

## DESIGN OF CABLE FORMS WIRING AND CABLING GENERAL EQUIPMENT REQUIREMENTS

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### 1. GENERAL

1.01 This practice covers the general equipment requirements for the design of cable forms where formed wiring is specified. This type of wiring is generally used for entire bays of equipment for units over five mounting plates in size, or for units having 206-type selectors, and for cases where surface wiring is not applicable.

1.02 Detailed reasons for reissue are listed under **Reasons for Reissue** at the end of this practice.

1.03 Surface wiring is generally used on bench-wired units consisting of five mounting plates or less, depending on the width of mounting plates and the type of apparatus mounted on the unit. Surface wiring of certain units, such as those consisting of a large number of terminal strips and relays, or those with a large number of printed wiring board connectors on one mounting plate, may result in a pileup of wiring so great that the wires extend beyond the outside edges of the mounting plate.

This condition may cause crushing, pinching, and/or displacement of wires by adjacent units during mounting, and/or displacement of terminals, which may cause shorts, or abraiding of the wires during shipment. In order to avoid this condition, the following should be considered in the choice between surface wiring and local cable:

(a) **Single mounting plate units consisting predominantly of terminal strips and wire spring relays** should generally be local cable wired if the design is such that the unit terminal strips provide more than 48 terminals.

(b) **Single mounting plate units consisting predominantly of printed wiring board connectors** that are not provided with horizontal wiring paths between terminals (such as the 906-through 914- and similar types), should be local cable wired except where the design of the unit is such that the number of surface wires running along the outside edges of the unit will not extend beyond the edges.

(c) **Units of two or more mounting plates consisting predominantly of terminal strips and/or wire spring relays** can generally be designed so that it will be possible to limit the number of surface wired leads at the top and bottom edges of the units to approximately 24 leads, with the balance of the leads run in the center of the units. However, on units with two mounting plates, if the unit terminal strips provide a total of 120 or more terminals, the unit should be carefully reviewed for the possibility of using local cable wiring.

(d) **Units consisting of two or more mounting plates consisting predominantly of printed wiring board connectors** can generally be surface wired, except where the design is such that the number of surface wires running along the outside edge of the units is so great as to result in a pileup of wiring that would extend beyond the outside edges of the unit.

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**1.04** The practices listed below contain wiring and cabling requirements that supplement the requirements of this practice, and where applicable, are referred to in other parts of this practice.

- 005-150-101—Wiring Symbols, Wiring Abbreviations, and Definitions
- 800-610-152—Gauge and Insulation of Wire
- 800-612-150—Specific Requirements for Electronic-Type Equipment
- 800-612-153—Stripping and Butting Cables
- 800-612-154—Connecting and Soldering Individual Conductors
- 800-612-156—Placing, Securing, and Supporting Cable Forms
- 800-612-157—Protection of Cable Forms and Skinners
- 800-612-158—Splicing Switchboard and Lead-Covered Cables, Local Cables, and Individual Conductors
- 800-612-160—Dressing of Skinners
- 800-612-161—Color Combinations and Uses
- 800-612-162—Selection of Standard Copper and Lightguide Central Office Cables
- 800-612-163—Specific Requirements for Crossbar-Type Equipment
- 800-612-164—Forming, Grounding, Splicing, and Terminating Shielded Wiring
- 800-612-165—Dressing of Skinners—Power Plant Apparatus
- 800-614-152—Switchboard, Power, and Local Power Cables
- 802-005-180—Assembly and Installation of Power Plant Bus Bar and Wiring

**1.05** Where lightguide cables are provided, they shall not be sewn into cable forms. Where it is necessary to secure the cables in order to hold them in place or in formation they may be taped to adjacent cabling, or they may be tied with twine to framework details. However, where the cables are to be tied, they shall be protected from contact with the twine and the metalwork by wrapping the cables with RM-583101, 1/64-inch thick sheet fiber. Although protected, the cables shall not be tied so tightly as to cause the fiber protection to deform the cables since deformation of the cables could adversely affect the transmission characteristics of the glass fibers. If a lightguide cable is kinked or otherwise damaged during handling or installation, the damaged cable shall be discarded and replaced by a new cable.

**1.06** The requirements covered in this practice should be followed except as modified by applicable specifications and drawings.

## 2. DESIGN OF CABLE FORMS

### A. General Shape of Forms

**2.01** Forms should, in general, follow the contour of the equipment framework and conform to the arrangement of the associated apparatus. Where possible, forms should be designed that all required bends in arms can be made while forming the cable. The design of forms should also be such that skinners located at the same point on an arm will break out of the arm in only one direction. Bends in directions other than in the plane of forms should be avoided. Where unavoidable, sufficient distance between the breaking-out points of the arms and skinners should be allowed to permit making such bends when the form is installed. Ladder-type forms should be avoided where possible. To facilitate the automated manufacture of cable forms, consideration should also be given in the design of the form to locating skinner break-outs, where practicable, at least 1/2 inch apart.

### B. Location of Forms

**2.02** *Locate arms of cable forms* that serve relays, resistors, capacitors, and similar apparatus mounted on mounting plates or panels on channel-type framework, or on unframes where mounting plates or panels are mounted on the front of the uprights, so that the inside edges of the forms are approximately 3-1/2 inches (not more than 3-3/4 inches, maximum) from the mounting plates or panels. On unframes where the mounting plates or panels are mounted on the rear of the uprights, and on ESS-type frameworks, locate arms so that the inside edges of the forms are approximately 2-1/8 inches from the mounting plates or panels. On bulb-angle or box-type frameworks, locate the arms so that the inside edges of the forms are approximately 2-3/8 inches (not more than 2-5/8 inches, maximum) from the mounting plates or panels. When local cable forms are used on duct-type frameworks, locate the arms in accordance with the equipment information.

(a) In general, shop-wired units should be designed with local cable arms located 2-3/8 inches from the mounting plates in order to permit their use universally on channel, bulb-angle, and box-type frameworks. Shop-wired units mounted exclusively on channel-type frameworks may be designed with local cable arms located 3-1/2 inches from the mounting plates or panels.

**2.03** *Locate arms of cable forms serving terminal strips* approximately 1/2 inch from the rear edge of the fanning strip. Locate the arms of forms serving terminal strips not equipped with fanning strips approximately 1/2 inch from the rear edge of the terminal strip mounting bars.

### C. Interference

**2.04** Forms should interfere as little as possible with access to apparatus for adjustment, repair, replacement, and cleaning. Forms should be located on the framework so they are within the limits of the guardrail or base of the frame.

**2.05** *There should be no interference of forms* with movable or removable equipment parts such as keyshelf braces, commutator brushes, and multiple banks.

**2.06** Where a cover is provided for the protection of wires or wire connections to backplane terminals, local, switchboard, and/or flat ribbon cable forms dressed to the backplane shall be designed and arranged so that sufficient clearance will be maintained between cover and cable forms, and between the cable forms and terminal field when the cover is in place. This may require the use of several small diameter forms instead of one large diameter form or several smaller pileups of flat ribbon cables instead of one large pileup which might displace the terminals when the cover is in place. Where a flexible cover is provided, clearances between the cover and cable forms shall be sufficient to assure that flexing of the cover will not disturb the wires or connections.

**2.07** *All forms should be located*, where possible, at least 2 inches from any wiring carrying outside service current that is not enclosed in armor or conduit.

### D. Forms With Horizontal and Vertical Arms

#### General

**2.08** On relay-rack units of older designs, the use of horizontal arms was restricted to cases where the apparatus of a circuit was located on one horizontal mounting plate or on two adjacent horizontal mounting plates. When the apparatus of a circuit group was located on three or more adjoining horizontal mounting plates, the apparatus in each circuit was arranged in an approximately vertical alignment and vertical cable arms were used. On the more recent relay rack units, particularly those which are equipped with D-type terminal strips and wire-spring relays, the practice of arranging the apparatus in each circuit in vertical alignment is not recommended due to wiring difficulties. In general, the present practice is to use surface wiring for relay-rack units of five mounting plates or less. (See 1.03.) On relay rack units of more than five mounting plates, the unit is local cable wired using horizontal cable arms.

#### Forms With Horizontal Arms

**2.09** Use horizontal cable arms for single circuit or for multicircuit units where the apparatus is mounted on more than five mounting plates. Horizontal cable arms are also used for cable-wired units of less than five mounting plates when surface wiring is not applicable. (See 1.01 and 1.03.)

**2.10** One cable arm for each two adjacent mounting plates may be used wherever it is advantageous to do so and the number of loop wires or "F" stitches is not excessive. The cable arm should be centered between the two mounting plates. An exception to this practice is when the two adjacent mounting plates consist predominantly of wire-spring relays. In this case, one cable arm for each mounting plate is recommended. Cable arms should be rigid enough to support their own weight without sagging or exerting tension on wire connections. In cases where the strength or rigidity of the arm is questionable, one of the following treatments should be provided:

- (a) Use one cable arm for two adjacent mounting plates. The cable arm should be located approximately in the center of the top mounting

plate of the two served. This will result in longer skimmers to the lower mounting plate, which may be an advantage for identification purposes.

(b) Where the tip of the cable arm contains only a few wires, the arm may end at the point where the arm becomes flimsy, and the wires to the apparatus on the far end of the mounting plate (away from the cable butt) may break out of the cable arm serving the plate above, or they may be run as surface wiring from the point where the arm ends, provided the type of wire insulation permits dressing against metalwork.

(c) Except for ESS\*-type equipment, use a stiffening wire such as a No. 16 gauge AM wire (COMCODE 803682533) or No. 12 gauge AT-7088 aluminum wire (COMCODE 400292215) sewn into the cable arm and formed and fastened to the framework as shown in Fig 1. In cases where it might be more practicable to use a single brace for two or more adjacent arms, reference should be made to Practice 800-612-156 covering placing, securing, and supporting cable forms, that includes procedures for cable form reinforcement and bracing.

(d) Except for ESS-type equipment, include two or three No. 16 gauge-type AM wires (dummies) or one or two No. 12 gauge aluminum wires in the form to provide the necessary stiffness.

(e) Reinforcement and bracing of cable forms on ESS-type equipment shall be in accordance with Practice 800-612-150.

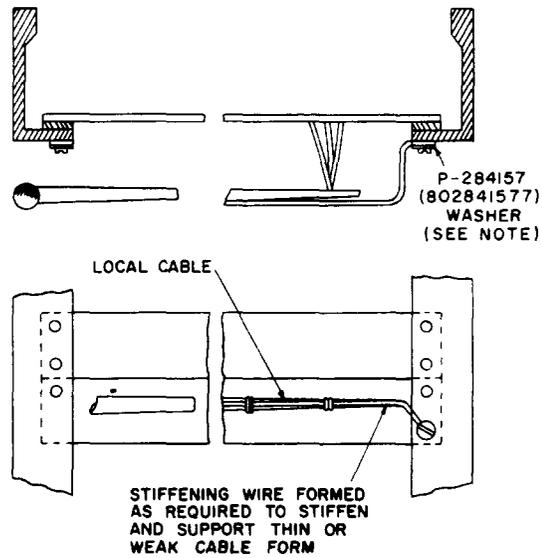
**Forms With Vertical Arms**

2.11 Vertical cable arms for relay-rack units should be limited to existing designs and to cases where the use of horizontal arms are not applicable. (See 2.08.)

2.12 Vertical arms may be provided where the apparatus in each circuit of a group is located on horizontal mounting plates and is approximately in vertical alignment.

2.13 *One vertical arm should be provided for each circuit* as follows:

(a) Where the apparatus is arranged with two apparatus positions (see *Note*) per circuit on all mounting plates.



NOTE - USE P-284157 (802841577) WASHER BETWEEN HEAD OF SCREW AND BRACE WIRE EYELET. WHEN MOUNTING PLATE SCREW IS INSERTED FROM FRONT, REPLACE WITH LONGER SCREW AND SECURE SUPPORT WITH P-125953 (801259532) HEXAGONAL NUT AND P-284157 (802841577) WASHER.

**Fig 1—Support of Form Stiffener to Frame Upright**

(b) Where the apparatus is arranged with two apparatus positions (see *Note*) per circuit on some of the plates and one position per circuit on others.

*Note:* More than two apparatus positions per circuit may be used for narrow apparatus such as 18- and 19-type resistors and 441- and similar-type capacitors.

2.14 One vertical arm for two adjacent circuits should be provided where the apparatus on all the plates is arranged with one position per circuit. More than one apparatus per circuit may be used for narrow apparatus such as 18- and 19-type resistors and 441- and similar-type capacitors.

**Forms With Both Vertical and Horizontal Arms**

2.15 Both vertical and horizontal arms may be used on the same unit, particularly on units having irregular arrangements of apparatus, such as on power boards; on units having 206-type selectors at one end and short horizontal mounting plates at the other end of the unit; and on units having multicontact relays or crossbar switches.

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**E. Forms for Hinged Parts**

**2.16** Forms that serve hinged parts, such as the keyshelves of switchboards, the swinging gate-type rear equipments of PBXs, and similar constructions, should be designed to provide the necessary movement with minimum strain on the cable wires. The design of such forms should permit the necessary movement of the form by a twisting motion in preference to a bending motion. The part of the form subjected to twisting should be as long as practicable.

**F. Size of Forms**

**2.17** Fig 2 through 4 show the approximate diameters of cables obtained when forming specific quantities of wire into sewn forms having circular cross sections. The wire codes shown in the figures are those most commonly used in wiring AT&T Technologies equipment. For codes not shown, the following formula may be used for calculating approximate diameters:

$$D = 2d \sqrt{T/3}$$

D = Diameter of cable

d = Diameter of wire

T = Total number of wires

**G. Switchboard and Desk Local Cables**

**2.18** The keyshelf arms of local cables are generally designed so they will enter the keyshelf at the right of each position, looking from the front. An exception to this is made where the framework construction or interference with apparatus makes it impracticable, in which case the cable is brought in at the left.

**2.19** *The keyshelf local cables should be brought through the keyshelf apron so*

that the bottom the cable is not less than 1/4 inch above the key pan at the point where the cable enters. The first bend should be located at a sufficient distance inside the keyshelf to prevent a strain on the cable when the keyshelf is raised.

**2.20** *When the keyshelf cable is of such size that it will not clear the end plug drilling where the cable passes under the plug shelf, the cable should be flattened to clear, if possible, but in no case should the cable overlap more than three fourths of the plug drilling. In general, the cable should not be flattened to a dimension of less than one inch.*

**2.21** *Where keys are arranged to lift out from their mountings, the wiring to the keys should be arranged in individually formed arms for each key.*

**Reasons for Reissue**

1. To add **1.04** listing associated Practices.
2. To add **1.05** covering requirements for lightguide cables.
3. To add **2.06** covering interference to wire connections to backplane terminals.
4. To revise **2.10(c)** to delete reference to TW or THW "and No. 12 gauge AP (iron)" wires; and to specify AT-7088 and COMCODES 803682533 and 400292215.
5. To revise **2.10(d)** to delete reference to TW or THW "and No. 12 gauge AP (iron)" wires.
6. To delete former Fig 2 covering approximate number of No. 22 and 24 gauge wires in forms having circular cross sections.
7. To add new Fig 2 to show new curves for AM- and BH-type wires.
8. To revise Fig 3 to add curve for 24BU wire and to specify 22BU in place of 26BW.
9. To revise Fig 4 to show new curves for DP-type wire.

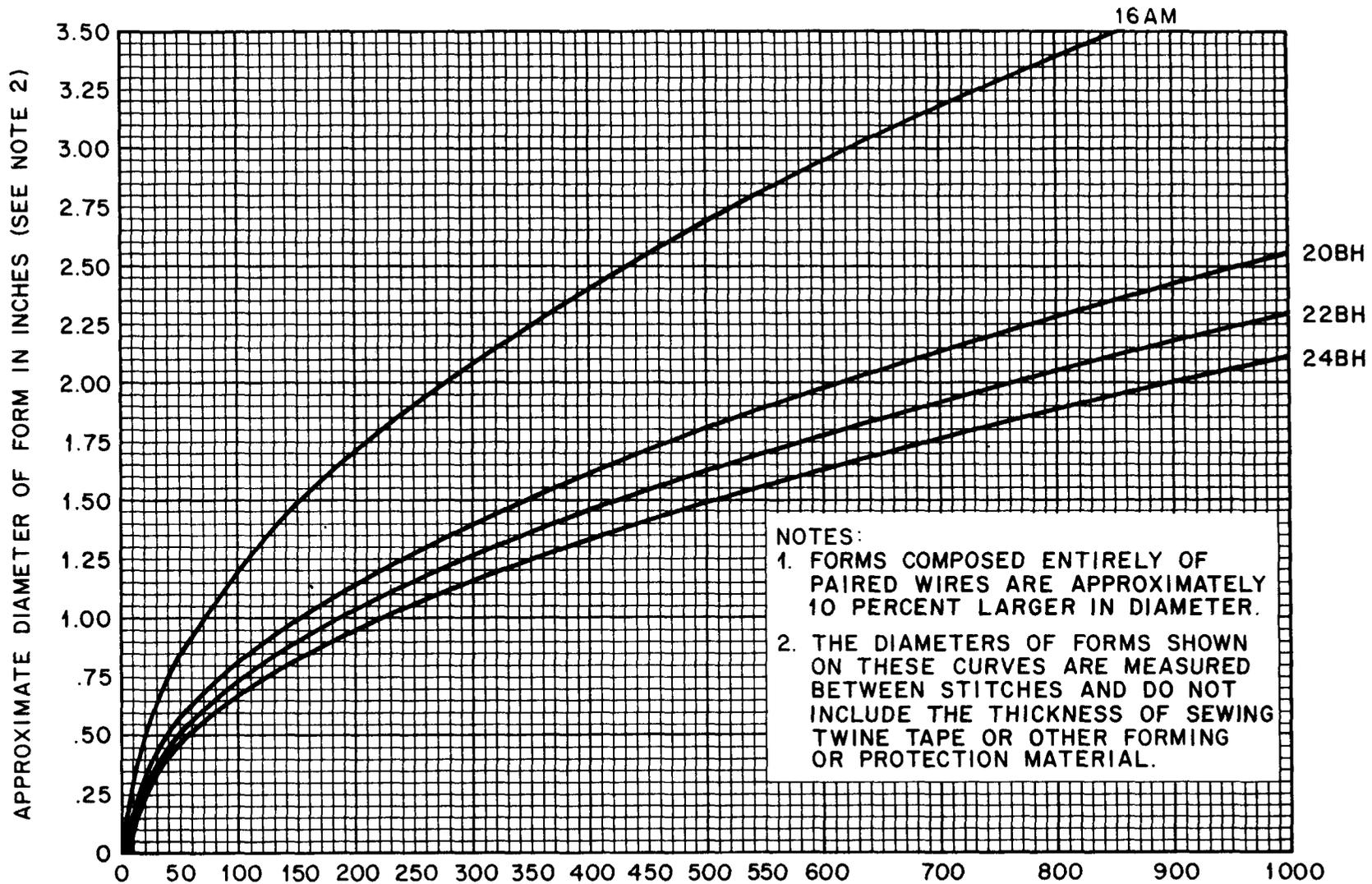


Fig 2—Approximate Number of AM- or BH-Type Wires in Forms Having Circular Cross Sections

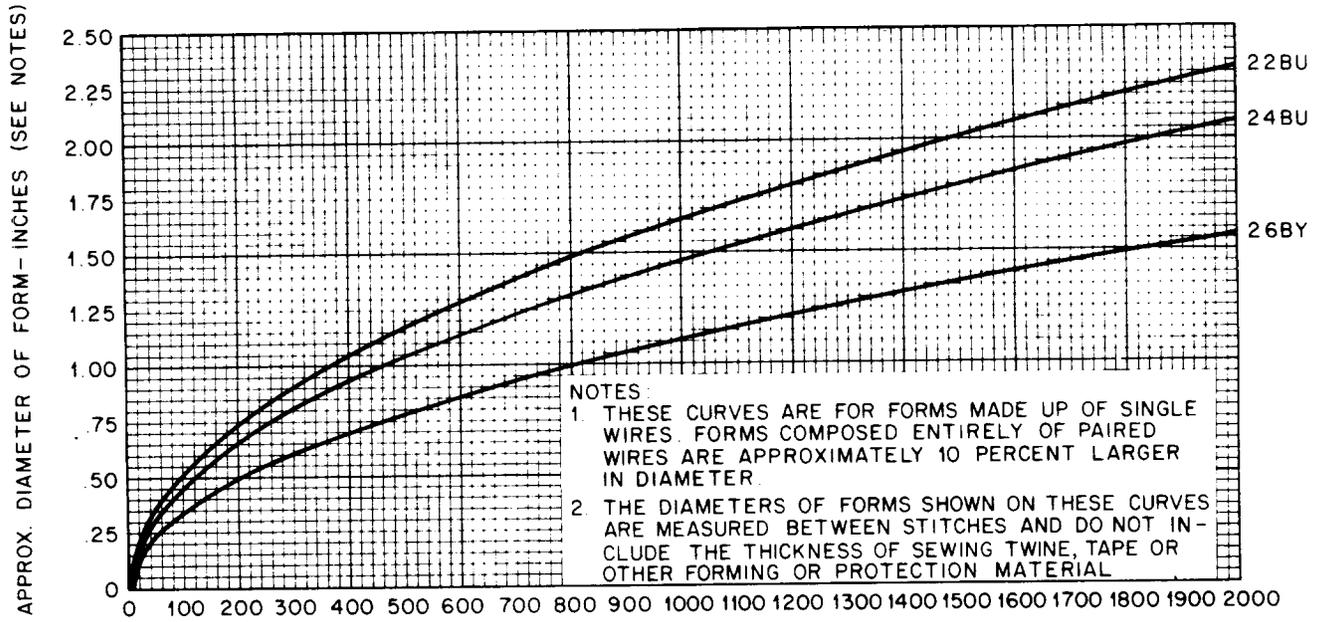


Fig 3—Approximate Number of BU- or BY-Type Wires in Forms Having Circular Cross Sections

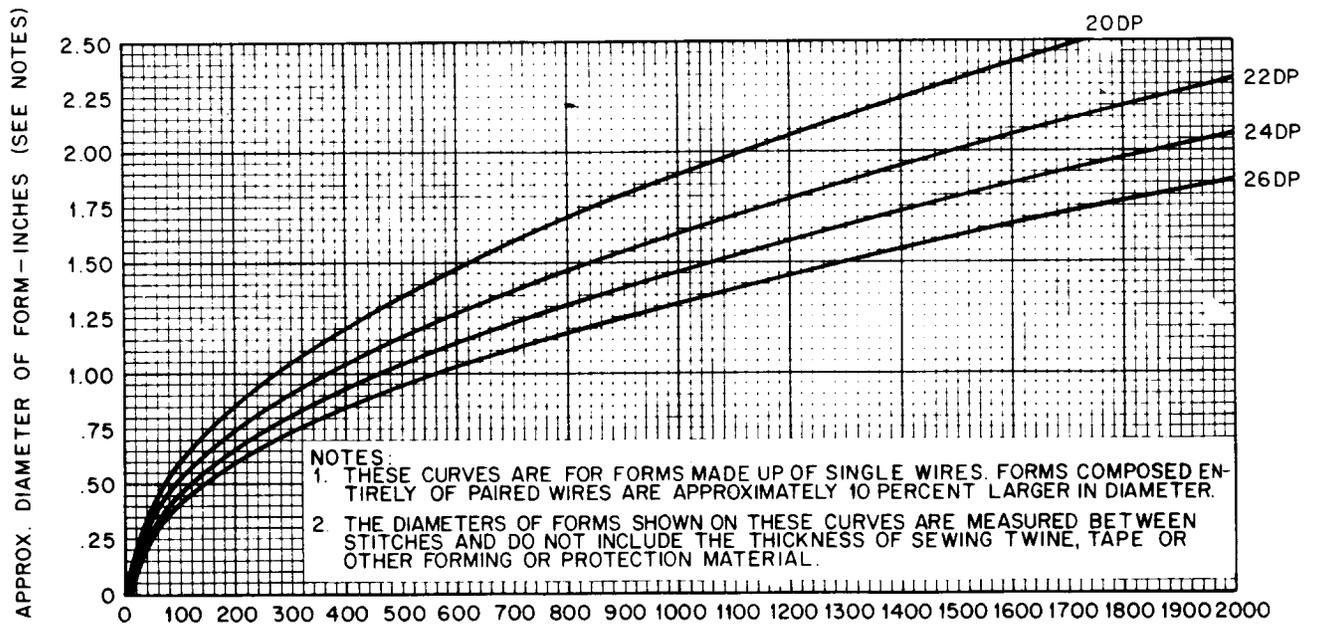


Fig 4—Approximate Number of DP-Wires in Forms Having Circular Cross Sections