Handbook of Electrical Systems Design Practices

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Preface

The ability of those involved in the construction and design of electrical systems for buildings to quickly and accurately transmit technical information through the preparation and interpretation of working drawings and written specifications is vital to the development, construction, and use of such systems.

Ideally, electrical contractors should be able to bid and construct any building's electrical system from the information furnished by the architect or engineer with no further questions concerning dimensions, materials, or the slightest detail in construction. To help make this possible, certain contract documents are necessary:

Specifications: Specifications describe the work to be done, the method of construction, the standard of workmanship, the manner of conducting the work, and the quality of materials and equipment to be used.

Floor Plans: A floor plan represents a cut horizontally through a building at approximately eye level showing the view from above. A separate drawing is made for each floor and the basement. Such plans show the arrangements and locations of walls, partitions, doors, windows, stairways, and all electrical equipment drawn to scale (where possible) using appropriate graphic symbols such as the ones covered in Chapter 2.

Elevations and Sections: Elevations are drawings of head-on vertical views of a building or equipment in a single plane. Sections are sliced open views of an area to reveal construction arrangements which can not be shown by conventional elevation or plan views.

Details: Although all parts of a building's electrical system are usually described in floor plans, elevations, sections, and written specifications, certain construction conditions cannot be adequately shown in the scale in which these drawings are usually made. Therefore, larger-scaled drawings must be made of such items or areas to ensure the necessary information for proper construction. These are termed special or large-scale electrical detail drawings and are found in nearly every set of electrical working drawings.

This volume provides practical electrical details taken from actual working drawings that have been used on a variety of projects for the past decade. All of the details, therefore, have been tried and proven to be useful to electrical designers and contractors.

After the first two introductory chapters, the remaining ones have been arranged in order of the CSI (Construction Specifications Institute, Inc.) Format for easy use by engineering firms, contractors, students, and others in the building construction field who need to provide or interpret accurate construction drawings.

Electrical engineers will find daily use for this book in preparing working drawings that are easily interpreted by the workmen on the job; electrical draftspersons should find it extremely helpful as a desk reference; electrical contractors and workmen will want to refer to the various details for solving installation problems which are constantly developing in their work; while various trade apprentice and student electrical engineers and technicians will find the details invaluable when used in conjunction with theory text books to better visualize actual installations.

I would like to express my appreciation to the many well-qualified persons who have been most helpful to me during the preparation of this book.

John E. Traister

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1

Branch-Circuit Wiring

The data included in this chapter have been grouped under the heading "branch-circuit wiring," which includes the installation of electrical outlets and related wiring size No. 10 AWG and/or 1-in. conduit (or equivalent) and under. Control and communication details appear in Chapter 5. The electrical details will cover such items as work-installation-plan study and layout, actual fabrication and assembly of branch-circuit outlets, and other directly related activities.

1.1 *CONCEALED OUTLET BOX IN SOLID WOOD DECK*

It is often desirable to conceal outlet boxes and related wiring in a solid wood deck or ceiling. Figure 1-1 shows one solution to the problem, and a detail of this sort should appear on working drawings to provide detailed supplementary instruction to both the electrical estimator bidding on the project and the electrician installing the system.

With such a detail, experienced electricians will know that immediately after the wood decking has been installed, all required outlets will be located and marked. A 4⅛-in. hole saw is used to drill through the wood deck at each outlet location. A 4-in. octagonal outlet box with an extension ring is inserted in the opening, flush with the underside of the deck. Branch-circuit conduits feeding each box are strapped against the

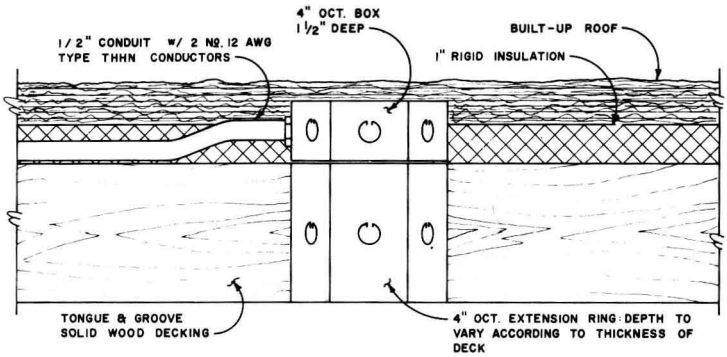

Figure 1-1 Detail of a concealed outlet box in solid wood deck.

wood decking to support the box. However, if only one conduit enters the box (the last outlet on the circuit), a piece of "dummy" conduit about 12 in. long should be connected to the outlet box to provide support for the box on two sides. THHN conductors should be pulled in the conduit, because of the high temperatures expected on the roof from direct sunlight.

When the raceway system is completed, the roofing contractor will install the rigid insulation—leaving channels for the conduit—and then proceed with the built-up roof.

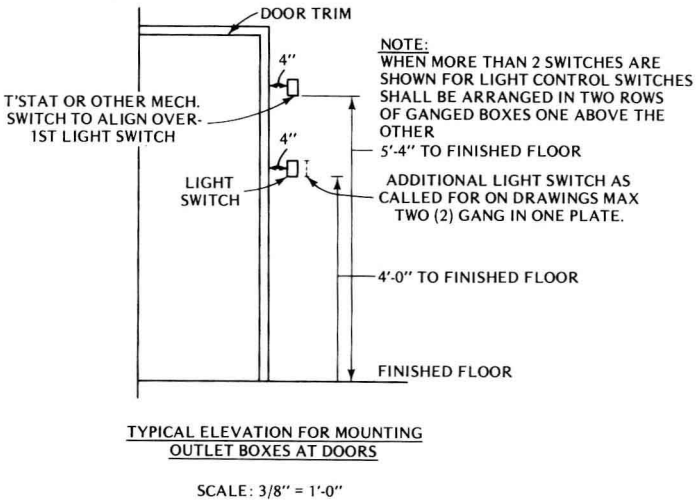

Figure 1-2 Electrical detail showing mounting height of outlet boxes.

1.2 MOUNTING ELEVATIONS FOR OUTLET BOXES

The mounting height of wall outlets is sometimes indicated in the symbol list (legend). For example: ". . . wall switches to be mounted 4′–0″ above finished floor to center of outlet box unless otherwise indicated." However, an electrical detail such as the one shown in Figure 1-2 is often more desirable when conveying the information on working drawings, especially where most of the outlets are to be mounted at one height. If a few of the switches are to be mounted at a different height from that shown in the detail, they can be shown as indicated in Figure 1-3.

The "Typical Elevation for Mounting Outlet Boxes at Doors" detail in Figure 1-2 not only shows the mounting height of the outlet box from the finished floor, but also gives the distances each switch box must be mounted away from the door trim. When these and other data shown in the detail are followed by the electricians on the job, a first-class installation will result.

A similar detail is shown in Figure 1-4. This drawing shows, in addition, the mounting height of duplex receptacles (regular and those above countertops), wall-mounted lighting fixture outlets, and TV and telephone outlets.

As mentioned previously, details showing the mounting height of various outlets are best used on drawings where most outlets (of the same type) are mounted at the same height.

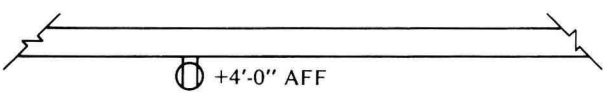

Figure 1-3 Method of showing mounting height of a few switches on working drawings.

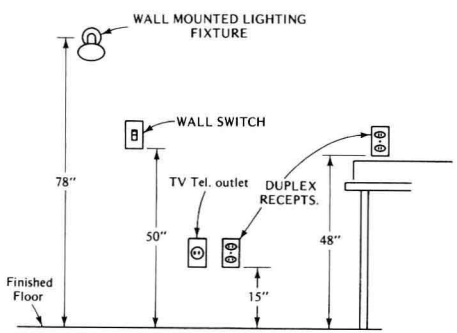

Figure 1-4 Detail showing mounting height of wall switches, receptacles, and wall mounted lighting fixtures.

1.3 SECTIONAL DETAILS

Special electrical outlets—such as the explosion-proof switch in Figure 1-5—sometime require additional installation information other than that which normally appears on conventional electrical drawings or is found in written specifications. The illustration in question shows a flush-mounted outlet box with a cover fitting against the finished tile. Therefore, a detail like the one shown will be highly beneficial to workmen roughing in the outlets, since the drawing gives a dimension of $3\frac{5}{16}$ in. from the back of the outlet box to the face of the finished tile. A note is also provided that states: "back box is recessed $\frac{7}{16}$ in. back of finished tile." With this detail, a neater installation of the finished work should result.

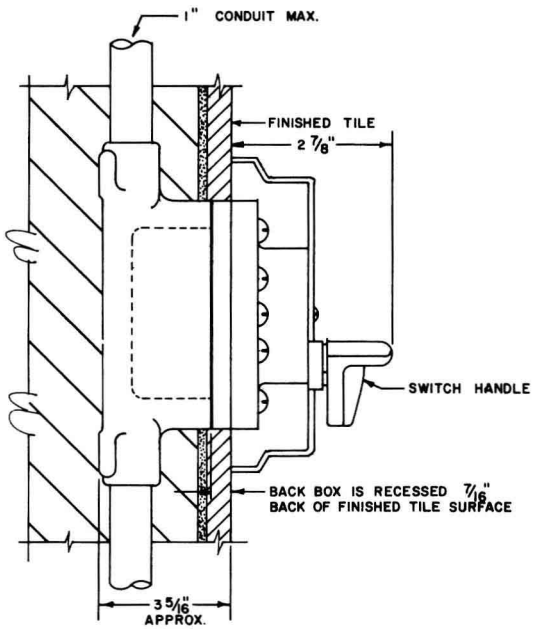

Figure 1-5 Detail of an explosion-proof switch.

1.4 OUTLET BOXES

The time involved during the roughing in of electrical branch circuits can be greatly reduced if the proper materials are utilized. The chart of outlet boxes in Figure 1-6 gives most of the types available, while the table in

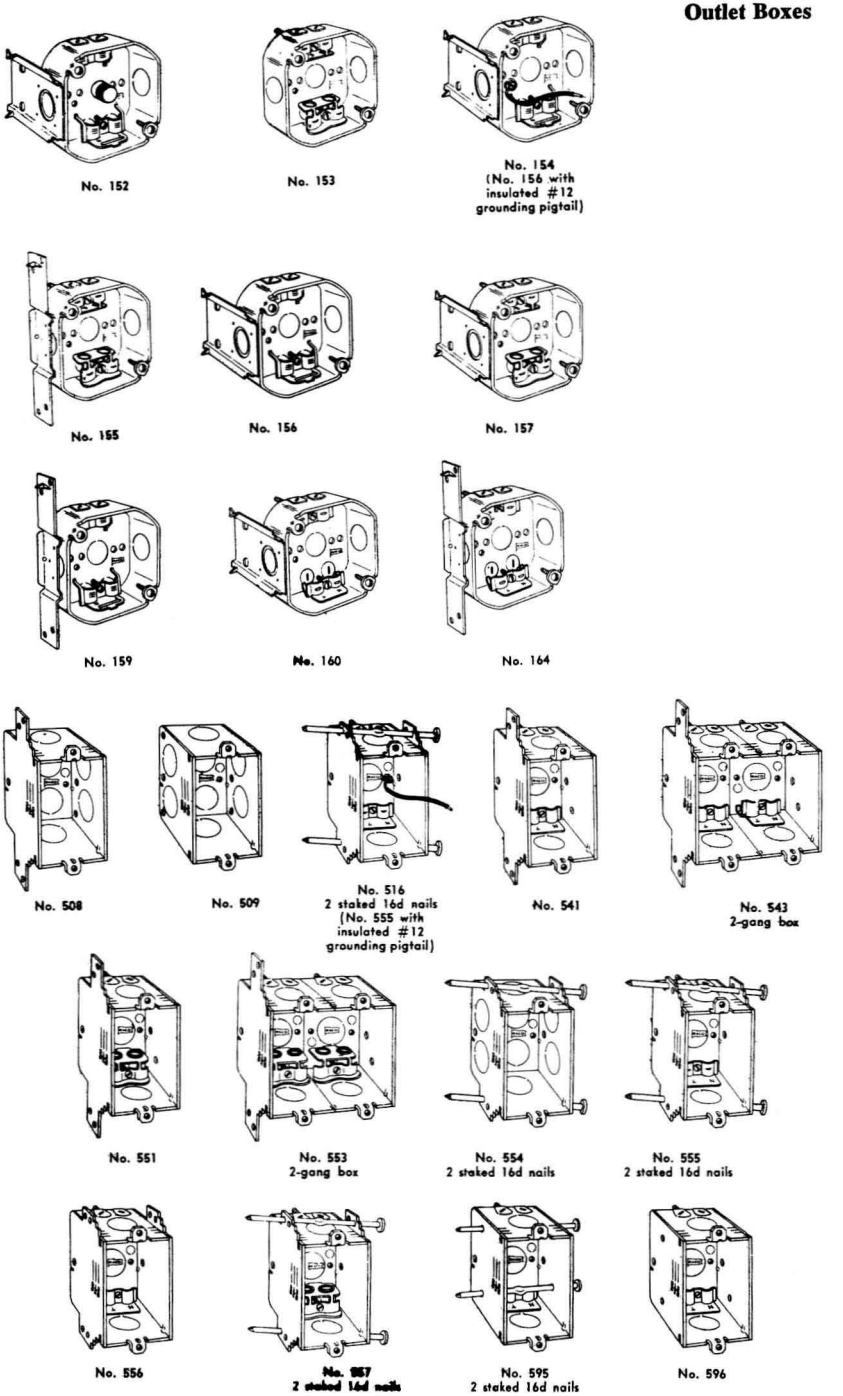

Figure 1-6 Example of several types of outlet boxes.

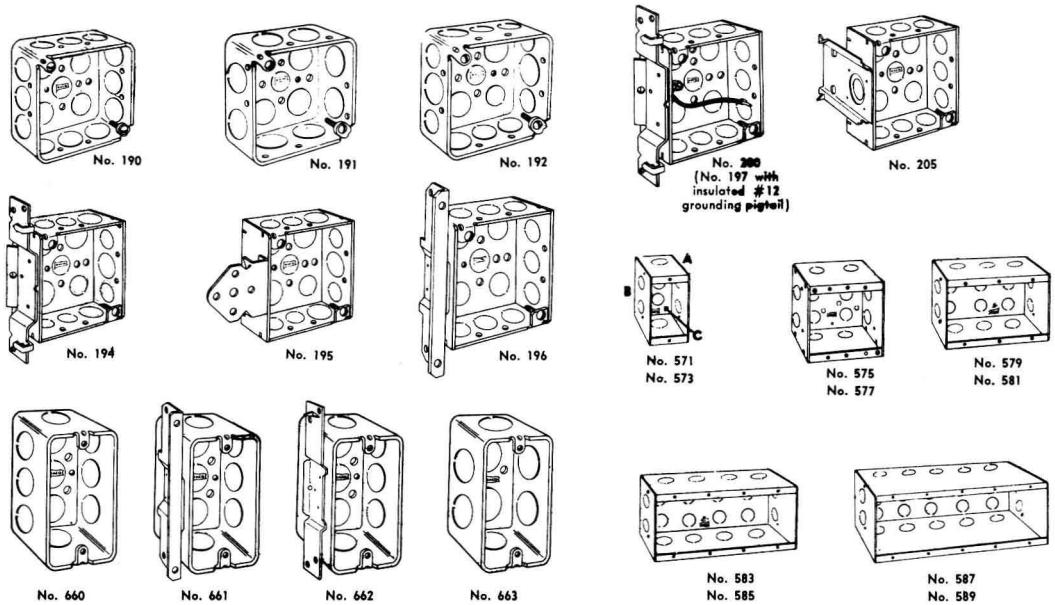

Figure 1-6 continued.

Box Dimensions, Inches Trade Size	Cubic Inch Cap.	Maximum Number of Conductors			
		No. 14	No. 12	No. 10	No. 8
3¼ x 1½ Octagonal	10.9	5	4	4	3
3½ x 1½ "	11.9	5	5	4	3
4 x 1½ "	17.1	8	7	6	5
4 x 2⅛ "	23.6	11	10	9	7
4 x 1½ Square	22.6	11	10	9	7
4 x 2⅛ "	31.9	15	14	12	10
4 11/16 x 1½ Square	32.2	16	14	12	10
4 11/16 x 2⅛ "	46.4	23	20	18	15
3 x 2 x 1½ Device	7.9	3	3	3	2
3 x 2 x 2 "	10.7	5	4	4	3
3 x 2 x 2¼ "	11.3	5	5	4	3
3 x 2 x 2½ "	13	6	5	5	4
3 x 2 x 2¾ "	14.6	7	6	5	4
3 x 2 x 3½ "	18.3	9	8	7	6
4 x 2⅛ x 1½ "	11.1	5	4	4	3
4 x 2⅛ x 1⅞ "	13.9	6	6	5	4
4 x 2⅛ x 2⅛ "	15.6	7	6	6	5

Figure 1-7 Number of conductors that may terminate in several types of outlet boxes.

Figure 1-7 gives the number of conductors that may terminate in each type of box. Both should prove invaluable in selecting the proper outlet box for the job.

1.5 *WIRING IN EXISTING BUILDINGS*

Whenever modernization work or wiring of existing buildings is undertaken, both designers and contractors try to avoid—as much as possible —the running of circuits in concrete decks. However, there are times when this cannot be avoided and the concrete must be cut and patched in order to place the conduit concealed in the slab. When such a situation arises, a detail such as the one in Figure 1-8 should appear on the working drawings to better show the installation procedure.

The detail in Figure 1-8 shows the concrete slab channeled to accept the conduit runs. One of the best ways of accomplishing this is to cut the channels with a diamond-tooth saw, making two parallel cuts the necessary width to accept the conduit. Outlet boxes are then connected to the conduit stub-ups, and when all wiring is complete, the cuts are patched with new concrete and finished flush with the existing floor.

When conduit installations under concrete permit a reasonable size access point on one end, a conduit pushing apparatus (Figure 1-9) may be used. This way, only a relatively small hole would be required at the outlet and a hole large enough to push the conduit parallel to the slab (the required depth) at the other end. A piece of conduit is then fitted with a plug and pushed under the slab from one end until it reaches the hole in the slab where the new outlet is to be located. An elbow is then attached using a union coupling to obtain the stub-up.

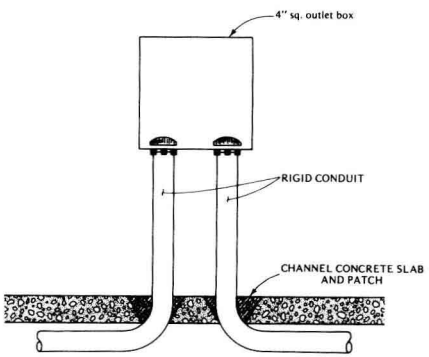

Figure 1-8 Outlet box detail with concrete slab channeled to accept conduit runs.

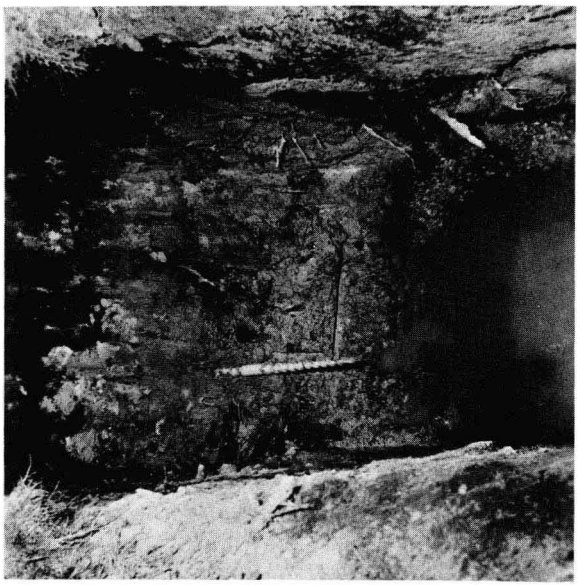

Figure 1-9 A conduit pushing apparatus.

When modernization of a building is undertaken, it is normally desirable to conceal all new wiring and damage the finished surfaces as little as possible. Wiring for wall receptacles usually can be fed from the basement or crawl space of a building, or else the baseboard (around the walls) can be removed, the wire or cable installed, and then the baseboard replaced to conceal the newly installed wiring. However, branch-circuit wiring for ceiling lighting often presents a unique problem, especially in multistory buildings. It is difficult to run wiring in the ceilings of these buildings, as there is no unfinished area about. "Fishing" of cables is also difficult because of the direction the joints might run; and, even if running in the right direction, bridging or firestops make "fishing" almost impossible.

A situation occurred in the renovation of a public office building requiring cables and conduits to be run concealed in a ceiling with no access room above, and also with a limited construction budget. The electrical designer specified that the cables be run along the wall–ceiling corner on the surface, and then a piece of molding was to hide the wiring. The detail shown in Figure 1-10 appeared on the working drawings and showed the contractor and the workmen exactly how the molding was to be installed. The decorative pattern of the molding also left little doubt as to exactly what was required.

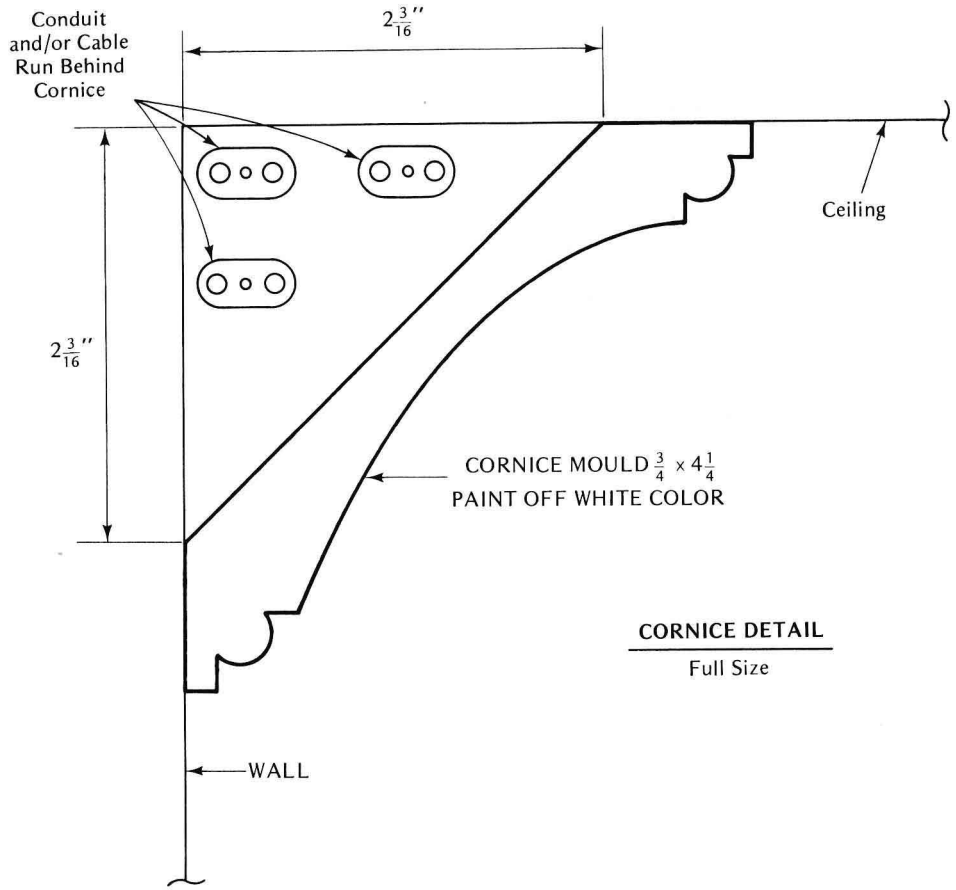

Figure 1-10 How wood molding is used to conceal electrical wiring.

The renovation or modernization of an existing building sometimes requires that some existing electrical equipment be removed, blanked out, or de-energized. When a case such as this exists, certain details are required to inform the electrical contractor and his workmen just what is expected of them. A "Removal Notes" schedule appeared on the working drawings of one such project, requiring certain items to be removed. It reads as follows:

REMOVAL NOTES

1. Remove all electrical equipment not indicated to remain. On equipment to be removed, the contractor shall remove all wiring back