminal board. Use unassigned line circuits or remove lines for test purposes. Proceed as follows:

a. "Busy Out" all links except link #1. A "Busy-Norm" toggle switch is provided on each link which allows taking the link out of service for testing, servicing, or, to disable a defective link until service can be made.

b. Locate one of the test telephones so that the switch and link operation can be observed as the instrument is operated. Now, remove the handset, the link distributor and link relays will operate and finder switch will automatically stop on the test telephone's number. At this time dial tone can be heard through the test phone.

c. Dial the test telephone's number. Observe link relay and connector switch operation. The connector switch will move to the number dialed (the test telephone's number) and busy tone should be heard through the test phone. Replacing the handset will release the link, the connector and preselect switch, if used, will return to the "home" position. The finder will remain on the test phone's number.

If the "All-Links-Busy" circuit is incorporated, test this by placing link #1 in the busy position and remove the handset. Busy tone should be heard and the link distributor should not operate, With the handset "off-hook", place the busy switch of Link #1 to the "Norm" position. This link should be seized and dial tone applied to the phone.

d. Now, dial the second test telephone's number, observe connector switch and link relay operation. Ring back tone should be heard on the calling test phone and the called test phone should ring. Allow the phone to ring two or three times before answering. Observe relay operation as the call is answered and check the talking circuit for loudness and clarity in both directions.

e. Hang up both telephones and check link #1 from the second test phone. Follow the above steps with the exception of the All-Links-Busy test. Repeat this operation until all links are tested. Be sure to restore all "Busy-Norm" to the "Norm" position after the test has been completed.

If any dificulty arises in certain links follow procedure outlined in Section 7.2.

5.1.6 Lubrication:

Periodic lubrication of rotary and two motion switches is an essential part of routine maintenance. This does not apply to any of the other components or relays of the switchboard. Lubrica-

tion is only necessary on the following:

Link Distributor rotary switches
Linefinder rotary switches
Pre-selector switches
Connector rotary switches
Connector two-motion switches

During the first 12 months of operation these switches require frequent lubrication, applied in small amounts. It is during this time that moving parts are "Wearing in" and lack of lubrication can cause permanent damage. To insure proper operation and long life it is essential that the following lubrication routine be followed:

At 25,000 revolutions or 3 months, which ever comes first.
At 75,000 revolutions or 6 months, which ever comes first.
At 150,000 revolutions or 9 months, which ever comes first.
At 250,000 revolutions or 12 months, which ever comes first.

Then after, every additional 200,000 revolutions or 9 months, which ever is the most frequent.

A properly lubricated switch will give long trouble free service. Remember these are precision mechanisms and improper application of lubricants can cause failure or permanently damaged switch components. The following simple rules will save many hours of needless service.

Do not lubricate surfaces that are dirty, wipe clean with a lint-free cloth before application.
Do not use an eye dropper or oil can for applying lubricants.
Do not use more than specified amounts of lubricant and then only on parts indicated.
Do not allow excess oil to run or drip on parts; remove any excess with a lint-free cloth.

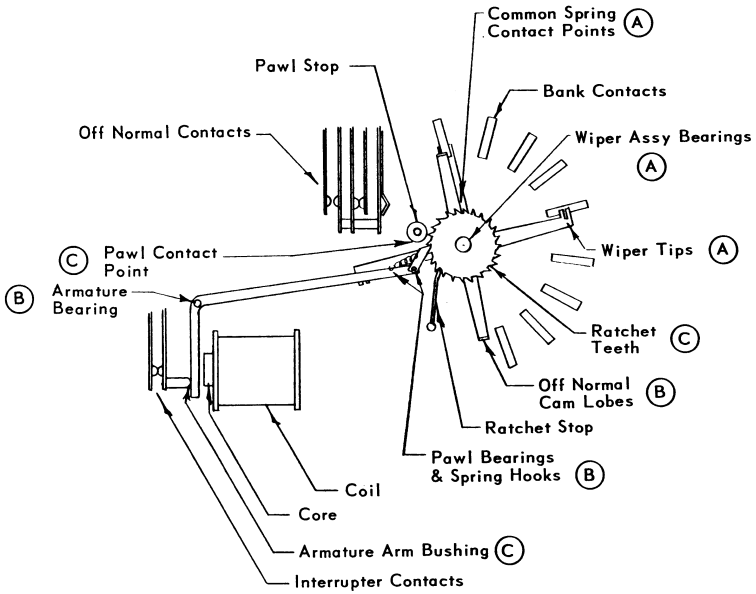
Most points can be lubricated with a #4 artists sable rigger brush, with the exception of wiper tips. A strip of bond paper treated with no more than two dips of oil is used to lubricate wiper tips. The paper shall be drawn through each pair of wiper tips and the assembly rotated to distribute the lubricant. A "dip" shall be that amount of lubricant retained on the brush when it is dipped 3/8 of an inch into the lubricant and lengthwise scraped on the edge of the container to remove excess. There never should be sufficient lubricant on the brush to form a drop.

Lubrication points for rotary switches are indicated on Fig. 1 and Fig. 2 pages 4 & 5 for two motion switches. These are intended to be used for quick reference as they are merely simplified diagrams of the various types of switches.

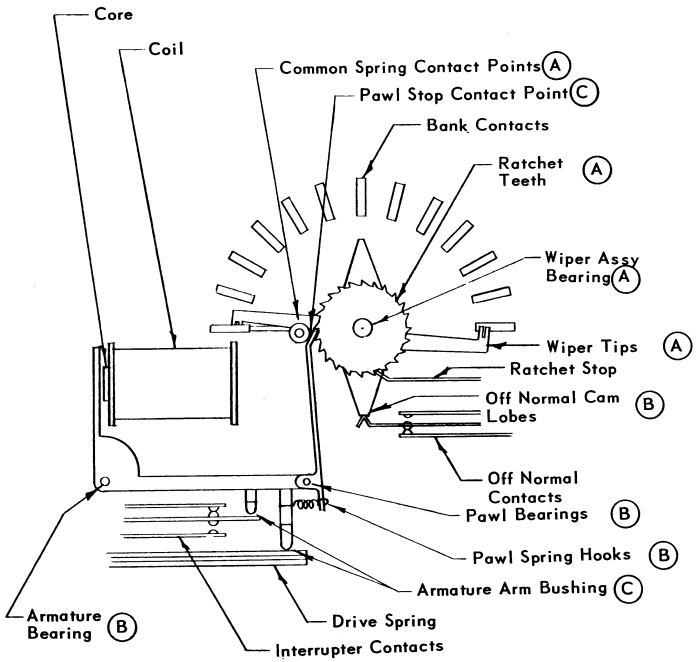
5.1.7 Lubrication Chart:

Rotary Switch		
Lubricant A	**Lubricant B**	**Lubricant C**
1. Wiper Assembly	1. Armature bearing	1. Ratchet teeth
2. Wiper tips	2. Pawl bearing	2. Armature arm bushing
3. Brush spring contact point	3. Pawl spring eyelet hooks	3. Contact point of armature restoring spring
	4. Off-normal spring cam holes	4. Pawl contact point on pawl stop

Two Motion Switches		
Lubricant A	**Lubricant B**	**Lubricant C**
1. Bearings of pawls and levers		1. Wiper shaft
2. Bearings of all armatures		2. Shaft restoring spring
3. Bushing pins		3. Teeth of hub, ratchet, guides & sliding surfaces
4. Springs on pawls		4. Stops of pawls, armature arms, and levers
5. Springs on levers		
6. Spring support points		

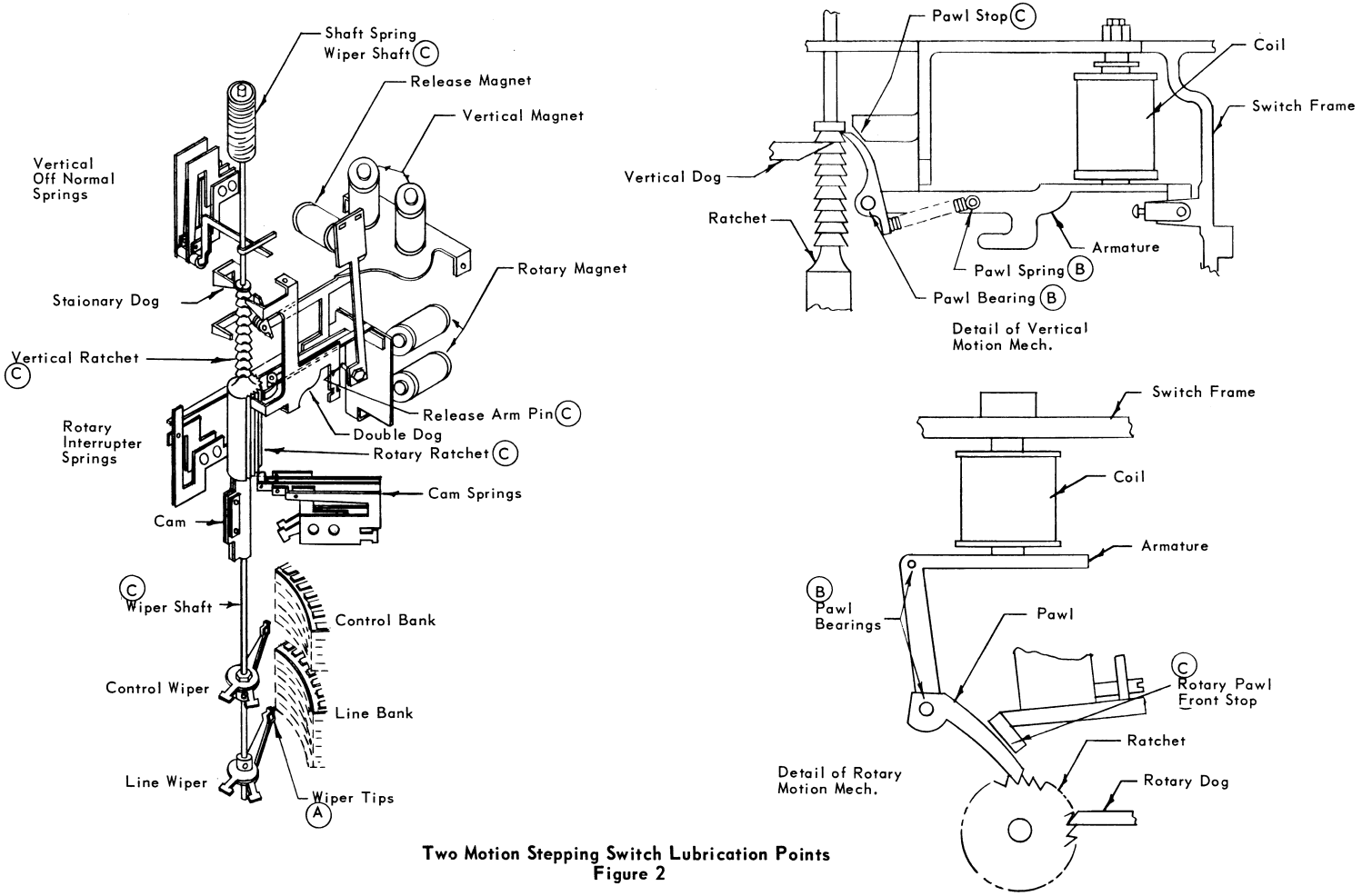


Direct Drive Stepping Switch



Spring Drive Stepping Switch

Rotary Stepping Switch Lubrication Points
Figure 1



Two Motion Stepping Switch Lubrication Points
Figure 2

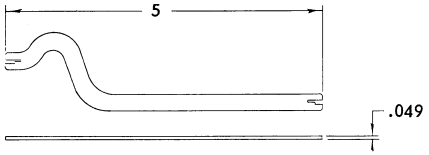
5.2 MAINTENANCE TOOLS AND TEST EQUIPMENT:

In addition to the usual tools and test equipment used in maintenance of electronic equipment, several different tools will be needed to properly adjust and repair relays and switches.

5.2.1 Minature Relay Type Adj. Tools:

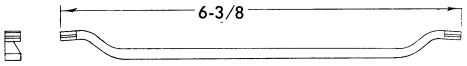
The following tools are necessary to check and adjust miniature type relays. These tools are not stocked by Webster Electric, however, they can be purchased from the P.K. Neuses Co., 511 North Dwyer, Arlington Heights, Illinois.

1. Armature Backstop Adjuster. P. K. Neuses No. SA-9



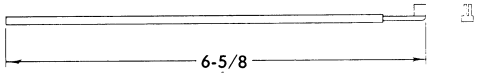
This tool is used to bend the armature backstop.

2. Offset Spring Adjusters. P. K. Neuses No. SA18 & SA-32



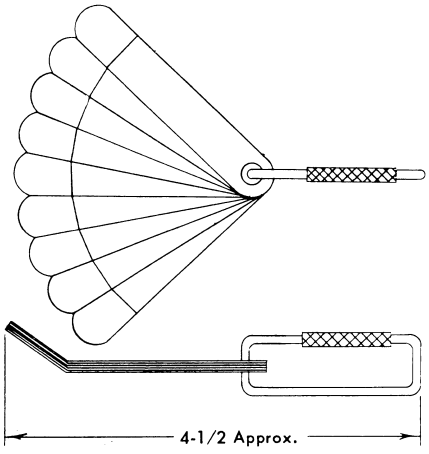
These tools are used to adjust stationary springs. The SA-18 has .018" lengthwise slots and the SA-32 has .032" lengthwise slots.

3. Single Ended Spring Adjusters. P. K. Neuses No. N-505A and N507A



These tools are used to adjust stationary springs. The N-505A has a single lengthwise slot .014" wide and the N-507A has a .032" wide slot.

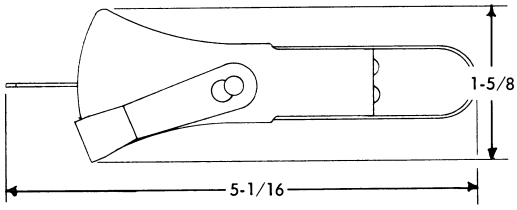
4. Thickness gauge set with bent tips. P. K. Neuses No. N-82-13.



Set has 13 leaves on a ring in the following sizes: .0015", .002", .003",.004", .005", .006", .007", .008",.009", .010", .011", .012" and .018". Each leaf has rounded ends, offset 1/2" from end, 3" long and 1/2" wide.

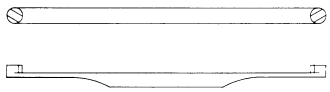
This tool is used to check residual gap, spring gauging, and armature stroke. The bent-tip gauges are preferred to straight tip because they can be used where relays are mounted close together.

5. Spring Tension Gauge P. K. Neuses No. STG-2-J



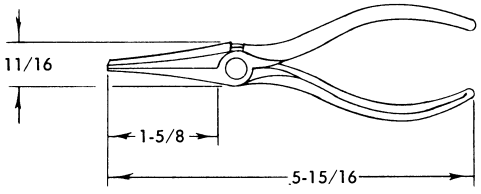
This tool is used to check spring tension on armature and stationary springs. Scale is calibrated on front and back, 0-150 grams in 5 gram steps. Folding handle is used as a protector for the indicating spring when closed.

6. Armature Adjuster. Automatic Electric Co. No. H.884149-1



This tool is used to adjust the relays armature arm where space is limited. Can be purchased from Automatic Electric Co., P.O. Box 25, Northlake, Illinois.

7. Relay Spring Adjusting Plier, Duck bill type. Klein No. 311-5 1/2.



This tool is used to tension and straighten armature springs. Manufactured by Mathias Klein & Sons, 7200 McCormick Road, Skokie, Chicago, Illinois, and may be purchased thru any of their local distributors.

5.2.2 Stepping Switch Tool Kit:

Mechanical Maintenance of stepping switches is highly skilled and should only be performed with proper tools. Complete tool kits for this purpose are available and can be purchased from C.P. Clare & Co., 3101 Pratt Blvd. Chicago 45, Illinois. Their kit #RP-11375 includes the necessary wrenches, screwdrivers, spring benders, pliers, etc. for maintaining all types of stepping switches. You may find that this tool kit is not a must for your maintenance program, however, the C.P. Clare & Co.'s RP-9466 standard lubrication kit is essential if routine lubrication is to be maintained.

5.2.3 Miscellaneous Tools:

Although the following list of items are miscellaneous, they are very useful and helpful aids for the serviceman. Most of these can be obtained through any Electronic Parts Distributor.

1. General Cement #9093 Solder aid and probe.
2. General Cement #5090 Inspection Mirror.
3. General Cement # Illuminated Inspection Mirror.
4. Ungar #7766 Solder Pencil Handle.
5. General Electric #15T7C Bulb, 115V, 15 Watt, candelabra base, to be used with item #4 as an inspection lamp.
6. Cleaning Solvent - Dry cleaning naphtha or denatured alcohol used for cleaning lubricated surfaces where required. Caution: Be sure naphtha does not leave residue when it evaporates.
7. Nylon tooth brush for cleaning relay contacts if exposed to very dusty conditions.
8. Relay paper. These can be cut sheets of good quality bond paper. Approx. 1-1/2" x 2-1/2". Edges must be lint and fuzz free.

5.2.4 Test Equipment:

Test equipment gives the service man a quick accurate indication of operating voltages, resistance and continuity. Locating faults during routine maintenance or trouble shooting is made easier if the test equipment is of good quality or designed to test circuits under actual operating conditions. The following test equipment is suggested:

1. Precision Model 120 or Triplett Model 630, volt, ohmmeter. Available through local Electronic Parts Distributors.
2. A 48-60 volt test lamp for checking energized circuits. See Fig. 3 for suggested arrangement. This can be built by the service technician. Lamp and sockets are available through local Graybar Electric houses.

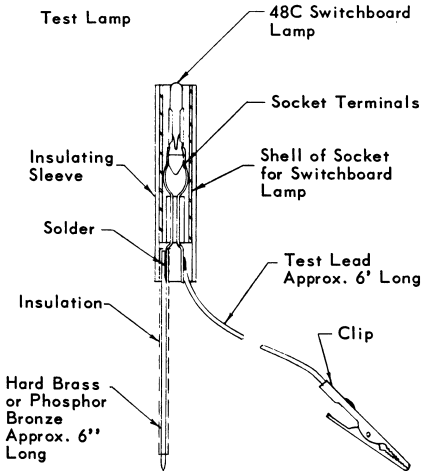
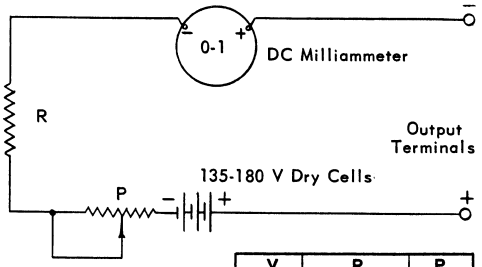


Figure 3

3. Continuity Meter, high voltage, for checking circuits where applied voltage must be similar to normal operating voltages. See Fig. 4 for suggested arrangement. This can be built by the service technician, parts are available through local Electronic Parts Distributors.



V	R	P
135	0.12 Meg.	25K
180	0.15 Meg.	50K

Figure 4

4. Test phone, for testing switchboard or links under actual operating conditions. The Western Electric #2011-BW phone can be purchased from local Graybar Electric house and the #203685-000 phone from Stromberg-Carlson.

5.3 MINIATURE RELAYS:

This type of relay is used throughout Telecom switchboards in link control circuits as well as the link distributor. Before adjustment or service is attempted the service technician should be familiar with basic relay operation and identification of parts. If this is understood, malfunction can quickly be recognized. This is important as many hours of trouble shooting can be saved when relay operation is understood.

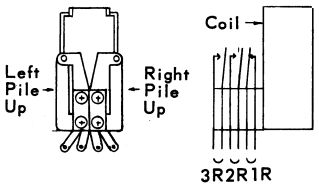
5.3.1 Relay Details:

In general, a relay can be broken down to four major sections, the armature assembly, coil and core assembly, the heel piece, and the spring pile up. See Fig. 5 below for basic diagram of a relay.

The **spring pile up** assembly, is of course, the most important part of the relay. The contacts must make or break in the circuit that they are used in and at the same time be independent from one another and be self cleaning for perfect contact. To accomplish this, the moving spring (Armature spring) and the stationary springs (fixed spring) must have different shapes and thicknesses as well as flexing lengths. By this means a different path of movement is provided and it is this difference that makes the contacts rub or wipe. When springs are properly adjusted, this wipe is sufficient enough to break through a film of oxidation or dirt and will not be excessive enough to cause contact wear.

Contact forms and arrangements used in Telecom relays are basic types used through the industry. The service technician should be able to identify these as well as the service terms applied to them. The five forms used are shown below in Fig. 6.

The arrangement of contact forms in a pile-up are usually described by naming in order each contact form in the pile-up starting at the one closest to the coil. Thus, a pile-up consisting of the first three forms shown in Fig. 6 would be described as 1A1B1C. Pile-ups are designated as single or double with the double pile-ups identified as right or left hand, determined by looking at the pile-up from the solder terminal end. See below.



The **Armature Assembly** consists of the pivoted armature, its mounting yoke, and armature bearing and pin. It's purpose is to move the moving springs (armature spring) in the spring pile-up so that contact is made or broken with the stationary (fixed) springs to make or break a circuit path. It is designed for minimum adjustment and usually all that is needed to keep them operating properly is periodic cleaning.

The Heelpiece is the "L" shaped bracket to which all parts of the relay are assembled. It is designed to provide the best possible mechanical and electromagnetic characteristics necessary for relay operation. An addition to this is, must provide mounting holes for final assembly of the relay to the mounting frame of a switchboard.

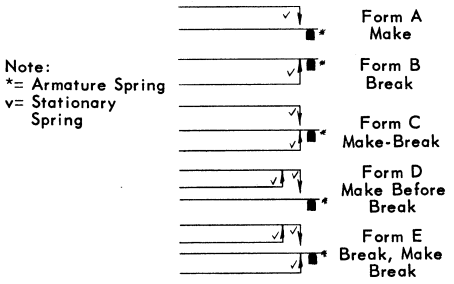


Figure 6

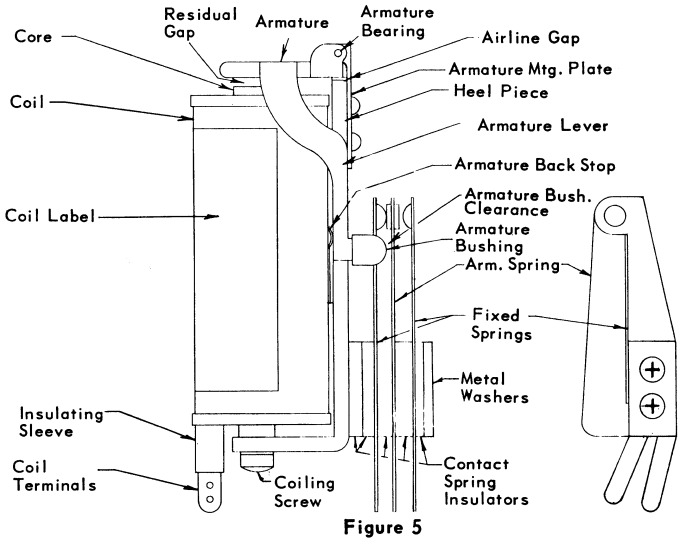


Figure 5

The **Coil and Core Assembly** acts as a magnet to attract the armature when current is passed through the coil. It is this attraction which makes the armature move and this movement is in turn transferred to the spring pile via the armature arm. Relays are usually designed to withstand appreciable abuse and when properly adjusted will give long trouble free operation. As with any instrument, mishandling may result in damaged or deformed parts which will effect this operation, however, **the major cause of relay failure is dirt.** Dirt, the common enemy of any moving machinery, is particularly undesirable in connection with relays.

A large percentage of relay failures can be avoided if the following basic common sense rules are observed:

1. During installation of equipment avoid excessive exposure of relays to dust or dirt. Keep cabinet doors closed and if necessary use a protective cover over the cabinet.
2. Do not adjust relay contact springs unless it is absolutely necessary. Simply cleaning the relay may be all that is necessary.
3. Use proper relay tools and follow prescribed relay adjustment specifications.
4. Upon completion of installation or maintenance, clean the entire interior of cabinet. Also clean the cabinet exterior to remove dust and dirt as it will eventually find its way to the relays.

Routine maintenance consists of regular inspection for signs of relay malfunctions which can be noticed by checking the following points.

1. Check for bent, loose, or defective parts.
2. Check contacts for wear, dirt, pitting, or metal transfer.
3. Check terminals for proper clearance.
4. Check relay visually for proper operation. Test manually with finger operation of armature.
5. Check visually to see that air line and residual gap are clear and not clogged by dirt. Use a piece of white paper for background when checking.
6. Visually check contact operation by manual operation of relay. There should be a slight but perceptible deflection of stationary springs.

5.3.2 Cleaning:

Use a brush to loosen dust and dirt from relays and mountings. Use a vacuum cleaner attachment hose to collect dust and dirt before it can be re-deposited. Always begin at the top and brush outwards from mounting, and hold hose as close as possible to the area being cleaned.

If contacts are dirty, a clean tooth brush should be used by gently wiping across contacts. If further cleaning is necessary a piece of hard bond paper can be used between contact points. Do not exert more than normal pressure to contacts. A burnishing tool should only be used if contacts cannot be cleaned with paper and then no more than one or two strokes. **Never use commercial liquid contact cleaners or carbon tet,** as they will leave a film of residue on contacts.

The residual and air line gaps must not be overlooked during the cleaning process as dust, dirt, or foreign matter in this area can give the appearance of relay misadjustment. Of course, readjustment would compound the problem where as simple cleaning this area would rectify the malfunction. Always check and clean the residual and air line gap before attempting relay adjustment. A piece of hard bond paper between the armature and pole face, withdrawn with slight armature pressure applied, will remove dirt. Repeat this operation until paper is clean when withdrawn.

5.3.3 Relay Adjustment:

Residual and Air Line Gap: The spacing between the armature and the coil's pole face is referred to as the Residual Gap and the space between the armature and heelpiece is referred to as the Air Line Gap. Due to the magnetic properties of these metal parts, they tend to retain a small amount of magnetism when the coil is de-energized. This is called residual magnetism which can cause these parts to stick or freeze together. To prevent this possibility, a non-magnetic space has been provided by the Air Line and Residual Gap. In some cases a non-ferrous shim or disc is used on the armature between the gap which is not adjustable. Some relays have screw adjustment residual to maintain gap.

The residual gap is not adjustable on minature relays, they are fixed by design or by use of a non-ferrous disc. However, some adjustment can be had for the air line gap, which is as follows:

Airline Gap Adjustment:

Airline gap adjustment is made by inserting a feeler gauge between the heel piece and armature for minimum setting of .005. The yoke screws are slightly loosened with gauge between heel piece and armature, tap the armature lightly for snug fit. Check both sides of gap, as gap must be even all the way across. Then tighten yoke screws.

Note: This adjustment can only be made on relays that have separate yoke screws. On relays without yoke screws, visually check the airline gap for clearance sighted against a light and with armature held in energized position.

Spring Contact Inspection and Gauging:

Check the spring pile-up assembly for alignment of contacts and armature bushings. Contact springs must not be bent, kinked, or excessively bowed. If springs do not meet this requirement they will need to be straightened. Use spring bender or duck-bill pliers and stroke the spring with the tool to remove links or bows.

Spring Tension:

It is important to the service man to understand spring tensioning and the role it plays in the relays operation. Tension is adjusted into the armature springs and effects relay operation, if it is not with specific limits. Too much tension can cause a relay to operate slowly or not at all. When current is applied or if the tension is too low, the relay may be fast operating and slow to

release. When ever spring tension is questionable it should be checked with a gram gauge. Apply a gram gauge to the moving spring of "break" contact, furthest from armature. Spring tension at the "break" point should be between 25 and 40 grams. Insert a thick piece of paper into this contact, and check next "break" contact. Check all "break" contact. If all contacts in a stack of springs are "makes", apply gram gauge to the spring closest to the coil as illustrated in Fig. 7 below. Spring tension is measured with the combined load of all springs and should read between 25 and 40 grams on the gauge.

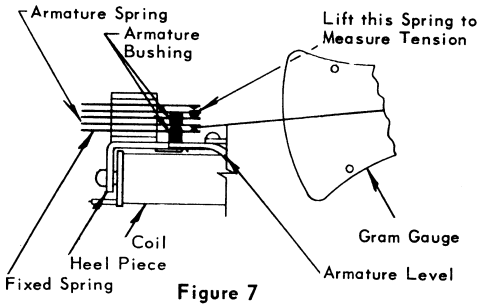
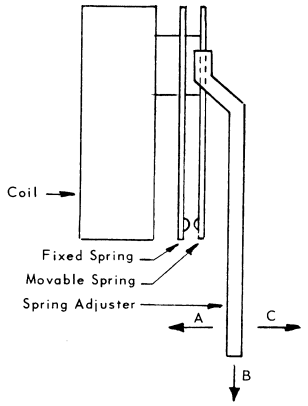


Figure 7

Spring Tensioning:

The process of spring tensioning is similar to curling a piece of paper with the dull edge of a scissors. Applying force in two directions, a slight twist towards bow and drawing scissors lengthwise in a wiping motion, some tension is acquired by the paper. This same process, but use a duck bill pliers or bending tool is applied to contact springs for increasing tension and for removing tension.

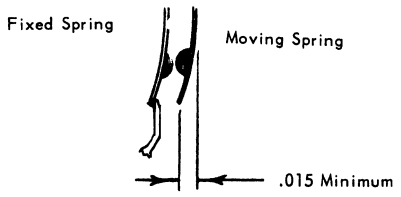
1. Place tool on spring just forward of clamped portion of spring. See Fig. below.



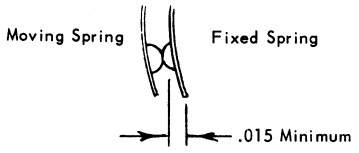
2. Apply slight force in direction 'A' below while moving tool in direction 'B' along movable spring.
3. Then straigten bow by placing tool near insulators an bend slightly in direction 'C'.
4. To remove tension bow spring in opposite direction by reversing above procedure.

Checking for "Follow":

Contact pressure or "Follow" on normally closed contacts are checked by observing "follow" on the break spring when support is relieved.



Contact pressure or "follow" on normally open contacts are checked by observing "follow" when relay is operated manually or electrically. As relay is operated, armature spring must continue movement after it first touches fixed spring.

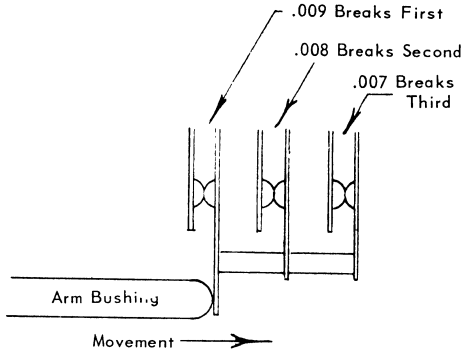


Spring Contact Gauging:

Gauging values for all Telecom miniature relays are noted on the spring gauging specifications shown in Sect. 5.3.4. The thickness gauge set is used to check operation of all contact forms of the relay. By this means, a relay operation can best be checked accurately. Gauging contact springs is done indirectly by measuring the size of the gap between the armature and core face and observing the contacts. Contacts that "break" when the coils is energized must just "break" with proper gauge inserted and contacts that "open" must just "make" with proper gauge inserted.

Sequence of Break Springs:

When two or more "break" springs are in a given pile up the "break" nearest the armature bushing should open first and the others follow in succession. This assures contact pressure on all "break" springs.



Observe contact operation. Each "break" in the pile must be checked in this manner using a gauge .001 smaller as you move to the end of the pile-up. "Breaks" in a form "C" "break-make" and form "E" "break-make" - before break are checked in the same manner. The only excep-

tion is a form D, make before break which is described in a later paragraph.

Gauging "Make" Springs:

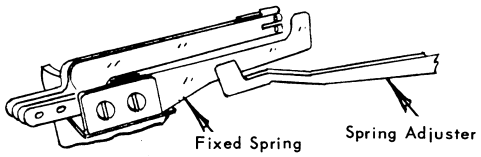
All "Makes" on a pile-up must barely touch when relay is operated with a .004, $\frac{+001}{-0}$ gauge in residual gap. The only exception to this is in the "make", in the "make-before-break" pile-up.

Gauging "Make-Before-Break" springs:

The "make" of this form should barely touch when relay is operated with .009 gauge in the residual gap. The "break" should barely open when relay is operated with .003 gauge in residual gap.

Contact Adjustment Fixed Springs:

Use spring adjuster as shown opposite. Do not scratch or kink springs and bend at a point closest to insulators.



Armature Backstop:

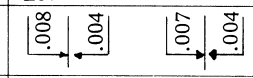
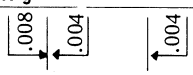
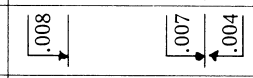
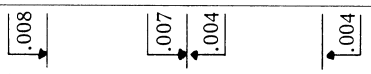
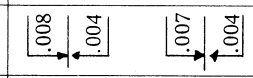
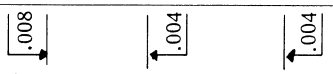
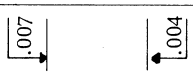
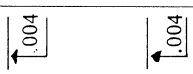
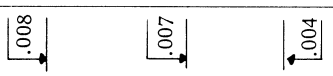
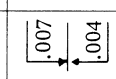
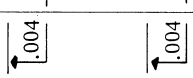
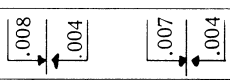
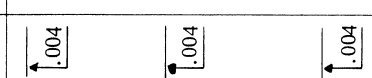
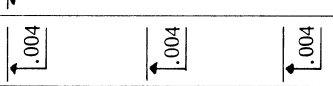
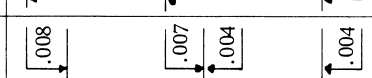
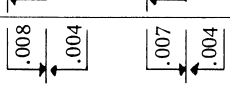
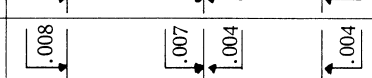
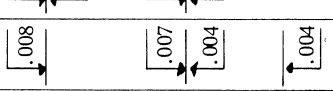
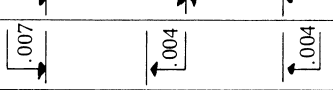
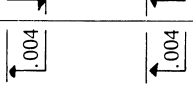
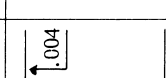
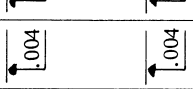
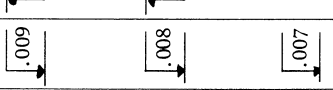
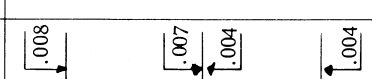
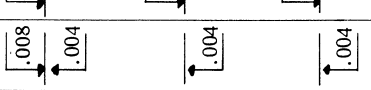
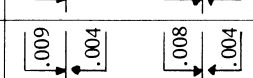
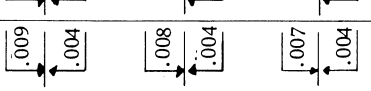
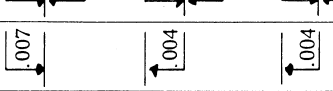
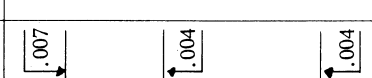
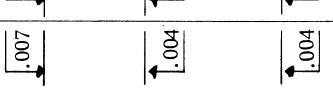
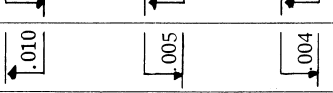
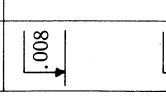
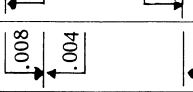
The role played by the armature back stop depends on the first combination in a pile-up.

If the first combination is a "break", the backstop should be adjusted (bent) so that the armature has perceptible play and none of the springs supported by the armature arm.

If the first combination is a "make" the reverse is true and the backstop must be adjusted so the armature arm supports the spring load. If this is not done, springs may sag against each other and cause malfunction.

5.3.4 Spring Gauging Specifications

Part Number	Left	Right
251-28701-11 (1B)		.007
251-28701-12 (1A)		.004
251-28701-13 (1C)		.007 .004
251-28701-14 (2B)		.008 .007
251-28701-15 (1C1A)		.007 .004 .004
251-28701-16 (1E1A)		.008 .003 .005
251-28701-17 (1C)	.007 .004	.007 .004
251-28701-18 (3A)		.004 .004 .004
251-28701-19 (2B1C)		.009 .008 .007 .004
251-28701-20 (2A) left (1B1A) right	.004 .004	.007 .004
251-28701-21 (1C1A) left (1B1C) right	.008 .004 .004	.008 .007 .004
251-28701-22 (1C1A) left (1C1A) right	.007 .004 .004	.007 .004 .004
251-28701-23 (2B1A) left (1B1C) right	.008 .007 .004	.008 .007 .004
251-28701-24 (3A) left (1B1C) right	.004 .004 .004	.008 .007 .004

Part Number	Left	Right
251-28701-25 (2C) left (1C1A) right		
251-28701-26 (1B1C) left (1B1C1A) right		
251-28701-27 (2C) left (1B2A) right		
251-28701-29 (1B1A)		
251-28701-30 (2A)		
251-28701-31 (2B1A)		
251-28701-32 (1C) left (2A) right		
251-28701-33 (2C)		
251-28701-34 (1D)		
251-28701-35 (3A) left (3A) right		
251-28701-36 (1B1C1A) left (2C) right		
251-28701-37 (1B1C1A) left (1B1C1A) right		
251-28701-38 (1B2A)		
251-28701-39 (2A)		
251-28701-40 (2A) left (2A) right		
251-28701-41 (3B)		
251-28701-42 (1B1C1A) left (1C2A) right		
251-28701-43 (2C) left (3C) right		
251-28701-44 (1B2A)		
251-28701-45 (1B2A) left (1B2A) right		
251-28701-46 Make Before Break (1AX2B)		
251-28701-47 (2B) left (1C1A) right		

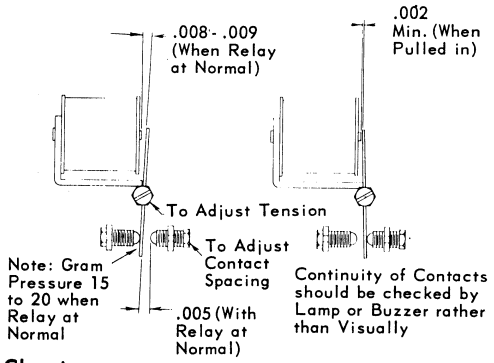
Part Number	Left	Right
251-28701-48 (2A) left (1C1A) right	.004 .004	.007 .004 .004
251-28701-49 (1B1C) right		.008 .007 .004
251-28701-50 (1C2A) left (1C2A) right	.007 .004 .004 .004	.007 .004 .004 .004
251-28701-51 (1AX1B1C) left (2C) right	.009 .006 .005 .004	.006 .004 .005 .004
251-28701-52 (2C) left (2C) right	.008 .004 .007 .004	.008 .004 .007 .004
251-28701-53 (1B1C) left (1AX1C) right	.006 .005 .004	.009 .006 .004

5.4 SENSITIVE RELAYS:

This relay is used in the Link Distributor as the "ST", "MA", and "MB" relays. These are sensitive enough to operate rapidly with very low current applied.

Adjustment of these relays are indicated below. Note that the adjustments are somewhat different from those applied to the miniature relays in that both residual gap and contact clearance are checked. These specifications are critical and must be as indicated for proper relay operation.

Adjustment of Relay 251-28030



Cleaning:

Use care when cleaning, never use a burnishing tool, all that is necessary is a piece of hard bond paper between contacts and armature. When cleaning, never apply more than light pressure to armature, as it can be easily bent and can cause permanent damage to the relay.

5.5 STEPPING SWITCHES:

Stepping switches, as used in Telecom switchboards, are small, high-speed mechanisms which act in response to electrical inpulses to connect a calling phone, through a link, to the called phone. Two basic types are used, the rotary and the two-motion stepping switches. These are rugged devices requiring very little field adjustment or maintenance.

5.5.1 Rotary Stepping Switches:

These switches are used as linefinders, connectors, and link-distributor, all are similar in action, differing only in the number of levels and circuits they connect to and in the drive mechanisms. Each switch consists of three main assemblies mounted on a metal fume. These assemblies are the bank assembly, and the driving mechanisms.

1. The bank assembly consists of insulating material, contacts, and wiper brush springs. These are assembled in laminated levels or are molded plastic.
2. The wiper assembly consists of a ratchet and hub assembly, a wiper blade for each bank level, and the indicator and off-normal cam.
3. Wiper tips come in two types, the bridging and non-bridging, both can be on the same assembly. Bridging wipers are used when a circuit must be continuous and unbroken. Non-bridging wipers completely brake one contact before it makes with the next contact.
4. There are two types of driving mechanisms, direct drive or spring driven, both move the ratchet so that the wipers connect to the various contact levels of the bank.

5.5.2 Simplified Details - Direct-Drive:

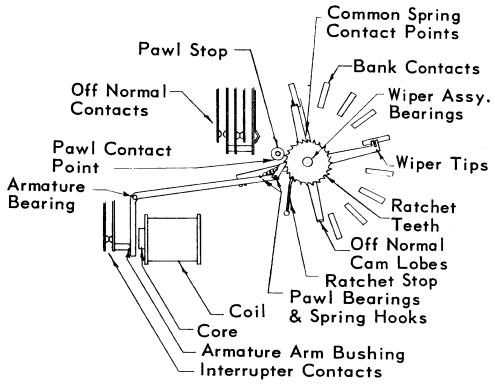


Figure 8

Direct Drive Rotary Stepping Switch
See Fig. 1 for larger details

5.5.3 Simplified Details - Spring Drive:

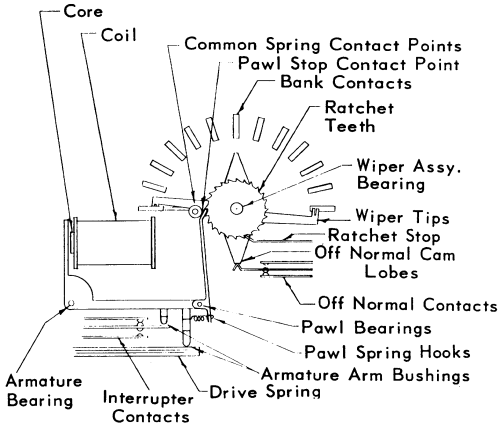


Figure 9

Spring Drive Rotary Stepping Switch
See Fig. 1 for larger details

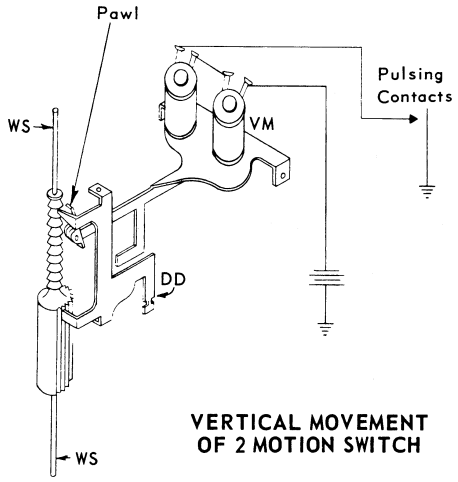
5.5.4 Details of the Type ST100, 2-motion Stepping Switch:

On larger switchboards a 2-motion stepping switch is used to provide access to a large number of lines with a minimum of dialed digits. The ST-100 provides access to 100 lines by the dialing of 2 digits. The 2-motion selection and the separate release action are all incorporated into a single switch mechanism. This mechanism moves a set of wipers or contacts in two planes - vertical and rotary or horizontal - at right angles to each other. During release the action is the reverse of the process of making the contact.

The stationary contacts of the switch, usually called bank contacts, are in one, two or three groups, depending on the number of contacts per step needed. Either one or two contacts per group, per step are available so that 1-6 contacts per step may be made.

With the standard arrangement of 10 vertical levels and 10 rotary steps per level, it is possible to leave a 1-6 pole, 100 throw switch. Most Telecom boards make use of 1 contact for each of 3 groups thus providing 3 pole, 100 throw switching.

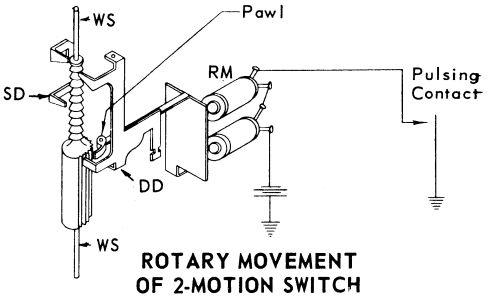
The movable contacts, usually called the wipers, are arranged to pass across the desired level to the selected step and thus make contact with the bank contacts at that step. Flexible wiper cords provide a connection from the wiper terminal to a fixed set of terminals for wiring in to the control relay circuits. The wipers are mounted onto a shaft whose position is controlled by the action of the switching mechanism. The first motion of the switch raises the shaft vertically to align the wipers with levels 1, 2 etc., up to 0 (10th level) according to the number of pulses given to the vertical magnet (VM). See Fig. 10 for a simplified sketch of the vertical action. VM causes the panel to be raised in turn lifting the wiper shaft (WS). The top arm of the double dog (DD) engages a ratchet arrangement on WS to prevent it's falling down between steps.



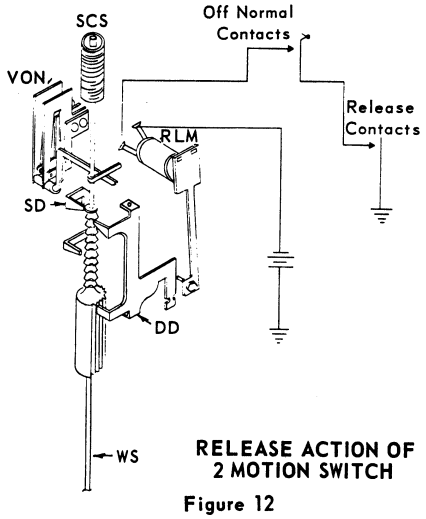
VERTICAL MOVEMENT OF 2 MOTION SWITCH

Figure 10

The second motion of the switch rotates WS so that the wipers come to rest on the bank contacts 1, 2, etc., up to 0 (10th step) depending on the 2nd digit dialed. The rotary (or horizontal) magnet (RM) shown in Fig. 11 cause WS to rotate.



ROTARY MOVEMENT OF 2-MOTION SWITCH
Figure 11

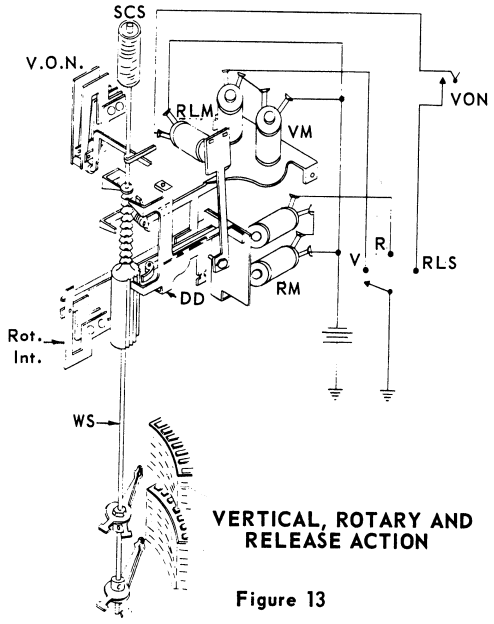


RELEASE ACTION OF 2 MOTION SWITCH

Figure 12

by action of the Pawl. The bottom arm of DD prevents the WS from rotating backwards between steps. A coiled spring builds up tension on each step to prepare to release at a later time.

At the termination of the call a release circuit is closed as shown in Fig. 12. The release magnet (RLM) actuates an arm which dis-engages DD from WS. A latching arrangement (RL), then holds DD in this condition until the first vertical pulse on the next call. The release circuit passes through off-normal springs on the vertical action so that RLM is automatically de-energized when WS returns to normal. The coiled spring (SCS) rotates WS to normal in the reverse rotary direction and gravity returns WS to normal in the downward vertical direction. All of these actions are shown together in Fig. 13.



VERTICAL, ROTARY AND RELEASE ACTION

Figure 13

5.5.5 Type 11 Rotary Switch:

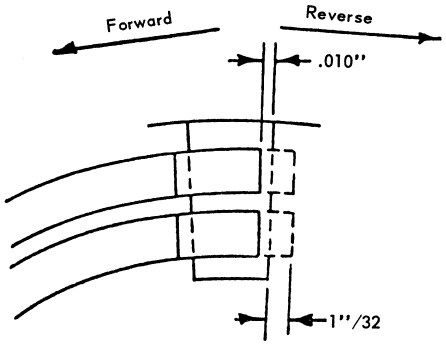
The type 11 is a spring driven rotary switch used as the PS connector on the 50 line and larger boards. It is also used as the link-disbributor in the 50 line switchboards.

Adjustment:

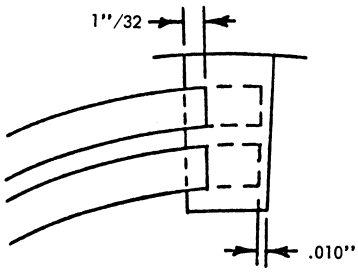
The Type 11 switch will hold adjustment for considerable life. Aside from lubrication no attention is required until life has reached 1/2 million revolutions. At this point and at every 1/2 million additional revolutions thereafter an adjustment inspection shall be made. The inspection shall be made in accordance with inspection procedures given below and in the sequence listed. Adjustments not within the inspection limits shall be corrected in accordance with the associated readjustment instruction. It shall be considered natural if some or all adjustments clear the inspection limits for one or more inspection period.

a. **Wiper Assembly**

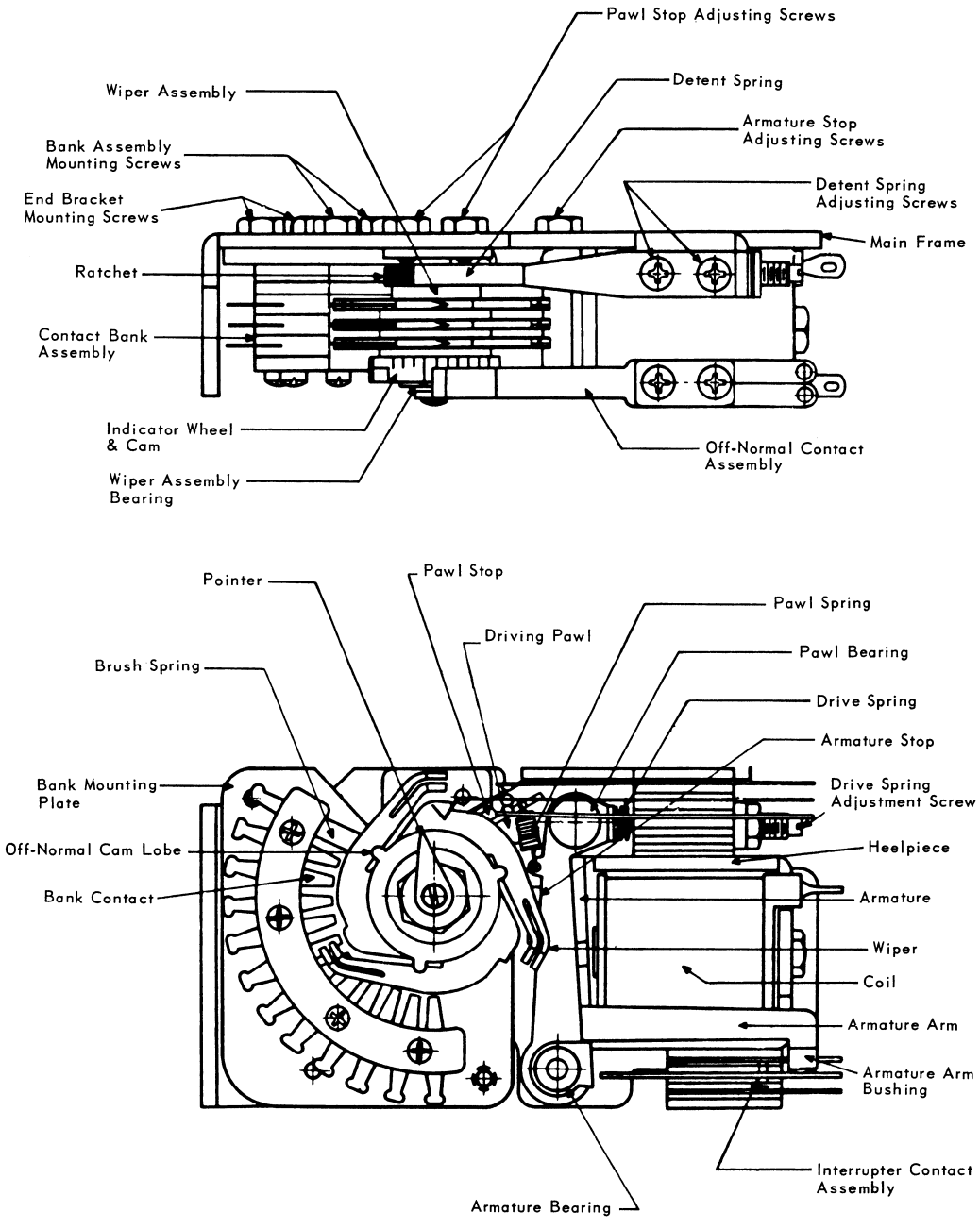
Inspection: With wipers on contact No. 1 rock wiper assembly gently forward and reverse by hand. Note contact area on which wiper tips play. The tips shall play within the limits shown on sketch.



Bridging Wipers



Non-Bridging Wipers



TYPE II SWITCH
IDENTIFICATION OF PRINCIPAL PARTS
Figure 14

Readjustment:

1. If tips play beyond forward motion limits the pawl stop shall be readjusted. It shall be moved slightly toward the pawl to check excessive forward motion of the wipers. The pawl stop face shall be carefully aligned to rest against the pawl as flatly as possible.
2. If tips play beyond reverse motion limits the detent spring shall be readjusted. It shall be moved slightly toward the ratchet to check excessive reverse motion of the wipers. The detent shall also drop freely into each tooth on manual stepping and shall be centered on the ratchet.

   The readjustments above shall provide near-zero wiper play with tips approximately centered between inspection limits of sketch.

b. **Armature Backstop:**

Inspection: The armature shall rest against the backstop. Inspect by inserting a .0015 in. thickness gauge between the armature and the stop. The gauge shall drag on withdrawal.

Readjustment: If the gauge has no drag on withdrawal, the backstop shall be readjusted. It shall be moved slightly forward to touch the armature but not far enough to lift the pawl from the pawl stop. Recheck for gauge drag, and for manual stepping with positive detent spring action, after tightening stop screws.

To have the armature and pawl strike their respective stops with approximately equal force is considered an ideal adjustment.

c. **Off-Normal Contacts (S.P.D.T.)**

Inspection: Step switch manually through "home" position making the following observations:

1. On positions adjacent to either side of "home" position the cam shall not touch the cam spring.
2. As the wipers move onto "home" position, the cam spring shall touch and visibly deflect the top stationary contact spring.

Readjustment: Adjustments that do not comply shall be corrected by bending the stationary springs slightly toward the cam spring.

3. Bending the bottom spring upward restores cam clearance, correction for C-1.
4. Bending the top spring downward restores deflection of the top spring, correction for C-2.

   Bending springs to the extent of reducing the normally open contact gap to below .010 in. shall be avoided.

d. **Interrupter Contacts (S.P.D.T.)**

Inspection:

1. The normally closed contacts require no attention unless used for self-interruption. In this case the switch shall be run through several cycles of self-interruption. Observe operation. Stepping shall be positive and smooth.
2. Close the armature manually against the heelpiece observing contact action. The movable contact spring shall touch and visibly deflect the normally open stationary contact spring.

Readjustment: Adjustments that do not comply shall be corrected by bending the stationary spring (s).

3. Bending the normally closed stationary contact spring slightly one way or the other adjusts for positive and smooth stepping, correction for D-1.
4. Bending the normally open stationary contact spring toward the coil restores deflection of the spring, correction for D-2.

   Bending springs to the extent of reducing the normally open contact gap to below .008 in. shall be avoided.

Lubrication - General:

Lubricants applied with a brush are measured in "dips." This is the amount retained on a #3 artist's brush immersed one-half its bristle length in the lubricant and drawn across the edge of the container to remove the excess. A "light dip" is similar, except the brush is immersed one-fourth its bristle length.

Lubricants used are:

"A" - Clock oil.
"B" - Light, colorless mineral oil.
"C" - A two-to-one mixture (by volume) of finely powered mica and clock oil.

Lubricant "A"

1. Apply one dip to the wiper assembly shaft at the inside of the support bracket. Apply one dip to the shaft at the outside of the ratchet.
2. Apply two dips to each side of a strip of bond paper. Lubricate each pair of wipers by passing the paper between them. Rotate the wiper assembly to transfer some of the lubricant to the bank contacts.
3. Treat another strip of bond paper as described above and pass it between the drive spring and the associated armature bushing. **Do not lubricate the interrupter bushing.**
4. Apply one light dip to each wiper pair at the points of contact between brush springs and wipers. Rotate the wiper assembly to distribute the lubricant.
5. Divide one light dip among the number wheel cam lobes.
6. Saturate the yoke bearing felt of low temperature switches having a felt with lubricant "D".

Lubricant "B"

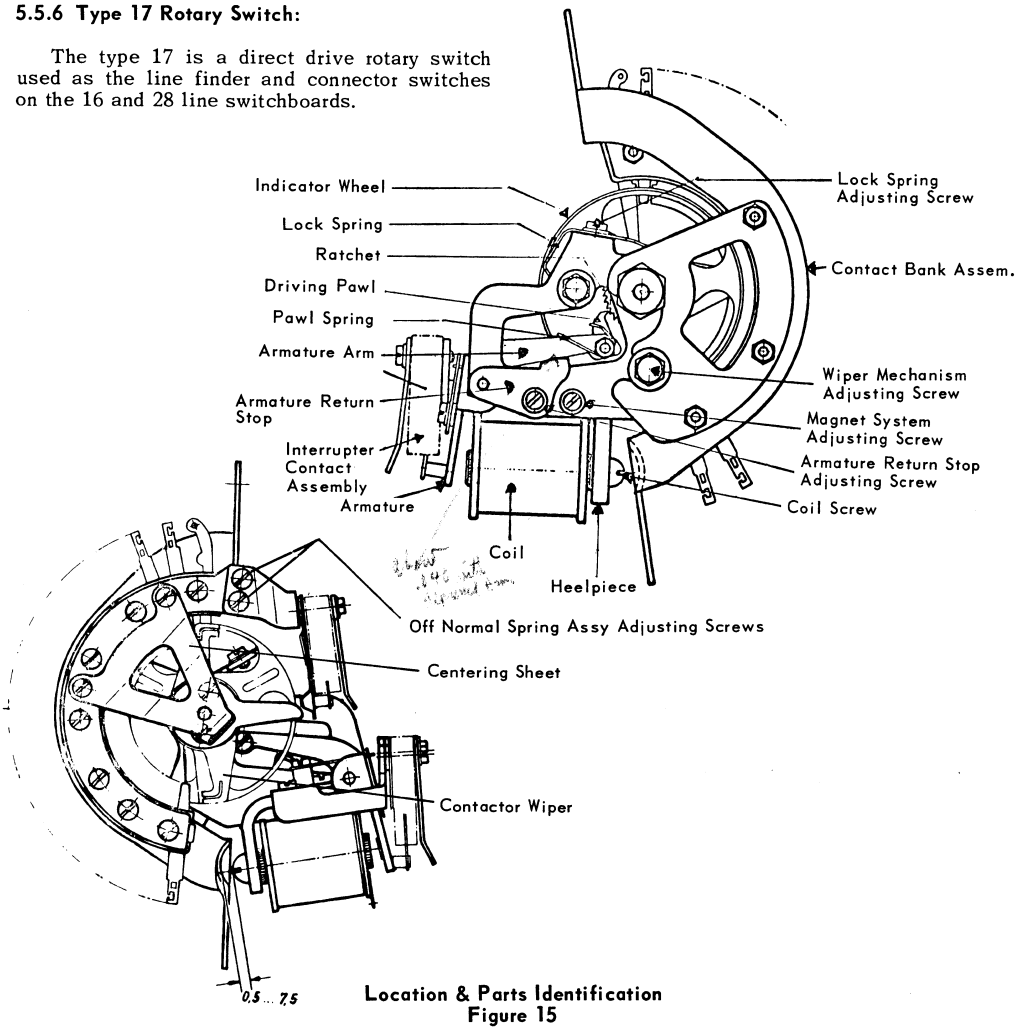
1. Apply one dip to each yoke bearing. On switches with a yoke bearing felt, saturate the felt.

Lubricant "C"

1. Apply two dips to the ratchet teeth while rotating the wiper assembly to distribute the lubricant.

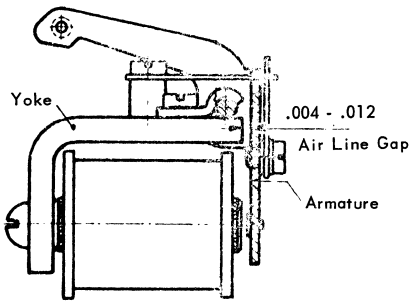
5.5.6 Type 17 Rotary Switch:

The type 17 is a direct drive rotary switch used as the line finder and connector switches on the 16 and 28 line switchboards.

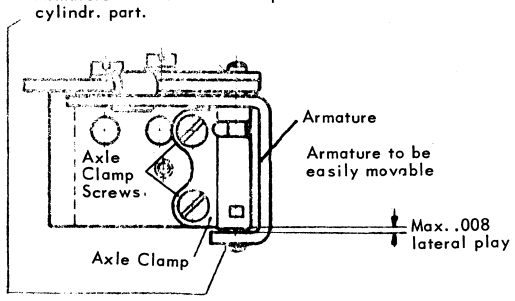


Location & Parts Identification
Figure 15

2. Magnet Systems:
   a. With armature held parallel to core, there must be a spacing between the armature and yoke. This spacing, Air Line Gap, must be .004 - .012".
      1. The spacing is adjustable by moving the armature axle clamp.



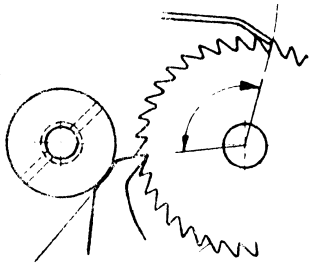
Despite the admissible longitud. play, the Armature Axle should still protude with its cylindr. part.



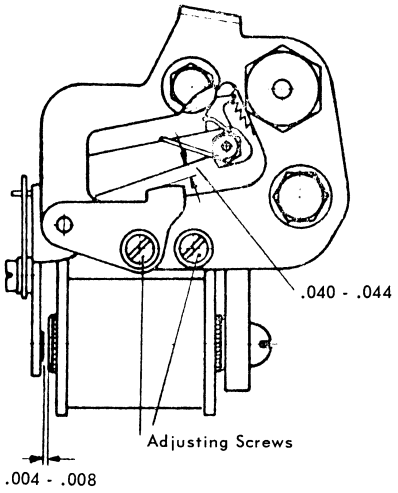
   b. Driving Pawl Stroke:
      1. Press armature against core, pawl must firmly thrust into tooth bottom and rotate ratchet until pawl comes to rest against pawl stop. In this position there must be eleven (11)

teeth between pawl and lock spring. See below.

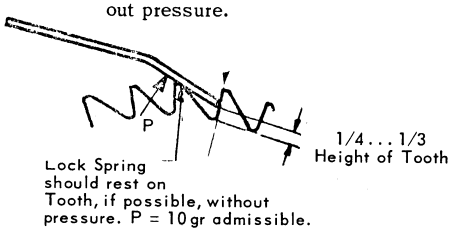
2. Driving pawl stroke is adjustable by loosening magnet system adjusting screw, #15, and armature return stop adjusting screw, #16. Put thickness gauge between armature and core and press armature against core; swing magnet system round the armature axle until driving pawl firmly thrusts tooth bottom. Hold armature in this position and tighten screw #15, then adjust spacing between armature and return stop #5. After adjustment, tighten screw #16 and recheck action.

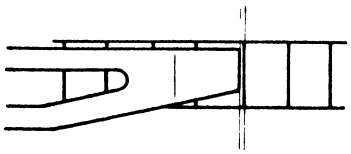


Stroke of Driving Pawl:



3. When armature is energized, Lock spring #10 must fall into tooth gap without any play.
4. Lock Spring is adjustable by loosening lock spring adjusting screw #12 and moving lock spring as necessary. Spring must be parallel to tooth and should rest on adjacent tooth without pressure.

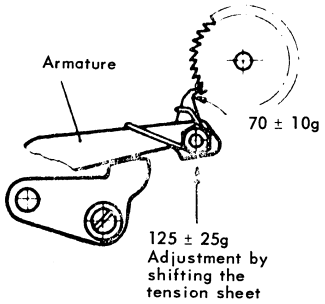


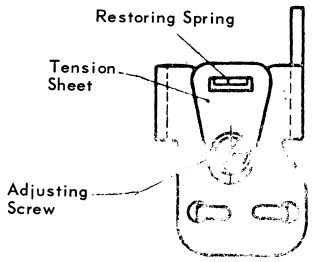


Lock Spring has to be positioned in parallel to tooth.

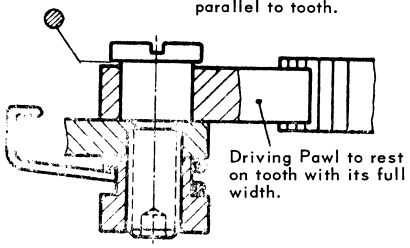
c. Armature Restoring Spring and Driving Pawl Bearing:
   1. The armature must return to the armature stop when coil is de-energized. This is accomplished by tension applied to the armature by the restoring spring. This tension must be 125 ± 25g. which is adjustable by shifting the tension sheet.
   2. The Driving pawl must move easily on its bearing and rest on tooth with it's full width.

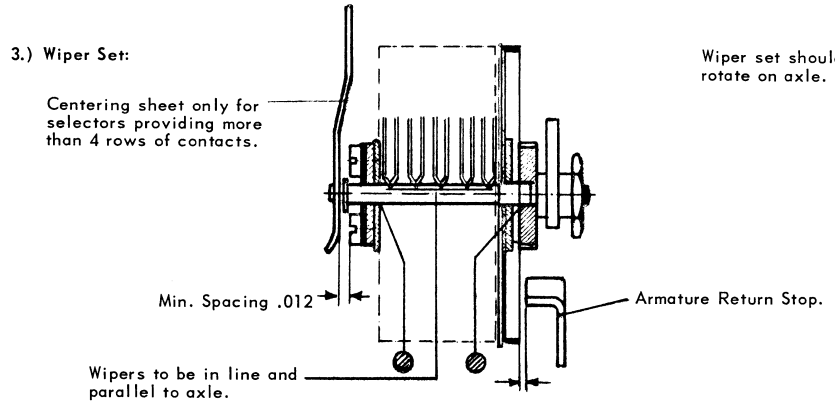
Armature Restoring Spring and Driving Pawl Bearing:



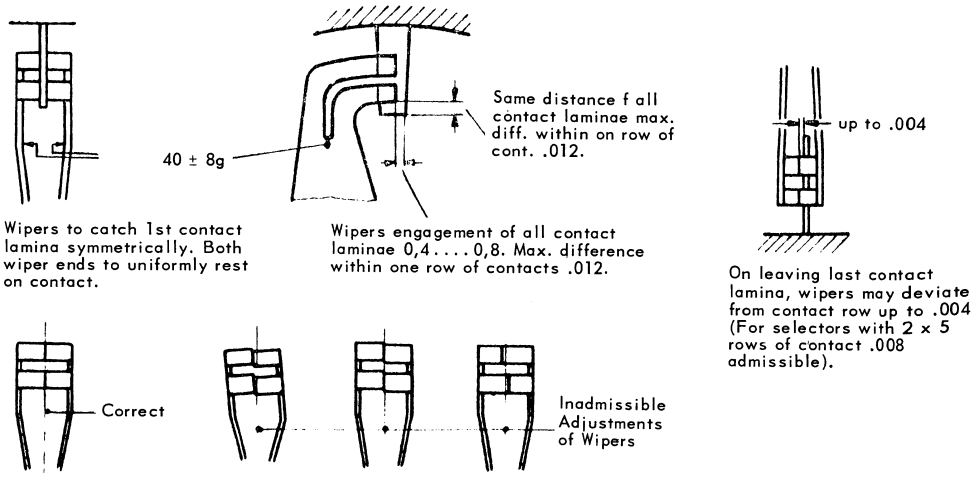


Driving Pawl to be easily movable. Edge of Driving Pawl to be parallel to tooth.





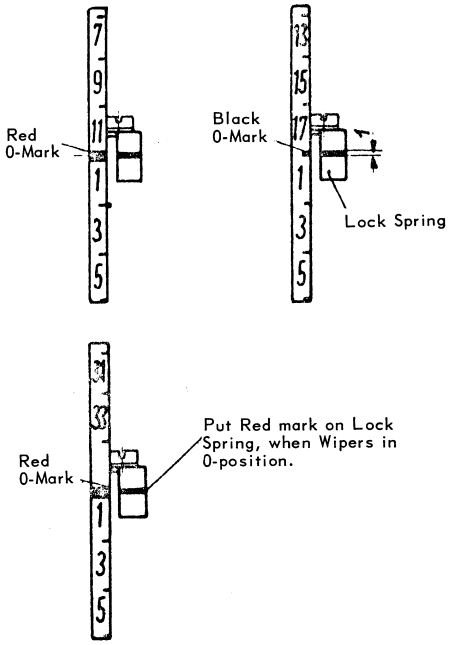
Wipers, Engagement and Disengagement of Contact Laminae:



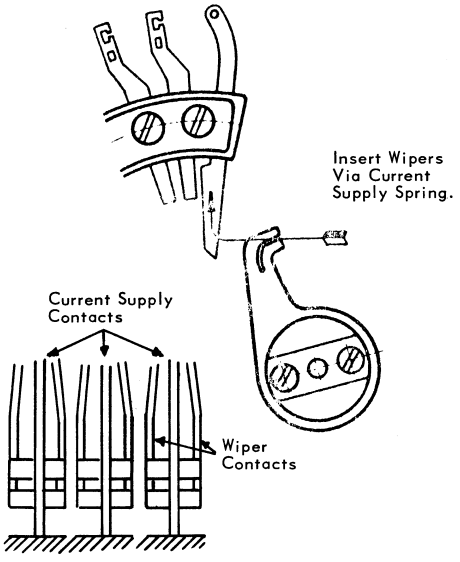
3. Wiper Assembly:
   a. The wiper assembly must rotate easily on it's axle and wipers must be parallel to axle.
      1. Wipers must be uniform and catch contact lamina symeterically with both ends to rest on contact.
      2. Wipers must rest on contact with 40 ± 8g measured at point indicated on diagram.
      3. Usually a visual inspection is all that is necessary of the wiper assembly. The diagram below illustrates the various operating steps to check. Care must be used in handling wipers, as they can be bent very easily.
4. Dis Assembly Instructions - Switch Gear From Contact Bank Assembly.
   a. When it becomes necessary to replace the coil, replace switch gear parts, or make repair it will be necessary to remove the switch gear from the contact bank assembly.
      1. Loosen adjusting screw #14 with a 5/16" wrench and rotate switch gear assembly so that adjusting screw #14 slides out of its location slot. Then hold centering sheet #20 away from wiper axle, lift switch gear assembly out of the contact assembly.
      2. Be careful not to damage or bend the wipers or indicator wheel.
      3. After part or parts have been replaced or repairs performed, adjust the magnet system before re-assembling switch gear to contact bank. Refer to preceding sections 2 and 3 for adjustment specifications.
5. Assembly Instructions - Switch Gear Assembly to Contact Bank Assembly.
   When the switch in question is a connector, it will be of advantage to remove the off-normal switch assembly before placing switch into the bank.
   a. Place wiper assembly on one of the following steps:
      11 point selector - set on step 10 (Link Distributor (LD Switch) on 2D16 & 4D28)

17 point selector - set on step 13 (Linefinder & Connector on 2D16 & 2DA16)
34 point selector - set on step 12 (Linefinder & Connector on 4D28 & 4DA28)

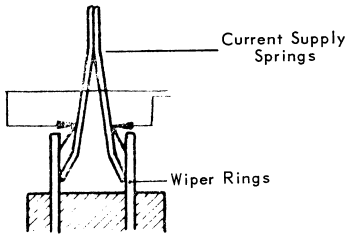
The number of points on a switch is identified on the indicator wheel. Only odd numbers are indicated on the wheel, even numbers are marked by the intermediate dashes.



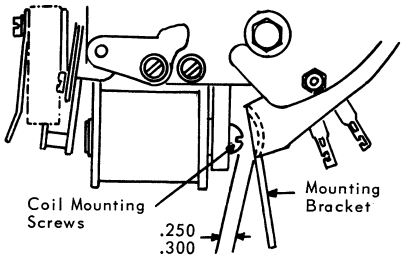
b. Set each pair of wipers so that current supply springs are between them.



c. Slide wiper assembly down into bank contacts so that current contacts fall into place between the wiper "rings."



d. After wiper and current supply contacts are in place, the wiper shaft will snap into the centering sheet and the adjusting screw will fall into its locating slot.
e. Set coil mounting screw approx. .250 to .300 away from mounting bracket and tighten adjusting screw (#14).

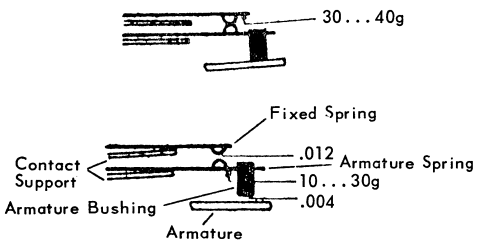


6. Adjustment of wiper to engage bank contacts.
   a. Step switch, manually, around so that the wiper tips are on or near current contacts of bank. The indicator wheel will be near the "0" mark, off-normal position on connector switches, and will be in line or nearly so, with the mark on lock spring.
   b. In this position the wiper tips must be approx. a 1/3 in from the leading edge of current supply contact. If adjustment is necessary, loosen screw #14 and swing wiper mechanism counterclockwise as necessary. When wiper tips are in proper position on current supply contacts, tighten screw #14.
   c. Manually step switch, one step at a time, and visually check that wiper tips engage each bank contact within the first 1/3 to 1/2 way in from leading edge.

7. Adjustment of Interrupter Contact Assembly. Normally closed contacts actuated by the armature and used to open the switch coil circuit are called "Interrupter Contacts."
   a. Tension or pressure between the normally closed contacts should be 30 to 40 grams. This is measured with a gram

gauge placed on the stationary or fixed contact. Tension of the armature or moving spring is checked in the same manner, except gauge is placed on armature spring with armature held against pole face. This should be between 10 and 30 grams.

b. Contact gap with coil energized should be .012. This is checked by placing thickness gauge between contact points.



c. With armature energized there should be a .004 space between the armature and armature bushing. This is checked with thickness gauge between these points.

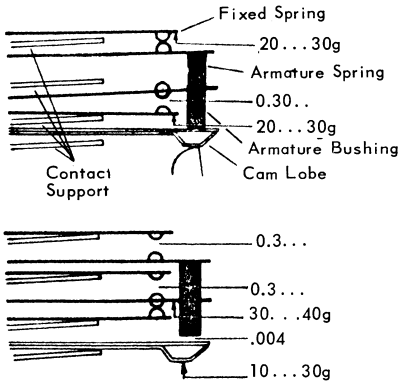
d. If readjustment is necessary, use spring adjusting pliers, Duckbill, and bend contact support as necessary.

8. Adjustment of Off-Normal Contact Assembly.

These contacts are operated by the off-normal cam which is a part of the wiper assembly. The switch assembly should be so positioned that the cam will engage the switch in the "home" or off-normal position. This is the "0" mark on the indicator wheel.

a. Tension or pressure on the stationary or fixed contacts should be 20 to 30 grams. This is measured with a gram gauge placed on these contacts. Tension of armature or moving springs is measured on the first armature spring and pressure measured is the combination of the two springs. This pressure should be between 30 to 40 grams.

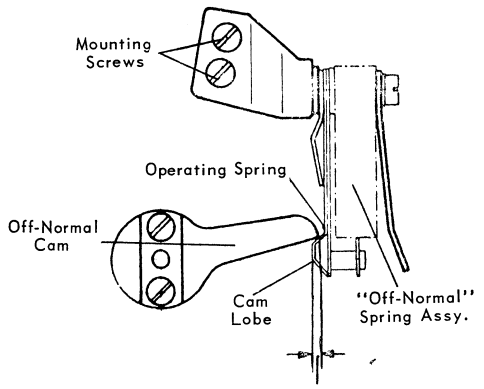
b. Contact gap when contacts are in the "open" position should be between .020 - .030 measured with thickness gauge between contacts.



c. With switch in the "normal" position there should be a .004 space between cam bushing and cam lobe.

d. If readjustment is necessary, use spring adjusting pliers, Duckbill, and bend contact supports as necessary.

e. The Off-Normal Contact Assembly is adjusted in relationship to the off-normal cam in the normal or operated position of wipers. The following edge of the off-normal cam must fall to the center of the cam lobe.



Adjust cam contact so that stroke of 0,8....1,2 is obtained, Adjustment of contact springs accord. to 12.

f. If adjustment is necessary, loosen the two mounting screws and position off-normal spring assembly as necessary. After this adjustment, check switch for proper switch operation in the "home" position.

5.5.7 Type 20 Rotary Switch:

The type 20 is a spring driven rotary switch used as the link selector on the 30DA series switchboards. Maintenance and adjustment information is covered in Section 5.5.8, as the type 20 and 26 are identical in construction and operation, the difference is in the number bank contact levels.

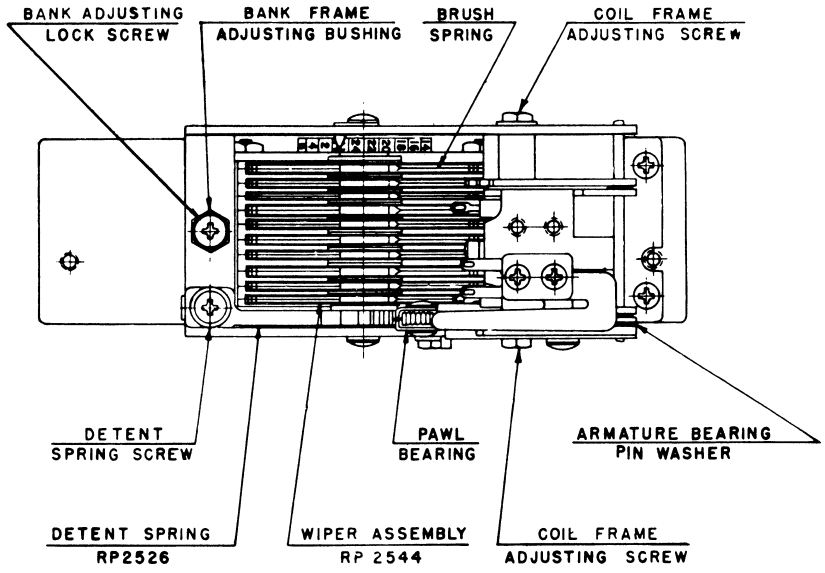
5.5.8 Type 26 Rotary Switch:

The type 26 is a spring driven rotary switch used as the line finder on the 50 line and larger switchboards, as the connector on the 50 line switchboard, and as the link-distributor on 100 line and larger switchboards.

Maintenance Specification for Type 26 Stepping Switch:

Springdriven stepping switches requiring readjustment shall be checked in accordance with the following specification and in the sequence as listed.

TYPE 26 SWITCH
IDENTIFICATION OF PRINCIPAL PARTS



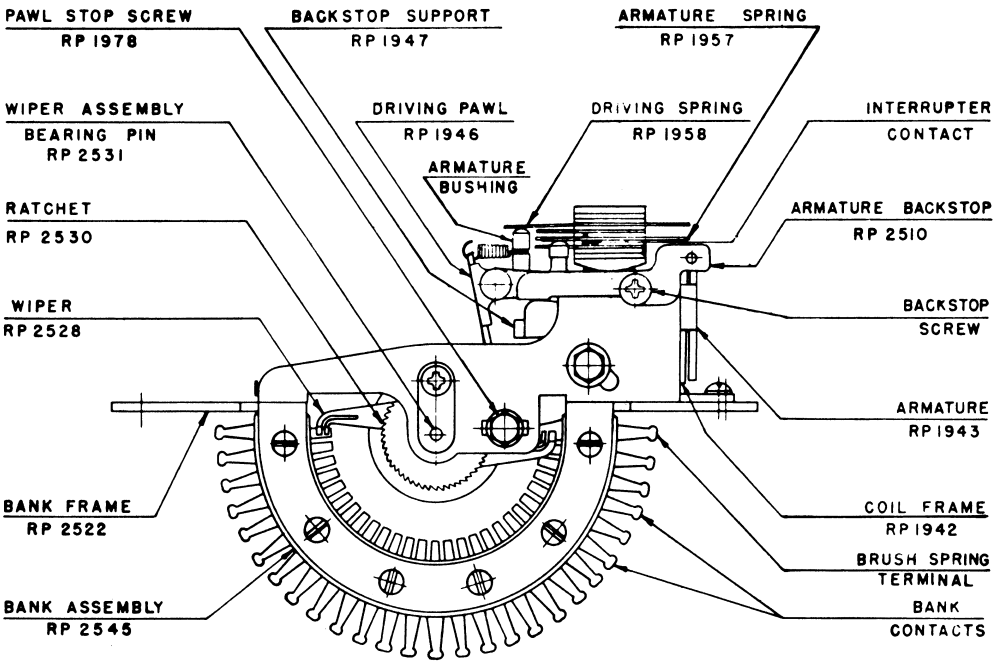


Figure 16

Adjustment:

1. **Sub-Assembly Adjustment**
   a. **Wiper Assembly**
      The wiper assembly is factory adjusted in jigs before assembly into the stepping switch. If the wiper assembly is removed from the switch and replaced, the following adjustments shall be made.
      1. Each wiper spring shall be approximately straight and shall have no kinks or sharp bends.
      2. The tips of bridging wipers shall be parallel to each other.
   b. **Bank Assembly**
      1. The bank assembly frame shall be square and the mounting face shall be perpendicular to the bank levels.
      2. All bank contacts shall be straight and in line with each other.
      3. Brush springs shall be straight and shall have no kinks or sharp bends. Each pair of brush spring tips shall be separated by approximately 1/8 in.
   c. **Wiper Assembled to Bank**
      1. When the wiper assembly is assembled in the switch the tension between each brush spring tip and the wiper shall be minimum 35 grams.
      2. Fingers of the twin contact wiper springs shall contact the bank contacts with approximately equal pressure.
      3. Wipers shall be adjusted to align with the bank contacts, and there shall be a maximum of .025 in. movement of the wipers as they enter and leave the bank.
      4. Total tension of the two tips of each wiper on the bank contacts shall be minimum 15 grams. The tension shall be approximately equally divided between the two tips of each wiper of the pair of wipers.

2. **Completed Assembly Adjustment**
   Assembled springdriven stepping switches requiring readjustment shall be checked in accordance with the following procedure and in the sequence as listed below:
   a. **General**
      Loosen, but do not remove, the pawl stop screw, the detent spring screw, and the coil frame adjustment screws, the back-stop screw, and the bank adjusting lock screw.
   b. **Wipers**
      1. Adjust wipers on contacts 1 to 3 by setting the pawl stop against the pawl. The wipers shall be adjusted to meet the following conditions:
         a. Bridging wipers shall have the trailing edge in line with the front edge of the contacts on which they rest.
         b. Non-bridging wipers shall have the tips resting on the center 1/3rd area of the contacts.
      2. Tighten the pawl stop screw.
   c. **Detent Spring**
      1. The detent spring tip shall rest in each ratchet tooth with 60 grams minimum tension.
      2. The tip of the detent spring shall be parallel to the edge of each ratchet tooth and the spring shall not touch the frame.
      3. The tip of the detent spring shall drop freely into each ratchet tooth but this clearance shall not be large enough to permit reverse rotation of wiper tips beyond the center 1/3rd area of each bank contact.
      4. Tighten the detent spring screw.
   d. **Driving Pawl**
      1. The tip of the driving pawl shall be parallel to the edge of each ratchet tooth and the pawl shall not touch the frame.
      2. With the armature operated by hand, the pawl shall drop into the next ratchet tooth without bind on the tip with a .002 in. gauge between the armature and the coil frame. The pawl shall not drop into the next ratchet tooth with a .006 in. gauge between the armature and the coil frame. The adjustment is made in moving the coil frame assembly by means of its mounting screws in the slotted holes.
      3. Tighten the coil frame adjusting screw on the side adjacent to the number wheel.
   e. **Armature Backstop**
      1. Set the backstop to touch the armature but not to raise the pawl from the pawl stop.
      2. Set the backstop support against the backstop.
      3. Tighten the coil frame adjusting screw on the side adjacent to the ratchet and tighten the backstop screw.
      4. Recheck D2 and E1.
   f. **Bank Adjustment**
      1. Adjust the wipers on the last 5 contacts to meet requirements B1a and B1b. This adjustment shall be made by turning the bank adjusting bushing.
      2. Tighten the bank adjusting lock screw.
      3. Recheck B1a and B1b.
   g. **Spring Assembly**
      1. **Driving Spring Tension**
         The driving spring shall rest against its associated armature bushing with 600 to 700 grams pressure.
      2. **Interrupter Spring Tension**
         The armature spring of the interrupter assembly shall have 400 to 500 grams tension measured just above the associated armature bushing.
      3. **Auxiliary Contacts**
         a. Armature spring tension of contacts other than the interrupter contacts shall be minimum 50 grams, maximum 100 grams.
         b. Contact separation shall be minimum .010 in.
         c. Stationary springs of normally open contacts shall deflect visually when the armature is manually operated.

4. **Off-Normal Contacts**
   a. Contact separation shall be minimum .010 in.
   b. Total pressure on each normally closed contact approximately 35 grams.
   c. Normally open contacts shall close with approximately 35 grams pressure when operated by the lifting cam.
   d. Armature springs without normally closed contacts shall have approximately 20 grams pressure.
   e. The lifting cam shall completely operate the O.N. contacts in the specified position. Clearance shall exist between the lifting cam and the cam arm on all other positions.

Lubrication:

Lubricate most points with the small artists' brushes. Use a separate brush for each lubricant, applied in the following amounts:

One dip is the amount retaining on the brush when it is immersed one half its bristle length in the lubricant, and then drawn across the edge of the container to remove the excess. In no case should a droplet form.

One light dip is the same as above, except that the brush is immersed one fourth its bristle length.

Apply lubricant "A" as follows:

Withdraw the wiper assembly bearing pin approximately 1/4 inch, apply one dip to each end, and replace the pin.

One dip to each side of a strip of bond paper. Pass the strip between each pair of wiper tips in four levels of the wiper assembly. Repeat for each additional four levels, then rotate the wiper assembly several times to lubricate the bank contacts.

Divide one dip among four levels of wipers at the inner surfaces where the brush springs ride. Repeat for each additional four levels, then rotate the wiper assembly several times to distribute the lubricant.

One dip to each side of a strip of bond paper. Pass the strip between each armature arm bushing and the spring it deflects.

Divide one light dip among the lobes of the off-normal cam, applying the lubricant to the lifting surfaces only.

Apply lubricant "B" as follows:

Remove the armature bearing pin, work one dip well into each armature bearing, and replace the pin.

One dip to the pawl bearing, working the lubricant in between the bearing, armature arm, and pawl.

Applying the residue on the brush into each pawl spring hook at the eyelets.

Apply lubricant "C" as follows:

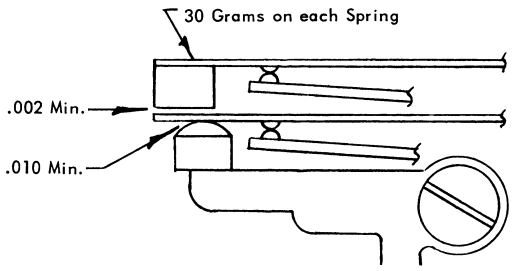
Stir the lubricant to the consistency of a smooth paste, and distribute two dips evenly over the ratchet teeth while rotating the wiper assembly.

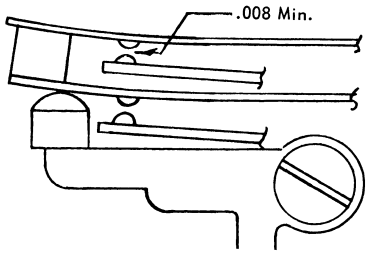
5.5.9 Type ST100 2-motion switch:

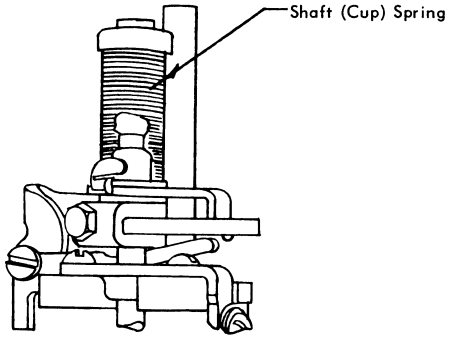
The type ST100 is used as the connector on the 100 line and larger switchboards. This is commonally referred to as the "Strowger" switch used throughout the telephone industry.

Adjust Vertical Off-Normal Assemblies:

a. Straighten tension and adjust off normal springs to set off normal lever.
   1. The springs shall be approximately parallel with the shaft with the switch at normal.
   2. There shall be a perceptible clearance between the lever bushing and the first lever spring with the off-normal lever in its highest position, but this clearance shall not be great enough to cause a bind between the normal stop pin and the off-normal lever, which will prevent the restoration of the shaft when it is released from the third contact of the first level.
   3. Where a lever spring has an adjacent back contact, there shall be a minimum space of .002" between the lever spring and the bushing of the lever spring of an adjacent back contact assembly when the shaft is off normal.
   4. The minimum contact separation shall be .008" for make or break contacts. Similar assemblies shall be adjusted in a uniform manner.
   5. There shall be .010" minimum between the off-normal pin with the switch up one and in one.
   6. For off-normal assemblies using the short off-normal lever, the contact pressure measured at the point of contact on each spring shall be minimum 20 grams.
   7. For off-normal assemblies using the long off-normal lever, the contact pressure measured at the point of contact on each spring shall be minimum 30 grams.
   8. The combined tension of the vertical off-normal springs shall not be sufficient to prevent the complete restoration of the shaft to vertical normal from any position between the first level and vertical normal.
   9. If a side switch is used the lever shall be adjusted to just allow the off-normal springs to close contact when the hub of the shaft is resting on the side switch lock.
   10. See that shaft is free and that cup spring tension is 1 to 1-1/2 turns.





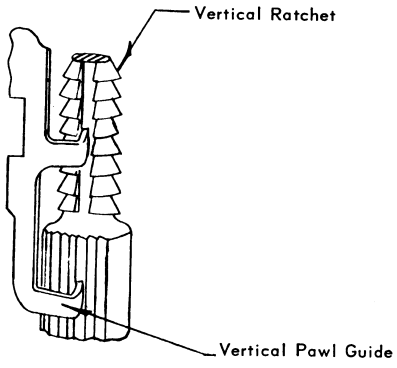


Adjust Vertical Pawl Guide:

There shall be a clearance of min. .010 between the vertical pawl finger and vertical guide just as the shaft starts to move vertically under the control of the vertical armature.

a. This requirement shall be met on all steps.

The pawl shall clear the vertical teeth as the shaft releases and shall clear the rotary hub when shaft is up ten.



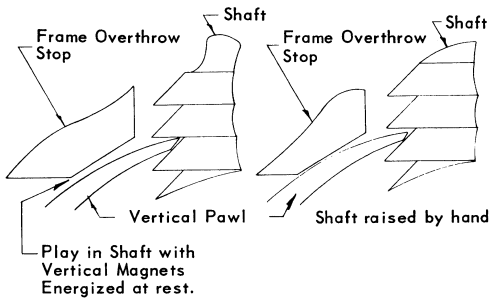
Adjusting Vertical Pawl & Stop:

With vertical magnets energized adjust them so that vertical armature strikes cores evenly. Adjust vertical play in shaft with double dog held away from shaft. Allow just perceptible play between vertical pawl and frame overthrow stop.

With the magnets electrically operated, the vertical armature shall strike both magnet cores. This requirement is satisfactorily met if the space between the armature and the closest point on either core does not exceed .002".

With the vertical magnets electrically operated and with the vertical pawl engaged with the vertical tooth corresponding to each level.

a. There shall be a perceptible play between the vertical pawl and casting (overthrow stop), with the shaft at rest.



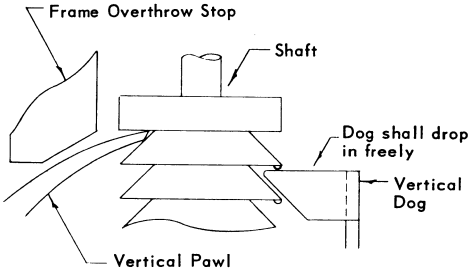
Adjust Vertical Stepping Assy. with Vertical Magnets Energized:

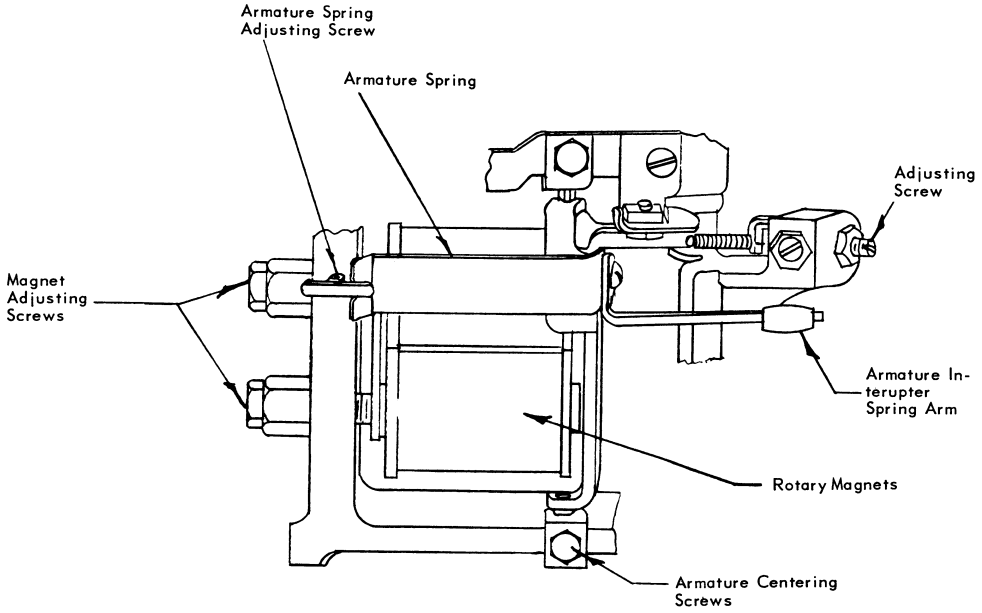
Adjust vertical dog. Energize vertical magnets when adjusting for paragraph 3.

The tip of the vertical dog when unlatched shall ride within the notches in the vertical ratchet with the shaft at rotary normal.

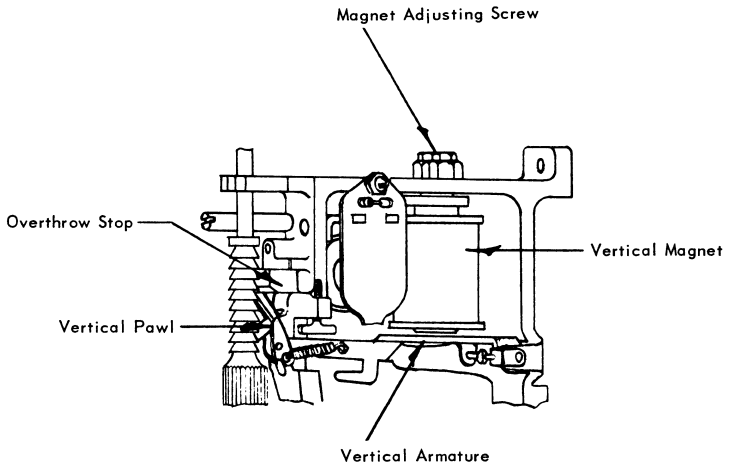
It shall drop in on all levels and may allow a perceptible drop (.003") in the shaft on some levels but shall not allow a perceptible drop (.003") in the shaft on all levels.

With the shaft at rotary normal and the double dog disengaged from the release link, there shall be a minimum of .002", maximum .010 outside play of the shaft without moving the vertical dog. This requirement shall be met on all levels except the 10th.

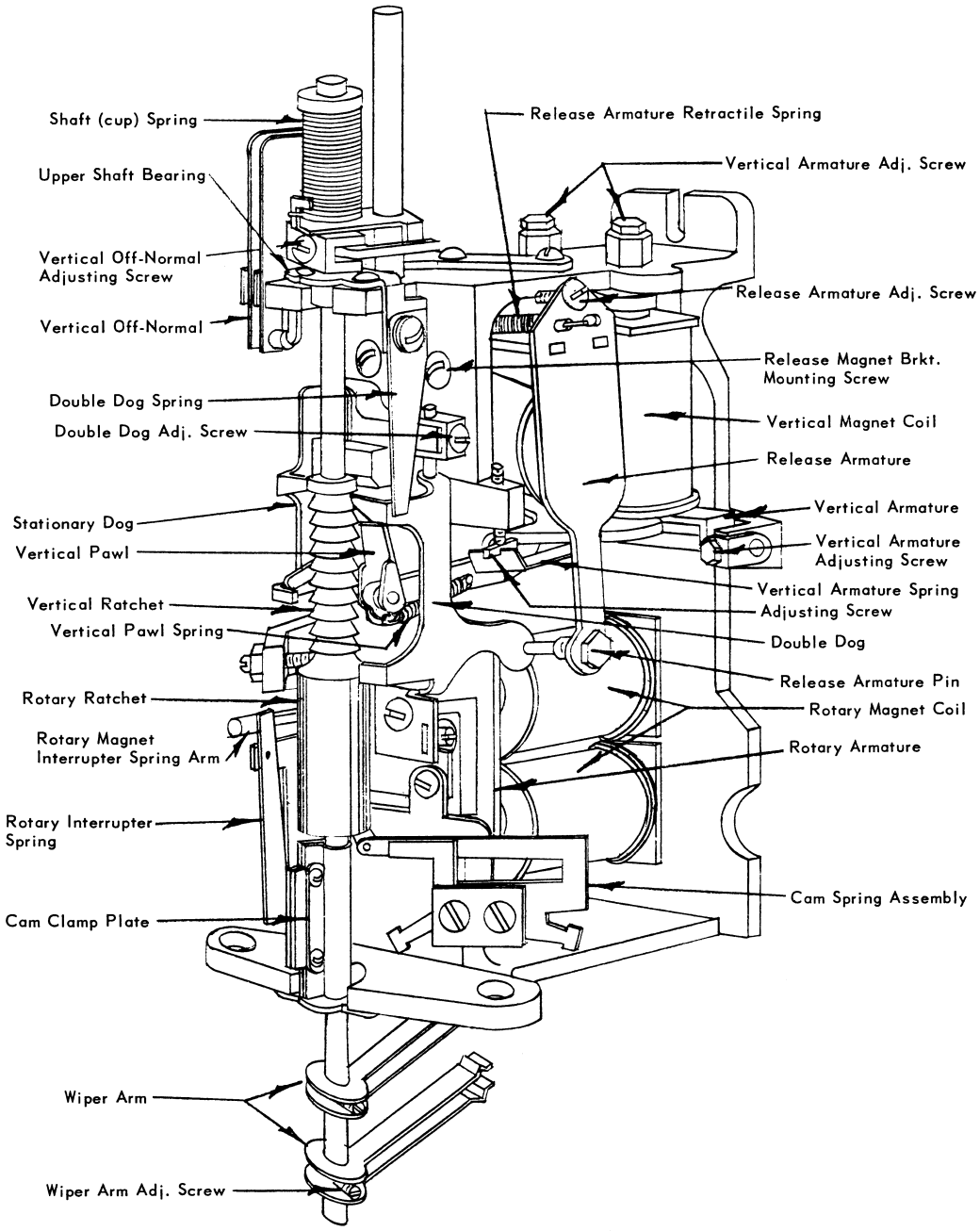




Rotary Magnet Mechanism

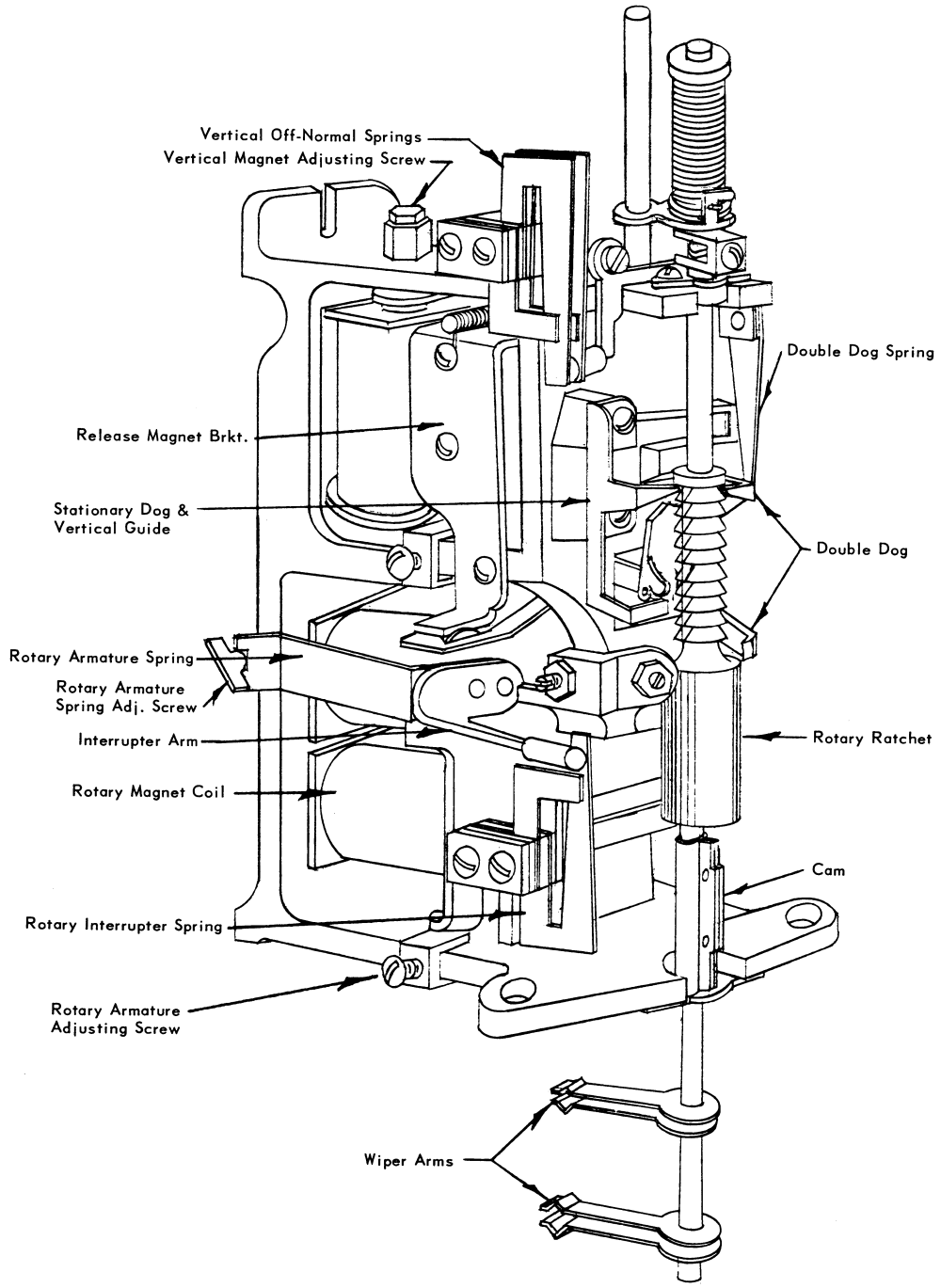


Vertical Magnet Mechanism



Type ST100
Two Motion Stepping Switch

Figure 17



Strowger Switch Mechanism (Left View) and Associated Parts

Figure 18

Adjust Armature in Operated Position:

Try vertical armature for side play and bind. Adjust vertical armature spring tension.

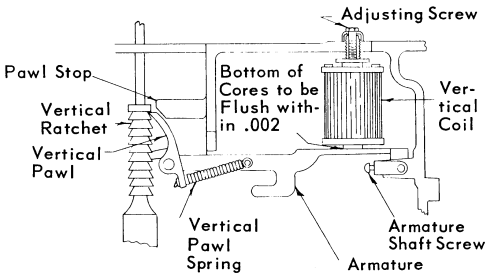
The vertical armature shall not bind nor have more than .012 side play.

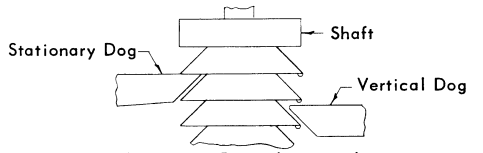
With the magnets electrically operated, the vertical armature shall strike both magnet cores. This requirement is satisfactorily met if the space between the armature and the closest point on either cord does not exceed .002".

With the vertical magnets electrically operated and with the vertical pawl engaged with the vertical tooth corresponding to each level:

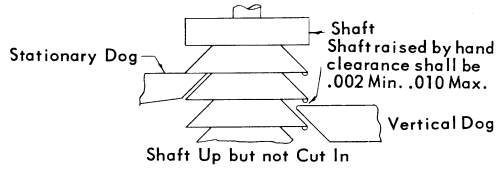
a. There shall be a perceptible play between the vertical pawl and casting (overthrow stop) with the shaft at rest.
b. There shall be a gap between the top of the vertical dog and the under surface of the vertical tooth not to exceed .10" with the shaft raised by hand so that the vertical pawl is resting against the casting (overthrow stop).

With other vertical requirements met, the vertical armature spring shall be tensioned for satisfactory operation, under the specified operating conditions, but its tension, when measured at the adjusting screw shall be 150 grams to 180.

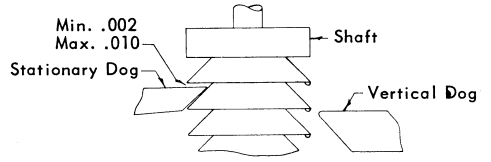




Stationary Dog takes weight of Shaft on Rotary Motion.



Shaft Up but not Cut In



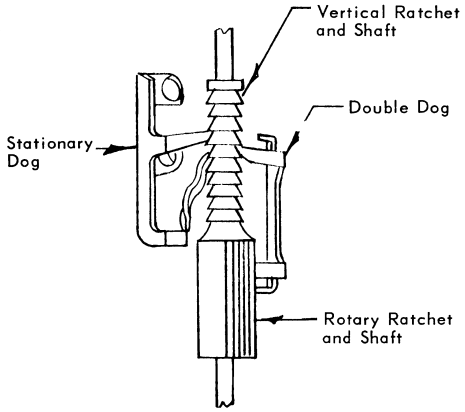
With Shaft up and in Stationary Dog allows Shaft to be raised by hand from .002 to .010 with Double Dog Disengaged.

Adjust Stationary Dog Assembly:

The stationary dog shall be adjusted, in the slot in the vertical shaft, to clear the teeth of the shaft by .003 maximum at the nearest point when the normal bracket is pressed against the normal post from the left.

The stationary dog shall not cause a rise (as gauged visually) and shall not allow more than a perceptible (.003) drop of the shaft as it cuts in on at least one level. With rotary magnets energized on the first rotary step, the shaft shall rest on the stationary dog so that the vertical dog will drop all the way in when pulled away from the shaft and released.

It shall allow a vertical movement of the shaft of .002" min. .010" max. with the shaft cut in two or more steps on any level. This test shall be made with the double dog held away from the shaft.



Adjust Double Dog Assembly:

a. The operated position referred to is the position, with respect to side play that the release armature assumes when the magnet is energized, de-energized and again energized.

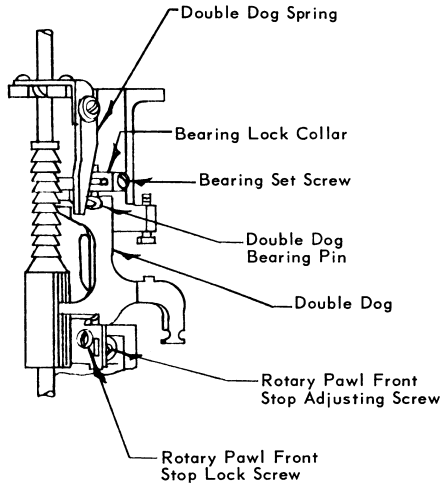
Try double dog for play and bind.

The double dog shall not bind nor have more than .002" vertical play.

Straighten and tension double dog spring.

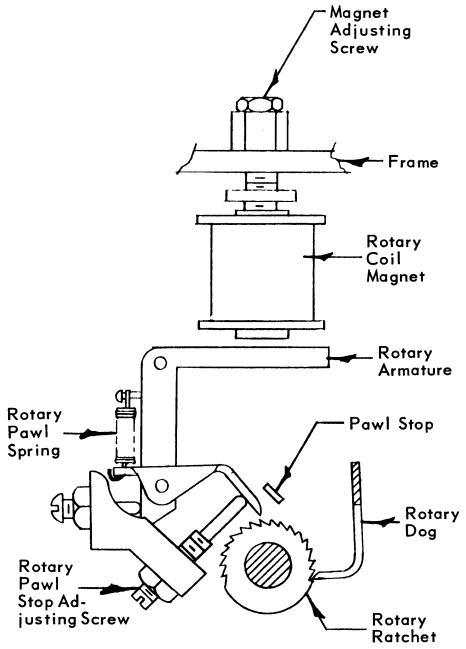
The double dog spring shall be free from unnecessary bends and shall have not more than .025" bow. The vertical center line of its broad surface shall be approximately parallel to the shaft.

Unless otherwise specified, with the double dog engaged in the release link, the double dog spring shall have a tension of at least 250 grams but no more than 400 grams measured just above the double dog.



Adjust Rotary Magnet Non Operative:
Check rotary dog. Do not bend rotary dog.

The stopping face of the rotary dog shall engage approximately flat with the radial face of the rotary teeth.



Adjust Rotary Pawl:
With shaft up one (1) and in one (1) adjust rotary pawl to teeth. Counting from rotary dog the pawl should strike behind the 8th tooth. Adjust rotary pawl to strike flank of tooth properly by means of rotary pawl guide screw.

The rotary pawl shall be free from bind.

The rotary pawl tip shall strike in the notch of the rotary teeth with the following limits:

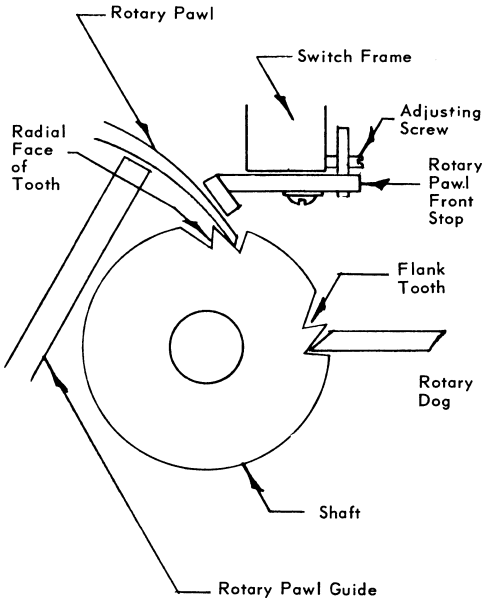
a. It shall not strike upon the radial face of any tooth.
b. It shall strike the base of the notch between the teeth or between this point and the center of the flank of a tooth.

By means of the normal pin adjust shaft to rotary pawl with shaft up one, but not in.

The normal pin shall be set so the pawl strikes the first tooth in the same relative position that it strikes the other teeth.

Adjust rotary armature back stop with shaft up 5 and in 10.

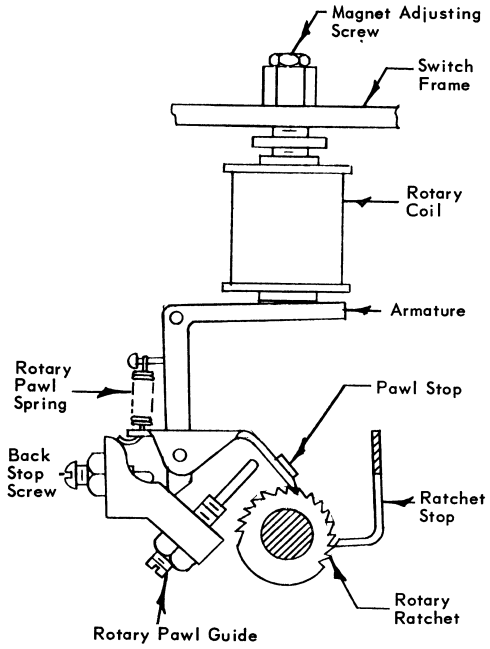
The rotary armature stop shall be set to allow the shaft to release from any level without striking the pawl and to have from .002" to .010" clearance between the pawl and the shaft with the shaft at normal.



Adjust Rotary Pawl with Magnet Energized:
Try rotary armature for play and bind. Vertical play shall be just perceptible (.003 maximum). Center rotary armature on back stop screw. Tension spring.

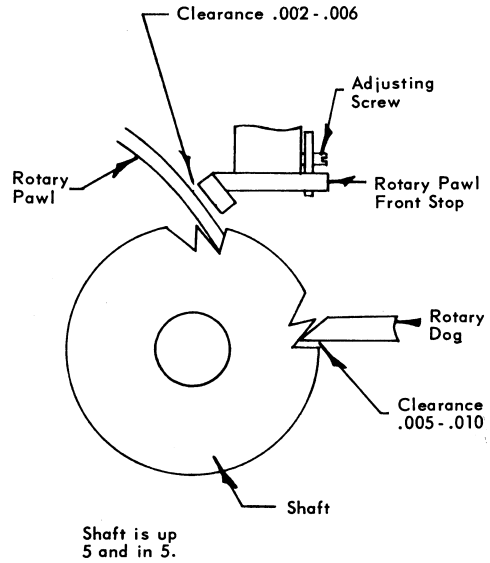
With the rotary armature in its non-operated position:
a. The rotary armature shall overlap a minimum of two thirds the diameter of the back stop as gauged visually.
b. The rotary pawl shall entirely overlap the end of the rotary pawl guide.

With other rotary requirements met, the rotary armature spring shall be tensioned for satisfactory operation, under the specified conditions, but its tension, when measured at the adjusting screw, shall not be less than 150 grams.



With rotary magnets energized, adjust clearance between rotary pawl and its front stop shall be between .002" to .006" at, the first, fifth and tenth rotary steps on the fifth bank level.

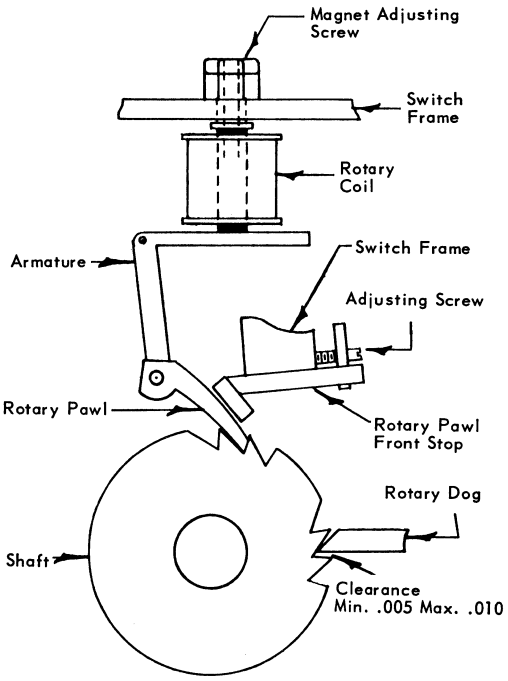
This requirement shall be met with coils at average room temperature.



Shaft is up 5 and in 5.

With rotary magnets energized adjust them so that armature strikes cores evenly and space between rotary dog and teeth falls between .005" and .010".

The rotary armature shall not bind nor have more than .003 vertical play and shall strike both magnet cores at the same time with the magnets electrically operated. The latter requirements is satisfactorily met if the space between the armature and the closest point on either does not exceed .002".



Adjust Rotary Interrupter Spring:

Straighten, tension, and adjust rotary Interrupter Springs.

The Interrupter Springs shall break contact as specified below with rotary magnets energized, unless otherwise specified.

a. When used with interrupter relays.

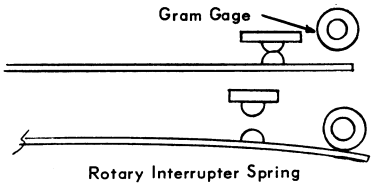
Minimum	Maximum
.003"	.008"

b. When interrupting own circuits.

Minimum	Maximum
.007"	.015"

The rotary interrupter spring shall have a contact pressure of 150 grams minimum, 300 grams maximum, measured at the end of the spring with rotary magnets de-energized. See below.

The minimum contact separation shall be .010" for maker or break contacts.



Rotary Interrupter Spring

Contacts shall break or make before the double dog drops in on the first rotary step.

There shall be a perceptible clearance between the closest point of the cam collar and the cam spring bushing and between the rotary hub and the cam spring bushing.

Adjust space between rotary dog and hub of shaft with release link engaged. Move release link on frame.

With the double dog latched in the release link and with the switch shaft on the fifth vertical level, there shall be a minimum of .030", maximum of .045" space between the engaging edge of the dog and the outside periphery of the rotary teeth.

When a side switch is used and the release link shall hold the spider arm lightly against the frame.

By turning release armature pin adjust so that release link drops over the dog without binding.

With the release armature at rest in its electrically operated position, the pin shall hold the double dog so that the release link drops completely over the double dog lug.

a. The operated position referred to, is the position with respect to side play that the release armature assumes when the release magnet is energized, de-energized and again energized.

With the release magnet energized and the release armature at rest in its normal position with relation to the release magnet bracket and a .006" gap between the release armature and the closest point on the core, the release link shall not latch the double dog.

Using the screw at the top of the release armature adjust the release armature stroke. Gauge between the release pin and double dog with release link disengaged.

The back stop screw shall be set to allow .006" min. .120" max. space between the double dog and the end of the armature pin when the release armature is at normal and the shaft is at rest in any off-normal position with the rotary dog resting on the rotary ratchet.

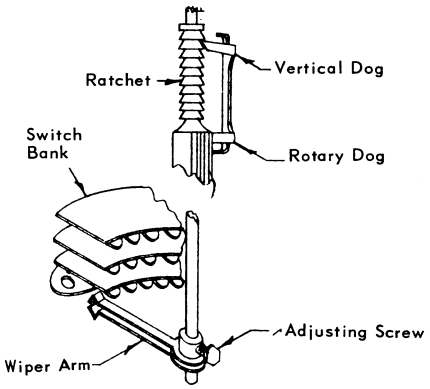
Center Vertical Pawl:

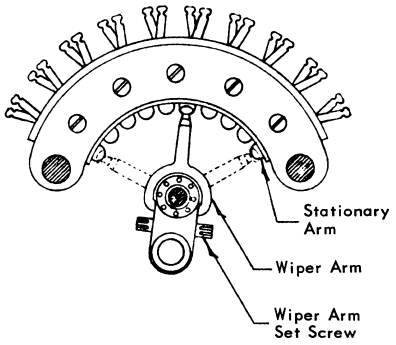
With the vertical pawl resting on the shoulder of the vertical ratchet above the first tooth, both corners formed by the arc at the pawl tip shall contact the periphery of the shoulder in same one position permitted by the side play of the vertical armature.

Adjusting Wiper Arms to Banks:

1. Allow shaft to drop to normal with assembly held in vertical position.
2. Loosen set screw to wiper arm and slide wiper to desired position of normal and retighten.
3. Step shaft assembly up (1) one wiper arm shall be adjusted so that wipers will be in line with first level of bank.
4. Step shaft assembly up one (1) step and in one (1) step.

   Wiper arm shall be adjusted so that wiper blades strike stationary arm on center, then step to center position of bank which is (5) make sure of alignment at 5th step and 10th. Allow arm to return to normal.





Adjust Switch Cam Springs:

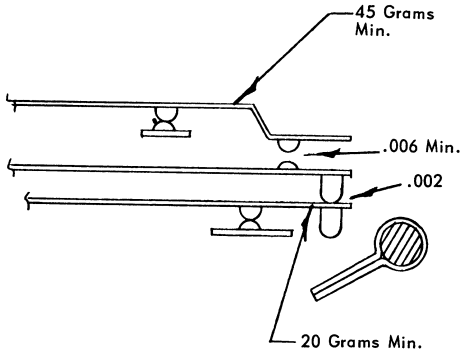
Gauging:

1. There shall be perceptible clearance be- the closest point on the cam collar and the spring stud which engages the cam, but this clearance shall not exceed 5/64.
2. There shall be perceptible clearance between the rotary ratchet and the spring stud which engages the cam, but this clearance shall not exceed 1/16".
3. The minimum contact separation for make or break contacts shall be .006".
4. Where there are two or more adjacent break contact assemblies there shall be minimum space of .002" between each lever spring and the bushing of the lever spring in the adjacent break assembly.
5. There shall be a perceptible clearance between the cam and bushing when the shaft is on the rotary step preceding the one on which the springs are to operate.
6. On levels on which the cam is not to operate the cam springs, there shall be per-

ceptible clearance between any point on the cam spring assembly and closest point on the cam.

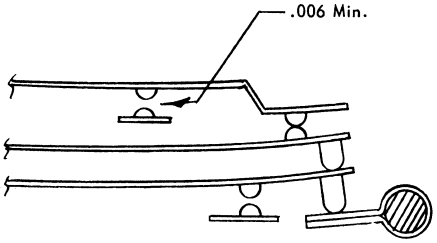
Tension:

1. Make or break springs shall have a perceptible follow when making or breaking contact.
2. Normally closed contact springs of make-before-break combinations shall have a pressure of 45 grams minimum measured at the end of the longer spring.
3. Lever springs shall each be tensioned against their back contact or against the adjacent lever spring in the direction of the cam with a tension of minimum 20 grams measured midway between the bushing and contact.
4. Make combinations shall have a contact pressure of 20 grams when made.



Latching Type Cam Springs Assembly:

1. With the rotary magnet energized with the wipers on the 10th step there shall be perceptible space between the cam and the latching spring.
2. Stepping the shaft electrically the cam shall not latch on the 10th step.
3. With the shaft at rest on the 11th step and the rotary armature at normal, the latching spring shall latch lug freely and shall be tensioned lightly against the latch lug bracket.
4. With the play in the shaft in its rotary normal position taken up by applying pressure at the right of the normal finger opposite the normal post and the latching spring unlatched, the releasing portion of the cam shall just clear the latching spring.



5.5.10 Minor Switch:

The Webster Electric 251-28036 Direct-Drive Stepping Switch is referred to as a "Minor Switch" and was used in the early Model 1B10 switchboard as the finder and connect switch, and the P.S. switch on the 4A30 series.

This switch is different from the usual rotary stepping switch in that it is dual-directional, which incorporates two coils. It steps in one direction and when the selected circuit is no longer needed, the switch is reset by operation of the release magnet which return the wipers to normal in the reverse direction. Refer to Fig. 19 for details.

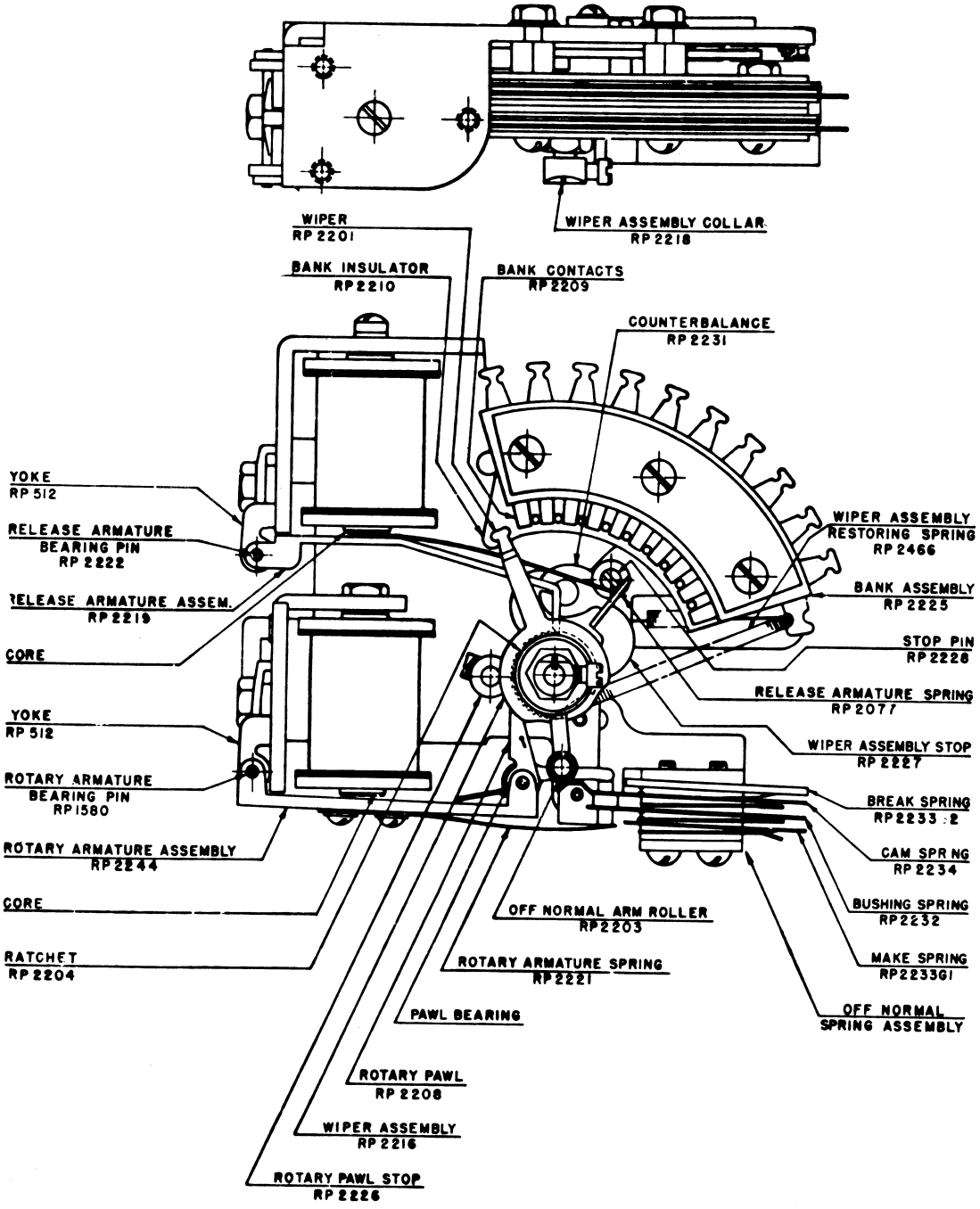
6. TROUBLE SHOOTING:

6.1 OPERATING LIMITS:

An important tool for the service technician is knowing and understanding the operating limits of the equipment. Telecom switchboards are designed to operate satisfactorily over a wide range of operating limits, however, there may be times when these limits are exceeded and equipment operation is effected.

6.1.1 Voltage Limits:

Each Telecom switchboard is equipped with it's own power supply, whereby, commercial a.c. power is fed through a power transformer, rectified and filtered to provide direct current for relay and switch operation. The power transformer's primary is adjustable to meet various line volt-



Direct-Drive Stepping Switch
Indentification of Principal Parts

Figure 19

age conditions and provide d.c. voltages within specified ranges.

The relays and switches will operate satisfactorily over a range of -44 to -54 volts a.c. but for best performance it is suggested that this be kept within -48 to -50 volts d.c. By adjusting for -52V. d.c., under no load condition, this range can be met for normal operating conditions. The bias voltage for line circuits will be between -60 to -65 Volts d.c. when the operating voltage is kept within the specified limits.

6.1.2 Line Limits:

The relays and switches are adjusted at the factory for a line loop resistance of 500 ohms. (including phone) 300 ohms without phone. It is important to keep your lines well within this loop resistance limit.

Typical resistance in the most commonly used wire sized are as follows:

26 gauge	440 Ohms per loop mile
24 gauge	274 Ohms per loop mile
*22 gauge	171 Ohms per loop mile
19 gauge	85 Ohms per loop mile

*From the above chart you can see why we recommend 22 gauge, for long runs. For extra long lines, check Webster's Sales Literature on CM Series trunking adaptors.

6.1.3 Extension Phone Limits:

There may be conditions where it is desireable to add extension phones to lines which, if exceeded, can affect the reflected impedance to the switchboard and the number of extensions should be kept to no more than three, with Ringers. Additional extensions may be added, however, the ringers should be removed or disconnected if more than three extensions are used on one line.

6.1.4 Temperature Limits:

It is not always possible to locate the switchboard under average room temperature conditions or in an air conditioned room, which would be the ideal location. Telecom switchboard design is such that equipment will operate satisfactorily over a temperature range of 0°F. to 120°F. if it is kept clean.

The design of the power supply is such that heat from it's components keeps the inside cabinet temperature 10 to 15 degrees higher than the outside air. This eliminates the possibility of condensation under extreme temperature variations.

6.2 LOGIC OF TROUBLE SHOOTING:

The main object of trouble shooting is to get the system operating in as short a time as possible. To accomplish this, a basic working knowledge of the system is necessary so that the trouble can be localized and corrected. Valuable service time can be saved by applying logic to trouble shooting. Never assume the equipment is at fault.

Importance of Routine Maintenance:

Preventive maintenance differs from trouble shooting in that it's performance is intended to eliminate major breakdown of equipment. During this routine, each relay and switch is periodically cleaned, checked for adjustment, lubricated, and it's operation tested to eliminate many problems caused by dirt, dust, adjustment, or lack of lubrication. Before trouble shooting is started, it is important to know if routine maintenance has been kept up and when it was last performed. If routine maintenance has not been performed, it can be assumed that a combination of small problems can make major faults difficult to locate. To avoid this possibility, it is suggested that routine cleaning and adjustment checks be made on relays and switches **before** trouble shooting is attempted.

6.2.1 Localizing the Trouble:

Obviously the best method for correcting problems is to pin point just what is at fault and to correct it. This is not always easy, however, by following a few basic checks common to all types of servicing, the problem can be localized and found much more readily.

1. Get all of the details and information possible from the customer as to the complaint, what happens, how, in what sequence, etc., to correctly **identify** the problem.
2. **Localize** where the trouble is, incorrect use of equipment, telephone instrument, interconnecting equipment or switchboard.
3. Check the operation and circuits of the localized section at fault to **locate** problem. For example, if all phones are dead, it can be assumed that the problem has to do with power failure at the switchboard. If the board is plugged in, start at the line input voltage and checking its path through the power supply will quickly locate the fault.

This method of analyzing and identifying the problem correctly, localizing where the trouble could be, then tracing it thru to pin point it must be applied in all cases. Note how the trouble chart in the following section breaks problems down to faults in common equipment, in lines, or in links, The following is a partial list of some troubles and the method of localizing them to a certain section. This gives you the method of reasoning to use on whatever problem you are working on.

1. **Trouble in all lines and all links.**
   Problems in common equipment such as:
   a. Line power failure - check for blown fuse.
   b. Switchboard Power Supply Failure - check for blown fuses and voltages.
   c. Tone failure - check tubes and components on tone interrupter assembly.
   d. Ringing failure - check lamp, fuse, and ringing voltage on power panel and RI relay circuit on tone and interrupter assembly.
   e. Finder switch fails to stop on any line - check -60 V. d.c. fuse and voltage - Link distributor relays and switch.

f. Failure to originate more than one call - check link distributor relays, switch and circuits.

2. **Troubles in all lines and one link** localize failure to finder switch or link connecting relays, and circuits. Use test phone and test jack provided on link to localize problem in link.
3. **Trouble in one line and all links.**
   a. Check line circuit of switchboard by removing suspected line and connected a test phone to the terminals. Proceed to originate a call, if call can be made through the switchboard, trouble is interconnecting line and/or the telephone.
   b. Check switchboard line circuit if check "A" indicates trouble is in switchboard.
   c. Check interconnecting line for shorts or opens and telephone if check "A" indicates trouble is in connecting wire or phone.
4. **Trouble in one line and one link.**
   a. Check to localize fault to either the finder or connector circuits.
   b. Failure in receiving dial tone indicates fault in link finder switch or line circuit.
   c. Failure to ring phone indicates fault in connector switch, line circuit, or telephone ringer.
5. **Intermittent - No Apparent Pattern in Trouble.**
   a. Check power equipment for low d.c. voltages caused by large variations in line voltage. This may only happen during certain periods of the day.
   b. Check for loose connections, broken wires, or intermittent shorts between bank contacts, etc.
   c. Check for intermittent component failure.

6.2.2 Trouble Chart:

Trouble in All Lines and All Links

Extent		Effect	Possible Causes	Remedy	Applicable Boards
Lines	Links				
All	All	**Dead**	Commercial Power Failure.	Restore Power.	All
			Switchboard AC Cord Unplugged.	Restore Power.	All
			AC or DC Fuses Blown.	Replace Fuse. Investigate cause of blowing.	All
All	All	**No Tones.**	Tubes on Power Panel	Replace Tube.(If one has Heater open, none will light).	All
All	All	**No Ringing.**	Lamp on Power Panel.	Replace Lamp	All
			RI Relay Fails to Release.	Replace 12BH7A Tube. Check Relay Restoring Spring.	All
			RI Relay Contacts are Faulty.	Check Relay Contacts for Pressure. Clean Contacts.	All
All	All	**Intermittent or Erratic Operation. Wrong Numbers.**	Low DC Voltage from Power Supply. Voltage Taps not set Properly. Defective Components.	See Section of TC-4 Relating to Power Supplies.	All
All	All	**Finder Switch will not stop on Any Line.**	-60 VDC Failure	Check Fuse and Output Voltage.	2DA16 & 4DA28
			Faulty M Relay in Link Distributor.	Check Coil and Contacts of Relay M.	
			Faulty Operation of MA Relay or MS Relay in Link Distributor.	Check Contacts and Adjustment on this Relay.	
			-60 Volt Failure:	Check -60 Volt Fuse and Output Voltage.	4DA50
			Link Distributor Faults:		
			Relay MA not Operating or Frame Ground.	Check MA Coil and Contacts.	
			Faulty Contacts of Relay M.	Check Contacts for Pressure. Burnish Contacts.	
			Levels "E" or "F" of LD.	Check Wiring of Wipers.	

Trouble in All Lines and All Links (Continued)

Extent		Effect	Possible Causes	Remedy	Applicable Boards
Lines	Links				
			-60 Volt Failure.	Check -60 Volt Fuse & Output Voltage.	6DA100 and larger
			Relay MA or MB not Operating.	Check MA & MB. Coils & Contacts.	
			Springs 1 & 2 or 3 & 4 of MC.	Check MC Contacts.	
			Levels "F" or "E" of LD.	Check LD. Check CA & CB Circuits thru LD Banks & Connecting Circuits.	
All	All Except One	**Only One Call can be Originated.**	Link Distributor not Operating:	Check Link Distributor Adjustment and Clean Banks. See Adjustment for Rotary Switch. (Type 12)	2DA16 & 4DA28
			Faulty Bank Contacts on Level F.		
			Open Coil on LD Switch.	Replace Coil and Check LD Adjustment. See Adjustment for Rotary Switch.(Type 12)	
			Fault in Link Distributor Relays.	Check Adjustment and Clean Contacts of Relays.	
			Link Distributor not Operating:		4DA50
			Dirty Bank Contacts of LD, Levels A and B.	Clean Banks.	
			Open Coil of LD.	Replace Coil and readjust LD.	
			Faulty Interrupter Contacts of LD.	Check Contact Pressure. Burnish Contacts.	
			Fault in Relays ST, TD, S2.	Check Relays for dirty contacts, etc.	
			Link Distributor not Operating:	Check LD for mechanical bend.	6DA100 and larger
			Dirty Contacts: Bank level "G" of L.D. 3 & 4 of SO. INT. springs of L.D.	Clean Contacts.	
			Open coil of LD or SO.	Replace coil & Readjust	
			Fault in Relays ST, TD, S2, S3, SO or RS.	Check Relays for Dirty Contacts, etc.	

Trouble in All Lines and One Link

Extent		Effect	Possible Causes	Remedy	Applicable Boards
Lines	Links				
One	Any	**Can not get Dial Tone.**	Line Wires Open or shorted or defective Telephone.	Remove Line Wires from Line Term. Board, and connect a test phone to the Line Terminals. If call can be made with test phone, fault is in the Line or Telephone. If call can not be made, fault is in the Swbd.	All
			Line Circuit Defective.	Check Resistor and Diode in Line Circuit. Check Line Circuit Wiring.	
One	One	**Cannot get Dial Tone.**	Finder Switch Bank Wiring open, or Dirty Bank Contacts.	Repair Wiring and Check Finder Switch Bank Wiring used for this Line. Clean Contacts.	All
			Finder Switch Faulty.	Check Finder Switch Adjustment.	
One	All	**Can not Reach Dialed Number.**	Defective Dial.	Repair or Replace Dial.	All
		Rings Wrong Number.	Line Resistance too High.	Measure Line Loop Resistance. Use Larger Wire if over 500 Ohms.	All

Trouble in All Lines and One Link (Continued)

Lines	Links	Effect	Possible Causes	Remedy	Appl. Boards
One	All	**Dial Does not Return to normal, or function smoothly.**	Defective Dial.	Repair or Replace Dial.	All
One	All	**Rings Wrong Number.**	Low DC Voltage.	Check Power Supply Adjustments.	All
			Relays B and C Not Remaining Operated During Impulsing with Marginal Impulse.	Check Adjustments of Relays. See Miniature Type Relay Adjustments.	
				Check Electrolytic Capacitors in Parallel with these Relays.	
One	All	**Can Not Ring Phone.**	Faulty Line or Faulty Phone Installation.	Check for Ringing at Line Terminal Board with Test Phone. If Test Phone rings, Fault is in Line or Phone Installation. Check Wiring and Connections.	All
			Defective Ringer.	Check Ringer Frequency. Repair or Replace Ringer.	All
			Defective Hookswitch.	Adjust and clean Contacts. Replace Hookswitch.	All
One	One	**Cannot Ring Phone.**	Connector Bank Wiring Open, or Dirty Bank Contact.	Check Bank Wiring and Bank Contact used for this Line. Clean Banks.	All
One	All	**Can Not Stop Ringing When Answered.**	Defective Hookswitch.	Adjust & Clean Contacts. Replace Hookswitch.	All
			Open Transmitter or Induction Coil.	Check Components and Phone for Continuity when phone is off Hook.	All

Trouble in One Line and All Links

Lines	Links	Fault	Reason	Remedy
One	Any	**Finder stops on wrong line. Each link may do the same in turn.**	Shorted diode in line circuit on which the finder stops.	Determine faulty diode by routine test & replace.
One	Any	**Connector does not follow dial pulses after a few pulses.**	SW operates due to ground on "+" line giving same action as Busy Over Ride.	Locate ground in switchboard or on external line and remove it.
One	Any	**Link is seized altho no phone calling. A1 relay fails to operate**	Ground on "–" line, or ground on C lead.	Locate ground in switchboard or on external line and remove it.
Two	Any	**Finder stops on line & F relay operates but does not hold. Action continues on successive links. Where may be no phone off the hook.**	Short between "–" of one line and the "+" of another line.	Locate short and remove it. In switchboard or on external lines.

Trouble in One Line and One Link

Lines	Links	Effect	Possible Causes	Remedy	Appl. Boards
Any	One	**Cannot get Dial Tone.**	Defective Link.	Operate Busy SW. on Defective Link until Link is Repaired.	All
			Link not plugged in properly, Defective Plug or Socket.	Check Connections	4DA50 and larger
			PS Switch not at home position (Party Line SWBD only)	Check PS Switch.	4DA50PL 50 larger
			Open Capacitor CP-D or CP-C.	Replace CP-D or CP-C.	All

Continued on Following Page.

Trouble in One Line and One Link (Continued)

Extent		Effect	Possible Causes	Remedy	Applicable Boards
Lines	Links				
Any	One	**Cannot get Dial Tone.**	Connector Switch not at Home Position.	Check Homing Circuit of Connector Switch. Check off Normal Contacts of Switch and other Adjustments. Check Coil for Continuity.	All
			Faulty Contacts on Relay BT.	Clean or Adjust Contacts.	All
			Tone Capacitor Open.	Replace Capacitor.	All
Any	One	**Can Not Step Connector Switch When Dialing.**	Faulty Contacts on Relays in pulsing Circuit.	Clean or Readjust Contacts.	All
			Relay C not Operating or Remaining Operated During Pulsing.	Check Relay C Coil and Associated Rectifier and Capacitor. Use Test Lamp to Determine if Pulses Get to Relay C.	All
			Faulty Connector Switch.	Check Coil Resistance and Adjustment of Connector Switch.	All
Any	One	**Cannot Step PS When Dialing.**	CI not Operating.	Check CI, RX-B, and Capacitor CE-D.	4DA50 and larger
			Dirty Contacts 1 & 2 of A, 4L & 5L of BI, 1, 2, 3, & 4 of CI, 1L & 2L of BT, IR & 2R of SW, O.N.-2 & 3 of PS.	Check Contacts in Path of PS Coil.	
			Open Coil of PS.	Replace Coil and Readjust PS.	
		Cannot Step MC When Dialing.	C2 not Operating.	Check C2, RX-C, and Capacitor CE-E. Check O.N.-1 & 2 of PS.	4DA50 and larger
			Connector Switch Plug not Seated.	Check Plug Connections.	
			Open Coil of MC.	Replace Coil and Readjust MC.	
All	One	**Cannot Step PS When Dialling. (Party Line SWBD. Only)**	Dirty Contacts 5 & 6 of PS O.N., 1R & 2R of SW, 3L & 4L of BT, 1, 2, 3, & 4 of C, 4L & 5L of B1, 1 & 2 of A.	Check Contacts in Path of PS Coil.	6DA100 and larger
			Open Coil of PS.	Check Coil of PS.	
All	One	**Cannot Step VM or RM of Two-Motion Switch.**	Dirty Contacts V.O.N. 1, 2, & 3.	Check Contacts	6DA100 and larger
			Open Coil of VM or RM.	Check Coils.	
			Ringing Path Open	Check Contacts on Relays BT, RT, and SW. Check Coil of Relay R and Also Check Associated Capacitor and Rectifier.	4DA28 & 2DA16
			Relay R Operated Prematurely.	Check Associated Capacitor and Rectifier. Check Adjustment of R. It should Not Operate Due to 3000 OHM Positive Line Resistor. Check for Shorts and Grounds on Called Line. See Adjustment for Miniature Relays.	All
All	One	**Does not Ring Called Line, due to Open Ringing Path.**	Dirty Contacts 1L & 2L of BT.	Check Contacts.	6DA100 and larger
			Level "B" or "C" Contacts or Wiring of PS. (Party Line Switchboard Only)	Check PS.	

Continued on Following Page.

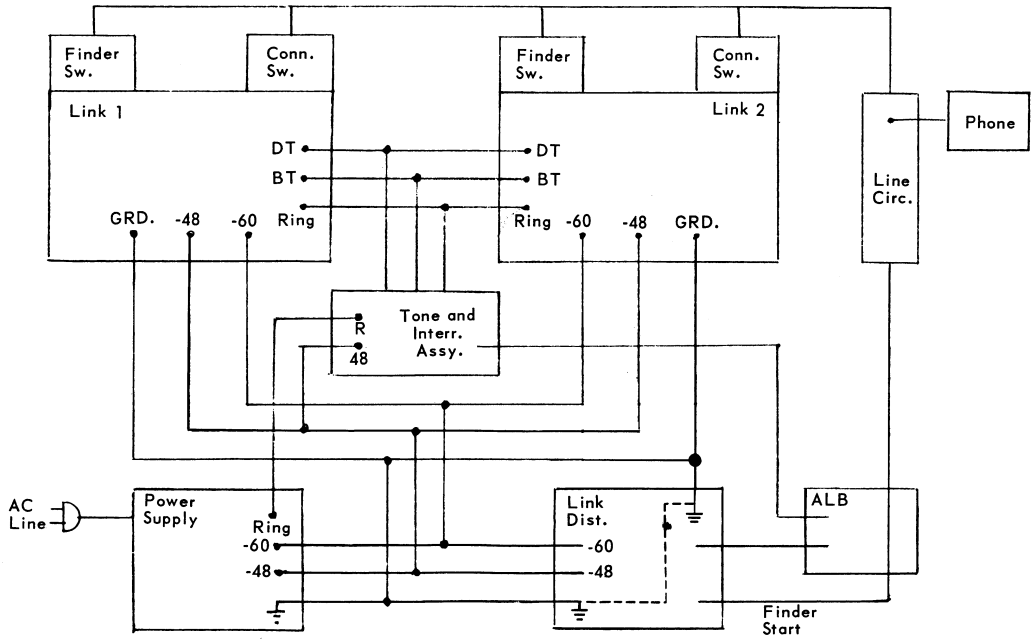
Trouble in One Line and One Link (Continued)

Extent		Effect	Possible Causes	Remedy	Applicable Boards
Lines	Links				
All	One	**Does not Ring Called Line, due to Open Ringing Path.**	"ON" Relay not Operating	Check Contacts in Path to ON Coil.	6DA100 & larger
			SW. Not Operating.	Check Contacts in Path to SW Coil.	All
			Dirty Contacts 3R & 4R of RT, 5R & 6R of SW, 3R & 4R of SW, 1L & 2L of RT.	Check Contacts in Ringing Path.	4DA50
			Dirty Bank Levels A & B of PS.	Clean Banks.	
All	One	**Does not Ring Called Line due to premature Ring Trip.**	Open Capacitor CE-D. CE-C on 4DA50 board.	Replace Capacitor	All
			Open Diode RX-B. or RX-E.	Replace Diode.	All
All	One	**Relays B and C Fail to Hold Operated During Dialing.**	Defective Capacitors in Parallel.	Try New Capacitor Observing Polarity Replace Capacitor if Faulty.	All
			Low DC Voltage.	Check Voltage from Power Supply and Adjust if Faulty.	All
All	One	**No Busy Tone, makes connection to Busy Line.**	Relay T Not Operating correctly.	Check Diode and other components in operating circuit of T. See if a voltage appears across T.	6DA100 and larger
			BT not Operating.	Check Contacts on Relays T & C1. Check Coil & Adjustment of BT. See adjustment for Miniature Relays.	
				T, C2, & D5 on 4DA50 Check Coil Add CF, BT	4DA50
All	One	**Relay B, B1, C, C1, or C2 fails to hold Operated during Dialing.**	Defective 50 MF Capacitor across Relay Coil.	Attach new Capacitor to Check this, observing correct Polarity.	4DA50 and larger
All	One	**Can not make Reverting Call. (Party Line SWBD. Only)**	RC not Operating.	Check Contacts 3 & 4 of A1, Level "D" of PS, 1R & 2R of RT, & Coil of RC. Check 5 & 6 of C1 on 4DA50.	6DA
Any	One	**Can Not Get Dial Tone, Can Not Reach Dialed Phone, Link Fails to Release after Both Parties Hang up, Etc.**	Defective Link	Operate Busy Switch on Defective Lind Until Link is Repaired.	All
			Link not Plugged in Properly.		
			Fault in Link Plug or Socket.		
All	One	**Can Not Stop Ringing When Answered.**	Link Fails to Trip Ringing Due to Lack of Operation of Relays R and RT.	Check Relays for Proper Coil Resistance. Check Contact Adjustment. Check Rectifier and Capacitor in Parallel with Relay R.	All
			Faulty Contacts in DC Tripping Circuit on Relays RT and SW.	Clean Contacts or Readjust Relays. See Adjustments for Miniature type Relay.	
All	One	**No Tones or Ringing When This Link is Used.**	Lack of Ground on P.ST. Lead.	Check Contacts on Relays RT and B1. Use Test Lamp to Trace Ground.	All

6.2.3 Checking Power Equipment:

When reference is made to this section it is understood that it includes the Direct Current Power Supplies, Ringing Supply and Tone Supply. This is common equipment and troubles in the section will affect all phones, lines, and links.

Any section of the Power Equipment can be checked either at the power supply's output terminal strip or at the socket of the tone and interrupter assembly. From this point the signal and operating voltages are fed to switchboard relays, switches, and line circuits and are common to all. The block diagram, below, illustrates this and can be used to localize troubles in this section.

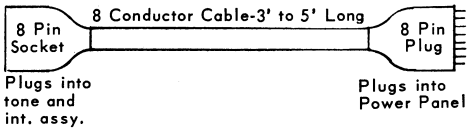


As each output of the power supply is taken through a suitable fuse, the supplies can easily be checked at this point with a voltmeter. By doing so, the fuses as well as the power supplies can be checked. To check the d.c. voltages, connect the positive (+) lead of the meter to switchboard frame (ground) and the negative (–) lead first to one clip of the fuse holder and then to the other. The 115 V a.c. ringing supply is checked in the same manner, except the meter is set on the **150VAC** scale.

The negative (–) lead connects to terminal number five (5) of the output terminal strip and the positive (+) lead to the fuse clips. **Caution:** Never replace fuses with higher than specified ratings. Fuses are provided to protect components and eliminate the need of costly parts replacement.

Problems in the Tone and Interrupter Assembly can be checked at the socket which is mounted on the power panel. All input voltages and output signals can be checked at this point. The dial and busy tones can be checked by using a test phone connected across pin 1 for dial tone or pin 2 for busy tone with pin 6 as the common ground. The ringing current can be checked in the same manner, one side of the test phone connected to pin 6 and the other through a blocking capacitor (.04MFD) to pin 4.

The tone and interrupter assembly is a plug-in unit which can be removed for repair or replaced when necessary. It would be convenient to provide an extension connecting cable which would permit testing under operating conditions. See Fig. below for construction details.



6.2.4 Checking Line Circuits:

The line circuits consists of the interconnecting wires, telephone hook switches, and the switchboard line circuits. Trouble in any one of these sections can affect the boards operation. Trouble in the interconnecting wires usually is due to open or shorted conductors. An open line is not serious or difficult to locate as its presence is clearly indicated by a dead telephone instrument. This is not the case when lines or pairs are shorted. Normally, insulation resistance between conductors is very high and even under adverse conditions will not cause problems. However, damage to this insulation can cause serious troubles and if not cleared, can cause costly repairs to the switchboard. Any condition that can damage the insulation to lower the resistance should be avoided.

Things to look for are locations where cable or wire can become damaged by the normal traffic through the area, damage inflicted by weather or

moisture, and wet or dirty junction block faces.

When line troubles are suspected it is suggested that the following procedure be applied.

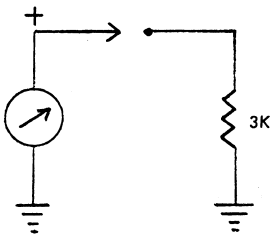
1. As indicated above, open conductors are not difficult to locate and pose no problem to the service man. The suspected line can quickly be isolated by checking at the switchboards line circuit with a test phone.
2. Shorted lines or pairs can be checked at the line terminal board with a high voltage continuity meter.
   Remove power from switchboard and connect (+) lead of ohm-meter to (+) line terminal and the (-) lead to the (-) line terminal. Any reading on the meter indicates trouble on the lines. Check each pair of lines in the same manner and remove shorted lines from switchboard. Be sure all phones are on the hook.
3. After faulty lines are removed the switchboard can be put back into service.
4. Faults in the telephone hook switch can be checked by removing the phone from the line and checking operation with a test phone. Replacing the defective phone will put this line into operation and repairs can be performed in the shop.
5. The line circuits of a telecom switchboard consist of two 3000 Ohm resistors and a diode for each line, mounted on the line terminal board, readily accessable for checking. These circuits can be checked with voltage applied or for resistance with the board disconnected from commercial power. The following voltage conditions exist when checked with a Triplitt Model 630 volt 1 ohm-meter. Use the 60 Volt d.c. scale of the volt meter.

All voltages are from switchboard ground to points indicated:

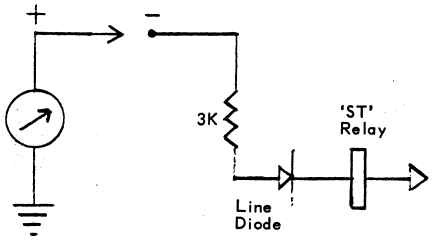
1. Line and Switchboard idle.
   a. "+" side of line to grd. . . . 0 volts.
   b. "–" side of line to grd. . . . 48 V. d.c.
   c. "C" lead, junction point of "–" line resistor and negative end of diode to grd. . . . 48 V. d.c.
   d. When call is waiting to be answered on some other line, voltage reading on a & b will be -40 V. d.c.
2. Line waiting on dial tone.
   a. "+" side of line to grd. . . . 15 V d.c.
   b. "–" side of line to grd. . . . 17 V. d.c.
   c. "C" lead, junction point of "–" line resistor and negative end of diode to grd. . . . 32 V. d.c.
3. Line Connected to Link.
   a. "+" side of line to grd. . . . 20 V. d.c.
   b. "–" side of line to grd. . . . 30 V. d.c.
   c. "C" lead, junction point of "–" line resistor and negative end of diode to grd. . . . 60 V. d.c.

With the meter set on the ohms scale and a.c. line power disconnected from the switchboard the following **resistance checks** can be made. All test points are as indicated:

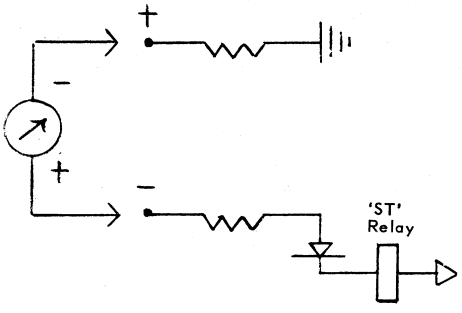
1. "+" side of line to ground.
   a. Correct reading is 3000 ohms.
   b. A 1500 ohm reading indicates circuit being checked is shorted to another "+" line.
   c. A 2000 to 2500 ohm reading indicates circuit being checked is shorted to a "–" circuit or line.



2. "–" side of line to ground.
   a. Correct reading 6000 to 7000 ohms.
   b. A 2000 to 2500 ohm reading indicates terminal being checked is shorted to a "+" line.
   c. A 3000 to 4000 ohm reading indicates terminal being checked is shorted to a "–" line.
   d. A reading less than 2000 ohms indicates terminal being checked is shorted to a "C" lead.
   e. With opposite ohmmeter polarity circuit will read "open" or infinite.



3. "+" side of line to "–" line.
   a. Correct reading approximate 10,000 ohms.
   b. A zero "0" reading indicates a short across line.
   c. A 7000 ohm reading indicates a shorted line diode.



4. Same as 3 above but opposite meter polarity.
   a. Correct reading "open" or infinite.
   b. A zero "0" reading indicates a short across line.
   c. A 7000 ohm reading indicates a shorted

line diode.

d. A reading over 7000 ohm indicates a possible faulty line diode. Check diode with high voltage continuity meter.

5. The actual condition of a diode can not be checked with an ohm-meter unless it is open or completely shorted. The high voltage continuity meter should be used. This meter applies high enough voltage to the diode to simulate the actual working voltage conditions and will indicate a marginal diode. An ohmmeter does not apply high enough voltage to the diode and actual leakage conditions are not indicated.

   The diodes can be checked across the line terminals if the switchboard power is off and there are no shorts on the lines. With the meter's negative lead connected to the "+" line terminal and the positive lead connected to the "–" terminal, the meter scale will read almost full. Reversing the meter polarity should give approximately 20% of full scale reading. Any reading more than this indicates leakage and the diode should be replaced. A zero reading in either direction indicates an open diode.

6.2.5 Checking the Link Distributor:

Troubles in the Link Distributor can be kept to a minimum if a sound preventative maintenance program is followed. Most faults in this section are caused by dirt and dust between relay contacts. Keeping relays clean is very important and doubly so on the ST and MA relays. The adjustment on these relays is very close and the slightest build up of foreign matter between contacts or the armature and pole piece can cause Link Distributor failure.

The LD switch must be kept clean and lubricated to prevent binding. Here, again the preventative maintenance program is all important.

6.2.6 Check the Link:

Troubles in the Link can be localized with use of the Busy Switch and Test Jack incorporated on each link. These features permit the service man to take a Link out of service while making checks and repairs under actual operating conditions. This in no way effects the operation of the switchboards good links and service can still continue through the system. By plugging a test phone directly into the link each operation of the Link can be checked and the fault localized to a certain circuit. These generally will show up as no dial tone, cannot step PS or MC switches, cannot ring called line, no ring back tone, no busy tone, weak talking path, and premature ring trip. In this manner any fault localized can be corrected by referring to the individual link schematics contained in the switchboards installation and maintenance manual.

6.3 SERVICE TIPS:

1. One of the most important items in a service man's tool kit is a small quantity of spare parts. There will be numerous times that a switchboard cannot be put back into service for the lack of a proper fuse, capacitor, or relay coils. These are small, inexpensive items but will save an unnecessary repeat service call if they are available on the job, and above all, customer relations will not be strained. The following list of small parts are suggested:

1 ea.	251-28974-A	Relay Coil 250 ohm
1 ea.	251-28974-B	Relay Coil 2100 ohm
1 ea.	251-28974-E	Relay Coil 4600 ohm
1 ea.	251-28618-1	Coil
6 ea.	251-38246	Diode
1 ea.	29507-2	Resistor, 100 ohm, 7 watt
1 ea.	29507-3	Resistor, 200 ohm, 7 watt
3 ea.	29506-16	Resistor, 3000 ohm, 5 watt
1 ea.	29506-4	Resistor, 33 ohm, 5 Watt
1 ea.	251-28151	Capacitor, 25 mfd, 50 V
1 ea.	251-28005	Capacitor, 50 mfd, 50 V
2 ea.	251-28701-44A	Relay Assem. "A"
4 ea.	251-41122	Link Fuse Assembly
4 ea.	251-41993	Link Fuse Assembly
2 ea.	251-28701-39A	Relay Assem. "PC"
2 ea.	251-28030	Relay Assem.

Assortment of fuses, 1/4 amp., 1/4 Slo Blow, 1/2 amp., 1 amp., 2 amp., 3 amp., 5 amp., 2 - 2N3645 transistor, 4 - MPS404A and 2 - 12BH7A tubes available through local parts distributor.

7. TELEPHONE TERMINOLOGY:

Line Circuits:

The total number of circuits available to which telephones can be connected in a switchboard. Taken collectively, the number of line circuits is a measure of the board capacity, commonly referred to as the number of lines.

Line:

Connecting wires between the switchboard and a telephone. This term is sometimes used with reference to the total talk path between phones.

Line Finder or Finder:

The stepping switch assembly in the link circuit which connects the calling telephone to this link circuit.

Line Connector or Connector:

The stepping switch assembly in the link circuit which makes the connection to the called telephone. Its position is determined from the dial impulses received from the calling telephone.

Line Terminal Block:

The terminal block on the switchboard to which incoming lines are connected either directly or through an MDF.

MDF (Main Distributing Frame):

An auxiliary terminal enclosure to which lines from the telephone are terminated. Short lines are then run from this central termination through suitable duct or pipe to the line terminal block on the switchboard. By use of straps in the MDF, telephone lines and switchboard lines are easily interchanged as personnel are relocated.

Line Finder Multiple:

A group of line finders in close proximity physically, or mounted to a common frame section with corresponding line terminals connected together.

Connector Multiple:

Same as above except line connectors.

Link:

The equipment group which connects functionally the calling line to the called line. It includes the finder switch assembly, the link control relay assembly, and the connector switch assembly. The number of simultaneous conversations possible through a switchboard is measured by the number of links. (The link may also include a group selector in 200 line or larger boards to select the 100's group involved.)

Link Gate:

Frame assembly on which link relay groups are mounted.

Connection Block:

A small connecting block supplied with each telephone to permit a secure connection between the telephone cable and the line wires.

Line Resistance:

The loop resistance of a pair of telephone lines between the line terminal block to the telephone connector block. This should not exceed 500 ohms DC for any pair of lines. Wire size selection is based on loop resistance and length of run.

Stepping Switch:

A multiple position relay type action switch. The wipers generally travel an arc traverse. Contacts being made by an arm operating in an arc. Stepping switches may have multiple banks with a common actuating mechanism and be equipped with auxiliary contacts for special control functions.

Dial Tone Generator:

A device or circuit for generating an audible tone, heard at the calling telephone when the handset is removed from its base to make a call, if a link is available on a switchboard. It indicates the system is ready for the caller to proceed dialing the phone number desired.

Ring Back Tone:

The audible signal heard in the calling telephone when a circuit has been established to a called phone and that phone is being rung.

Ringing Current:

The intermittent current supplied to the called telephone to actuate its ringer.

Busy Tone:

An interrupted audible tone in the calling telephone, heard after dialing a number, if the called telephone is in use.

Reverting Call:

A special circuit in a two-party line telephone system which permits one phone on a party line to call the other phone on the same line.

Two-Party Line System:

In a two-party line system, two telephones are assigned to each line. Each telephone has an individual ring (selective ringing). Only one conversation path exists to the switchboard. Each party line phone may have extensions.

Selective Ringing:

Circuit allows the individual ringing of either phone in a two-party line group connected to a party line switchboard.

Private Line:

A line having only one telephone connected. It may have extension phones connected.

Protectors:

Devices used to protect lines run outside of a building from lightning and high voltage. Not required on inside installations.

Sub Cycle:

A circuit or device used to generate ringing frequencies other than standard line frequency. Required only where 60 cycle ringing is not acceptable.

Line and Cut-Off Relays:

Relay groups which control the start and stop of line finder operation when a telephone is taken off the hook to initiate a call. The diode line circuit replace this in Webster Telecom switchboards.

Link Distributor:

An equipment group, including link selecting switch, which serves three specific purposes.

1. It locates a link which is not busy.
2. It insures sequential operation of links, sharing the load and wear on links; and insuring that no link will remain indefinitely idle because of low traffic conditions.

Equipment in consistent use is far less susceptible to potential dust problems.

3. It automatically steps to a usable link in the event there is a fault in the first link selected, preventing board tie-up due to an inoperative link.

Trunk Circuits:

Generally used as related to talk circuits between independent switchboard systems.

Tie Lines:

Special interconnecting lines between two points or systems which by-pass the normal connecting circuits for a more direct connection.

Trunkage or Linkage:

Generally is considered as a measure of the percent maximum duty of a switchboard system, and is usually expressed as the ratio of

$$\frac{\text{Number of separate simultaneous conversation paths}}{\text{Number of telephones}} /100$$