

TELEPHONE READING COURSE
ON

**STEP-BY-STEP
DIAL SYSTEM**

CENTRAL OFFICE EQUIPMENT

SECTION 2

PART I

MECHANICAL ADJUSTMENTS

OF

**STEP-BY-STEP
DIAL SYSTEM
EQUIPMENT**

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STEP-BY-STEP MECHANICAL ADJUSTMENTS

Good telephone service depends upon a great many things all of which are essential in the sense that, should any one be omitted, either service could not be given at all or its quality would be impaired.

Among these things there are two of vital importance with which this course is chiefly concerned; namely, the correct design, manufacture and installation of the mechanism herein described; and the mechanical and electrical adjustments necessary to the faithful performance of their assigned functions.

Design, manufacture, and installation are terminable proceedings; but maintenance continues as long as the mechanism remains in service.

The maintenance of any modern telephone office, with its vast numbers of relays, switches and other pieces of apparatus operating on small amounts of energy and on close margins, is very largely a matter of mechanical adjustment.

When telephone mechanism was in a less advanced stage of development the adjustments were determined by the experience of the maintenance men; and the practices in any office depended almost entirely upon the skill and resourcefulness of the one in charge.

Gradually as design and manufacture advanced, as more precise performance became possible, as more thought was given to adjustment problems, and as more knowledge of correct procedure became available, adjustment procedures became an exact science.

Today the vast experience of the older maintenance men who had to devise their own methods and learned much by the trial and error process, supplemented by the contributions of laboratory and operating engineers has been preserved in print and is available to all in the Bell System whose work requires it.

This information is issued under the name of **Bell System Maintenance Practices—Central Offices** and is most specific.

These practices describe what are considered the most effective methods and procedures for maintaining central office equipment operating under standard conditions.

Bell
System
Maintenance
Practices

These practices already include an enormous amount of information essential to the installers and maintenance men and additions and revisions to keep pace with the rapid advance in the telephone art are being made constantly. The aim is to have them ultimately comprise all the latest information needed for the maintenance of standard equipment, and to have each central office supplied with such portions of these Practices as are needed by the plant men in that office.

All our present step-by-step offices are now well supplied with this information and each new office as it is made ready for service will be equally well supplied. A definite routine is in operation for keeping this information up to date.

Indexing
of
Information

The indexing of this information is of great importance; for, it is evident, should a switchman want to know how much tension to put on a particular set of contact springs on any one of the numerous kinds of relays in his office, or what clearance to provide between the vertical teeth and the vertical pawl on a certain selector, the rapidity with which he can get that information largely determines its value to him.

Manifestly, it is impracticable to include in this section the information contained in the Practices, but an outline of how they are made up and an illustration of how a switchman might go about getting the facts as to the adjustment of a selector, for example, are included for such help as it may prove to be to students of this course.

A description of the Bell System Maintenance Practices is given in Section 101.001, a description of Division 400

is given in Section 101.004, and the Plan for issuing them is given in Section 102.001.

These three sections are reproduced herein in their entirety because it is desirable to have these facts freely available to all interested in maintenance work.

**BELL SYSTEM MAINTENANCE PRACTICES
DESCRIPTION AND STRUCTURE
SECTION 101.001**

1. GENERAL:

- 1.1 The practices included under the general title, "Bell System Maintenance Practices—Central Offices," are descriptive of what are considered the most effective methods and procedures for maintaining central office equipment operating under standard conditions.
- 1.2 They are prepared primarily to serve as a working manual for the forces on the job who are directly responsible for the maintenance of equipment, and it is intended that these practices together with the supplementary Bell System central office maintenance information described in other sections, will include ultimately all the maintenance information required by these forces.
- 1.3 The plan provides uniform and definitely located information for use throughout the System, and the effective application of these standard practices will aid materially in the furnishing of satisfactory service at minimum cost. The general use of standard maintenance practices should tend also to establish uniform educational programs.
- 1.4 In the adoption of a plan which would provide the desired uniformity, the required flexibility was also kept in mind. Therefore provision was made for the inclusion of special practices required by local companies as well as for future practices which may be required by the development of new equipment.
- 1.5 "Bell System Maintenance Practices—Central Offices" are divided at present into eight major divisions as follows:

100—General.

200—Routine Tests and Inspections.

300—Operating Methods and Non-Periodic Routines.

400—Apparatus Requirements and Adjusting Procedures.

500—Methods of Performing Various Work Items.

600—General Troubles.

700—Description of Testing Equipment and Tools.

800—Educational Information.

2. DIVISION 100—GENERAL:

2.1 Division 100, "General", deals with the description, scope and structure of the plan and other items of a general nature. The various indices are also included in this division.

3. DIVISION 200—ROUTINE TESTS AND INSPECTIONS:

3.1 Division 200, "Routine Tests and Inspections", includes those sections which describe the procedures to be followed in the performance of routine tests and inspections which may be scheduled at certain frequencies. This information is grouped according to types of offices except for those items which are common to all offices and which are grouped in separate subdivisions.

3.2 It is expected that this division will be used as a working manual by experienced men, and also as information which can be used in the instruction of new men not familiar with the routine tests and inspections.

3.3 The index of this division provides a means for scheduling of routines; in some cases the tests and inspections have been further subdivided

below the section number into parts designated alphabetically in order to facilitate the scheduling of particular parts of a routine where it is desirable to make only a part of the test or inspection at one time.

4. DIVISION 300—OPERATING METHODS AND NON-PERIODIC ROUTINES:

- 4.1 Division 300, "Operating Methods and Non-Periodic Routines", covers operating routines and other practices associated with the day by day activities of the plant forces, such as the following:

Operation of Power Plant.
Interdepartmental Routines.
Emergency Routines.
Operation of Plant Desks.
Records and Reports.
Main Frame Protection Practices.

5. DIVISION 400—APPARATUS REQUIREMENTS AND ADJUSTING PROCEDURES:

- 5.1 Division 400, "Apparatus Requirements and Adjusting Procedures", includes those sections which cover the requirements and adjusting procedures for the various types of adjustable central office apparatus. This division is described in detail in Section 101.004.

6. DIVISION 500—METHODS OF PERFORMING VARIOUS WORK ITEMS:

- 6.1 Division 500, "Methods of Performing Various Work Items", deals with methods of performing work such as running cross-connections on distributing frames, soldering, repairing switch-board cords, etc.
- 6.2 Information covering piece parts data and replacement procedures for central office apparatus are included in this division.

7. DIVISION 600—GENERAL TROUBLES:

7.1 Division 600, "General Troubles", describes certain typical troubles and approved methods for locating and clearing such troubles.

8. DIVISION 700—DESCRIPTION OF TESTING EQUIPMENT AND TOOLS:

8.1 Division 700, "Description of Testing Equipment and Tools", includes descriptive and educational information on standard testing equipment, testing circuits, tools and gauges.

9. DIVISION 800—EDUCATIONAL INFORMATION:

9.1 Division 800, "Educational Information", includes sections descriptive of various systems and apparatus, and also other fundamental information considered essential in the training of central office forces.

**BELL SYSTEM MAINTENANCE PRACTICES
DESCRIPTION AND STRUCTURE OF
DIVISION 400, SECTION 101.004**

1. GENERAL:

- 1.1 This section covers general information regarding the structure and application of sections in Division 400 of the Bell System Maintenance Practices—Central Offices.
- 1.2 Division 400 entitled, "Apparatus Requirements and Adjusting Procedures" includes the mechanical requirements and adjusting procedures for adjustable central office apparatus. Electrical requirements for certain types of apparatus are also given in Division 400, although the majority of such requirements are given in circuit requirement tables.
- 1.3 General requirements and definitions which, unless otherwise specified, apply to all sections of Division 400, are covered in Section 400.001.
- 1.4 Prior to January 1, 1929, much of the information included in Division 400 was covered by X-Specifications in the 70,000 to 72,499 series. A description of these specifications is given in Section 105.001.
- 1.5 A checking list for Division 400 is provided in Section 128.004. In this list the corresponding X-Specification number will be listed until the second issue of the checking list after the X-Specification has been re-issued as a Bell System Maintenance Practice. A cross reference list is contained in Section 400.002.

2. INDIVIDUAL APPARATUS:

- 2.1 The requirements and adjusting procedures for individual pieces of adjustable apparatus are covered in subdivisions 401. to 489.

- 2.2 Each section of this series is usually divided into three parts, namely, Part 1—General, Part 2—Requirements and Part 3—Adjusting Procedures.
- 2.3 Part 1—General, of each section covers definitions and general information essential to the proper application of the requirements and adjusting procedures covered by the section.
- 2.4 Part 2—Requirements, of each section covers the requirements which are used in checking the apparatus prior to and at the time of turn-over as well as for current maintenance activities. The application of these requirements is more fully covered in Section 400.001.
- 2.5 Part 3—Adjusting Procedures, of each section covers the adjusting procedures which are provided for the guidance of the maintenance forces in adjusting the apparatus to meet the readjust requirements specified in Part 2 of each section. Lists of tools, gauges and materials are included with the adjusting procedures.
- 2.6 When sections in the 401. to 489. series are re-issued, the changes which have been made in requirements are listed under "Reason for Reissue" at the end of each part that has been changed.
- 2.7 Sections in the 401. to 489. series of Division 400 have a letter associated as a suffix to the issue number, which indicates the basis of application. The letters A, AR, B and D are used for this purpose. This change classification is intended primarily to advise the installer regarding the basis of application of new requirements and methods and is also useful in giving the maintenance forces an idea of the importance of any change that is made. The

interpretation of the letters indicating the basis of application of any section is the same as that given for standard drawings in Part 3 of Section 105.001. In case changes of more than one class are included in a re-issue, the particular change classification letter applying to each item is indicated at the end of each item under "Reason for Reissue."

- 2.8 Associated with the issue number of each section in the 401. to 489. series, one of the following ratings is given: "Provisional", "Provisional Standard", or "Standard." These ratings correspond to those given standard drawings.
- 2.9 Provisional and provisional standard issues are issued on yellow paper unless the new issue supplements an existing standard section in which case the new information is considered as an addendum and is issued on pink paper. All standard sections are issued on white paper.
- 2.10 In general, all changes made in requirements or methods, tools and testing equipment are the result of extended study and experience in the field and represent desirable improvements. Therefore, it is expected that only the latest issues of sections in Division 400, will be used for maintenance purposes and accordingly no superseded issues are kept in stock.

3. ADJUSTMENT BY TYPES OF CIRCUITS:

- 3.1 In order to cover cases where a testing and adjusting procedure for adjustable apparatus has been set up on the basis of a uniform procedure for a class of apparatus such as supervisory relays in "A" operators' cord circuits in a No. 1 office, subdivisions 490. to 498. have been allotted to requirements and procedures for adjustment of such apparatus by types of circuits.

- 3.2 Sections in this part of Division 400 have a slightly different arrangement than those described in Part 2 of this section, and since the installer is not affected by these sections, the issue letter covering the basis of application and the rating are omitted. The color of paper used and the manner of reissuing these sections is the same as for the sections in other divisions of the Bell System Maintenance Practices.
 - 3.3 In some cases, it has been found desirable to give electrical values in this series due to the impracticability of changing all circuit requirement tables and BT sheets which are in use in the field.
4. ASSOCIATED COMPANY APPARATUS:
 - 4.1 Subdivision 499. has been reserved for requirements and adjusting procedures for non-standard apparatus or for special conditions where due to local conditions the standard requirements and methods cannot be used. The information in this subdivision is usually prepared by the local telephone company in whatever form appears to be desirable. (See Section 102.101.)

PLAN FOR ISSUING BELL SYSTEM MAINTENANCE PRACTICES—CENTRAL OFFICES
SECTION 102.001

GENERAL:

The plan under which "Bell System Maintenance Practices—Central Offices" will be made available to the field, provides for a flexible arrangement, with respect to binding, in order to meet the widely varying requirements of each office or individual.

Under this arrangement the sections may be selected and bound so as best to meet these requirements for general reference, supervisory or functional maintenance purposes.

Volumes of "Practices" issued to supervisory forces should contain, in addition to the sections of general nature which constitute Division 100, all sections contained in Divisions 200 to 800, inclusive, which relate to the types of equipment and apparatus under their charge. On the other hand, volumes which are prepared for functional use, such as routine testing, apparatus adjustment, test board operation, etc., would ordinarily contain only such sections as apply to these particular functions.

In addition to the volumes provided to meet the supervisory and functional requirements in the larger offices, one or more complete volumes comprising all of Division 100, and all sections of the other divisions relating to the types of equipment and apparatus contained in such offices, may be required for general reference purposes by the exchanging forces.

It is further expected that volumes constituting a complete file of all sections of "Bell System Maintenance Practices—Central Offices" which relate to the types of apparatus and equipment involved, will be provided to meet the requirements for general refer-

ence purposes in the General, Division and District Offices of each Associated Company.

RESPONSIBILITY FOR ISSUANCE AND REVISION:

"Bell System Maintenance Practices—Central Offices" are issued by the American Telephone and Telegraph Company, Department of Operation and Engineering.

Revised sections will be issued in the same manner as that employed for initial sections. Checking lists will be forwarded to each Associated Company from time to time, which will indicate the status of each section issued.

SIZE, COLOR SCHEME AND BINDING:

Sections of "Bell System Maintenance Practices—Central Offices" are furnished in loose-leaf form printed on white paper, size 8½ inches by 11 inches. The back edge is suitably perforated to facilitate binding in the approved cover available for this purpose.

This cover, which should be provided for each group or volume of sections, is designed so as to facilitate the addition, replacement or rearrangement of the subject matter. It is sufficiently rugged to withstand the wear which will ordinarily be encountered in connection with maintenance use.

The title appears on the front cover and also on the back edge of the binder, which is also arranged for marking to designate volume number and range of section numbers contained therein when this is desirable.

NUMBERING PLAN:

"Bell System Maintenance Practices—Central Offices" are divided into major divisions numbered consecutively from 100 to 800. If found necessary, other divisions will be added later.

Each division, in turn, is further divided into subdivisions for the purpose of grouping sections together with respect to their character, or reference to types of equipment, apparatus or other classifications.

A six digit scheme is used for numbering the individual sections, which permits the assignment of different section numbers up to 100,000 items in each major division. Each section number is composed of six digits, ciphers being used where other digits are not required. The first three digits are separated from the last three digits by a decimal point to facilitate reading and also to divide the subdivision number, as indicated by the first three digits, from the detailed section number.

In the grouping of subdivisions and sections, in Divisions 200, 300, 500, 600, 700 and 800, as will be noted by reference to the numerical index, the first 11 subdivisions of each division have been assigned to equipment common to all offices, while subdivisions -12. to -98. have been assigned or are subject to assignment to equipment peculiar to particular offices.

The last one thousand numbers in each division are reserved for use by the Associated Company in assigning section numbers covering practices of local character on subjects or types of equipment which will not be covered by "Bell System Maintenance Practices—Central Offices."

The subdivisions and sections in Division 400 are grouped, with a few exceptions, according to types of apparatus. Exceptions are necessary to take care of certain apparatus requiring test set preparation, or procedures peculiar to the circuit arrangement of the apparatus; these cases are grouped according to circuits in the series of numbers 490.001 to 490.999.

DISTRIBUTION AND REPLACEMENTS:

"Bell System Maintenance Practices—Central Offices" are stocked by the Western Electric Company and may be obtained from the Branch Houses on requisition by specifying the desired section numbers in full.

It will be necessary for each Associated Company to place in effect a plan which will insure distribution and upkeep of the proper sections to the various types of offices. Checking lists of the sections in force should be provided for the field forces from time to time in order to provide for the replacement of obsolete sections and to insure that the latest issues are being used in every case.

Illustration of how to use

Suppose that a switchman in a step-by-step office wants to know the adjusting requirements for a No. 197 type connector, for an A. E. Co. secondary line switch and for a No. 225 type W. E. Co. relay; and let us make a further assumption that he is showing a new man how to get this information from the Practices.

Says the switchman: "Here is Section 101.001 and under **Division 100-General** par 2.1 the last sentence tells you that the various indices are also included in this division."

"Looking through Division 100 we find Section 127.101 **Index—Step-by-Step Offices**, which you see contains the names of many pieces of apparatus—apparently all that would apt to be in any step-by-step office—and in addition the names of certain tools, test sets, and tests all arranged in alphabetical order."

How to
Find the
Informa-
tion

"Under C we find 'Connector operation tests' but none of the items listed there are what we are after; but under 'Connectors' we find 'requirements' and under that 'No. 197-100 point' which refers us to section 477.002 for further information."

"Turning to Section 477.002 we find that it bears this section number all right but its original designation is R. A. P. X-70053-01 Issue 2-D."

"Now," continues the switchman, "if the information we are seeking is found in this X-specification and it is, we need not at present enquire into the reason for giving it a Section number, but when you do get time look at Section 105.001 which will give you many useful facts concerning X-Specification, Circuit Schematics, Circuit Requirement Tables, and Circuit Description sheets."

"After that you may examine Section 128.004 called a Checking List, which gives, in numerical order, all the present Section numbers from 400.001 to 491.603 and the X-specifications with their titles that have been given these Section numbers."

"Returning to Section 477.002 you have here many pages of printed matter and remarkably clear illustrations covering every detail of adjustment on all parts of 197 and 198 type switches. All the tools required are listed and many illustrations are given showing just how to use some of these tools."

"Of course," adds the switchman, "you must make those adjustments yourself again and again before you will become a competent switchman. You can't get everything out of books."

"You may think that your eyesight is good now but later on you will be amused at the many things in this switch that you looked at but didn't see. That's training."

Expe-
rience
Essential

"That shaft 'feels' all right to you now but it isn't right enough to give service."

"Your muscles may be just right to pitch a baseball but they need further adjustment to handle a gram gauge or a spring bender. That's more training, all of which you will have to give yourself."

"Books will help you some, as this Section will, and I may show you from time to time what to do and maybe help you to keep from getting rattled, but the real vital part you will supply yourself."

"One thing more," pursued the switchman, "don't let anyone spoof you about absolute accuracy to be attained in getting the clearance and spring tensions given in these requirements."

"In the first place the requirements are given as **limits**, not as absolute distances or pressures, for the excellent reason that it is not practical to get precisely a clearance of .010 inches between the rotary dog, for example, and the radial face of a tooth on a shaft hub, but it is relatively easy to make this clearance somewhere between .005 inches and .022 inches."

"On sheet 4, Requirement 3.13 gives those limits; minimum .005 inches, maximum .022 inches, which means

not less than .005 inches and not more than .022 inches. It further tells you the gauge to use."

"In another place on this same sheet (Rq. 3.11) a dimension of not more than .003 inches is given, adding 'gauge by eye and feel'."

"You will find the same thought throughout these X-specifications and throughout all the requirements in the Practices."

"They specify limits which it is practicable to work to. They are precise and specific in their wording as they need to be but not arbitrary; but they would be valueless without the skill, judgment and common sense of those who use them."

In a similar way the switchman pointed out that Section 127.101 lists "Line Switches" and a sub-listing of "requirements" which refers one to Section 478.002. The latter is found to be the new designation for Specifications X-70029-02 Issue 1.

Likewise under "Relay requirements W. E. Co., Type No. 225" is found a reference to Section 460.030 which was formerly R. A. P. X-70105-01 Issue 2-0.

"That's fine," said the new man, "I think I understand, but I want to be sure about these limits."

"Going back to the rotary dog for example and supposing that I am making the adjustment, should I call it OK if I get just above the lower limit .006 for instance or .021 which is just under the upper limit?"

"You would be strictly within requirements," replied the switchman, "but you should remember that we want to make this adjustment so that it will last for a long time; hence, getting about half-way between the limits given will increase the probability of the adjustment remaining within the limits longer than it would if we get only just over the line above or below; and this applies with equal force to every adjustment given whether it concerns a switch or a relay or any other piece of apparatus."

"Don't forget maintenance costs," continued the switchman, "and make your adjustments so that you will not have to come back and do them over in a little while."

QUESTIONS

1. What does "maintenance" mean to you with reference to telephone equipment?
2. Why are adjustment requirements given as limits rather than some one definite value?
3. Explain briefly the contents of Division 400 of the Bell System Maintenance practices.
4. What is the number of the section which gives the requirements and procedure for adjusting No. 200 type selectors? Also give the X-specification number by which this section was previously designated.
5. What are the limits of the tension requirements for the retaining pawl of a 200 type selector and what other requirement is gauged by eye?
6. In what section of Bell System Maintenance Practices would you find the requirements for adjusting primary or secondary line switches?
7. When readjusting a No. 105 type key, what gauge is used for testing the pressure between closed contact and what is the minimum contact pressure?
8. What is the requirement for contact alignment of 206 type relays?
9. What should the minimum contact separation be between a pair of contacts which are normally open on a 122 type relay?
10. How are most of the adjusting requirements for No. 197 and 198 type Selector and Connector switches gauged?