UNDERSTANDING INDUSTRIAL DIAGRAMS

Know the symbols and types of diagrams you may encounter and the problem is half solved

By TOM JASKI

YOU do not read an industrial electronics diagram as you do a communications electronics one. They just aren't the same. Symbols differ, and the same symbols may represent different components. However, once a few basic points are clarified, industrial schematics will be no more difficult to read than the familiar communications schematic.

The table presents a list of symbols with the communications symbol on the left, definition in the center, industrial symbol on the right. In most instances the differences are not great, and many devices are represented by the same symbol in both communications and industrial usage. But there are some differences which may get confusing.

One of these is the industrial symbol for a relay contact. It looks very much like the communications symbol for a capacitor. Also, the industrial symbol for a normally closed relay might be confused with the communications variable-capacitor symbol.

The American Standards Association (ASA) has been trying to standardize symbols, but it is difficult to get such symbols universally accepted. Many industrial electronics engineers and draftsmen were once communications engineers and carry with them old habits of presentation. Manufacturers have extensive files of diagrams and catalog cuts which were made before standardization became an obvious necessity, and the cost of changing existing drawings may be prohibitive.

There is no real impasse. It is simply a matter of time before a practice becomes universal, and eventually industrial electronics will play such an important role in our lives that there will probably be a tendency to unify the existing symbols. But this may be a long time away. In the meantime you must get along with the mixture and compromises now in use.

Types of diagrams

Drawing practices also vary. Industry has long used "wiring" and "elementary" diagrams, unlike the schematic diagrams used in communications. Fig. 1 shows the difference between the three types. In the wiring diagram (Fig. 1-a) items such as relay contacts are drawn adjacent to the relay coil. This is also true in the schematic (Fig. 1-b). But in the elementary diagram (Fig. 1-c), we are concerned primarily with showing the sequence of events. So if A must happen before B, we show A first and then B, even if they are part of the same piece of equipment. If we have a transformer, and the items fed by various secondaries are separated in the elementary diagram, we will cheerfully draw all the secondaries where they are needed, and thus scatter the parts of the transformer all over the sheet. This is graphically illustrated by the separation of the relay contacts from their coil. Of course, parts thus separated must be carefully identified.

Elementary diagrams came in vogue with the introduction of complicated relay control diagrams, where the circuit often could not be understood unless there was a clearly indicated sequence of events in the diagram. (*Symbols, pages* 66-67; *text continued page* 68)

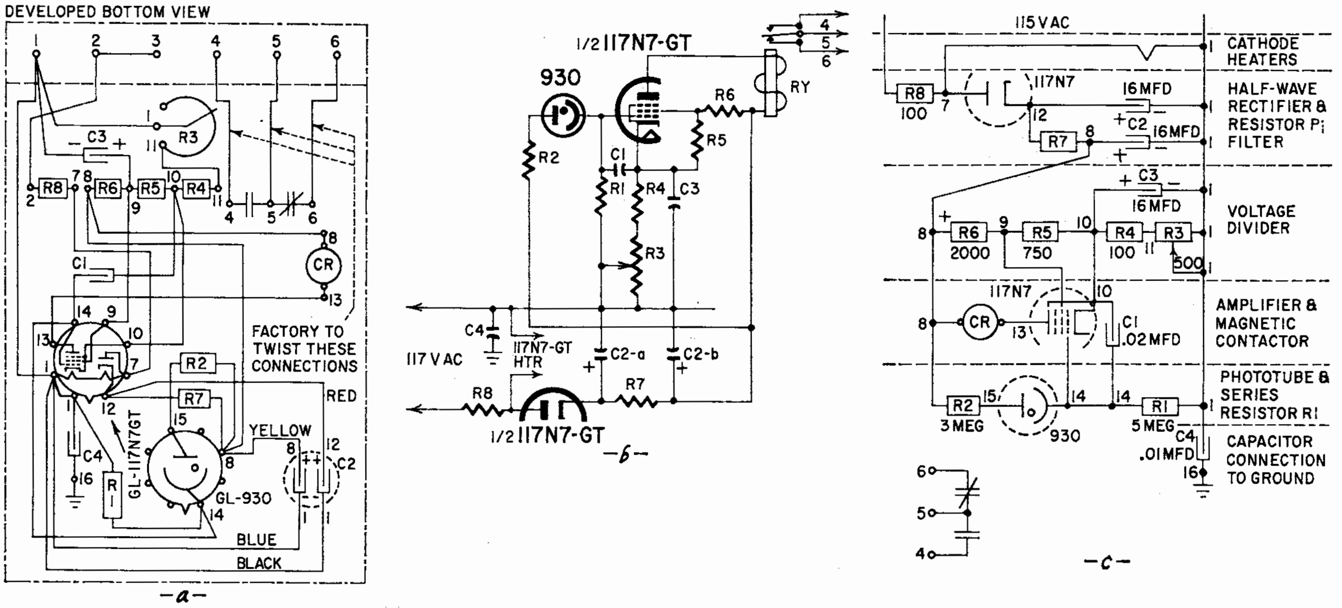

Fig. 1—Circuit of a G-E photoelectric relay: a—wiring diagram (industrial); b—schematic diagram (communications); c—elementary diagram (industrial).

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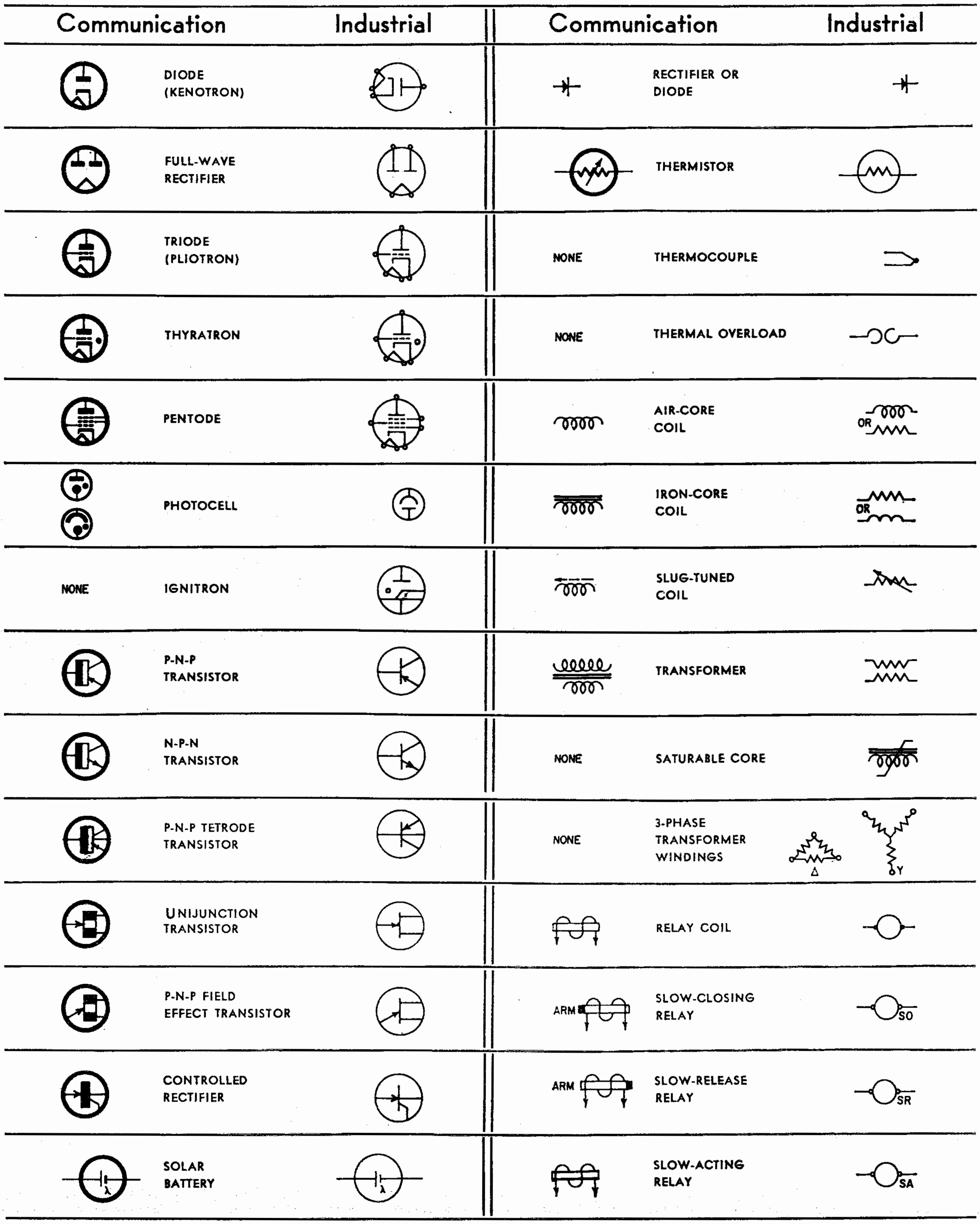

Communication		Industrial	Communication		Industrial
	DIODE (KENOTRON)			RECTIFIER OR DIODE	
	FULL-WAVE RECTIFIER			THERMISTOR	
	TRIODE (PLIOTRON)		NONE	THERMOCOUPLE	
	THYRATRON		NONE	THERMAL OVERLOAD	
	PENTODE			AIR-CORE COIL	OR
	PHOTOCELL			IRON-CORE COIL	OR
NONE	IGNITRON			SLUG-TUNED COIL	
	P-N-P TRANSISTOR			TRANSFORMER	
	N-P-N TRANSISTOR		NONE	SATURABLE CORE	
	P-N-P TETRODE TRANSISTOR		NONE	3-PHASE TRANSFORMER WINDINGS	Δ Y
	UNIJUNCTION TRANSISTOR			RELAY COIL	
	P-N-P FIELD EFFECT TRANSISTOR		ARM	SLOW-CLOSING RELAY	SO
	CONTROLLED RECTIFIER		ARM	SLOW-RELEASE RELAY	SR
	SOLAR BATTERY			SLOW-ACTING RELAY	SA

Table of Symbols

Communication		Industrial	Communication		Industrial
	NO (NORMALLY OPEN) RELAY CONTACT			ANTENNA	
	NC (NORMALLY CLOSED) RELAY CONTACT		OR	BATTERY	OR
	SPDT RELAY CONTACT			CONNECTOR	
NONE	DELAYED-OPENING RELAY CONTACT	TDO		MANUAL SWITCH	
NONE	DELAYED-CLOSING RELAY CONTACT	TD		PUSHBUTTON SWITCHES	
LS (NO)	LIMIT SWITCH	LS (NO)		PILOT LAMP	R LETTER FOR COLOR
	CIRCUIT BREAKER			NEON LAMP	
NONE	MAGNETIC OVERLOAD			FUSE	
	RESISTOR			CIRCUIT WIRE	NONE
	TAPPED RESISTOR			GROUND BUS	NONE
	ADJUSTABLE RESISTOR	OR	NONE	CONTROL WIRE	
	CAPACITOR		NONE	POWER WIRE	
	VARIABLE CAPACITOR			CROSSING WIRES, NO CONNECTION	
CHASSIS	GROUND	OR		CROSSING WIRES CONNECTED	

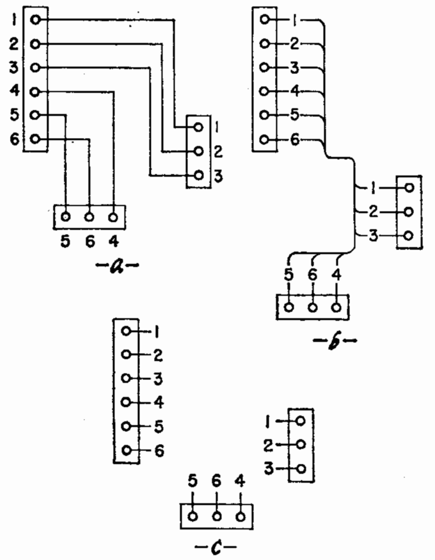

Fig. 2—Three ways of drawing multiple-lead wiring: a—all leads are drawn; b—all leads are combined into one lead and terminals are numbered; c—no leads are shown, terminals are numbered.

They served so well there that the practice was carried over into other kinds of circuits.

But this is not all. Another difference is illustrated in Fig. 2. Almost invariably in communications diagrams all connections are shown, even if it means drawing many parallel lines (Fig. 2-a). In industrial diagrams there may be so many parallel wires that the drawing becomes impractical. Then the draftsman will pull these wires into one line and will designate the origin and destination with a number (Fig. 2-b).

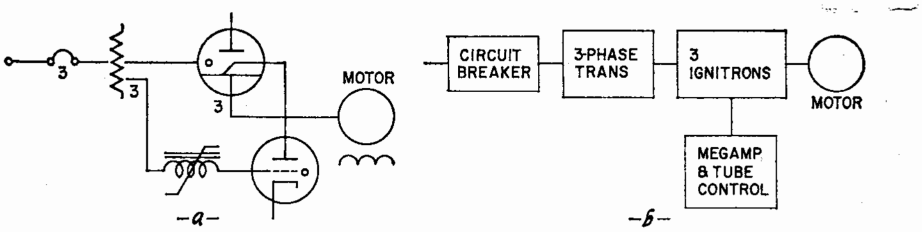

Fig. 3-a—one-line diagram; b—block diagram. Both serve the same purpose.

This does not mean necessarily that these wires are cabled, although they often are.

We can go one step further, leave out the lines altogether and simply designate the origin and destination of the wires (Fig. 2-c). This is universal and long established practice in wiring diagrams used in large powerhouse switchboards and control systems, and is being carried over into industrial electronics. For one accustomed to having every line drawn, this may need some study.

Long familiar to communications are block diagrams. Their equivalent in industrial diagrams are single- (one-) line diagrams. These are essentially similar to block diagrams, except that instead of blocks with designations written in, the single-line diagram often shows the more graphic single-line symbols as in the power business. Fig. 3 shows the difference. Single-line diagrams are used to give a quick view of the entire system and its major components.

A fifth kind of diagram you may encounter is the construction diagram. It is very much like the wiring diagram and sometimes serves the same purpose. Construction diagrams show the components in their actual physical relationship, with quite a lot more accuracy than a wiring diagram, and show only terminals. Thus rather than show the vacuum tubes and transformers with their internal construction schematically presented, only circles or rectangles are shown with the actual terminals and socket connections. Unless you are familiar with all the components involved, it is almost impossible to determine function from a construction diagram. Such diagrams also indicate how wires are dressed, whether or not they are cabled, and how various parts are fastened. It usually takes several construction drawings to give all the details of a particular system or instrument.

Here you have the most important differences in diagrams you may have to cope with. There are many hybrids, wiring and construction diagrams mixed, schematics and elementary diagrams combined and so on. Nor can you expect to find a pure application of symbols of one kind or another everywhere. But knowing about the possible differences is half the battle in coping with them. END

solder removal made easy

COSTLY repairs are being reduced at ITT Federal Electric, Clifton, N. J., with a vacuum pump connected to a length of Teflon tubing. The device is used to remove solder from connections being disassembled. Once the joint is hot and the solder melted, the vacuum pump pulls the molten solder away through the Teflon tube. An ordinary fuel-line filter keeps the solder from getting into the pump (see diagram).

In one particular application, we had to remove quartz crystals from printed-circuit boards. With normal methods of heating the joint and wiggling leads free, excessive heat would ruin an average of $30 worth of crystals per board. With the vacuum pump pulling the molten solder away, heat can be removed much sooner and all the crystals can be saved. The job goes much faster too.

The Solder removal method also has many other applications in repair operations. Solder can be drawn away from almost any type of soldered connection to facilitate the removal of components. This makes an easy job of the old problem of removing solder from tube socket pins, terminal lugs, printed-circuit feedthrough holes, and other difficult spots.

The only problem you are likely to encounter in using the device is that, after long use, some solder may start to build up around the end of the Teflon tube. When this happens, cut off the clogged end and you're back in business.

We use a ¼-hp motor to insure picking up all molten solder, an automotive type fuel-line filter and a 4-foot length of 8-gauge Teflon sleeving.—*William J. McGuinness*