NEW AND IMPROVED COAXIAL CONNECTORS

LOWER VSWR — NEW LOCKING TYPES — LOWER LEAKAGE

The TYPE 874 Coaxial Connector* has found increasingly wide acceptance each year since its introduction in 1948. It is a unique device, designed primarily for use in measurement systems and compatible, through a comprehensive line of low-reflection adaptors, with all other commonly used coaxial connectors.

Its hermaphroditic feature — all connectors are identical and any one plugs directly into any other — and its excellent VSWR have made it the basis of an extensive line of measuring instruments and accessories for use at frequencies up to about 5000 Mc. Because the original design of the connector contemplated its manifold applications, these instruments have provided outstanding performance and versatility both in the electronics industry and in educational institutions.

To the instrument manufacturer, the problem of what type of coaxial connector to supply on his product has been a difficult one, for different customers want different types of connectors. The TYPE 874, with its associated line of adaptors, has provided the solution for a growing list of instrument manufacturers. New connector and adaptor designs, described in this article, make this solution much more attractive and more satisfactory than ever before.

The use of several millions of these connectors in a wide variety of applications at frequencies ranging from dc to several thousand megacycles per second has clearly demonstrated the versatility and soundness of the basic concept and design. Not surprisingly, however, such widespread usage has also indicated where improved performance would further enhance the utility of the connector and has generated requests for additional features. The improvements most frequently requested have centered in four areas.

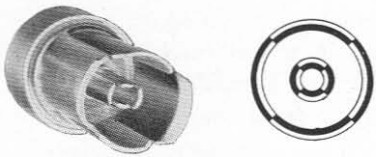


Figure 1. (Left) Type 874 Coaxial Connector. (Right) Cross section of two connectors plugged together.

1. The desire for a permanent connection is obviously in conflict with the desire for quick-connect/disconnect feature of the TYPE 874. Nevertheless, many users have expressed a desire for a permanent locking feature while still retaining all the other desirable characteristics of the connector.

2. Although rf leakage is of the same order as that found in other widely used connectors, the usefulness of the connectors in certain critical applications would be increased if the leakage were reduced.

3. Although VSWR for these connectors has been lower than that of most other basic connectors up to frequencies of the order of 4000 or 5000 Mc, a reduction in the VSWR and an even wider frequency range would naturally be welcomed. The VSWR should also be closely reproducible, regardless of how

*U. S. Patent No. 2,548,457.

many times a pair of connectors is plugged together and unplugged.

4. In the original design, some loosening of the connector assembly could occur with prolonged use as a result of cold flow of the insulating support bead. A design in which the secureness of the connector assembly does not depend upon the bead compression would provide more rigid and permanent mechanical assemblies.

An active and continuous development program in design, manufacturing technique, and quality control has been carried on for several years, with particular emphasis on the areas mentioned above. The results of this program to date are detailed below, wherein the new locking version of the connector is described, as well as the improved performance and reliability of both the locking and the non-locking versions. Included in the expanded line are also locking adaptors to other types of connectors.

GENERAL IMPROVEMENTS

Minor revisions in dimensions, closer tolerances, improved tooling, and a particularly rigorous program of statistical quality control have extended the range of satisfactory operation to about 7000 Mc, improved reliability, reduced VSWR variation from unit to unit, and improved the mechanical feel and ease of use of the connector. The most significant design change, however, provides a secure metal-to-metal joint in the outer conductor assembly, eliminating dependence on compression of the polystyrene bead which now serves only to support the inner conductor. Although the bead is still put under compression when the connector is assembled, this is merely to ensure that the bead stays in place. Figure 2 shows this construction.

Needless to say, one of the important criteria for any design change was that the improved connector be compatible electrically and mechanically with connectors already in use. Any TYPE 874 connector, regardless of vintage, will connect satisfactorily to any other TYPE 874 connector.*

THE NEW LOCKING CONNECTOR

The new locking version of the TYPE 874 complements the non-locking, quick-

*The only exception is that a new locking connector will not mate with a TYPE 874-P Panel Connector because of its long shroud. This type of connector is now replaced by the TYPE 874-PB and -PL Panel Connectors.

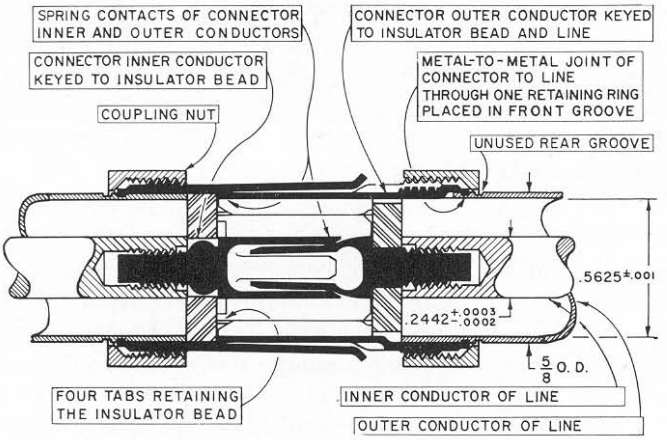


Figure 2. Sectional view of improved non-locking connector. The back edge of the connector outer conductor is drawn up against the retaining ring when the coupling nut is fully tightened. The beveled inside surface of the coupling nut forces the split retaining ring solidly against the bottom of the groove in the outer conductor of the line, and thus a solid metal-to-metal joint is obtained between the outer conductors of the connector and line. The insulating bead is held securely in place by four small tabs which sink into the insulator as the coupling nut is tightened.

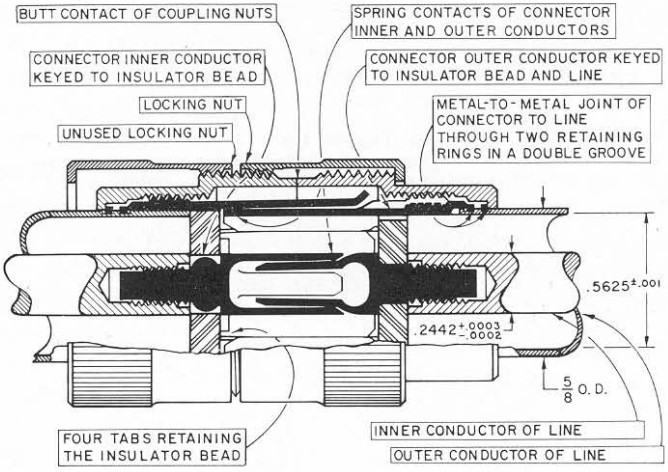


Figure 3. Sectional view of the new locking connector. The solid metal-to-metal joint between the connector and the line on which it is mounted is obtained by clamping a pair of retaining rings against a ridge between two grooves in the outer conductor of the line. As the coupling nut is tightened, the two rings are forced against the ridge by the back edge of the connector outer conductor and a shoulder inside the coupling nut.

connect/disconnect type by providing a rigid connection for semi-permanent installations. These are now in production, and they offer the following features:

1. Provision for rigid mechanical coupling (at the user's option, connectors will mate without locking).
2. Ease of use.
3. Retention of the hermaphroditic feature so that any two connectors will mate and lock together.
4. Compatibility with existing non-locking TYPE 874 connectors.
5. Retention of the quick-connect/disconnect feature when the locking feature is not wanted.

The last two items are particularly significant. The ability to connect together a non-locking and a locking type (and to use the lock or not to use it as one chooses) results in a coaxial connector system of extraordinary flexibility and versatility.

Figure 3 shows in detail how the above results have been achieved. The coupling nut, which fastens the outer connector to the coaxial line, has been modified and a locking nut added. When two locking TYPE 874's are plugged together, the locking nut of either can be screwed onto the coupling nut of the other to lock the connection. The locking nut on the second connector is backed off to a storage position. When the two connectors are mated and locked, the coupling nuts are butted together and provide a stop, eliminating the possibility of damage to the inner or outer conductor through overtightening.

The solid metal-to-metal joint mentioned previously is an integral and, in fact, essential part of the design of the locking connector.

The new locking connectors are available for use on air lines, cables, and panels. Locking cable connectors are available in five sizes to accommodate various popular coaxial cables. Locking panel connectors are available in both recessed and nonrecessed versions, each having four cable sizes and one wire-lead type.

ELECTRICAL PERFORMANCE

Standing-Wave Ratio

VSWR characteristics of typical TYPE 874-BL Locking Connectors and TYPE 874-B Connectors taken from a current production run are shown in Figure 4.

The slight difference between the

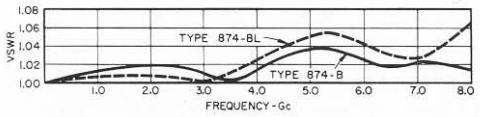


Figure 4. Typical VSWR of Type 874-B and -BL Connectors. Each curve shows the VSWR that a *pair* of connectors introduces into a line.

VSWR of the locking and non-locking versions is the result of a design feature whereby the connectors are normally disengaged very slightly when the locking nut is fully tightened, thereby preventing forced bottoming, which might cause distortion of the connector contacts. The VSWR characteristic plotted corresponds to the statistically maximum disengagement of the connectors.

In addition to the improved mechanical features of the locking connector, the rf leakage has been greatly reduced, owing to the additional shielding provided by the coupling and locking nuts. The leakage from typical sets of the TYPE 874-BL Locking Connectors is shown as a function of frequency in Figure 5. The leakage characteristics of the non-locking TYPE 874 Connector and Types BNC and N connectors are shown for comparison. An improvement of approximately 50 db over the non-locking version is shown.

For these measurements, the connectors tested were inserted in a coaxial line, which was terminated in 50 ohms. This line was in turn made the center conductor of a larger, terminated, 50-ohm coaxial line, and the power leaking into the larger line was measured. The db values indicated in Figure 5 are the ratios of the power input to the internal coaxial line to the leakage power absorbed in the termination of the larger line.

NEW AND IMPROVED ADAPTORS

Obviously, the TYPE 874 Adaptors were designed to adapt TYPE 874 Connectors to other coaxial connectors, but equally important is their ability to interconnect different types of military connectors without introducing major reflections (see Figure 6). The more types of connectors involved, the more attractive are the TYPE 874 Adaptors. As an illustration, suppose that the

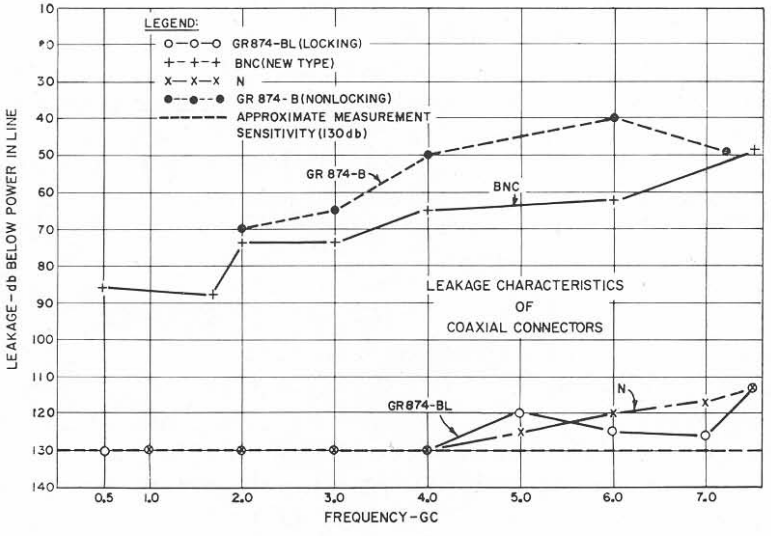


Figure 5. Leakage characteristics of several types of coaxial connectors.

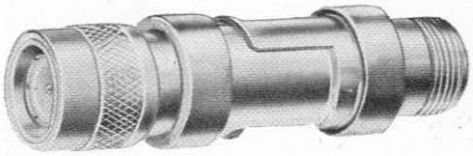


Figure 6. Type 874-QCP and -QNJA Adaptors plugged together. This assembly will connect a Type C jack to a Type N plug.

equipment in a laboratory contained the Types BNC, C, HN, LT, N, and UHF plugs and jacks. The number of direct adaptors needed to interconnect any connector with any other type is 60, while only 12 TYPE 874 Adaptors will do the same job (and permit connection to TYPE 874 Connectors as well). Not only is there an economy in adaptors, but, since many of the needed 60 direct adaptors do not exist, a pair of intermediate TYPE 874 Adaptors often comprises the most direct means available.

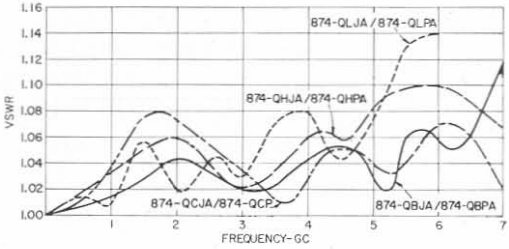
The performance of standard nonlocking adaptors has been improved by redesign that incorporates the basic connector improvements already discussed. In addition, most adaptors have been shortened, and at the same time the performance of the "military" end of the connector has been improved. In most cases, the VSWR of an adaptor with its two connectors is as low as, or lower than, that of the corresponding standard military connector (see Fig. 7).

A new, shortened adaptor is identified by a final A in the type number. Eight such adaptors are presently available to connect TYPE 874 Connectors to Types BNC, HN, and LC plugs and jacks, and Types C and N plugs.

Longer life and more reliable performance will be obtained from all new TYPE 874 Adaptors than from the standard military connectors to which they mate, because hardened beryllium copper (or, in some types, phosphor bronze) is used in the plug contacts instead of brass.

NEW LOCKING ADAPTORS

To the long list of available TYPE 874 Adaptors have been added several popular types incorporating the new locking connector. The locking feature is now available in six of the more popular adaptors. Each of these adaptors contains locking TYPE 874 Connector and a Type BNC, C, N, SC, TNC, or UHF



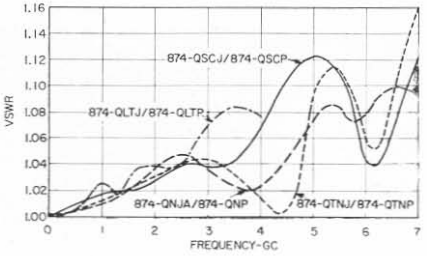
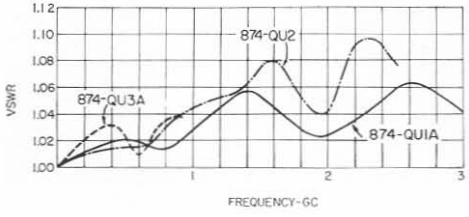
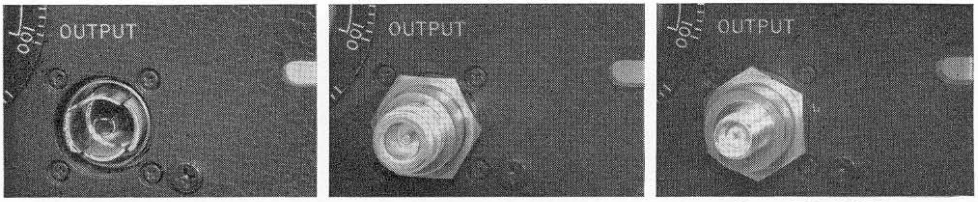


Figure 7. Typical VSWR introduced in line by *pairs* of Type 874 Adaptors plugged together.





Type 874-PRL Type 874-QNJL Type 874-QTNJL

Figure 8. A recessed panel connector, Type 874-PRL (shown at left), is converted to other connector types by the addition of adaptors, as shown in the photographs above and in those at the foot of the page.

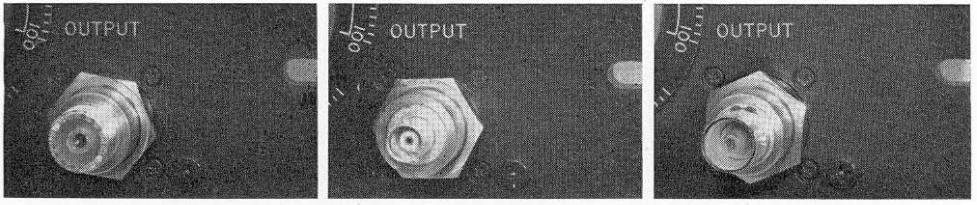
jack. Thus an instrument equipped with TYPE 874 Locking Panel Connectors can be quickly converted to any of these military connector systems by means of rigid, semi-permanent adaptors as shown in Figure 8.

The quick-conversion capability offers to the instrument manufacturer a basic panel connector that can be quickly adapted to meet individual customer specifications for various coaxial connectors. Furthermore, the user of an instrument equipped with the locking panel connector can readily change from one type of connector to another. If the instrument is equipped with the new recessed locking panel connectors, the conversion is especially neat, for the locking adaptors extend only about an inch in front of the panel.

Locking connectors are presently being used on the panels of several new GR instruments so that conversion to Type N, C, BNC, SC, TNC, or UHF connectors can be made merely by locking the desired adaptor firmly in place. The use of locking panel connectors will gradually be extended to most instruments in the GR line. Most components (tees, lines, attenuators, pads, etc.) have been, or will be, modified to permit the use of either locking or non-locking connectors.

The older TYPE 874 Connectors on these latter components cannot be directly replaced with the locking type, since an additional groove is required and the groove position is different. Components with non-locking connectors having the new construction can be identified by an unused groove in the outer conductor which appears directly behind the coupling nut.

Increased acceptance of the TYPE 874 Connector has already resulted from the increased versatility and the improvement in performance. This connector is well on the way to the same universal acceptance that has been accorded the banana plug, first introduced in the United States by General Radio in 1924. The development program which produced these design changes is continuing with emphasis on improvement of the cable connectors and on further reductions of VSWR.



Type 874-QUJL Type 874-QBJL Type 874-QCJL

CONNECTORS

	Type	*Fits*	*Code Word*	*Price**	
Basic Connectors	**874-B**	50-ohm Rigid Air Line	COAXBRIDGE	**$1.60**	*See Fig. 1*
	874-BL	50-ohm Rigid Air Line (locking)	COAXYPIPIT	**2.50**	
Cable Connectors	**874-C**	874-A2 Cable	COAXCABLER	**2.30**	
	874-C8	RG-8/U Cable	COAXCORDER	**2.30**	
	874-C9	RG-9/U, RG-116/U Cables	COAXCAMMER	**2.30**	
	874-C58	874-A3, RG-29/U, RG-55/U, RG-58/U, RG-58A/U Cables	COAXCALLER	**2.30**	
	874-C62	RG-59/U, RG-62/U Cables (nonconstant impedance)	COAXCANDOR	**2.30**	
Cable Connectors —Locking	**874-CL**	874-A2 Cable	COAXYROBIN	**3.50**	
	874-CL8	RG-8/U Cable	COAXPARROT	**3.50**	
	874-CL9	RG-9/U, RG-116/U Cables	COAXYJUNCO	**3.50**	
	874-CL58	874-A3, RG-29/U, RG-55/U, RG-58/U, RG-58A/U Cables	COAXYSNIPE	**3.50**	
	874-CL62	RG-59/U, RG-62/U Cables (nonconstant impedance)	COAXYSWIFT	**3.50**	
Panel Connectors —Flanged	**874-PB**	874-A2 Cable	COAXAPPLER	**3.20**	
	874-PB8	RG-8/U, RG-9/U, RG-116/U Cables	COAXBATHER	**3.20**	
	874-PB58	874-A3, RG-29/U, RG-55/U, RG-58/U, RG-58A/U Cables	COAXABATER	**3.20**	
	874-PB62	RG-59/U, RG-62/U Cables (nonconstant impedance)	COAXBARKER	**3.20**	
Panel Connectors —Locking	**874-PL**	874-A2 Cable	COAXYFINCH	**3.75**	
	874-PL8	RG-8/U, RG-9/U, RG-116/U Cables	COAXYVIREO	**3.75**	
	874-PL58	874-A3, RG-29/U, RG-55/U, RG-58/U, RG-58A/U Cables	COAXTHRUSH	**3.75**	
	874-PL62	RG-59/U, RG-62/U Cables (nonconstant impedance)	COAXTOUCAN	**3.75**	
	874-PLT	Wire Lead	COAXWILLET	**3.75**	
Panel Connectors —Locking, Recessed	**874-PRL**	874-A2 Cable	COAXYGOOSE	**4.00**	
	874-PRL8	RG-8/U, RG-9/U, RG-116/U Cables	COAXCONDOR	**4.00**	
	874-PRL58	874-A3, RG-29/U, RG-55/U, RG-58/U, RG-58A/U Cables	COAXCURLEW	**4.00**	
	874-PRL62	RG-59/U, RG-62/U Cable (nonconstant impedance)	COAXAVOCET	**4.00**	
	874-PRLT	Wire Lead	COAXMERLIN	**4.00**	

*For quantities of 1 to 99; prices for larger quantities on request.

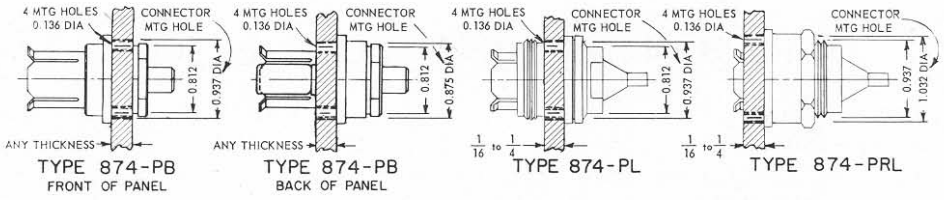
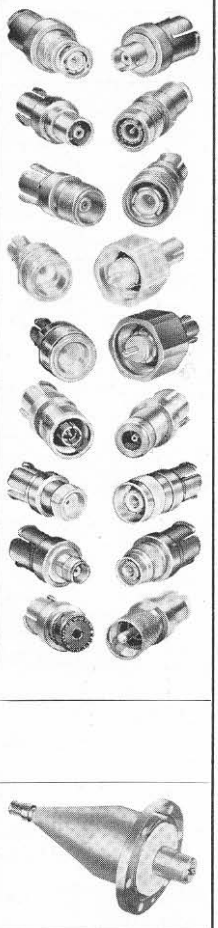


Figure 9. Mounting dimensions for Type 874 Panel Connectors.

ADAPTORS

	*Type**	*Connects Type 874 to . . .*	*Code Word*	*Price*
TO TYPE BNC	874-QBJA	BNC Plug	COAXBOGGER	$4.75
	874-QBJL	BNC Plug (locking 874)	COAXCASHEW	5.75
	874-QBPA	BNC Jack	COAXBUNNER	5.25
TO TYPE C	874-QCJA	C Plug	COAXCOGGER	5.50
	874-QCJL	C Plug (locking 874)	COAXYPECAN	6.50
	874-QCP	C Jack	COAXCUFFER	6.25
TO TYPE HN	874-QHJA	HN Plug	COAXHAWSER	6.00
	874-QHPA	HN Jack	COAXHANGER	7.50
TO TYPE LC	874-QLJA	LC Plug	COAXLITTER	12.00
	874-QLPA	LC Jack	COAXLUGGER	20.00
TO TYPE LT	874-QLTJ	LT Plug	COAXLAGGER	20.00
	874-QLTP	LT Jack	COAXLOBBER	25.00
TO TYPE N	874-QNJA	N Plug	COAXNAGGER	5.00
	874-QNJL	N Plug (locking 874)	COAXWALNUT	6.00
	874-QNP	N Jack	COAXNUTTER	5.00
TO TYPE SC	874-QSCJ	SC Plug (Sandia)	COAXCOSTER	9.00
	874-QSCJL	SC Plug (Sandia) (locking 874)	COAXALMOND	10.00
	874-QSCP	SC Jack (Sandia)	COAXCASHER	9.00
TO TYPE TNC	874-QTNJ	TNC Plug (Sandia)	COAXTUNNER	6.50
	874-QTNJL	TNC Plug (Sandia) (locking 874)	COAXYHAZEL	7.50
	874-QTNP	TNC Jack (Sandia)	COAXTUSKER	6.50
TO TYPE UHF	874-QUJ	UHF Plug	COAXYUNDER	5.00
	874-QUJL	UHF Plug (locking 874)	COAXYBEECH	6.00
	874-QUP	UHF Jack	COAXPUPPER	5.00
TO TYPE 274	874-Q2	274 Plug or Jack	COAXTIPPER	5.50
	874-Q9	938 Binding Posts	COAXPOSTER	6.00
	874-QN6	274-NO Patch Cord	COAXCHOSER	3.75
TO UHF RIGID LINE	874-QU1A	7/8-in. 50Ω UHF Rigid Line, RG-155/U (EIA TR-134)	COAXYUMBER	35.00
	874-QU2	1 5/8-in. 50Ω UHF Rigid Line, RG-153/U (EIA TR-134)	COAXYUSHER	80.00
	874-QU3A	3 1/8-in. 50Ω UHF Rigid Line, RG-154/U (EIA-TR134)	COAXYULTRA	135.00



*In adaptor type numbers, a J indicates that the adaptor *contains* a jack and a TYPE 874 Connector; a P indicates that the adaptor *contains* a plug and a TYPE 874 Connector. For example, a TYPE 874-QUP Adaptor contains a UHF plug and a TYPE 874 Connector, and will therefore adapt a TYPE 874 to a UHF jack.

NEW TOOLS FOR TYPE 874 LOCKING CONNECTORS

Three tools have been added to the TYPE 874-TOK Tool Kit to help in the installation of locking connectors on air lines and other components. In such installations, it may not be possible to slide back the coupling nut (see Figure 3 in preceding article) enough to expose the retaining-ring grooves because of changes in diameter of the outer conductor or various other obstructions; setting

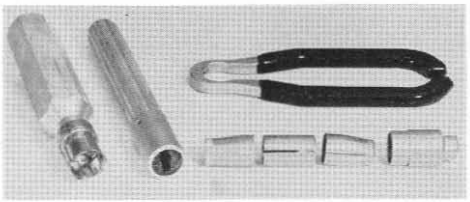


Figure 1. Type 874-TOK Tool Kit consisting of (left) an outer-conductor wrench and an inner-conductor wrench, (right, top) a coupling-nut wrench, and (right, bottom) ring installation tools.

the rings into the grooves can then be difficult, especially inasmuch as the rear ring must pass over the front groove on the way to its position. The three new tools make installation of the retaining rings a simple matter whether grooves are exposed or not. The ring is first placed on one of two cylindrical loaders, depending on which groove it is destined for. The loader is then placed over the outer conductor and the third tool, a cylindrical pusher, is placed over the loader and used to push the ring off the loader and into place in the groove.

The other tools in the TYPE 874-TOK Tool Kit, described in the May, 1960 *Experimenter*, are an inner-conductor wrench to hold and install the insulating bead and the inner connectors, and an outer-conductor wrench and a coupling-nut wrench to install the outer connector and to tighten the coupling nut.

Type		*Code Word*	*Price*
874-TOK	**Tool Kit**	COAXKITTEN	**$20.00**

ANALOG OUTPUT FROM THE DIGITAL COUNTER

Digital counters offer high precision and accuracy combined with a degree of operating convenience for visual readout that is not easily obtained by other means. In many applications, however, it is desirable to have permanent records. Digital printers are useful for this purpose when individual point-by-point measurements are made, but, when the data vary continuously, the printed information must be evaluated line by line. Unless automatic equipment can be used, this process is tedious and slow.

For instance, if the frequency of a quartz-crystal oscillator as a function of temperature is to be determined, a direct analog plot of frequency versus temperature is usually wanted. Figure 2 shows this information in both forms; the analog curve and the printed data. The curve takes only seconds to evaluate, while little can be deduced from

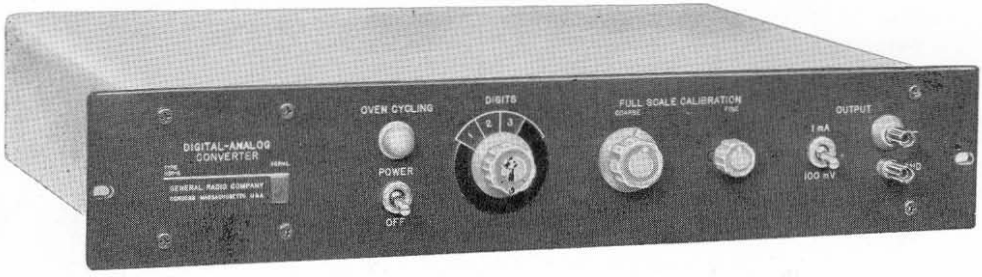


Figure 1. Panel view of the Type 1134-A Digital-to-Analog Converter.