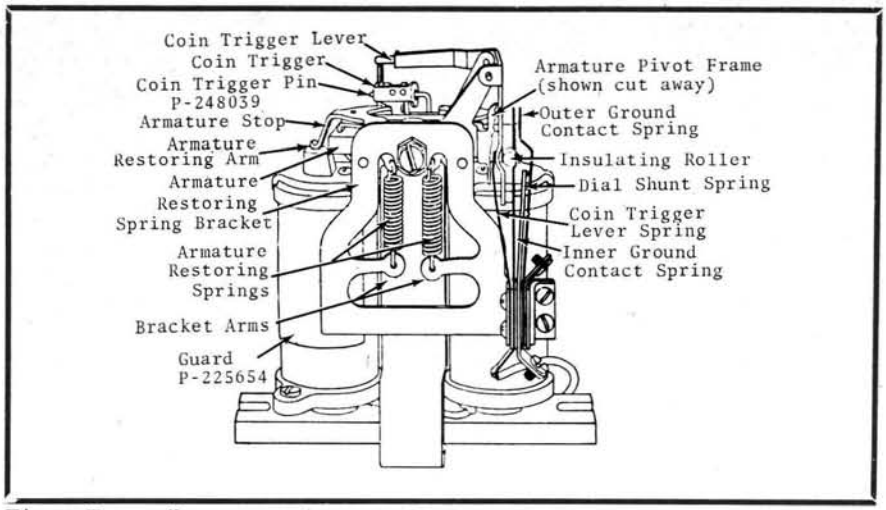


Fig. 1 Two-coil prepay coin control relay.

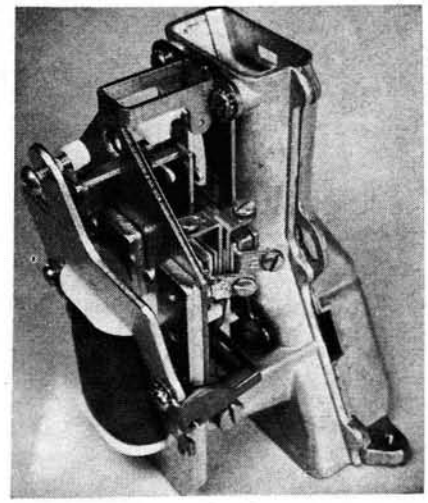


Fig. 2 Single-coil relay.

Repairing the coin control relay

Chapter 15 of this series digs into the details of a vital area of paystation instrument repair

Melvin E. Hacker

THE LAST ARTICLE in this series gave a quick rundown on coin telephones and their repair. Now we get down to an in-depth review of coin control relay maintenance and allied repair operations on coin telephones within the repair center. Emphasis will be placed on the "care and feeding" of prepay coin telephone equipment since most paystation instruments are of this type.

Two different types of coin control relays (Figures 1 and 2) are used on prepay sets. The two-coil type coin control relay which has been in use for 55 years, recently has been superseded by a newly developed single-coil variety. The new relay, in association with a redesigned hopper assembly, offers greater coin capacity and reduced field maintenance, as well as the ability to operate efficiently over longer subscriber loops than its predecessor.

Where the older hopper could accept a maximum of 11 quarters, the single-coil hopper is designed to hold 20 quarters without jamming. This latter feature is of great value in reducing the lost operating time involved in multiple collections for long distance calls. The new $5 capacity effectively reduces the number of collections required for each toll call that would have exceeded the capacity of the older hopper. However, only a relatively small number of the single-coil relays are in use now, so this article will be devoted to the requirements of the two-coil variety. Those interested in learning more about the single-coil relay may refer to the January, 1968, issue of the "Automatic Electric Technical Journal" for a comprehensive technical description of its development and operation.

Two-coil coin control relay

General—The two-coil prepay coin relay (See Figure 1) is an electro-mechanical device that serves a number of purposes. While its primary function is to provide a means of collecting and refunding deposited coins, the relay also satisfies other important circuit control requirements.

In the prepay coin telephone system, central office equipment and the telephone set are teamed up to enforce coin deposit before telephone calls are permitted. This minimizes fraudulent use of the paystation. For example, although dial tone may be obtained merely by lifting the prepay coin telephone handset (Automatic Electric Co. equipment) it is impossible to dial a number due to the absence of the ground necessary to permit dialing. (The required ground is pro-

 Mr. Hacker is customer equipment engineer for GT&E Service Corp., New York City. Chapter 1 of this series appeared in the March 23, 1968, issue of TELEPHONY.

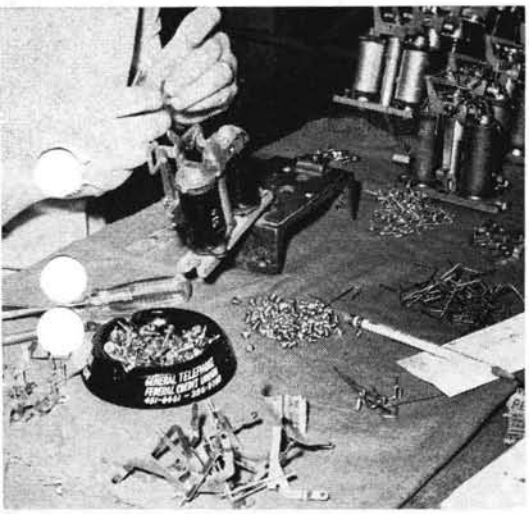


Fig. 4 Reassembling two-coil prepay coin control relay.

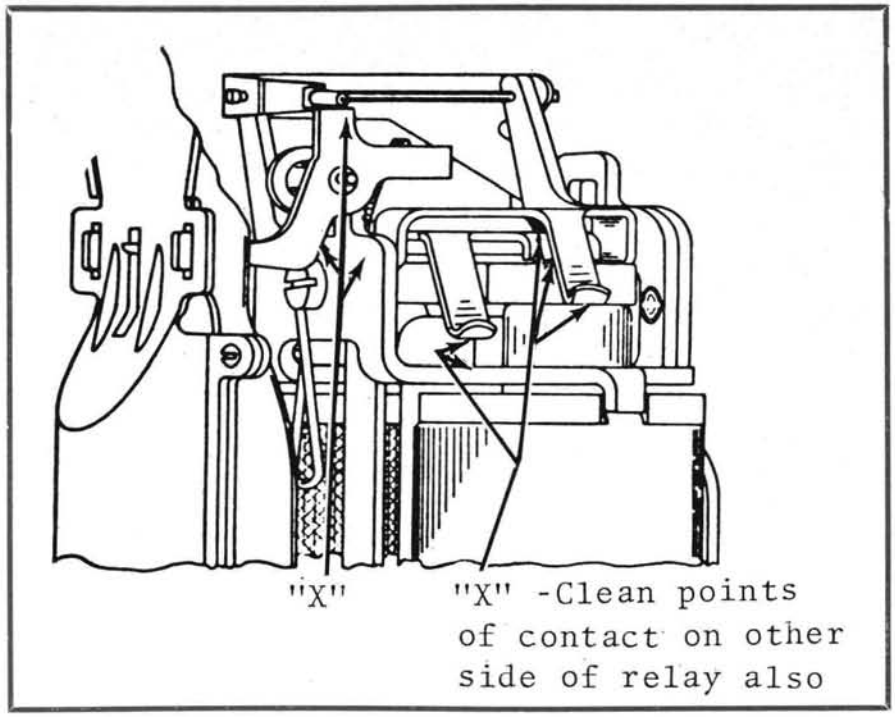


Fig. 5 Arrows points out areas that likely will need burnishing.

ularly to the relay armature and armature restoring arms (See Figure 4).

After cleaning, it is important to avoid exposing the relay components to foreign (especially magnetic) particles. Accidental contact of the relay permanent magnet parts with iron filings *must* be prevented, because if magnetic particles get into the relay assembly it won't function properly. To avoid this use clean storage trays, exhaust type dirt accumulators, uncontaminated cleaning solvents and clean service cloths. These simple precautions will make the relay repair operation more efficient.

In this regard, it is important to note that the removal of accumulations of dirt, lint or other foreign matter by means of a suitable solvent normally will not dislodge magnetic particles that have attached themselves to either armature or coil pole faces. A good way to remove these particles is to use short lengths of rubber insulating tape, pressing the tape on the affected surfaces. Rubber insulating tape is well suited to this job since it removes foreign particles without learning any harmful residue from the tape itself.

Relay assembly and adjustment

After the relay parts have been thoroughly cleaned, an inspection is made to determine the possible existence of deteriorated bearing surfaces (especially armature pivot bearings), deformed coin trigger lever, armature stop, armature restoring arms or any other metal part. Armature pivot screws that show signs of wear should be discarded since these components represent a critical point in obtaining proper relay performance. Even slightly worn pivot screws may cause an otherwise perfect relay assembly to bind.

During the coin relay reassembly task, an orderly and sequential method of repair is essential. Certain adjustments are interrelated and the adherence to tested and proven repair techniques will reduce, to a practical minimum, the amount of time required for relay rehabilitation. During the inspection of the several parts that comprise the two-coil relay, the repairman must also watch for the presence of burrs on critical surfaces. Except in extreme cases, the burrs will be slight and may be removed with crocus cloth. Relay maintenance instructions will specify the required points of emphasis. Figure 5 shows eight areas that need special attention during relay assembly and adjustment. These must be burnished with crocus cloth prior to relay adjustment and test.

In assembling the relay it is important that the armature restoring arms be able to move freely. This freedom of movement must be assured before the armature restoring springs are installed. Restoring arms that do not move freely cause difficulty in obtaining consistent collect and refund current flow values. The armature restoring arms should return by their own weight when released from a point one-fourth inch above the normal position. Restoring arm side play should be in the range of .005 to .020 inches as gauged visually.

While checking the freedom of movement of the armature restoring arms, the armature should also be checked—and this check also is performed before the restoring springs are installed. If the armature binds, the armature pivot screws are adjusted to produce perceptible lateral movement. Armature side

vided by the coin control relay when a coin is deposited.) Further, even if a fraudulent ground is somehow applied, dialing still cannot be achieved without coin deposit because the coin control relay maintains a shunt across the dial impulse contacts. Thus, it is evident that the prepay coin-control relay is critical to the satisfactory performance of the coin telephone instrument.

Theory of Operation—The two-coil coin control relay is of the polar type, that is, the combination of its permanent magnetic elements and its two electromagnetic coils imparts to the mechanism a bi-directional operating capability. This is essential because the prepay coin telephone must be able to collect as well as refund deposited coins under control of associated central office equipment. With coins deposited in the hopper, a −110 volt dc potential applied to the tip conductor of the telephone line will cause a properly adjusted relay to operate in the *refund* mode, while the application of +110 volt dc to the tip conductor will initiate a *collect* relay cycle.

Although it is only necessary to apply the relay control potential to the tip conductor of the telephone line, in actual practice most central office repay paystation repeaters connect the control potential to tip and ring conductors simultaneously. This feature is used to advantage in the long loop operation of coin control relays inasmuch as an additional relay within the paystation instrument operates during the collect/refund interval to also short the T and R conductors at the station; with the loop thus shorted at each end, its effective resistance is *halved* and thereby permits increased relay control current to flow. Increased current flow, of course, results in improved operational reliability.

The reliability with which these functions are performed is in part related to the degree of precision and care exercised by repair personnel in the maintenance of the coin relay itself. A related factor, of course, is in the level of maintenance applied to central office paystation repeaters and associated equipment.

Tools for the job

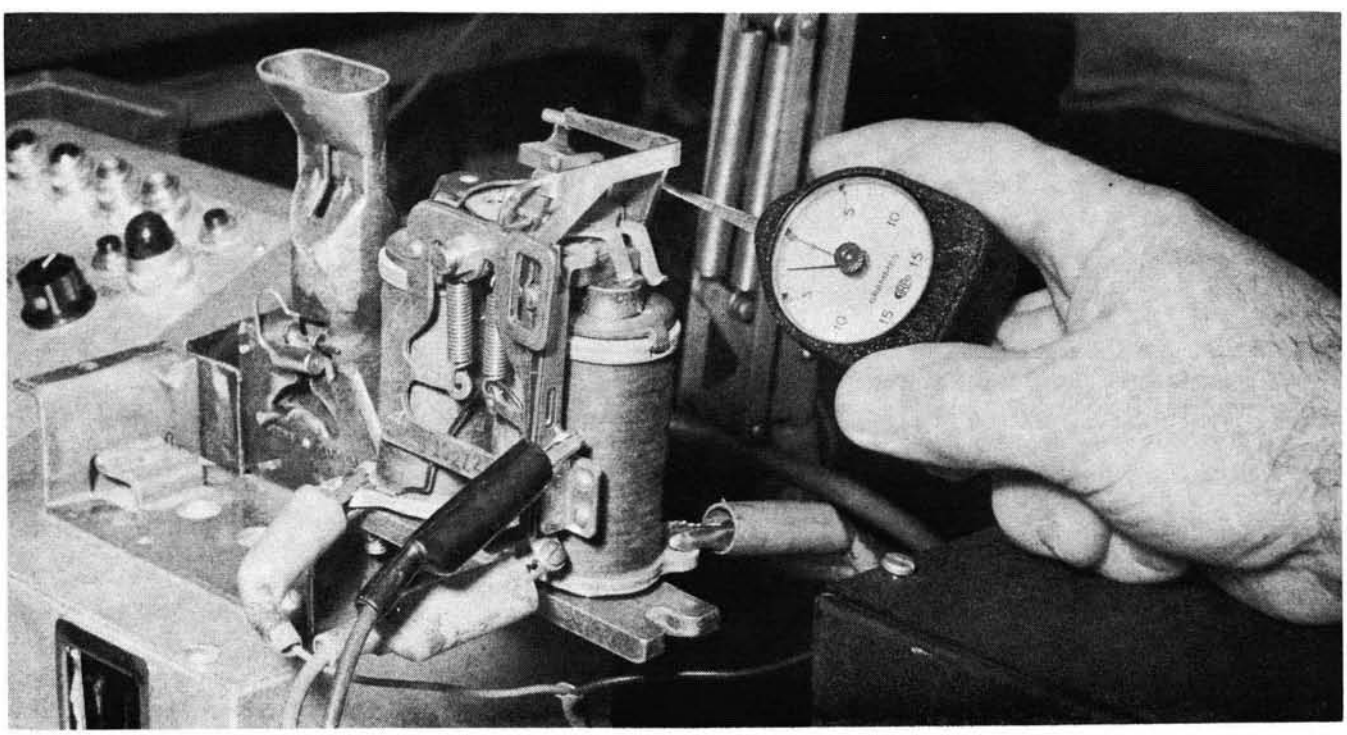
Maintenance of the two-coil relay, and indeed all coin control relays, requires the use of precision tools. Heavy duty spring bender, small screwdriver, inspection mirror, burnishing tool, set of thickness gauges, crocus cloth, gram gauge (see Figure 3), light duty spring bender, duckbill pliers and special feeler gauges are some of the items required.

The number and types of tools will be identified in the appropriate shop procedure devoted to the repair of coin control relays, and personal copies of this as well as other paystation repair instructions should be maintained by each of the employes assigned to the paystation repair section.

Clean it, keep it clean

All prepay coin control relays that have been returned from field service should be completely dismantled and thoroughly cleaned. Ideally, the disassembled relay parts should be reassembled in their original operating positions; this applies partic-

Fig. 3 Checking operating gram tension of coin trigger.



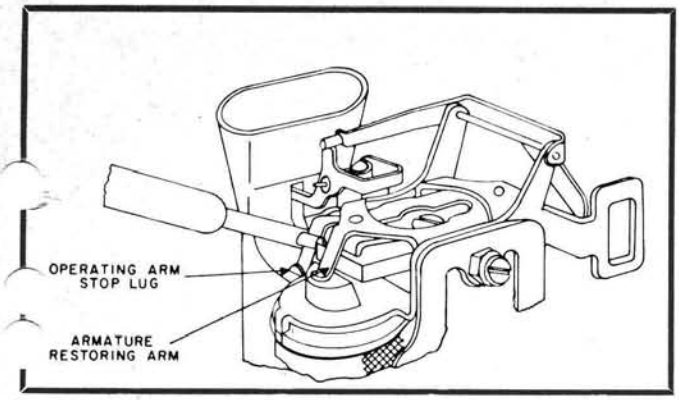


Fig. 7 Adjusting coin relay operating arm stop lug for proper clearance.

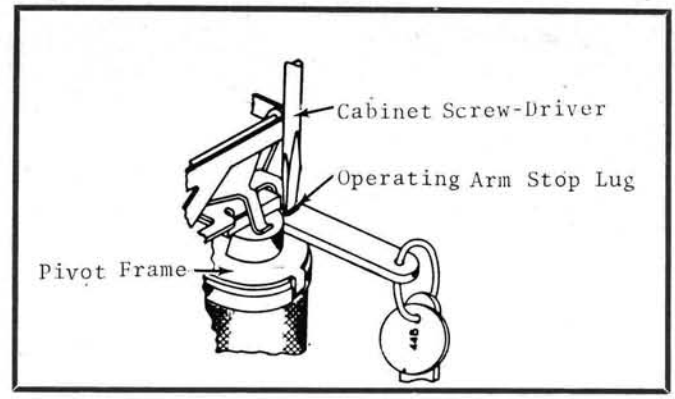


Fig. 8 Using gauge and screw-driver to check and adjust armature operating travel.

bent as required to obtain the quired clearance.

When mounted within an in-rument, the relay operating arm fork must bring the coin vane to a vertical position such that it may be seen through the center hole of the coin trap; this adjustment may be met by sliding the relay assembly right or left, as required. When the coin relay is installed in a paystation instrument, the positioning of the vane at the mid-point of the enter hole of the coin trap *is tically important.* The displacement of the coin vane even slightly to either side, gives the coin relay a mechanical bias whenever coins are deposited. This can produce the same type of malfunction as is produced by improper adjustment of the clearance between the core faces and the armature restoring arms. Thus, it is apparent that a multiplicity of adjustments af-cts the two-coil coin relay as-mbly and that optimum performance is obtained only by observing each individual requirement, and assuring that proper limits are satisfied.

In addition to these, there are other mechanical adjustments that are equally important to the isfactory disposal of deposited coins. For example, the relay armature is required to operate electrical contacts to permit a mber to be dialed as well as to establish a circuit for the ultimate disposal of deposited coins. Adjustment of the coin trigger and its related switch lever combine to assure that these requirements are met. Checks must also be made to ascertain that proper clearance conditions exist between the trigger lever and the operating arm and that the spring tension present in the contact assembly is within the range necessary to permit proper operation under the condition of a single 10-cent deposit. The coin trigger must be free of binds about its bearing pin and possess a side play of .005 inches as gauged by eye.

When installed in a coin telephone set, the coin trigger must trip under a maximum load of 5 grams applied midway between the hopper and the coin relay assembly. With the coin trigger in a *tripped* condition, gradually lifting the switch lever from the trigger cam should cause the trigger to restore to normal. With the coin trigger tripped and the operating arm operated to the refund position, the coin trigger lever is adjusted to permit the trigger to restore with a .015 inch gauge under the operated stop lug and not restore with a .030 inch gauge under the lug. This test is repeated on the collect side and the adjustment of this tolerance is illustrated in Figure 8.

It was stated earlier that the coin relay contains switching elements to enforce coin deposit as well as provide an operating path for the relay itself. These contacts are normally adjusted in connection with the establishment of coin trigger operating parameters. The mechanical positioning of the contacts, the application of required spring tension (under both normal and tripped coin trigger conditions) and the movement of the nylon roller that actuates the contacts must be attended to. To avoid upsetting the mechanical balance of the relay assembly, the manufacturer's adjustment specifications must be strictly followed.

Relay test and final adjustment

While the two-coil coin relay may be brought to a close approximation of its optimum operating point by adjustments applied outside the telephone set, it is important to note that *final adjustments should be applied while the relay is mounted within a paystation instrument.* It has been found that the magnetic flux established by the current flowing through the relay coils is disturbed by the metallic structure of the paystation upper housing. For this reason, a relay that appears to function properly with the upper housing removed may fail to refund or collect with the upper housing in place.

The final adjustment of the coin relay requires the provision of a rather simple piece of test apparatus. Supplied by a suitable power source of stable direct current, the test set must be capable of applying the required operate, non-operate and release

play of a properly adjusted relay will fall in the range of .002 to .005 inches.

After these checks, the armature restoring springs are installed. A check is then made to determine that the armature spacing between the respective coil pole faces is within limits. The gaps between the armature ends and the collect and refund cores should be equal as gauged visually. At the same time, the end of the armature should line up with the respective cores. Minor deviations may be corrected by loosening the two small screws on top of the armature bearing saddle and turning the center cam screw in the proper direction. Be sure to retighten the two small lock screws after making this adjustment. If the armature cannot be satisfactorily repositioned as just described, it will be necessary to replace either the armature or coil pole pieces.

With the proper armature-to-coil core spacing established, a check is made to determine that the armature *lines up* with the cores. Armature alignment errors are corrected by loosening the locking nuts on the armature pivot screws and simultaneously adjusting front and rear pivots to move the armature in the required direction. When making this adjustment, the proper amount of armature side play must be maintained as discussed earlier in this article.

With the armature properly positioned within the relay frame, a series of checks and adjustments is required to establish the conditions necessary for optimum coin relay performance. These include the adjustment of the gap between the armature and its stops on the operating arms and the adjustment of the restoring arms and their relationship to the two core faces. In the case of the former, the gap should be in the range of .007 to .020 inches as measured individually with all the play

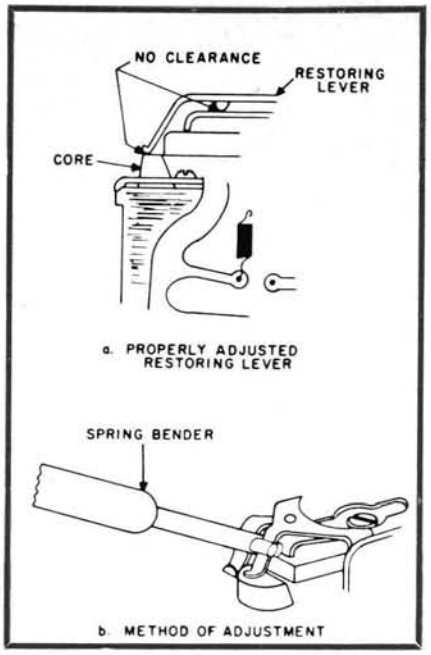


Fig. 6 The clearance adjustment is highly critical.

taken up from the opposite gap, while the latter adjustment specifies *no clearance* between the restoring arms and coil cores and between the operating arms and restoring arms. (See Figure 6). With respect to the clearance between operating arm and armature stop lug and the armature, the clearance should be in the range of .010 to .020 inches with all the play taken up from the opposite gap. This requirement is met by bending the armature stop as close as possible to its point of contact.

Of all the adjustments thus far described, the *no clearance* requirement shown in Figure 6 is perhaps the most important. Lack of attention to this seemingly minor adjustment has been the cause of many coin relay failures in the field. What happens is that *money is collected when it should have been refunded.* Detailed analysis of the relays involved showed that there was clearance between the armature restoring arm and the relay coil cores and, under the influence of the mechanical bias of a coin load, imparted the necessary movement to make proper relay operation marginal. That is, under the indicated conditions, application of a refund signal collected the deposited coins instead of refunding them, because the mechanical and electrical relationships of the coin relay favored the undesired mode of operation. This particular adjustment, as well as another to be described later concerning coin relay installation, deserves great emphasis during the apprenticeship phase of coin relay maintenance personnel.

Operating arm travel is next determined by adjusting the operating arm stop lug as shown in Figure 7. In its normal position, the clearance should be from .125 to .133 inches. This adjustment establishes the proper displacement of the coin vane in the coin hopper under collect and refund conditions. The stop lug is

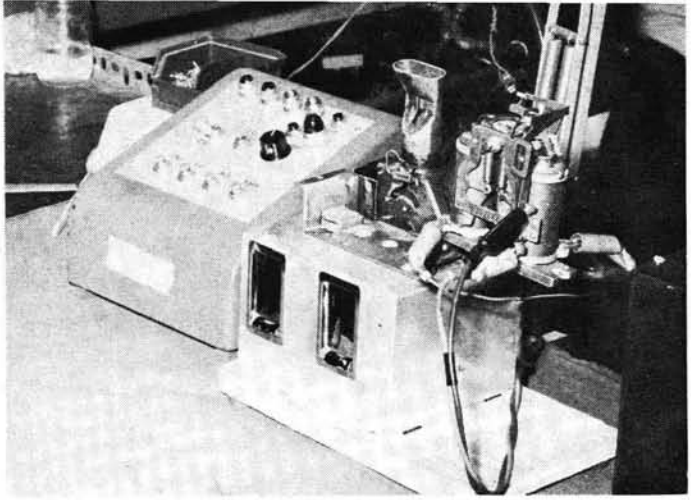


Fig. 9 This test set used in final adjustment of the coin relay was constructed by a telephone repair center.

current values to the coin relay. At the same time, the test device is required to provide a *soak current* of opposite polarity to certain of the required tests. Figure 9 illustrates a unit constructed by a repair center for satisfying the foregoing requirements.

While undergoing final testing, the coin relay is subjected to both mechanical and electrical exercises. For example, a check is made to determine that the relay will collect or refund a single dime (of minimum weight) as well as a coin load of 11 nickels. The relay must dispose of the coins whenever 56.8 milliamperes of current are applied immediately following operation of the armature in the reverse direction by the 120 milliampere soak current. This requirement is met by adjusting the tension of the armature restoring springs and establishes the operate value of the coin relay.

The non-operate value test is performed next. In this test, 42.2 milliamperes are applied to the coin relay. While the current is flowing, 11 nickels are deposited and proper performance is observed if the coins are retained within the coin hopper. This test is made for both collect and refund conditions. In the unlikely event that the armature operates, a check is made to determine that the coin vane is visible and bisects the center hole of the coin trap. If it does, the armature restoring springs may have to be readjusted slightly. In this event, the operate value of the relay must be retested.

A final electrical test verifies the release point of the coin relay. A current of 120 milliamperes is applied to the coin relay and then slowly reduced to 29.4 milliamperes without an interruption; at 29.4 milliamperes, the armature must restore to normal.

Study the manual

Although this and the preceding article have explored in reasonable detail paystation equipment maintenance, these two articles are by no means intended to supplant the existing manufacturer's adjustment instructions or repair shop procedures on this subject. Nevertheless the uninformed reader should, from a reading of the two articles, gain a better understanding of the problems confronting those who service not only the paystation instruments, but also the coin relays. It should be evident that repair personnel assigned to servicing paystation equipment require intensive training. Comprehensive training procedures together with supervised practical experience in cleaning, repairing and adjusting paystation sets will develop the technical competence required to assure the production of uniformly high quality telephone equipment by the repair center. □

(The next article in this series will cover the maintenance of key telephone sets and systems.)