DESIGN PARAMETERS for...

Wire-Wrap®

- TERMINALS
- HARDWARE
- WIRE

GARDNER-DENVER COMPANY

Wire-Wrap® DIVISION

GRAND HAVEN, MICHIGAN

CONTENTS

HARDWARE DESIGN GUIDE FOR GARDNER-DENVER "WIRE-WRAP" EQUIPMENT

I. INTRODUCTION

Shortly after the end of World War II, the telephone industry was ready to utilize a new concept in telephone relays. These relays were designed with pin-type terminals which required a new connecting method because of space limitations. Those studying the problem realized that the solution involved twisting the wire and terminal together or wrapping the wire around the terminal. It soon became apparent that the wrapping process was the logical solution.

Final tool development stemmed from close co-operation of Bell Telephone Laboratories, Western Electric Company, and the Gardner-Denver Company. Since this initial development, Gardner-Denver engineers have refined the solderless wrapping process and the tools used to make the connections. The most recent advance of the process is the automatic "Wire-Wrap" machine.

As the solderless process became more and more popular, the number of component suppliers increased. With the increased number of component suppliers, the types and styles of components have also pyramided. Unfortunately, they are not all as compatible to the portable "Wire-Wrap" tool and the automatic machine wrapping process as they might be. To assist in the selection of the components that are most compatible for the solderless process, the Gardner-Denver Company has prepared this manual containing the design parameters for terminals, hardware, and wire that is to be used with portable "Wire-Wrap" tools and automatic "Wire-Wrap" machines.

II. HAND HELD "WIRE-WRAP" TOOLS

"Wire-Wrap" tools have proven their worth in the electronics industry for some ten years. In the billions of finished connections which have been made in that time, there has never been a reported electrical connection failure. With solderless wrapping, the user can expect fast, reliable connections. The time cycle for the complete wrapping sequence is approximately three seconds with the actual wrapping requiring about one-tenth of a second. By eliminating the use of solder, the user avoids thermal damage to heat sensitive materials, hazards of hot soldering irons, fires and burns to personnel, soldering fumes and splashes, resin joints, cold solder joints, stress concentration which leads to broken connections, and the expense of costly solders. Most users report a cost savings per connection of 50% or better.

The Gardner-Denver hand tool product line includes tools from the manual "Wire-Wrap" tools (similar to a hand screwdriver) to air and electrically operated tools (similar in appearance to a pistol type gun). In the gun-type tools, the wrapping bit is either turned with a manually operated gear mechanism, by an air motor, by an electric motor with a 110-volt source, or by a small electric motor which is powered by rechargeable batteries.

The design engineer in designing a circuit finds that a certain size wire must be used to meet the electrical requirements of the circuit. After the wire size has been chosen, consideration must be given to the selection of a terminal not only to meet the physical requirements of the connection but also to meet the space limitations imposed upon the application. In choosing a terminal, consideration should be given to the size of wrapping bit that will be required to wrap the particular terminal and wire combination. It is the combination of the stationary sleeve O. D. plus the eccentricity of the terminal hole to wrapping bit that determines the minimum grid or terminal spacing. To understand this more clearly refer to Fig. 1 which shows a dimension "R".

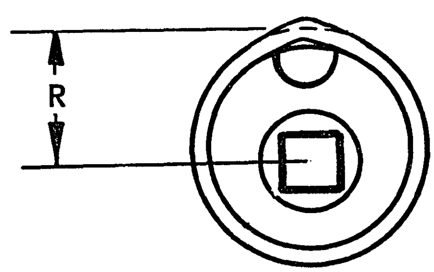


FIG. 1

Fig. 1 is to be used in conjunction with Table "A". The dimension "R" is referred to as the "effective radius" and is the radius of the minimum area around the center of the terminal, which must be clear to accommodate the wrapping bit and sleeve used with a specified terminal and wire size.

Table "A" gives the effective radius "R" dimensions for the most commonly used combinations of wire and terminal sizes.

TABLE A

Wire Ga. Req.	Common Terminal Sizes	Effective Radius "R"
30-32	.020" sq. .025" sq. .010" x .020" .016" x .032"	.081
26	.035" x .050" .045" sq. .031" x .062"	.104
24	.035" x .050" .045" sq. .031" x .062"	.104
22	.035" x .050" .045" sq. .031" x .062"	.125
20	.045" sq. .031" x .062"	.150
18	.062" sq. .062" x .093"	.170
16	.080" sq. .062" x .093"	.257
14	.125" sq. .093" x .125"	.288

When the combination of wire and terminal sizes shown in Table "A" are not suitable for a particular application, it is suggested that all information concerning the application be submitted to the nearest Gardner-Denver representative for his comments. This time spent may save the user thousands of dollars.

Once the terminal or grid spacing has been tentatively picked, thought should be given to whether the spacing is compatible for automatic machine wrapping. Your future production requirements might dictate the necessity of automatic machine wrapping. Considerable amounts of time and money could be saved with a little forethought at this point.

III. AUTOMATIC "WIRE-WRAP" MACHINE

The Gardner-Denver Automatic "Wire-Wrap" Machine is a unit designed for automatically attaching interconnecting wiring with solderless wrapped connections. Products wrapped are any electronic or electrical assemblies, which have a modular terminal arrangement with the terminals on a common plane. This machine is capable of interconnecting terminals within a given area using a variety of wiring patterns. The machine consists of movable carriages containing wrapping tool assemblies and dressing fingers that are positioned at modular points to give the desired wire pattern.

There are four basic models available. They are the 14F - 15 x 15 x .125, the 14F - 20 x 20 x .200, the 14F - 22 x 22 x .025, and the 14U - 22 x 22 machines. The 14F - 15 x 15 x .125 and the 14F - 20 x 20 x .200 model machines have what is termed a fixed grid. The 14F - 15 x 15 x .125 can position only on .125" increments, and the 14F - 20 x 20 x .200 positions only on .200" increments. The 14F - 22 x 22 x .025 machine, often referred to as our universal model, is capable of positioning on any grid as long as it is some increment of .025". We refer to this .025" dimension as the basic grid for this machine. The basic grid could also be furnished to some other positioning increment, such as 1/32", or 1 millimeter, if a customer so desired. The 14U - 22 x 22 model "Wire-Wrap" Machine is an economy version of our universal "Wire-Wrap" machine. It can be built to position on either .025", .031", .050", .062", or 1 millimeter increments. The major difference between the machines is that the 14U1 has one dressing finger, the 14U2 has two dressing fingers, while the 14F has four dressing fingers.

All models are designed to handle 24-gauge solid conductor wire with PVC, nylon-jacketed PVC, "Kynar", nylon-jacketed "Teflon" or "Teflon" insulated wire. These machines can be modified to wrap 22-, 26-, 28-, or 30-gauge wire as well.

The largest of these machines is capable of interconnecting any two points on a panel in a terminal area up to 22" x 22". By longitudinally shifting the panel, this machine is capable of wrapping a total area of up to 22" x 42". In effect, the wrapping can be done on the larger area by overlapping 22" x 22" areas.

IV. TERMINALS

The Gardner-Denver Company is concerned only with the wrappable portion of the terminal since the customer's application dictates the type of terminal contact required. Therefore, the following design parameters are for only the wrapped portion of the terminal.

Any terminal that has at least two sharp edges crosswise to the axis of the wire is usually suitable for making a "Wire-Wrap" connection with hand tools. Types of terminals in everyday use include square, rectangular, embossed, serrated, V-type, coined twisted wire, and square drawn wire. Square terminals offer some advantages over the other types. Although the advantages gained are not always significant when making "Wire-Wrap" connections with a hand-held tool, they become of major importance with the use of automatic "Wire-Wrap" machines. Some of these advantages are as follows:

1. The natural wrapping motion of a wire on a square terminal is in a circular pattern. A rectangular cross section terminal, particularly one with a high-width-to-thickness ratio, results in an elliptical wrap with constant variation of radius.

2. A rectangular cross section, which causes an elliptical pattern, results in the possibility of the tip of the wire being wrapped projecting from the pattern. This condition is referred to as a pigtail (refer to Fig. 2). This is less likely to occur with the circular wrap which circumscribes the square cross section.

TOO MUCH PIGTAIL

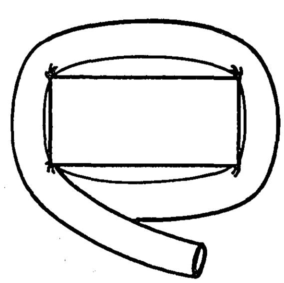


FIG. 2

3. A square cross section has a more uniform section modulus in all directions. This is more useful in initially positioning the terminal relative to its true position and also tends to make the terminal more rigid during the wrapping operation where straight jumper wires have a tendency to toe in the terminals due to the opposite rotation of wrapping bits.

4. The square cross section has far less tendency to twist about its axis than does the rectangular cross section.

5. The square terminal is more conducive to a symmetrically pointed tip for lead-in to the wrapping bits on a "Wire-Wrap" machine.

6. The strip force values obtained on square terminals are usually more consistent than those obtained from rectangular terminals of similar cross-sectional area and edge radius.

7. Wrapping bit life is increased when square terminals are used.

Terminals must be of sufficient strength to withstand the torsion of wrapping the wire. They should be designed to fit the terminal hole diameter of the wrapping bit. The diagonal of the terminal should be no greater than the wrapping bit terminal hole diameter minus .005". As a general rule, the terminal tickness should not be less than one wire diameter, and the terminal width should not be more than double the terminal thickness. The maximum terminal width should not be more than 3-1/2 times the conductor diameter. (For example, the maximum terminal size for 24-gauge would be .035" x .070".) Refer to Table "A" for recommended terminal sizes.

Each 24-gauge "Wire-Wrap" connection requires approximately 1/4" of wrappable terminal length. Wrappable terminal length is defined as the length of terminal which has a full cross-sectional area available for wrapping after completion of all operations prior to wrapping. It is recommended that the terminal be made long enough to accommodate the two wraps that will be used in production, plus enough length to accommodate an additional wrap in the event that there is an engineering change. Attachment 1 (refer to last page) gives the formulas for calculating wrappable terminal length for various wire gauges.

Corner radii of the terminals should not exceed .003". Maximum edge burrs should not exceed .0015".

The most common and successful materials that are used in making terminals are copper, beryllium copper, plated steel, copper nickel, tinned and untinned brass, phosphur bronze, and nickel silver alloys.

Certain finishes, particularly hard gold plate, tend to lower the force necessary to slide or move the wrapped connection on the terminal post. To compensate for the reduction in stripping force, the wire must be wrapped under greater tension, thus requiring tighter process control and reducing bit life.

Plating is not a requirement for a reliable wrapped connection; however, terminals are usually plated for one of the following reasons:

1. Tin plated wire is used in applications where wiring changes or repair in the field will be made by soldering.

2. Where the opposite end of the wrap post is a plug-in type contact, gold plating is used for increased contact reliability.

As long as minimum adjacent dimensions are not violated, the tolerance on the location of the terminal to be wrapped is not critical when using hand-held wrapping tools. However, the true position tolerance of the terminal is extremely critical when wrapping with an automatic machine. This will be more fully discussed under "Hardware".

It is recommended that a taper be provided on the terminal tip. For hand-held tools the terminal tip should have a maximum flat approximately one-third the size of the terminal cross section. The purpose of this taper is to assist the operator in getting the terminal into the terminal hole of the wrapping bit. This, in turn, will increase the overall process efficiency.

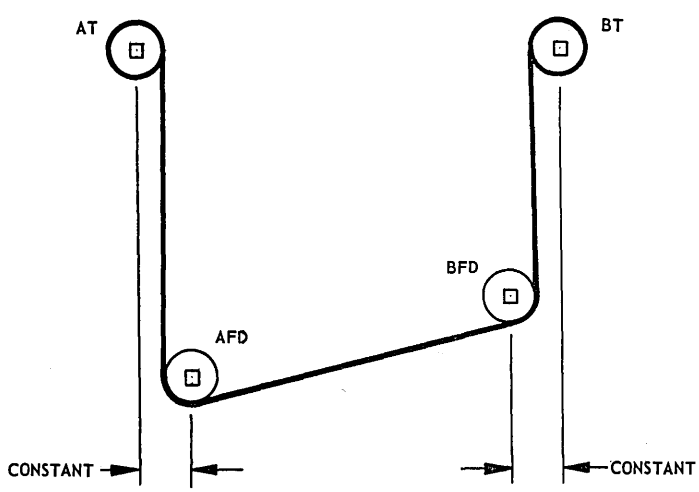
The maximum tip flat for terminals used in machine wrapping 24-gauge wire is .015" x .015". For 30-gauge machine wrapping, terminals should have a maximum tip flat of .010" x .010".

V. HARDWARE

When designing hardware that will be machine wrapped, consideration should be given to the design in order not to impair the efficiency of the machine wrapping process. Factors are proper terminal location, terminal strength, and excessive wire density on certain types of circuitry. Since the "Wire-Wrap" machine is designed to position on a grid system, the terminals within the panel must be placed on a grid system that is compatible with the "Wire-Wrap" machine. The two grid systems that are commonly used with 24-gauge wire (the size wire used on nearly all automatic machine wrapping to date) are a .200" square and a .250" staggered grid arrangement.

In choosing the grid system, it must be kept in mind that there should be sufficient channel width between the terminal rows to allow for placement of the wires in the channels, since the wire patterns are formed above the terminals and laid down into the terminal mass after formation. For 24-gauge wire, we recommend a minimum channel width (the clearance between two terminal rows) of .150".

It must be remembered that the distance between each wrapping tool and its own dressing fingers in the "X" direction is constant and is determined by the terminal spacing. Refer to Fig. 3. The constant dimension for the 14F - 15 x 15 x .125 is .250", and the 14F - 20 x 20 x .200 is .200". The constant dimension for the 14F - 22 x 22 x .025 and 14U - 22 x 22 can be either .200" or .250".



AT = "A" WRAP TOOL
BT = "B" WRAP TOOL
AFD = "A" FRONT DRESSING FINGER
BFD = "B" FRONT DRESSING FINGER

FIG. 3

Therefore, to obtain maximum versatility of the machine, the grid in "X" direction should be some ratio of the grid in the "Y" direction, such as 1:1, 1:2, 1:3, etc. This will allow use of dressing fingers in all four table rotational positions (TRP) on square or rectangular grids.

Staggered grids, such as the .250" staggered grid shown in Fig. 4, do not permit the dressing fingers to be used on all pins in all TRP's; however, by the proper selection of wire patterns and TRP positions, any two pins within the wrap area can be interconnected.

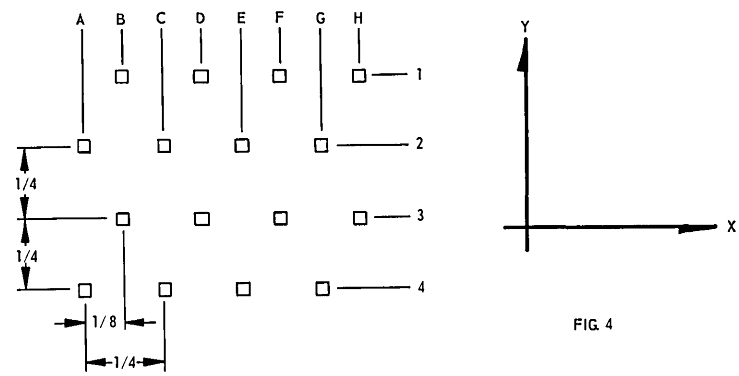


FIG. 4

The constant distance between each tool and its dressing finger when using the .250" staggered grid is .250". For example, suppose pins A_2 and F_1 were to be interconnected. Since these two pins cannot be directly interconnected because of pins being in the way, a dressing finger must be used. Fig. 5A shows a dressing finger positioned over pin B_3. This pattern cannot be wrapped this way since the rule stating that "the distance between each wrapping tool and its dressing fingers in the "X" direction is constant" has been violated.

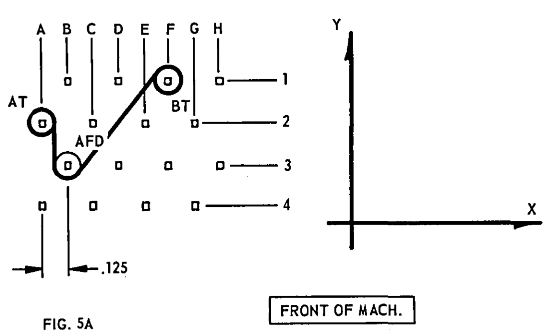


FIG. 5A

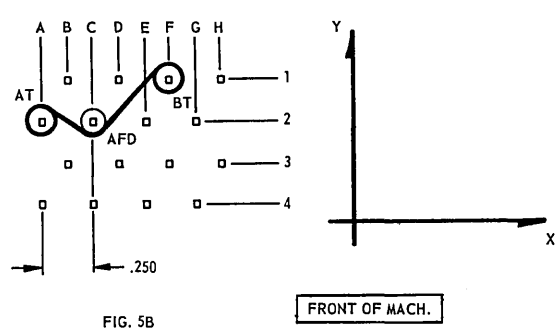


FIG. 5B

Pins A_2 and F_1 can be interconnected using pin C_2 as a dressing finger position, since we now meet the requirement of having an "X" separation between the wrap tool and the dressing finger of .250" (the constant for the .250" staggered grid). Refer to Fig. 5B. By the proper selection of wire patterns and TRP positions, any two pins within the wrap area of the machine can be interconnected using the .250" staggered grid.

Each of the aforementioned grid systems have distinct advantages. The .2" square grid system allows for greater pin density in a given area; however, the wiring is limited to straight "X" and straight "Y" directions, as diagonal channel widths are not sufficient to allow for successful placement of the wire in the channel. Refer to Attachment 2, Sheet #801017. The .250" staggered grid system achieves less pin density in a given area; however, it does have a greater channel width which allows for diagonal wiring with sufficient channel width. This is advantageous in circuits where electrical noise and crosstalk problems are critical as there is less parallel wiring within a given channel. Refer to Attachment 3, Sheet #801015.

If a staggered grid is chosen and rectangular pins rather than square pins are used, it is recommended that the pins be positioned in the relationship shown in Fig. 6. This relationship allows for maximum channel width.

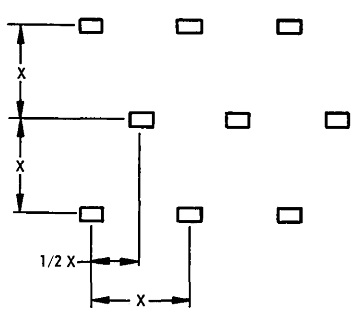


FIG. 6

The interest in miniature wrapping of micro-modules has prompted the Gardner-Denver Company to develop machine components capable of wrapping 30-gauge wire. At the present time, the smallest grid that can be machine wrapped using 30-gauge wire is the ~~.125~~ .100" square grid. Other suggested grids are the .150" square and .150" or .125" staggered. Until a major technological breakthrough is made in the area of component manufacturing, it looks as if the ~~.125~~ .100" square grid is adequate for the present state of art. Customers generally arrive at .150" or .125" or .100" grids after a complete packaging study.

There are two basic types of panels available. They are the plate-type panel and the connector-block type panel. The plate-type panel is usually made from metal or one of the synthetic materials now available. The panel size is usually determined by either customer's application or the capability of the "Wire-Wrap" machine to accept the panel. In cases where metal plates are used, holes are usually punched or drilled on a grid to relatively close tolerances. Each terminal is inserted in its own insulator and the insulated terminal then inserted into the punched holes in the panel.

Since the synthetic material used in making the panel is non-conductive, the terminal can be inserted directly into the panel. Some method of staking the terminal in position must be provided. Temperature and humidity have an effect on some of the synthetics; therefore, it is essential that all tolerances be kept to a minimum.

In the connector-block type panel, terminals are inserted or molded in connector blocks. The connector block is usually molded from one of the synthetics. Each of these connector blocks has some type of locating device since they must be located accurately within a frame and assembled to make a panel. Fig. 7 shows a typical method of locating connector blocks.

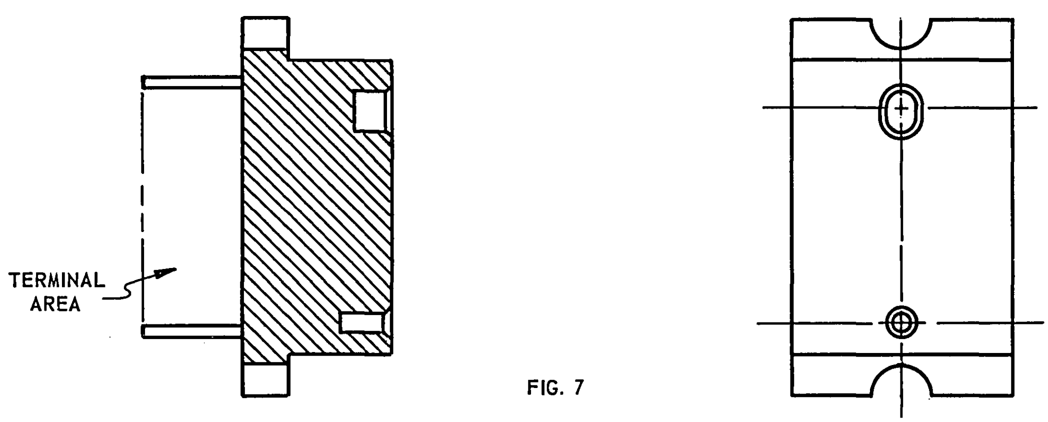


FIG. 7

This method employs the use of two molded holes, one of which has been elongated to compensate for the shrinkage that may occur during the molding process.

The blocks are then placed in an assembly fixture. This fixture has a series of pins which locate the blocks in proper relationship to a common point on the assembly fixture. A frame is then assembled around the blocks, holding them in their proper relationship and forming a complete panel. Normal manufacturing tolerance for the pins within a block is $\pm$.012" and $\pm$.003" for locating the block within the panel assembly.

Whether the plate-type or connector-block type concept is used, the assembled panel should be flat and straight within .030" over its entire length. The terminal location tolerance within the panel must be held to a minimum for efficient production results. For consistent engagement of the terminals by the wrapping tools, the terminals must be located within .030" TRUE POSITION of a common reference point on the panel. For an explanation of "True Position Tolerancing" refer to MIL-STD-8B, dated 16 November 1959.

To accomplish the terminal location tolerance requirement, the terminals or connector blocks must be located in the panel with respect to a common reference point. This same reference point should be used for locating the panel within the "Wire-Wrap" machine to eliminate tolerance build-up. This may be accomplished in the plate-type concept by designing the panel so that it has two .312" or .375" holes located near the extremities of the panel diagonal, as shown in Fig. 8. This can be accomplished in the connector-block concept by either using the same method used in the plate-type concept or assembling the frame around the connector blocks and using the holes in the connectors for locating the panel within the machine.

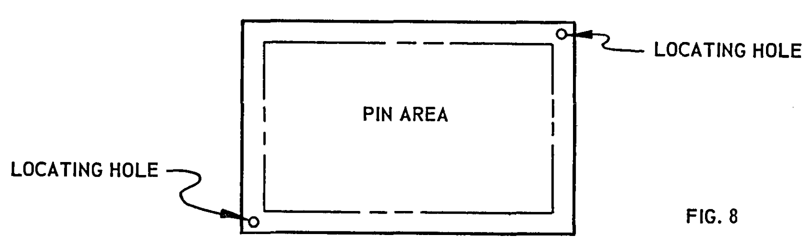


FIG. 8

One of the two holes should be designated as the common reference point and used for all terminal and connector block locating.

The maximum panel size and maximum wrap area that the four "Wire-Wrap" machine models are capable of accepting are as follows:

Model No.	Maximum Panel Size	Maximum Wrap Area
14U - 22 x 22	24" x 24"	22" x 22"
14F - 15 x 15 x .125	22-5/8" x 39-1/8"	15-5/8" x 32-1/8"
14F - 20 x 20 x .200	22-1/2" x 40-1/2"	19.8" x 37.8"
14F - 22 x 22 x .025	24" x 44"	22" x 42"

The carriages in the machine are designed to clear the top of the terminals by 1/8"; therefore, it is advisable to keep the wrap side of the panel free from any protrusions such as panel stiffeners or mounting brackets that might obstruct the operator's vision. The over-all process efficiency will be increased since the operator will be able to detect and correct minor malfunctions before they lead to machine downtime.

Hardware for miniature wrapping (30-gauge) is similar to that of standard hardware except the tolerances on terminal location are closer. For consistent engagement of the terminals by the wrapping tools, the terminals must be located within .020" TRUE POSITION of a common reference point on the panel.

We recommend a .025" square terminal for use with a .125" square, .150" square, or .150" staggered grid. One-half inch of wrappable terminal length will allow three levels of connections with .350" of wrappable terminal length being required for two levels of connections.

VI. WIRE

Wire used in hand tool applications should be a solid conductor such as copper, brass, nickel iron, or nickel. Most wires are tin plated, with tin plated solid copper the most widely used. Stranded wire can be wrapped but it should be soldered for permanency.

Wire insulation may be of any of the types generally accepted for electrical use for hand tool applications. Since all leads must be stripped of insulation prior to wrapping, easy to remove insulation is preferred.

Minimum wire elongation for solid conductor copper wire should be approximately 15% for 26- and 24-gauge, and approximately 20% for 22- and 20-gauge.

"Wire-Wrap" machines are designed to handle 24-gauge solid conductor wire with nylon-jacketed PVC, PVC, "Kynar", nylon-jacketed "Teflon", or "Teflon" insulated wire. It is recommended that the nominal diameter over the insulation be held to .042" with a maximum tolerance of $\pm$.002" for "Teflon" insulated wire. The recommended nominal diameter over the insulation is .045" with a maximum tolerance of $\pm$.0015" for nylon-jacketed wire. The recommended nominal diameter for "Kynar" insulated wire is .042" with a maximum tolerance of $\pm$.0015". Recent developments indicate that we may be able to handle broader wire insulation O.D. tolerances in the near future.

Since the Gardner-Denver Company's primary interest in wire lies in the area of suitability for machine wrapping, we feel that our recommendations should be made in this area only. Any electrical characteristics which the wire must possess should be specified by the user. The following are the recommendations as to the properties 24-gauge solid conductor copper wire should possess to make a mechanically strong connection:

1. <u>Tensile Strength</u>

   The tensile strength should be approximately 30,000-40,000 psi.

2. <u>Outside Diameter of Conductor</u>

   The outside diameter of the conductor should be .0201" +.0006" -.0002" with the overall tolerance variation for a particular spool not to exceed .0003".

3. <u>Elongation</u>

   Insulations extruded at low temperatures are normally put on tin-plated copper conductors with the elongation of the completed wire being a minimum of 15%. High temperature extruded insulations, such as TFE "Teflon" are put on either silver-plated or nickel-plated copper conductors with the elongation of the completed wire being between 22% and 38%. This increase in elongation is caused by the conductor being annealed during the extrusion process.

4. Insulation Outside Diameter

The nominal diameter over the insulation of "Teflon" insulated wire should be held to .042" with a maximum tolerance of $\pm$.002". The nominal diameter over the insulation for nylon-jacketed PVC, semi-rigid PVC wire should be .045" with a maximum tolerance of $\pm$.0015". The recommended nominal diameter of "Kynar" insulated wire is .042" with a maximum tolerance of $\pm$.0015".

5. Insulation Concentricity

The minimum thickness of insulation shall be not less than 80% of the maximum thickness at a particular cross section.

6. Insulation Elongation

The insulation elongation should be not less than 125%.

7. Insulation Bond Strength

The bond strength should be such that a force of 3/4 to 4 pounds, applied under constant pressure, will strip a three-inch long piece of insulation off the conductor.

8. Wire Packaging

It is recommended that wire be furnished in a barrel pack, with the barrel diameter being approximately 20" and the minimum diameter of the coil, 13". Wire can also be furnished on spools; however, it is recommended that the minimum core diameter of the spool be held to 12".

9. Minimum Curl of Wire

When a 30" length of wire is cut from a barrel or spool, the wire, when lying unrestrained on a smooth, flat surface, shall not curl up to a diameter of less than 10 inches within one minute at ambient temperatures. This specification prevents wire manufacturers from taking wire from a spool with a core diameter less than the recommended diameter and rewinding it on a spool that will meet the core diameter requirements, since most wire has a characteristic referred to as "memory" and will try to return to its original shape.

For machine wrapping 30-gauge wire we recommend a high tensile alloy conductor such as copper coated steel core, or zirconium copper. The tensile strength of the conductor should be a minimum of 50,000 PSI. The insulation should be a homogenous material rather than jacketed with an outside diameter of .021" ±.001".

VII. SUMMARY

This manual has been prepared listing the design parameters for terminals, hardware, and wire that will be used with "Wire-Wrap" hand tools and automatic "Wire-Wrap" machines. Undoubtedly there will be questions on certain areas of the manual or special applications that the manual does not cover. Any questions or requests for information on special applications can be forwarded to the Gardner-Denver Company, "Wire-Wrap" Division, Grand Haven, Michigan.

Minimum Wrapping Length

A. Terminals wrapped with conventional solderless connections should have a minimum wrapping length calculated as follows:

$L_B = N(n_1 d_1 + sn_1 + S)$

L_B = Minimum wrapping length for the required number of connections which does not include tip or base configurations or tolerances on terminal length.

N = Number of connections to be made on the terminal.

n_1 = Maximum number of turns of uninsulated wire per connection.

d_1 = Nominal diameter of uninsulated wire.

s = Space allowance between adjacent turns within a connection.

S = Space allowance between adjacent connections.

B. Terminals wrapped with modified* solderless wrapped connections should have a minimum wrapping length calculated as follows:

$L_A = N\left[d_1 n_1 + n_2 d_2 + s(n_1 + n_2) + S\right]$

L_A = Minimum wrapping length for the required number of connections which does not include tip or base configurations or tolerances on terminal length.

N = Number of connections to be made on the terminal.

n_1 = Maximum number of turns of uninsulated wire per connection.

n_2 = Maximum number of insulated turns per connection.

d_1 = Nominal diameter of uninsulated wire.

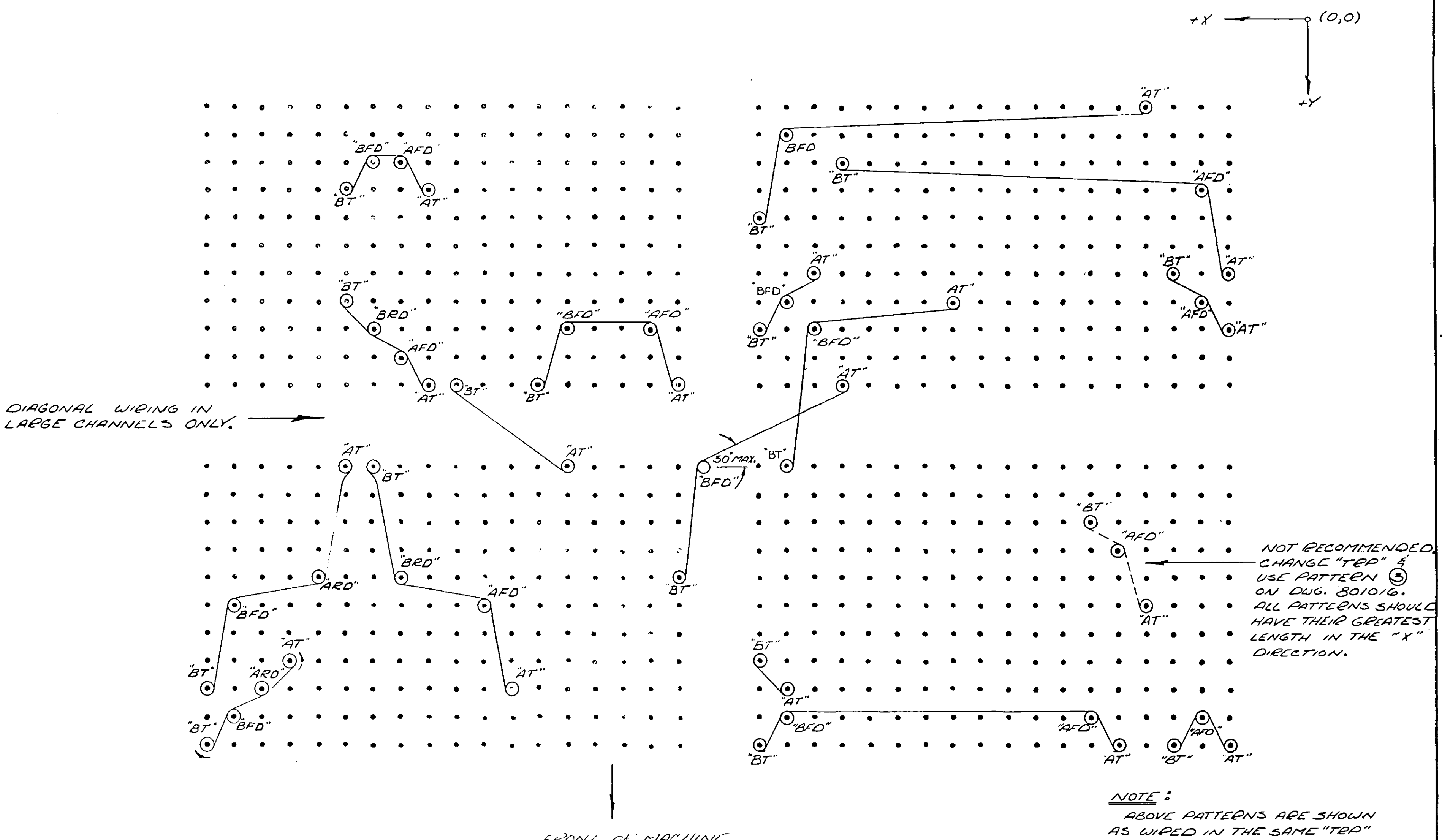
d_2 = Nominal diameter of insulated wire.

s = Space allowance between adjacent turns within a connection.

S = Space allowance between adjacent connections.

* A modified solderless wrapped connection provides a wrapped portion of insulation (usually 1/2 to 2 turns) around the terminal in addition to wrapping the stripped wire. Modified wraps are used for additional resistance to vibration.

PART NO. A 0108



FOR PROGRAM DATA SEE DWG #801016 (B)

NOTE:
ABOVE PATTERNS ARE SHOWN AS WIRED IN THE SAME "TRP" POSITION AND AS VIEWED FROM THE FRONT OF THE MACHINE.

SYM.	DEFINITION
"AT"	"A" TOOL
"AFD"	"A" FRONT DRESSING FINGER
"ARD"	"A" REAR DRESSING FINGER
"BT"	"B" TOOL
"BFD"	"B" FRONT DRESSING FINGER
"BRD"	"B" REAR DRESSING FINGER

UNLESS OTHERWISE SPECIFIED - FRACT. DIM. ± ~ DEGREES ± ~ PERPENDICULAR SURFACES TO BE SQUARE WITHIN ~ GEOMETRIC SYMBOLS PER MIL-STD-8A
DIA'S. ON COMMON ℄ TO BE CONC. WITHIN ~ T. I. R. BREAK SHARP EDGES .010 MAX. & MACHINED FILLETS .010 TO .025 — MACHINED SURFACES √ FINISH

LTR	REVISION	DATE	DR.	CK.
A	[illegible]	12/7/61	GF	
B	WAS 311-3301	3/21/62	FC	
C	REVISED	6/13/63	CN	MA

1ST. ASSEMBLY USED: 14F-22x22-.025
PRODUCT USED ON DISTRIBUTION

GARDNER-DENVER CO. GRAND HAVEN MICHIGAN

MATERIAL ~
MIN. SIZE ~
HEAT TREAT SPEC. Rc
FIN. SPEC

NAME: WIRING PATTERNS .200 MODULE
DR. JLP 5-11-61
CK. ~
MET. APP.
ENG. APP. M P White 6-14-63
SCALE
PART NO. 801017

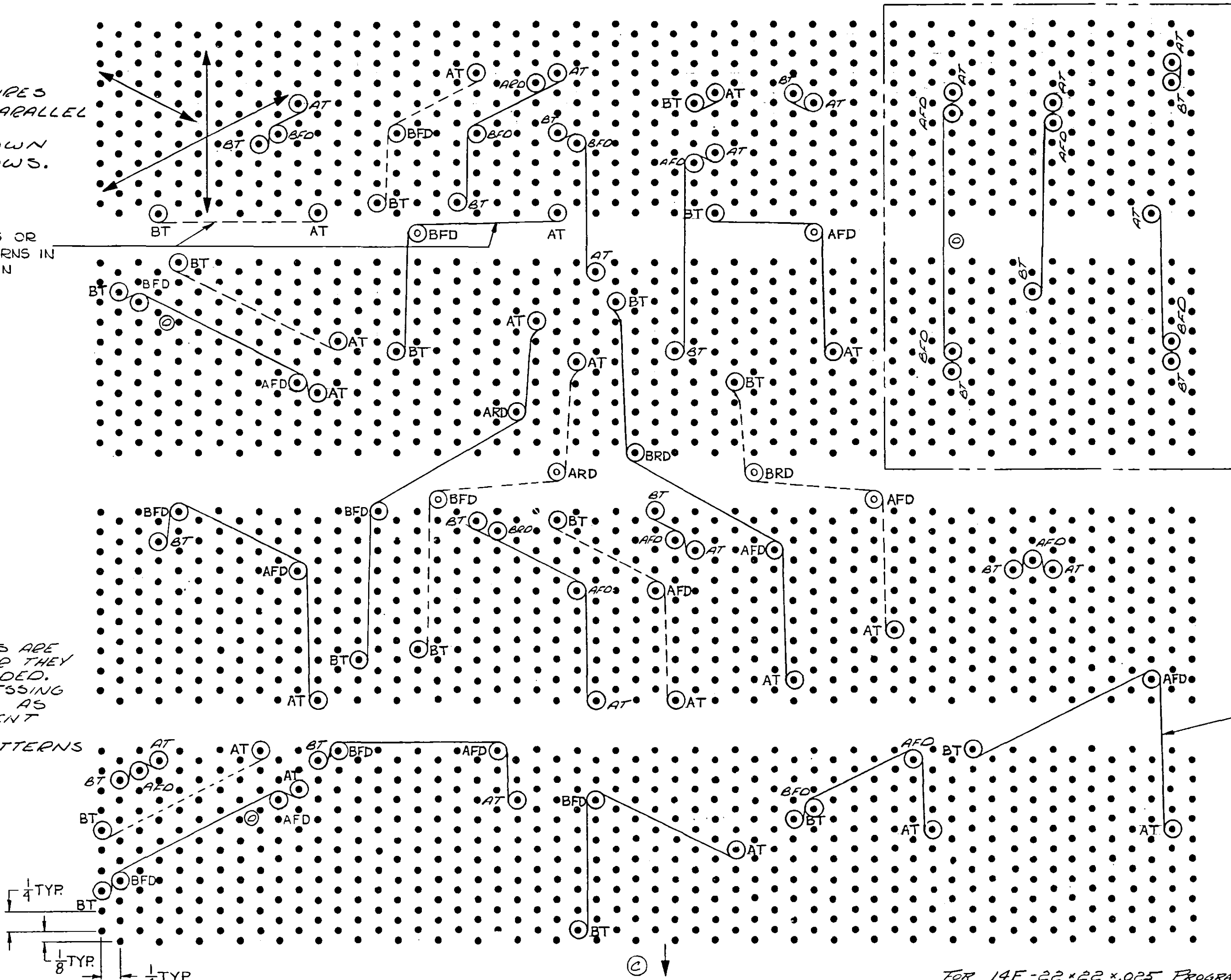
ATTACHMENT 2

801015 PART NO.

IN PIN AREA, WIRES MAY BE RUN PARALLEL TO THE THREE CHANNELS SHOWN BY THE (3) ARROWS.

ALL STRAIGHT WIRES OR LEGS OF WIRE PATTERNS IN THIS PLANE MUST BE IN CHANNELS ONLY.

FRONT OF MACHINE (FOR THIS GROUP OF WIRES ONLY) (C)



NOTE: (C)
#1. STRAIGHT WIRES ARE POSSIBLE, HOWEVER THEY ARE NOT RECOMMENDED. INSTEAD USE DRESSING FINGER PATTERNS AS SHOWN TO PREVENT TAUT WIRES.
#2. SOLID LINE PATTERNS PREFERRED

24 GAGE WIRE ONLY

ABOVE WIRING PATTERNS MUST MAINTAIN RELATIONSHIP WITH TERMINAL GRID PATTERN AS SHOWN.

(C) FRONT OF MACHINE

FOR 14F-22×22×.025 PROGRAM DATA SEE DWG. 801014 (B)

AT - A TOOL
BT - B TOOL
AFD - A FRONT DRESSING FINGER
ARD - A REAR DRESSING FINGER
BFD - B FRONT DRESSING FINGER
BRD - B REAR DRESSING FINGER

UNLESS OTHERWISE SPECIFIED - FRACT. DIM. ± DEGREES ± PERPENDICULAR SURFACES TO BE SQUARE WITHIN GEOMETRIC SYMBOLS PER MIL-STD-8A
DIA'S. ON COMMON ℄ TO BE CONC. WITHIN T. I. R. BREAK SHARP EDGES .010 MAX. & MACHINED FILLETS .010 TO .025 — MACHINED SURFACES √ FINISH

LET.	REVISION	DATE	DR.	CK.
A	WAS SH-3300	12-6-61	[illegible]	
B	WAS SH-3299	3-21-62	F.L.	
C	ADDED NOTES	1-17-63	CN	MPW
D	WERE REAR DF'S	1-17-63	CN	MPW
E	MODIFIED	6-20-63	CN	MPW
F	REVISED DWG	9-9-64	CN	CLM

1ST. ASSEMBLY USED

14F 22×22×.025 PRODUCT USED ON

DISTRIBUTION

GARDNER-DENVER CO. GRAND HAVEN MICHIGAN

MATERIAL

MIN. SIZE

HEAT TREAT SPEC. Rc.

FIN. SPEC

NAME .025 MODULE WIRING PATTERNS

DR. GRITZMAKER	5-10-61	MET. APP.	
CK. MPN	6-20-63	ENG. APP.	6-20-63 mpwhit.
SCALE			

PART NO. 801015

ATTACHMENT 3

SALES AND SERVICE OFFICES

UNITED STATES and MEXICO

ATLANTA, GEORGIA - 1114 W. Peachtree St., N.W.
BIRMINGHAM, ALABAMA - 817 Green Springs Highway, P. O. Box 6042
BOSTON (NEEDHAM HEIGHTS), MASSACHUSETTS - 65 Crawford St.
BUFFALO, NEW YORK - 4532 Bailey Ave.
BUTTE, MONTANA - 215 East Park St.
CASPER, WYOMING - 502 N. Fenway
CHICAGO (BROADVIEW), ILLINOIS - 2535 S. 25th Ave.
CINCINNATI, OHIO - 2327 Park Ave.
CLEVELAND, OHIO - 5400 Warner Road
CORPUS CHRISTI, TEXAS - P. O. Box 5057, 4522 Baldwin Blvd.
DALLAS, TEXAS - 7125 Harry Hines Blvd., P. O. Box 35106
DENVER, COLORADO - 1727 E. 39th Ave., P. O. Box 1020
DETROIT (OAK PARK), MICHIGAN - 12700 Capital Ave. P. O. Box 3707
DULUTH, MINNESOTA - 521 E. Superior St.
EL PASO, TEXAS - 1704 E. Paisano Dr., P. O. Box 10260
GRAND JUNCTION, COLORADO - 2909 N. Ave.
HARTFORD (NEWINGTON), CONNECTICUT - 2525 Berlin Turnpike, P. O. Box 204
HOUSTON, TEXAS - 3325 South Rice Ave., P. O. Box 6705
INDIANAPOLIS, INDIANA - 3957 S. Meridian
KALAMAZOO, MICHIGAN - 2403 Helen Ave., P. O. Box 2586
KANSAS CITY, MISSOURI - 309 W. 79 Terrace
KNOXVILLE, TENNESSEE - 709 N. Fifth Ave., P. O. Box 3236
LAFAYETTE, LOUISIANA - 1022 Auburn St.
LOS ANGELES, CALIFORNIA - 7654 E. Slauson Ave.
LOUISVILLE, KENTUCKY - 2003 Crum's Lane - Shively, P. O. Box 16038
MILWAUKEE, WISCONSIN - 5148 N. Teutonia Ave.
MINNEAPOLIS, MINNESOTA - 1701 W. 80th St.
NEW ORLEANS (HARVEY), LOUISIANA - 1100 Destrehan Ave.
NEW YORK DOMESTIC (TETERBORO, NEW JERSEY), 700 Huyler St.
ODESSA, TEXAS - P. O. Box 6467, East Highway 80
OKLAHOMA CITY, OKLAHOMA - 2200 South Prospect Ave., P. O. Box 94636
PHILADELPHIA (HORSHAM), PENNSYLVANIA - 406 Caredean Drive
PITTSBURGH, PENNSYLVANIA - 520 McNeilly Road
QUINCY, ILLINOIS - Gardner Expressway
RICHMOND, VIRGINIA - 3917 W. Franklin St.
ST. LOUIS (HAZELWOOD), MISSOURI - 6011 N. Lindbergh Blvd.
SALT LAKE CITY, UTAH - 113 W. Second South St.
SAN FRANCISCO (SOUTH SAN FRANCISCO), CALIFORNIA -- 144 W. Harris Ave.
SEATTLE, WASHINGTON - 615 Eighth Ave., South
SHREVEPORT, LOUISIANA - 1025 Joseph Street, P. O. Box 7341
TULSA, OKLAHOMA - 6746 E. 11th St.
WALLACE, IDAHO - Samuels Hotel Bldg., 408 7th St., P. O. Box 788
WASHINGTON D.C. - 6200 Chillum Place, N.W.
WICHITA, KANSAS - 6631 E. Kellogg, Suite 213, P. O. Box 3041

MEXICO CITY 6, D.F. MEXICO, Apartado 575, Versalles y Marsella 8
GARDNER-DENVER WESTERN HEMISPHERE CO., NEW YORK, NEW YORK
INTERNATIONAL DIVISION - NEW YORK, 233 Broadway, NEW YORK, NEW YORK

CANADA

GARDNER-DENVER COMPANY (CANADA), LIMITED

EDMONTON, ALBERTA, 14415 - 114 Ave.
KIRKLAND LAKE, ONTARIO, 61-A Prospect Ave.
MONCTON, NEW BRUNSWICK, East Main St.
MONTREAL 28, QUEBEC, 5825 St. James St., West
NELSON, BRITISH COLUMBIA, 745 Baker St.
SEPT-ISLES, QUEBEC, 295 rue Joliette
SUBBURY, ONTARIO, 1869 LaSalle Blvd., East
TORONTO 16, ONTARIO, 14 Curity Ave.
VANCOUVER 9, BRITISH COLUMBIA, 1775 Pine St.
WINNIPEG 21, MANITOBA, 1370 Sargent Ave.

INTERNATIONAL

GARDNER-DENVER INTERNATIONAL - QUINCY, ILLINOIS
GARDNER-DENVER CO. (BELGIUM) S.A. - BRUSSELS, BELGIUM
GARDNER-DENVER COMPANY SVENSKA AB - STOCKHOLM, SWEDEN
GARDNER-DENVER do BRAZIL, S. A. - RIO de JANEIRO, BELO HORIZONTE, SAO PAULO, BRAZIL
GARDNER-DENVER WESTERN HEMISPHERE COMPANY - BARRANQUILLA, COLOMBIA
GARDNER-DENVER WESTERN HEMISPHERE COMPANY - LIMA, PERU
GARDNER-DENVER ARGENTINA, S. A. - BUENOS AIRES, ARGENTINA
GARDNER-DENVER COMPANY - c/o MAURICIO HOCHSCHILD S.A.I.C., SANTIAGO, CHILE
GARDNER-DENVER (AUSTRALIA) PTY. LTD. - SYDNEY, BRISBANE, VICTORIA, PERTH, ADELAIDE, AUSTRALIA
GARDNER-DENVER CO. AFRICA (PTY.) LTD. - JOHANNESBURG, REP. OF SOUTH AFRICA
GARDNER-DENVER CO. AFRICA (PTY.) LTD. - NDOLA, NORTHERN RHODESIA
GARDNER-DENVER CO. AFRICA (PTY.) LTD. - SALISBURY, SOUTHERN RHODESIA

FACTORIES

DALLAS, TEXAS
DENVER, COLORADO
GRAND HAVEN, MICHIGAN
LA GRANGE, MISSOURI
QUINCY, ILLINOIS
REED CITY, MICHIGAN
YORK, PENNSYLVANIA
JOHANNESBURG, S. AFRICA
WOODSTOCK, ONTARIO, CANADA
WESTHAUSEN, GERMANY

GARDNER-DENVER COMPANY

QUINCY, ILLINOIS

LITHO-IN U.S.A.