ELECTRICAL CONNECTORS AND TOOLING

Companies must constantly strive for maximum daily utilization of their investment in equipment. Unscheduled maintenance down-time is costly in terms of lost utilization of equipment and man hours.

Electrical connecting devices and their associated tooling create much confusion and time delays. There are numerous manufacturers that supply direct and functionally equivalent devices under their own proprietary part numbers. Most of these numbers are also equivalent to military standard part numbers and part numbers initiated by the equipment manufacturers. Additionally, there is a proliferation of basically identical tools designated by various supplier part numbers and/or military standards that perform the same functions.

Accordingly, Connector Microtooling Systems, Inc. offers this brief instructional aid on electrical connectors and the tooling required to repair and maintain these connectors.

The Electrical Connector - Background

The origin of the circular connector can be traced to the early days of the motion picture industry, as studio lighting required a connector that could not be accidentally disengaged. This need was met in 1925 with the introduction of a receptacle and a plug with a mechanical locking ring. Called the "M" (motion picture) Series, it was developed by Robert Cannon, founder of Cannon Electric (now ITT Cannon).

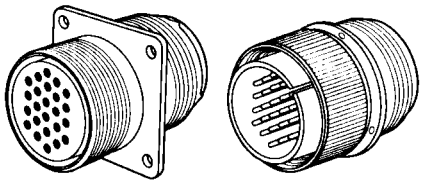
The "P" (Paramount Studios) Series was developed for sound cameras in the late 1920's and introduced features still in use today; die cast shells, molded pin inserts and latch locking devices.

The "F" (Fox Studios) Series incorporated the familiar threaded coupling ring used on many popular connector series today. An adaptation of this series was used on the Douglas DC-1 aircraft. Subsequent DC models utilized variations that were specifically designed and produced for aircraft use such as the "AF" firewall connector, the first hostile environment connector designed for airborne use.

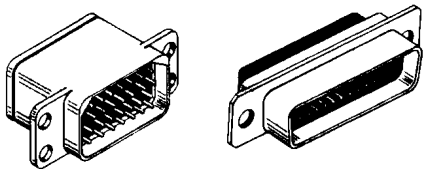
Types of Electrical Connectors

Electrical connecting devices consist of four (4) basic designs:

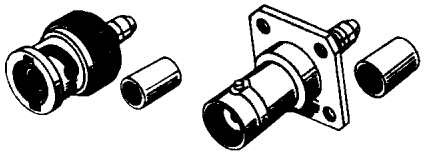
1. Circular or Cylindrical



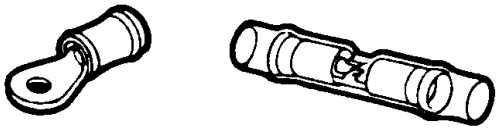
2. Rectangular



3. Coaxial



4. Terminals and Splices



Contact Retention Methods

Early connector designs utilized fixed, non-removable contacts which required soldering to terminate the wires.

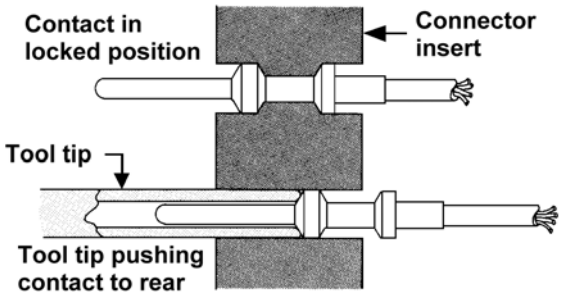
Most connectors in use today utilize crimp, removable contacts for termination. These connectors are crimp removable or solderless connectors because the removable contacts have wires crimped or staked to them. These connectors consist of three (3) main components:

1. The shell, which is the main body of the connector;
2. A rubber or plastic insert;
3. Removable metal contacts.

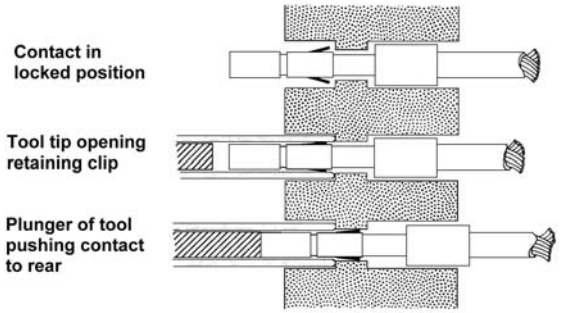
Contacts are typically male (pin) and female (socket) which are installed in plug connectors which are usually attached to the cable end or in receptacle connectors which are usually attached to a bulkhead or other fixed object.

Connector contacts are held in place in the inserts by three (3) different methods:

1. Friction or Interference Lock - the contacts fit very snugly into a hard rubber insert. Contacts are installed and removed by force using the proper tooling. This kind of connector is used in areas outside the aircraft such as the wheel wells. The contacts are usually inserted from the rear of the connector and removed from the front (face) of the connector.

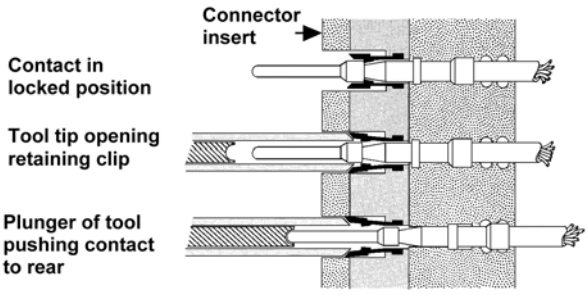


2. Contact Lock - the locking device is located on the contact itself in the form of a spring finger which snaps into place on a ring inside the insert. The contacts are usually inserted from the rear of the connector and removed from the front (face) of the connector.

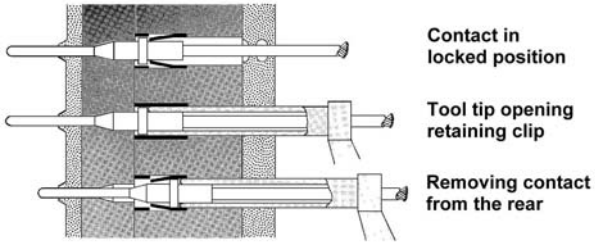


3. Insert Lock - the contact has a ridge (shoulder) machined around the contact which snaps into place in the spring clips (tines) located inside each cavity of the insert. The contacts are usually inserted from the rear of the connector and removed either from the front or rear of the connector.

The top contact, in the insert lock illustrations below, is shown in the "locked" position. The middle contact is shown with the tool probe or tip opening the spring clips. The bottom contact is shown as it moves out of the rear of the connector.



Typical Front Release Retention



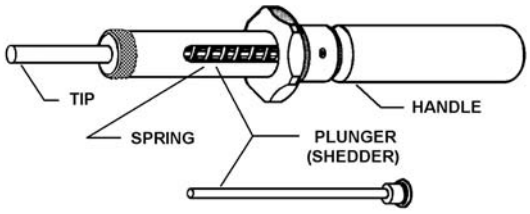
Typical Rear Release Retention

Front release mechanisms - with the front release system, contact positions can be identified easier from the mating end of the connector for releasing and servicing purposes. The removal tool engages the front portion of each contact, then by application of axial force, the contact is displaced until it is visible at the wire bundle side. It can then be removed by hand.

Front release systems utilize all three of the contact retention methods described above.

Care must be exercised with the front-release system, particularly when servicing pin contacts, not to cant the removal tool excessively. This action can bend the contacts.

Front release removal tools, illustrated below, typically consist of a handle, a tip and a plunger (shedder) which is sometimes spring loaded.

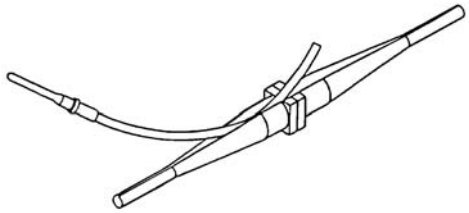


Rear release mechanisms - connectors requiring release and removal of the contacts from the rear of the connector almost always have a blue color band around the shell (body) of the connector and utilize insert lock retention. With the rear release system, identifying the wire from the back side of the connector is difficult. Removal tools must be put over the wire and inserted through an insert (grommet) to release the contact; the tool and wire must be pulled together to remove the contacts from the connectors.

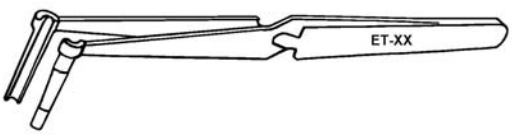
Contact bend damage, while servicing, is minimized since the tool does not shroud the contact. Additionally, the person servicing the connector only has to work from one side of a panel, or piece of equipment, to insert and remove contacts. Depending on the size of the equipment this could eliminate the need for two technicians, one in front and one in back.

The connectors can be serviced in a mated condition. This could also be important if extensive retesting or re-lockwiring is required after connectors are unmated.

Rear release connectors require the use of double-ended tools or metal tweezer type tools illustrated below.



Double-ended Type Tool



Tweezer Type Tool

Identification of Electrical Connectors

After locating a faulty connector, closely examine the main body or coupling ring for any identifying marks (Do not use a number found on a backshell adapter or strain relief).

The connector manufacturer's part number is usually an alpha-numeric designation, ie: "KPSE(*) ITT-CANNON".

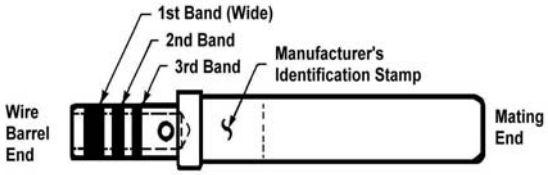
The military standard part number is usually an alpha-numeric designation prefixed with an "M" or "MS", ie: "MS3120(*) ITT-CANNON".

The equipment manufacturer's part number is usually prefixed by: "DC" for McDonnell-Douglas, "BAC" or "10-" for Boeing or "LS" for Lockheed.

(*) indicates that additional alpha-numerics follow to further make up the complete part number.

Contact Identification

Military contacts are identified by a series of three color bands, each representing a specific digit known as the BIN (Basic Identification Number) Code. The color bands are read from the wire barrel end of the contact (widest color band), then towards the mating end of the contact as shown below:



0 = Black	4 = Yellow	8 = Gray
1 = Brown	5 = Green	9 = White
2 = Red	6 = Blue	
3 = Orange	7 = Violet	

Example:
A contact with color bands of orange (widest band), blue and white is a BIN Code of -369. The complete part number would be: M39029/64-369

If the contact has only two color bands, this is a code used only by the connector manufacturer and should not be confused with the military BIN Code described above.

CONNECTOR REPAIR PROCEDURES

There are two major causes for electrical connector failures that will determine the procedure for repair:

1. Bent contact or broken wire in the connector.
   Examine the main body or coupling ring of the connector to identify the connector manufacturer and connector "series" designation.

2. Wire and connector burned beyond recognition.
   First, untie and unclamp the wire harness back to where a wire number can be identified. Using the equipment manufacturer's contractual data Wire List, noting the "wire identification" column, identify the circuit function and wire number. Move to the "termination from" column which will show the connector type, i.e., "P" for plug and "R" for receptacle, then a manufacturer and part number.

If identifying marks cannot be found, refer to the wire list contained in the maintenance manual. All connectors will be identified by the manufacturer's part number, a military standard part number or the equipment manufacturer's part number.

Electrical connectors often use similar contacts and tools. After identifying the connector part number on the shell (body) of the connector, refer to the ***"Connector Reference Guide"*** and locate the series (family) to which this connector belongs. Most tooling can then be found in the document titled, ***"Electrical Connector Tool Selection Data".***

Contacts must often be replaced. Make sure that the proper contacts are used as indicated in the maintenance manual. Contacts with the equipment manufacturer's part number (sometimes color bands) are usually of a specific design; therefore, only that part number should be purchased as a replacement. Contacts with a military part number may be purchased from any approved supplier, within that specification, as the contacts must always be interchangeable.

The technician should always refer to the equipment manufacturer's maintenance manual for specific detailed instructions concerning special procedures or techniques required in specific connector repair.

Cutting and Stripping Insulated Wire

To ensure the proper termination of size AWG 10 and smaller wires, into machined contacts, precision cutters and strippers are absolutely required. Side cutters (or dykes, as they are sometimes referred) deform the insulation and conductor strands and leave a sharp tapered point at the end of the conductor. Shear type blades are preferred as they provide a square, clean cut with no ragged strands.

Precision wire strippers are required for all electronic systems, aircraft, aerospace, missiles, radar and guidance systems and provide extreme reliability while maintaining critical tolerances. The die type blades are designed for specific wire specifications and contain counter bored holes sized for the conductor, insulation material and thickness. The end result is nick free strips and a clean insulation cut without flagging.

Wire strip lengths are usually indicated in the maintenance manual. For AWG 24 through 10 wires an insulation gap between the insulation and the contact wire barrel should measure 1/32" minimum to 1/16" maximum. Strip length shall be sufficient so that conductor strands shall be visible in the inspection hole on all contacts. Insulation should never extend inside the contact wire barrel.

Contact Removal and Insertion

There are generally two types of connector crimp contacts; front release and rear release (refer to pages 3 & 4).

Connectors with rear release contacts are identified by a blue color band around the connector body.

It is recommended that isopropyl alcohol be used to clean and lubricate contacts prior to insertion into the resilient grommet of environmental connectors.

Many of the insertion and removal tools are very delicate; therefore, never force, rotate or spread the tips while inside the connector insert (grommet) as damage may result to both the tool and the connector.

Contact Crimping

Select the proper tool, turret, positioner, die or locator as indicated on the maintenance manual. Strip the wire insulation, to the proper length and proceed according to the specific instructions, for the tool being used, found in the manual.

MILITARY CONNECTOR SPECIFICATIONS

Commercial industry and the military recognized the need for connectors which could be mated and positively locked. For some time, the military used commercially available connectors specified and ordered by the manufacturer's part numbers.

Connectors first appeared in the military part numbering system in the early 1930s, although the system used by the Army and Navy were completely different. It was soon realized that the services were ordering identical parts under several different part numbers. To consolidate military procurement efforts, the "AN" (Army/Navy) series of drawings was established.

The United States Department of Defense has established military specifications and standards as the basis for procurement of electronic components for military and space equipment. The purpose of these specifications is to establish a supply of standardized components specifically designed and tested to withstand the reliability, performance and environmental requirements of the application for which they are intended.

The specification establishes the connector housing dimensions, insert layout patterns and operating characteristics. Manufacturers that produce connectors to specification and whose products meet the stringent qualification tests defined by the controlling military authority, are added to the government's Qualified Products List (QPL) under the specific military connector product.

CIRCULAR CONNECTORS

Circular or cylindrical connectors consist of two mating halves or shells, each of which contains multiple pin or socket configurations. Internal insulating spacers (inserts) support the contacts in their proper orientation. The plug end which is usually attached to the cable or moveable portion and the receptacle which is often mounted in a fixed position. The plug consists of a barrel, a coupling nut and a back-end termination. The barrel fits inside the receptacle shell and the coupling nut holds the mated pair together. Alignment of pins and sockets must conform to rigid tolerances during the manufacturing process in order to avoid bending or breaking during separation or closure of the two halves. Wires are attached to the individual connector pins by crimping or soldering. As in most connectors, crimp contacts are always inserted from the rear. Depending on the connector series, contacts will be removed either from the front or rear of the connector.

By the nature of their shape and construction, circular connectors tend to be rugged and are generally used in hostile environments. Shells are fabricated of aluminum, steel, plastic, rubber or combinations thereof. Military specification connectors are often polarized to prevent mismating.

Couplings

Couplings are designed to lock together a plug and a receptacle. The two most common methods are:

1. Threaded coupling, in which the body of the plug contains an affixed, internally threaded coupling ring that mates with threads cut in the receptacle shell.

2. Bayonet coupling, which employs three pins spaced 120 degrees apart on the external perimeter of the receptacle. The coupling ring of the mating plug is fitted with corresponding grooves and is spring loaded to ensure positive closure.

Contacts

Circular connector contacts are either soldered or crimped. Solder contacts are usually permanent because wires are soldered to contact solder cups.

Removable contacts, in which wires are crimped to the barrel of the contact, can be separated from the connector generally by use of a contact removal tool. Removable contacts are either front release or rear release types, depending on whether contact removal requires the removal tool to be inserted into the front or rear of the connector. Connector applications and the requirements for field reparability dictate the choice between contact types.

MIL-C-5015

The first military specification which defined all physical and operating parameters of a circular connector, AN9534, appeared on November 1, 1934. This specification was superseded two years later by AN-W-C-591, which was used with various revisions for the duration of World War II. The growing importance of airpower during the war led to the establishment of the U.S. Air Force as a separate branch of the military with a whole new set of connector requirements.

In 1949, MIL-C-5015 superseded AN-W-C-591 and became the first coordinated connector specification approved for use by all three services, Army, Navy and Air Force. Considered the "Granddaddy" of all connector specifications, MIL-C-5015 covers power connectors available in contact sizes from 16 to 0 and operating voltages ranging from 200 to 3000 volts AC (rms). Initially, these connectors did not include environmental sealing and were available only with solder contacts. Class "M", a moisture resistant version, soon appeared but was superseded by Classes "E", "R" and "F". The environmental characteristics of the connector improved with each new class. Revision F became effective in 1971 and unified accessory thread configurations and also added a rear release crimp contact connector known as the "3450" series. The current revision is Revision G which clarifies definitions, testing and operating requirements.

MIL-C-22992

MIL-C-22992 was a contemporary of MIL-C-5015. As the number of connectors used in electronic equipment grew, so did the incidents of connector mismating. The military needed a more positive polarization method than the single key and keyway provided by MIL-C-5015. MIL-C-22992 defined a connector which used MIL-C-5015 insert arrangements and a shell with five keys and keyways instead of one. Double-start acme coupling threads were specified. Two existing commercial series, the Bendix "QWL" and the ITT Cannon "CWL", met all the requirements of the new specification except that they only had one key. To accommodate the additional keys, the coupling end of the existing commercial connectors was increased by one size while the insert and the accessory threads remained the same size.

MIL-C-26482

The explosive growth of airborne electronic systems in the 1950s demanded high density connectors with smaller contacts than the size 16 specified in MIL-C-5015. Specification MIL-C-26482 came into being with insert arrangements originally available with sizes 20 and 16 contacts. Size 12 contacts also are a part of the specification now. An improved five-keyway polarizing system and a quick connect/disconnect coupling based on the bayonet coupling design of the Bendix "PT" series was adopted. Series 1 connectors incorporate front release contacts and Series 2 connectors utilize rear release contacts.

MIL-C-26500

When the Minute Man missile program was in its conceptual stages, the need arose for a high reliability crimp contact connector with contact sizes 20, 16 and 12. MIL-C-26500 utilized removable, front release crimp contacts and was available in either threaded or bayonet coupling styles. Although still used extensively on commercial aircraft, this specification is now inactive for new design and has been superseded by MIL-C-83723 Series III.

NAS1599

With the advent of manned space vehicles in the 1960's, NASA needed a high reliability connector capable of high temperature operation, 200 degrees C, with minimum outgassing and hypergolic fuel compatibility. With the cooperation of Boeing and North American Aviation, NASA created the specification NAS1599 (National Aerospace Standard), which covers threaded and bayonet coupling connectors with removable rear release crimp contacts. The threaded version is based on MIL-C-26500 shell dimensions and insert configurations, and is intermateable with corresponding MIL-C-26500 and MIL-C-83723 Series II connectors.

MIL-C-27599

After MIL-C-26482 had been in use for a number of years, a requirement arose for a similar connector with a low profile, bayonet coupling, scoop-proof design and size 22 contacts. All of these connectors had solder contacts available in sizes 22 thru 12. These connectors, with crimp removable contacts, later formed the basis for
MIL-C-38999.

MIL-C-28840

MIL-C-28840 was developed to meet the Navy's requirement for crimp front release contact connectors for shipboard signal applications. These connectors are environmentally sealed and completely fluid resistant.

MIL-C-38300

Before MIL-C-38300 could be fully implemented, it was discarded in favor of MIL-C-83723 Series III.

MIL-C-38999

When the Air Force saw the low profile and scoop-proof connectors of MIL-C-27599, it wanted the same design except with rear release crimp contacts rather than solder. MIL-C-38999 was issued for contact sizes 22 through 8. Series I covered the scoop-proof connectors and Series II covered the low profile designs. The popularity of this specification led to the introduction of Series III which has a triple-start acme thread coupling and a self-locking feature on the coupling ring which eliminates the need for safety wiring. Series IV connectors utilize the same contacts, inserts and accessories as Series III except the coupling mechanism is known as a "breech-lock".

MIL-C-81511

As the sophistication of electronic systems grew, so did the need for higher density connectors. Series I and III connectors are 100% scoop-proof while Series II and IV are 50% scoop-proof. Series I and II connectors have an unusual contact retention system whereby the contacts are retained by a rear assembly nut. For removal, the nut is loosened and the contact is pushed out from the front of the connector. Series III and IV utilize rear release contacts, retained by individual metal clips in the insert.

MIL-C-81703

Connectors in this specification were originally developed for commercial use, became part of an unrelated connector specification to allow their use by the military, and finally had their own specification issued when a new connector series was added. MIL-C-81703 now consists of Series I with solder contacts, Series II with front release crimp contacts and Series III with rear release crimp contacts.

MIL-C-83723

During the Vietnam War the Air Force developed this specification to cover each of the three connector specifications most commonly used on military aircraft. Series I was intended to supersede MIL-C-26482, Series II was to supersede MIL-C-5015 and Series III was to supersede MIL-C-26500. All series would utilize rear release crimp contacts. Only Series III is active and replaced MIL-C-26500 for new designs.

RECTANGULAR CONNECTORS

Named for their shape, these connector types are designed so that two halves mate in much the same manner as cylindricals. Historically, rectangular connectors were known as rack-and-panel connectors and were originally designed to plug and unplug instrumentation and military gear from racks that contained a common bus bar. The term "rack-and-panel" still designates connectors used for cable-to-chassis, cable-to-cable (cabinet) and/or cable-to-rack (cabinet), connection with the drawer or box containing the electrical equipment.

MIL-C-24308

Adapted from military connectors first offered in the 1950's, D-subminiature pin and socket connectors have rectangular shells with D-shaped mating faces. Plug connectors hold pin (male) contacts while receptacle connectors hold socket (female) contacts. Crimp removable contacts are rear release.

MIL-C-24308 is the primary standard which defines D-subminiature dimensions, construction, materials and performance. Standard military connectors are fully intermateable with their commercial counterparts. Other versions can contain ports for coaxial, high voltage and high current contacts.

In the commercial world, most standards for low and medium speed serial data communications, specify or recommend D-subminiatures, as in applications on a personal computer.

MIL-C-81659 and ARINC Connectors

The ARINC name is derived from the acronym for Aeronautical Radio, Inc. an airline industry association active in specifying connectors for use in commercial aircraft. The ARINC connector family features military-type construction and is designed with seals against moisture for use in high-reliability aircraft applications. The original environmental resistant version, the ARINC 404 series, was designed for use by the commercial aircraft industry. The military produced its own version under specification MIL-C-81659. The ARINC 600 series was later developed specifically for the commercial aircraft industry. A multitude of insert configurations are available containing size 22 and larger power contacts and coaxial contacts.

CONNECTOR CONTACTS

MIL-C-39029

This specification covering crimp contacts was released in 1976 to define plating finishes, standard methods of testing and color coded identification bands (BIN Codes) described on page 5.

"RF COAXIAL CONNECTORS

MIL-C-39012

The specification includes subminiature, miniature, medium and large general-purpose coaxial connectors for radio frequency (RF) applications. It covers many popular types of coaxial connectors and includes mating and overall dimensions, materials, performance and procedures for testing performance for each type of connector covered. The standard divides coaxial connectors into two classes. Class I is a theoretical classification for connectors that are high performance, high cost, laboratory types. Class II connectors are standard types for field use and comprise six categories covering reparability and termination methods. The most common termination method used in repair situations is to solder the inner contact and crimp the outer braid ferrule. Soldering the inner contact provides the most reliable signal connection while crimping the outer braid ferrule provides the most consistent, reliable, mechanical and electrical bond.

TERMINALS, SPLICES AND END CAPS

MIL-T-7928

This specification is perhaps the most widely used for crimp type connection devices. It covers insulated ring and rectangular tongue terminals and butt splices as well as uninsulated ring tongue and flag terminals. A wide range of terminals, splices and wire caps are also covered with their own standards:

A. MS25036 covers insulated ring tongue terminals;
B. MS17143 covers insulated rectangular tongue terminals;
C. MS21004 covers uninsulated rectangular tongue terminals;
D. MS20659 covers uninsulated ring and rectangular tongue terminals;
E. MS25274 covers insulated splices and spare wire caps.

CRIMP TOOLS

The early specifications for removable contact crimp tools were introduced in the early 1960's. MS3191-1 was a military drawing which defined the tool and its accessories. The tool utilized a four indent crimp pattern together with a positive stop locator which controlled the travel of the indenters (crimp depth).

An improved design featuring independently adjustable crimp depths was later introduced as MS3191-4. It had an internal adjustment, totally independent of the locator, which permitted the selection of seven separate crimp depths, allowing optimal crimping of conductors ranging from AWG 12 to 26 regardless of the wire barrel size of the contact. It also introduced the use of the double tipped indenter to produce an eight indent crimp pattern which has consistently achieved superior tensile values. It also introduced the concept of a turret head containing three locators which could be used without separating any of them from the basic crimp tool.

In 1969 two military specifications for crimp tools were developed to replace the existing military drawings. MIL-C-22520C (Navy) and MIL-T-83724 (Air Force) defined a standard size crimp tool similar to the MS3191-4, but with an expanded eight step crimp depth range. These specifications also defined a miniature crimp tool to crimp conductors as small as AWG 32. Both documents were combined in 1971 into MIL-C-22520D.

MIL-C-22520 has since replaced many other crimp tool documents including: MS3198, MS14037, MS17776, MS22910, MS27426, MS27437, MS27828, MS27832, MS28731, MS55619, MS90388 and others. This list includes specifications for indent crimp tools, terminal lug crimp tools, pneumatic crimp tools and coaxial cable crimp tools.

INSERTION AND REMOVAL TOOLS

As part of the military's standardization program, MIL-C-81969 applies to all contact insertion and removal tools and provides a means for qualifying these tools. Front release is defined as a system in which contacts are released with a tool from the front (face) of the connector and removed from the back (wire bundle side) of the connector. Rear release is the method whereby releasing and removing the contact is accomplished from the back side of the connector. In both systems, contacts are retained by means of a shoulder somewhere on the contact's shank and a retention clip housed internally in the connector. Contact retention mechanisms can be constructed of either metal or dielectric materials. Refer to pages 2, 3 & 4.

Wire Breakage

Wires can be broken at the contact crimp joints while assembled to connectors. Should this occur, they must be removed for repair. Under this condition, a special tool must be used to remove contacts in connectors utilizing the rear release system. In connectors utilizing a front release system, contacts can be easily removed with standard removal tools.

Wire Accommodations

Normally, larger diameter wire sizes can be accommodated easier with the front-release system than with the rear-release system. Contact and removal tool geometry prevent the rear-release system from accepting larger diameter wires. This statement applies only when comparing the same size contacts on identical center spacings. It is based on the fact that removal tools must completely encompass the wire insulation's circumference in the rear-release system. However, the development of thin wall insulation and high performance wire has generally minimized this problem except for special applications on firewall or shipboard equipment.

Plastic versus Metal Service Tools

Both plastic and/or metal service tools are used; plastic tools are predominantly used with the rear-release system and metal tools with the front release system.

Combination-type plastic insertion and removal tools are normally expendable and are packaged with each connector half, i.e., plug and receptacle. They are intended to service one connector only. By having the correct tool delivered with the connector, the servicing personnel, particularly in field maintenance, will always have the correct tool for the connector.

Metal type tools, conversely, are more durable. They are designed to withstand thousands of contact insertions and removal cycles. Each tool has relative advantages and disadvantages. Plastic tools can be broken while in the grommet and cause uncalculated problems, such as damaging the grommet while trying to remove the tool or degrade performance when not removed properly. Metal tools should be examined frequently to assure that wear has not generated a sharp edge which could damage a resilient grommet when inserting or removing contacts.

Pin Contact Skewing

This characteristic is dependent upon the length of contact in bearing and the tolerance of the hole in the insert which accepts the contact. Connectors with hard inserts and long contact in bearing lengths will provide the minimum amount of skew. This characteristic varies with each manufacturer dependent upon individual design. Closed-Entry Socket Inserts provide a means of guiding a bent pin into the socket contact. This feature is obtainable only when hard dielectric material is used for socket inserts. While this feature is available in both front and rear release connectors, it is generally more predominant in the rear release types.

OTHER SPECIFICATIONS

Military specifications also exist for printed circuit board connectors and plug-in sockets. Numerous other specifications exist for flat cable connectors, fiber optic connectors, connector hardware, relay sockets, environmental splices and many additional components that cannot be covered in this document.

Military Standard 1353

With the continuing changes and upgrading in connectors over the years, plus the development of military specifications for these changes, the armed services have become concerned with overlap, duplication and possible confusion resulting from the number of specifications available and the logistical problems which have developed. The situation has been compounded by a proliferation of different contacts, insertion tools, removal tools, crimp tools, etc. Repair and maintenance of connectors by technicians in the field is complicated by the number of connectors, contacts and tools required for each connector specification. The need for standardization was apparent and after an in-depth study of existing specifications, Military Standard 1353 was established in early 1980 for connector applications in new equipment design.

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