NAVSHIPS 900,171

ELECTRONIC INSTALLATION PRACTICES MANUAL

This manual is intended for the use of the electronic installation worker. It may be used as a reference book on installation practices or in training beginners in Naval electronic installation work.

Subject matter in this text is intended as supplementary to, but not superseding existing and applicable specifications.

Appreciation is extended to the various Naval Shipyards, Commercial Firms, Service Representatives and Manufacturers who were contacted and without whose cooperation this manual would not be possible.

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SECTION 17-1

TUBES

1. INTRODUCTION.

The electron tube is a very sensitive and important instrument. It is the heart of the electronic equipment, the product of the coordinated efforts of engineers and craftsmen. Its great use lies in its ability to instantaneously react to the flow of millions of electrons while using only a small control voltage.

There are many classes of electron tubes including related devices which may be described generally as follows: cathode ray tubes, cold cathode tubes including voltage regulator tubes, crystal rectifiers, gas filled rectifier tubes, high vacuum rectifier tubes, pick-up tubes, klystrons, magnetrons, photo tubes, pool tubes, pulse modulators, spark gap modulators, receiving tubes, TR-ATR and pre-TR tubes and miscellaneous.

This chapter covers transmitting and receiving tubes in some detail, as well as special receiving devices. Figure 17-1 illustrates various receiving tube styles. The chapter also covers some of the less frequent applications to which tubes may be used.

It is important to remember that some tubes, although used in different applications, are in many cases similar type tubes. For example, a 6SJ7 may be used in a receiver unit as well as a transmitter unit. See Figure 17-1.

Tubes may also be classified according to the envelopes the electrodes are enclosed in.

2. TUBE DESIGNATION.

The first developed tubes were numbered according to a series of two or three numerals designating the manufacturer's order of development. However, in 1930, a system was originated for the tube designation to tell something about the tube. Because of the many types of receiving tubes at this time, only receiving tupes were included in the system. This is the system discussed below in subparagraph a.

With the advent of the large number of special purpose and transmitting tubes, a system was devised in 1942 to tell something about the nature of these tubes. This system is discussed below in subparagraph b.

In 1948, it was determined that neither of these systems were adequate to accommodate the large number of tubes being developed. The RTMA, (Radio Television Manufacturers Association), with the cooperation of all tube manufacterers, inaugurated a new system to eliminate the duplication of type numbers by tube manufacturers, but it also proved inadequate. The "5500" series was then devised. It is the purpose of this system to prevent the duplication of type numbers. This numbering system tells nothing about the tube type. The system works somewhat in the following manner. A manufacturer develops a new tube type and reserves a number for it with RTMA. Although the tube

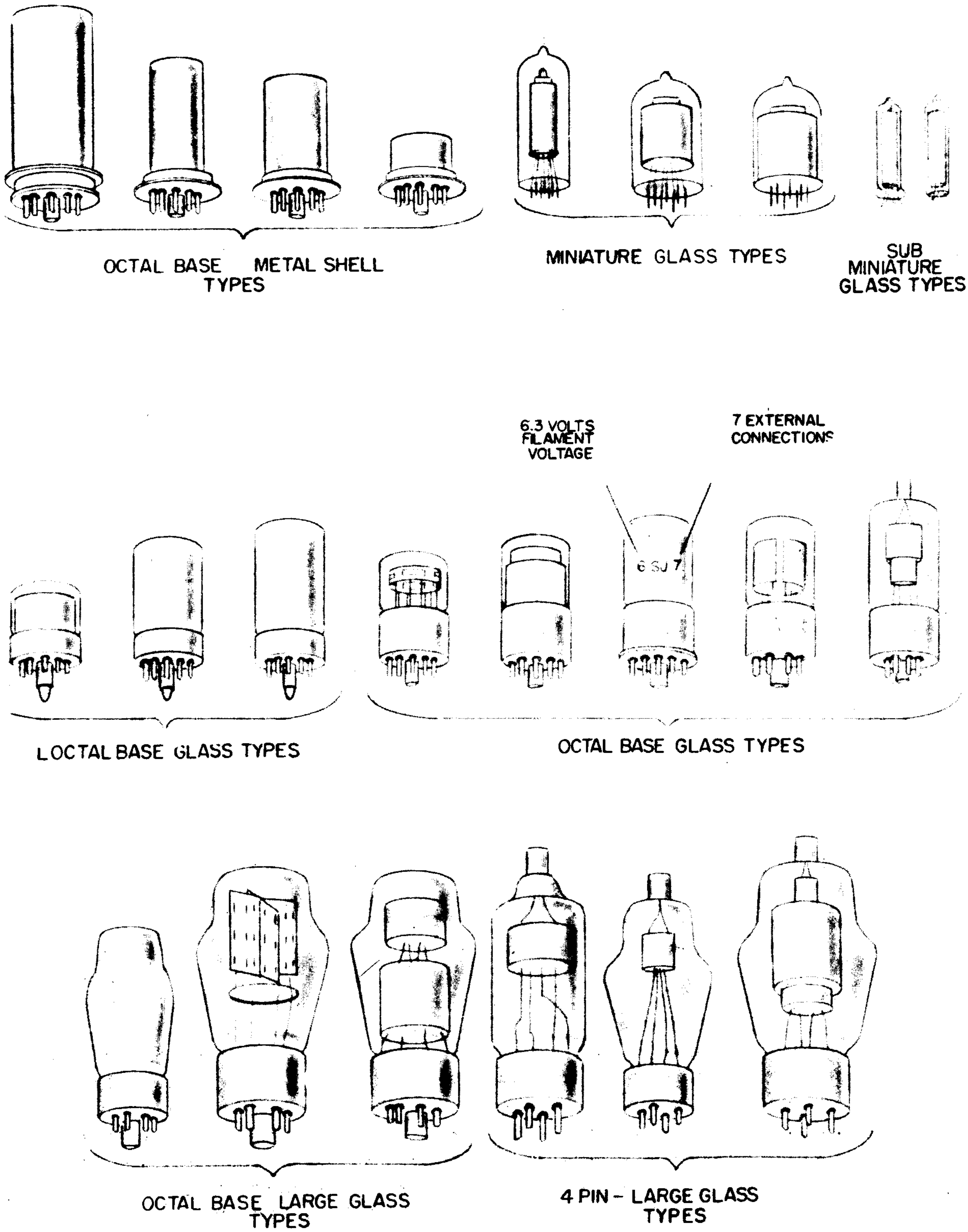


Figure 17-1. Typical Receiving Tubes

may never reach mass production, its type number is retained. If another manufacturer devises a tube that is the same or almost similar to the first tube developed, the same type number is assigned. It is important to note two facts. First, this system is designed to include only tubes used for non-entertainment purposes. Second, this system is being used only on newly developed tube types. Also, the system of designation used for crystals and cathode ray tubes is to be retained in its present form and tubes previously marked according to the old system will continue to be marked in that manner.

The addition of a last letter to a tube type number will usually mean an electrical or mechanical improvement has been made to the original tube type. The first such improvement will be shown by an A and subsequent improvements will receive higher alphabetical designations. Usually a tube having such improvement will work better where the older type was used, however an older type will not necessarily work in a circuit designed for the newer type tube.

The numbers assigned to tubes by the RTMA are usually retained by JAN in their listings.

a. RECEIVING TUBE MARKING.– Receiving tube numbers usually consist of one or a group of numerals designating the approximate filament voltage of the tube, a letter or a group of letters usually signifying the manufacturer's order of development, a numeral signifying the number of independent external connections, and at times a letter or group of letters signifying mechanical construction. An example of this type designation is 6A7, where the 6 denotes 6.3 filament voltage and the 7 denotes there are seven independent external connections. The 6K7 tube has an external top grid cap connection. The addition of an "S" to the type number of the tube signifies that the 6SK7 has the grid connection brought out to a pin at the bottom of the tube. As a rule the presence of an "S" together with another letter in the type number denotes the above mentioned improvement in an older tube type. It is important to note that these tubes are not readily interchangeable, until the circuit into which they are inserted has been modified.

A common last letter designation is G or GT (6K6G), (6K6GT). Here the tubes have similar properties and can be readily interchanged. The GT is a smaller version of the G style. If tubes are marked GT/G this signifies the GT type has replaced the G in production.

(1) RUGGEDIZED AND RELIABLE TYPE TUBES.–An effort is being made to replace tubes in use at present with a ruggedized and reliable series of electron tubes. Tube manufacturers are at present working under Army and Navy Contracts to produce another group of these type tubes. Tubes are chosen for this ruggedized program because of their use in important equipments. Table 17-1 lists these tubes that are being produced at present, together with the tube type they replace as well as any factors which effect their direct interchangeability with their previous type. Wherever reliability or ruggedness is a factor, it may be advisable to use these types as they become available. In other instances, stocks of standard types should be exhausted before the improved types are used.

b. TRANSMITTER TUBE MARKING.– In 1942, the RTMA and the Army and Navy devised a system of type designations. Its purpose was to make type numbers somewhat descriptive of the tube and avoid duplication of type numbers.

Included in this system of designation are some of the special purpose tubes.

TABLE 17-1. IMPROVED TUBE TYPES INTERCHANGEABILITY LIST

Standard Type	Improved Type	Differences Affecting Interchangeability
OA2	6073	Interchangeable
OA2	*OA2WA	Interchangeable
OB2	6074	Interchangeable
OB2	*OB2WA	Interchangeable
OC3	OC3W	Interchangeable
OD3	OD3W	Interchangeable
2A3	5930/2A3W	Improved type has a base 0.30" greater in diameter than the standard type.
2C51	5670	The improved type has a 50 ma greater fil drain than the standard type.
2D21	5727/2D21W	Interchangeable
5R4GY	5R4WGY	Bulb shape is slightly different
5R4GY	*5R4WGYA	Bulb shape is slightly different
5U4G	5931/5U4WG	See note under 2A3
5Y3GT	5Y3WGT	Interchangeable
5Y3GT	*5Y3WGTA	Interchangeable
6AC7	6AC7W	Interchangeable
6AC7	*6AC7WA	Interchangeable
6AK5	5654/6AK5W	Interchangeable
6AK6	* 6AK6WA	Interchangeable
6AL5	5726/6AL5W	Interchangeable
6AN5	* 6AN5WA	Interchangeable
6AQ5	6005/6AQ5W	Interchangeable
6AS6	5725/6AS6W	Interchangeable
6AS7G	* 6080WA	Different bulb and base
6AU6	* 6AU6WA	Interchangeable
6BA6	5749	Interchangeable
6BE6	5750	Interchangeable
6C4	6C4W	6C4W is 0.38" shorter than 6C4
6C4	Z2096	Not yet known
6C4	* 6C4WA	Same as 6C4W
6H6GT	6H6WGT	Interchangeable
6J4	* 6J4WA	Interchangeable
6J5GT	6J5WGT	Interchangeable
6J6	6J6W	Interchangeable
6J6	* 6J6WA	Interchangeable
6L6GA	5932/6L6WGA	See not under 2A3

TABLE 17-1. IMPROVED TUBE TYPES INTERCHANGEABILITY LIST (Cont'd)

Standard Type	Improved Type	Differences Affecting Interchangeability
6L6GA	6L6WGB	Interchangeable
6SA7GT	6SA7WGT	Interchangeable
6SJ7	5693	5693 has more conservative ratings
6SJ7GT	6SJ7WGT	Interchangeable
6SK7	6SK7W	Interchangeable
6SK7	* 6SK7WA	Interchangeable
6SL7GT	6SL7WGT	Interchangeable
6SL7GT	5691	5691 has 0.6 amp heater & more conservative ratings.
6SN7GT	6SN7WGT	Interchangeable
6SN7GT	* 6SN7WGTA	Interchangeable
6SN7GT	5692	5692 has more conservative ratings.
6X4	6X4W	Interchangeable
6X5GT	6X5WGT	Interchangeable
6X5GT	5852	Heater Current of 5852 is twice that of the 6X5GT.
7F8	7F8W	Cgp for 7F8W is 1-1/2 that for the 7F8.
12AT7	* 12AT7WA	Interchangeable
12AU7	5814	Same as 2C51
12AX7	5751	Same as 2C51. Mu of 5751 is slightly lower.
12AY7	Z2101	Not yet known
12J5GT	12J5WGT	Interchangeable
25Z6GT	25Z6WGT	Different base diameter
807	5933/807/W	See note under 2A3
807	* 807WA	See note under 2A3
2050	2050W	Interchangeable
5651	* 5651WA	Interchangeable
5687	* 5687WA	Interchangeable

* Included in BuShips quality procurement program but not yet available.

This system has, however, been found inadequate and discontinued as far as new type tubes are concerned.

In general, these designations comprise 3 symbols, the first (a number) indicates the approximate heater power

TABLE 17-2. RANGE OF HEATER POWER AND CLASSES OF TUBE STRUCTURE

First Number	Range of Heater Watts	Letter	Tube Structure
1	0	A	Single Element
2	0-10	B	Diode
3	10-20	C	Triode
4	20-50	D	Tetrode
5	50-100	E	Pentode
6	100-200	F	Hexode
7	200-500	G	Heptode
8	500-1000	H	Octode
9		J	Magnetron
		K	Klystron
		N	Crystal rectifiers and detectors
		P	Photoemissive

of the tube; the second (a letter) indicates the general class of tube structure, and the third (a number) gives the serial order in which the designation was assigned (beginning with the number 21 in order to avoid conflict with the receiving tube designations).

Range of heater power and classes of tube structure with the assigned symbol are listed in Table 17-2.

Examples of these designations would be 2J21; where 2 is 0-10 heater watts, J is magnetron and 21 is the first magnetron developed with this type of marking. In a 4C35 tube the 4 would mean 20 to 50 heater watts, C for triode and 35 for 14, the type to be assigned under this designation.

c. SPECIAL PURPOSE TUBES.

(1) CATHODE RAY TUBES.-Cathode ray tubes are one of the few types of tubes easily recognized by their type number. Designation of each tube is assigned by the Radio Manufacturers Association Data Bureau. The designations for cathode ray tubes are:

(a) A number to correspond to the maximum tube face diameter in inches.

(b) A letter to designate the type.

(c) A letter "P" and a number to indicate the type of phosphor or color. For example, 7AP1 signifies a 7 inch bulb, A means first 7 inch type registered, and type P1, phosphor. See Table 17-3 for types of phosphor.

An addition of A to this nomenclature (7AP1A) indicates an improvement was made after the original registration of the 7AP1.

It is important to note that the screen size of rectangular cathode ray tubes is measured diagonally across the face.

(2) CRYSTALS.- Crystal diodes may be recognized by the "N" in the type number.

Silicon crystals are used as super high frequency first detector diodes. Their type number is usually an indication of the wavelength of the receiver they are used in. A few examples are a 1N21, used in a 10 cm receiver; a 1N23, used in a 3 cm receiver; a 1N51, used in a 1 cm receiver.

TABLE 17-3. TYPES OF PHOSPHOR

Screen	Persistance	Composition	Fluorescence	Phosphorescence	Applications
P1	Medium	Zinc orthosilicate	Green	Green	Visual observation. High efficiency of P1 screen results in bright traces at relatively low accelerating potentials.
P2	Long or Short	Zinc sulphide	Blue-green	Yellow-green	General purpose screen for oscillographs employing accelerating potentials of 4,000 volts or more. By filtering, either short-persistence blue component, or long-persistence yellow component may be selected. High efficiency for high-speed single, transients. Not recommended for use at less than 4000 volts acceleration.
P3	Medium	Zinc Beryllium	Yellow	Yellow	General oscillographic use. Not as efficient as P1. Persistence has exponential decay that is chiefly of interest in television.
P4	Medium	Zinc sulphide and zinc beryllium silicate	White	White	Used primarily for television picture tubes.
P5	Short	Calcium tungstate	Blue	Blue	Used primarily for photography on continuous motion film for frequencies above 200 kc. Not as active as P11.

TABLE 17-3. TYPES OF PHOSPHOR (cont'd)

Screen	Persistance	Composition	Fluorescence	Phosphorescence	Applications
P6	Medium	Zinc sulphide and a complex compound of zinc and calcium sulphide	White	White	Developed chiefly for use in color television.
P7	Long or Short	Zinc sulphide cascaded on zinc and calcium sulphide	Blue-white	Yellow	Developed originally for radar. Similar in characteristics to P2 screen, but has longer persistence. Useful for radar, integrating noise, and repetitive phenomena and low speed transients.
P8	Same as P7	(Reserved by British as being confidential during World War 11)			
P9	Long	Calcium Phosphate	White	White	Very long persistence with high definition, developed primarily for radar applications.
P10	Nearly Permanent	Potassium Chloride	Magenta on White	Magenta on White	Used chiefly for radar. Pattern erased by infra-red irradiation.
P11	Short	Zinc sulphide	Blue	Blue-green	Used primarily for oscillographic recording; has higher visual and photographic efficiency.
P12	Long	Zinc magnesium fluoride	Orange	Orange	Used primarily for fire-control radar for scanning rates of from 4 to 16 scans per second.

TABLE 17-3. TYPES OF PHOSPHOR (cont'd)

Screen	Persistance	Composition	Fluorescence	Phosphorescence	Applications
P13	Discontinued		Red	Red	Also developed for fire-control and radar.
P14	Long	Zinc sulphide cascaded on zinc and calcium sulphide	White	Orange	Developed for radar operating at a scanning rate of about 1 scan per second. Also for moving-target indication.
P15	Very Short	Zinc oxide	Blue-green	Blue-green	Shortest persistence presently available. Used primarily in flying-spot scanners or for high-resolution, high-frequency continuous motion recording. Not as active as P11.

The first developed crystals were given designations as shown above. However, as electrical and / or mechanical improvements were made, an A and B were added to the type number. In each of these cases, the sensitivity of the crystals was increased.

Germanium crystals are most widely used as detectors in radio receivers. Their type numbers start in the 30's. As electrical or mechanical improvements are made on these type crystals, a letter will be added to the nomenclature. For example, the 1N38 was a ceramic germanium crystal. The "sealed in glass" 1N38 was designated 1N38A, the A showing an improvement was made. A second mechanical or electrical improvement on this type would be designated 1N38B.

(3) MAGNETRONS.-The newer magnetrons are numbered according to the above mentioned "5500" series. Older types still in use, however, may be recognized by the presence of a J in the JAN type number. At present, the most common magnetrons are the 2J and 4J series. The difference in these types is in the power for which the tube is designed. The 2J series is designed for heater power up to 10 watts and the heater power for the 4J series will range from 20-50 watts.

(4) PHOTO TUBES.-Photo tubes, other than those registered in the "5500" series, may usually be recognized by the presence of a P in the JAN type number.

3. HANDLING OF TUBES.

All tubes should be handled with the greatest care.

Unnecessary rough handling could result in destruction of a tube. In the case of cathode ray tubes, dropping them could cause a violent implosion, with the consequent danger to personnel, while the dropping of a tube containing radio-active material could present a radiological hazard.

Where practicable, tubes should be carried to their place of installation in shipping containers. Shipping containers provide protection to such an extent that if a tube is dropped, it will usually not be damaged.

a. SPECIAL PRECAUTIONARY MEASURES. - As shown above, cathode ray tubes and those containing radio-active material require special handling. Other types of tubes as listed below will also require special handling.

(1) CATHODE RAY TUBES.- Cathode ray tubes have a high vacuum and present a constant source of danger to personnel.

These tubes are individually packed in cardboard containers, and are centrally positioned in the container. The carton is clearly marked as to which end is the top as well as to the tube it contains. See Figure 17-2.

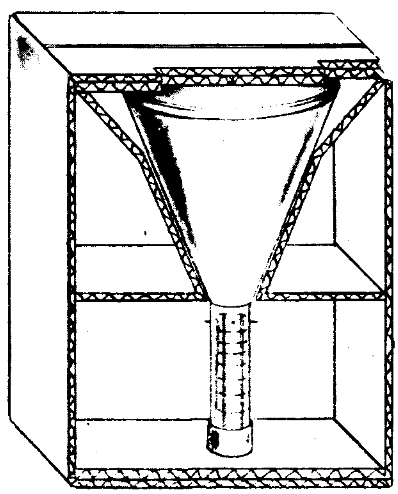


Figure 17-2. Cutaway View of Cathode Ray Tube Carton

All cathode ray tubes should be carried to the place of installation in original cartons. Do not unpack a tube at a stowage space and carry it unprotected to the place of installation.

All tubes over 10-inches in diameter should be handled by two workers.

Gloves and a suitable face mask should be worn in handling cathode ray tubes.

A list of precautions in handling cathode ray tubes as prepared by the RTMA is given below.

(a) All personnel handling cathode ray tubes should wear canvas aprons, gauntlet type gloves, and a suitable face mask. The gloves should be high enough to protect the forearms and other protection should be provided for the upper arms. A suggested face mask which would provide adequate protection is one similar to a welder's mask, with safety glass inserted in the eye piece. This mask will protect the face and neck as well as the eyes if a tube should be imploded. It is important that all exposed areas of the body, be protected.

(b) All personnel entering areas near exposed tubes should wear goggles as a minimum of protection precaution.

(c) Cathode ray tubes should be kept in original cartons until they are actually needed. If they are inspected on arrival or if any interval exists between inspection (or test) and installation on the chassis, they should be replaced in the carton immediately after inspection and the carton sealed. They should be removed from cartons again only when tubes are installed.

(d) Where a cathode ray tube is mounted on an open chassis, the tube should be covered with a layer of heavy canvas, or equivalent, whenever possible.

(e) When tubes are used regularly for testing equipment, the test tubes should be mounted permanently in a protective shield with safety glass over the screen. See Figure 17-3.

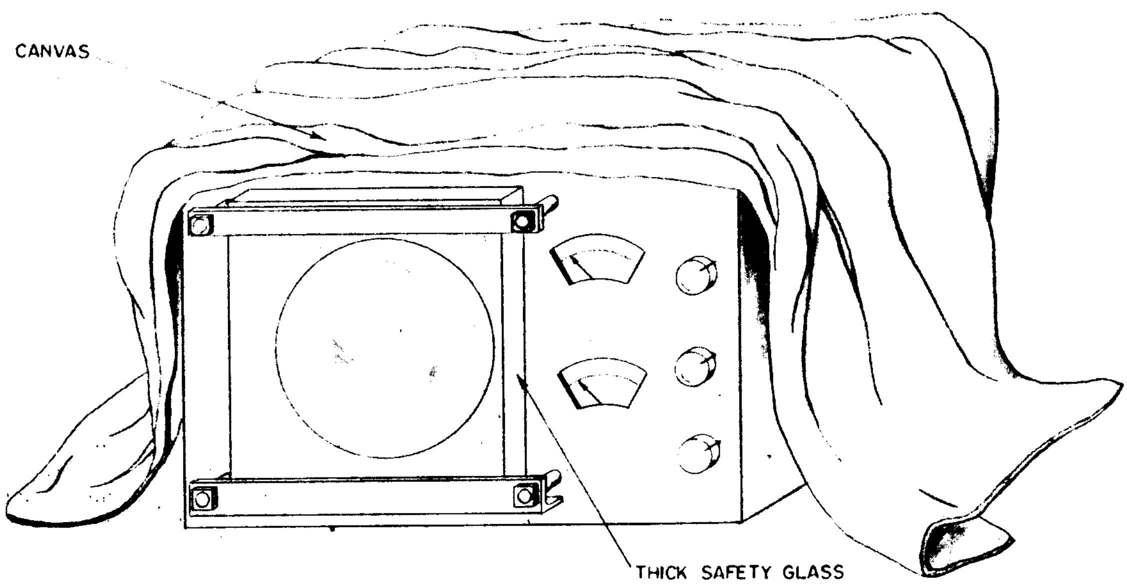


Figure 17-3. Test Chassis Covered by Canvas and Safety Glass

(f) A tube should be inserted or withdrawn from a carton in such a way that the face is toward the end of the carton through which the tube passes. A tube should be inserted or withdrawn by grasping the edge of the face.

(g) A tube should never be grasped by the neck nor should force be exerted on the neck.

(h) Special precautions should be taken to avoid scratching the glass of a tube (a small scratch in certain areas will greatly reduce the strength of a tube).

(i) If a tube must be laid on a flat surface, it must never be laid on its side; it should be placed vertically on its face and on a soft pad of suitable material free of abrasive substances.

(j) Tubes should never be subjected to jarring or sliding. If a chassis with tube installed must be moved, it should be moved on rollers.

(k) If for any reason a tube must be replaced, the old tube should be put into a safe container immediately. The carton from which the new tube is taken is good for this purpose.

(l) Old or unusable tubes should be stored and handled with the same safety precautions as new tubes. If they are to be disposed of, they should be destroyed and not allowed to pass into the hands of people unfamiliar with the hazards.

(m) If tubes are to be destroyed, they should be broken in a closed steel can with a small hole in the cover, or in a sealed carton through which a heavy instrument such as a crowbar can be driven. See Figure 17-4

(n) Cathode ray tubes are generally operated at voltages which are high enough to be very dangerous and special precautions should be taken to protect personnel from this hazard.

(o) Some cathode ray tubes and equipment under certain operating conditions are known to give off X-rays and Grenz rays. Periodic checks on this hazard should be made and adequate shielding and other precautions should be applied.

An exception to RULES (g) and (h) above is in the case of cathode ray tubes having an insulating coating over the bell of the tube. These tubes will be packed with proper handling instructions. They should be handled by the neck only, never touch the coating. See Figure 17-5.

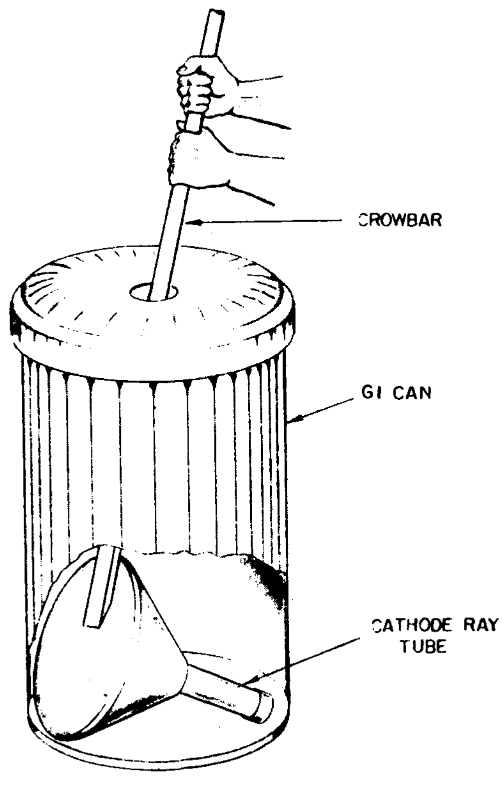


Figure 17-4. GI Can and Crowbar Method of Destroying Old Cathode Ray Tube

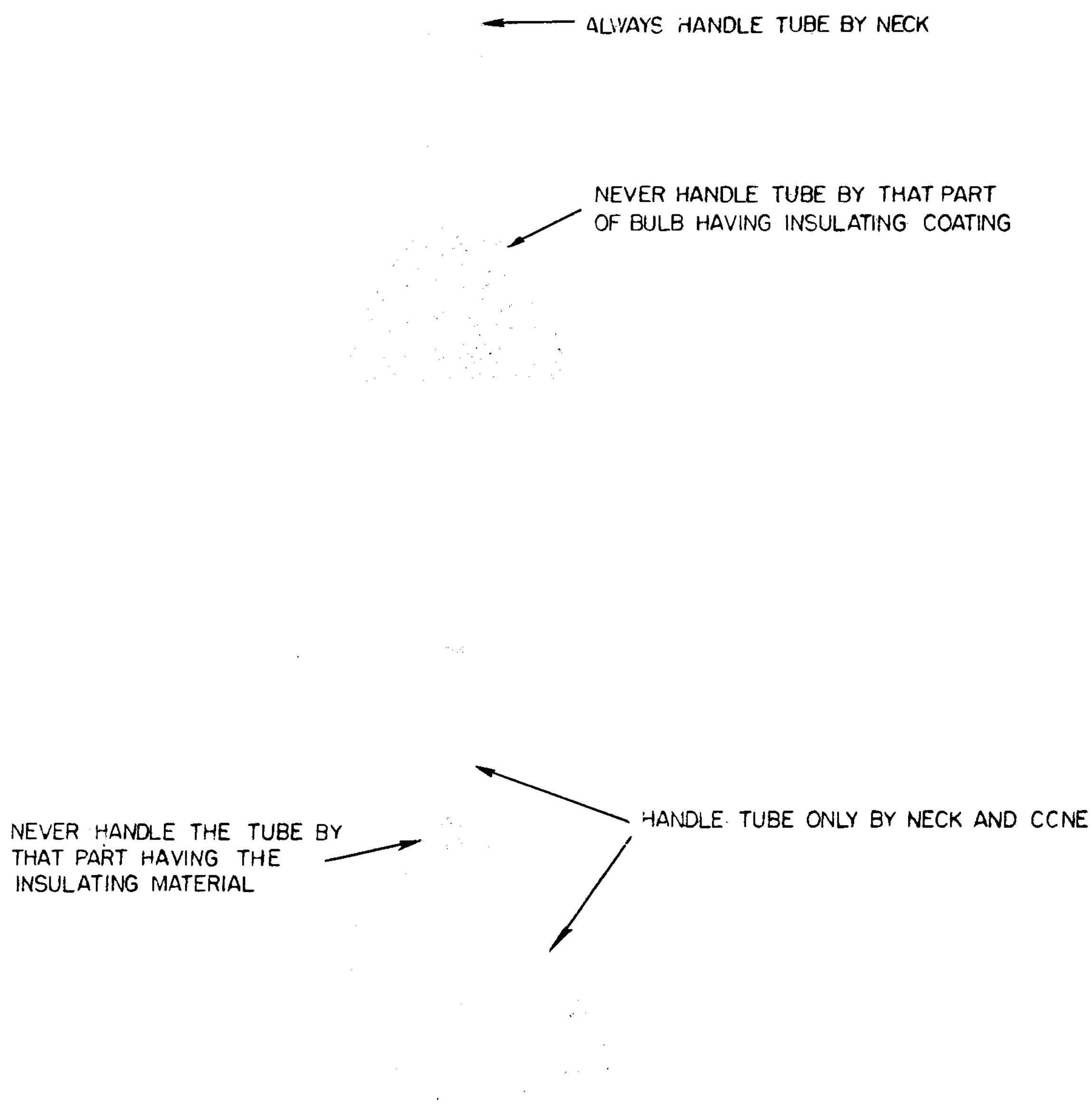


Figure 17-5. Cathode Ray Tubes Having a Coating About the Bell Part of the Tube

(2) RADIO-ACTIVE TUBES. - Table 17-4 lists tubes known to contain radio-active material.

TABLE 17-4. TUBES KNOWN TO CONTAIN RADIO-ACTIVE MATERIAL

SPARK GAP TYPE				
1B22	1B31	1B42	1B49	
1B29	1B41	1B45		
GLOW LAMP OR COLD CATHODE TUBES				
313C	313CD	359A	405A	
313CA	333A	372A	413A	
313CB	346B	376B	423A	
313CC	353A	395A	727A	
TRANSMIT-RECEIVE TUBES				
1B	1B28	1B58	1B63A	721A
1B24	1B40	1B60	702A	721B
1B26	1B50	1B62	702B	724A
1B27	1B55	1B63	709A	724B

(a) HANDLING OF RADIO-ACTIVE TUBES. - No radiation hazard to personnel exists from normal handling of radio-active tubes for removal or installation in equipment.

Great care should be exercised in handling these tubes, however, for extensive tests have revealed that danger does exist for personnel from any radio-active particles or gasses entering the body by breathing, eating or through cuts in the skin.

(b) PRECAUTIONS FOR BROKEN RADIO-ACTIVE TUBES. - Two methods are advanced for cleaning an area where tubes have been broken. Both are given below. Personnel should always wear gloves when cleaning such an area.

1. WET METHOD. - Pick up any large pieces with forceps or tweezers. Using a wet cloth, or cotton, wipe across the area as follows: Make one swipe at a time. Fold the cloth in half after each swipe, keeping the clean half out at all times. All debris and cloths used for cleaning should be sealed in a container such as a plastic bag, or glass jar and disposed of as outlined in paragraph (c) following.

2. DRY METHOD. Pick up any large pieces with forceps or tweezers. Clean the area carefully with a vacuum cleaner. If the breakage of such tubes is a frequent occurance, the exhaust from vacuum should have an appropriate type of collector. The collecting bag should be disposed of by sealing it in a plastic bag or glass jar. It should be disposed of as outlined in the following paragraph.

(c) DISPOSAL OF RADIO-ACTIVE TUBES. - When convenient, all useless radio-active material should be sunk at sea. At shore installations it is best to collect the tubes and debris in special containers to be weighted, sealed and shipped out to be sunk at a convenient time. If possible, radio-active material that is to be junked should be encased in concrete to insure no parts will float to the surface when the material is sunk at sea.

An alternate method of disposal is to set aside a clearly marked burial ground. However, the former method of disposing is recommended.

(d) TOOLS USED. - If practical, all tools used in handling radio-active material should be sunk with other debris. Where this procedure is not practical, tools should be thoroughly cleaned before using them for other purposes.

(e) SAFETY RULES.

1. No material contaminated by radio activity should be allowed to come in contact with any part of the body at any time. Protective gloves should be worn at all times when the handling of radio-active waste and broken parts is involved.

2. No food or drinks should be brought into a contaminated area.

3. Personnel handling radio-active material in any way should wash their hands and arms thoroughly. They should remove any clothing which may have been contaminated before eating, drinking or smoking and immediately after leaving the contaminated area.

(f) FIRST AID FOR CUTS.- Cuts caused by broken fragments of radio active tubes require the following emergency first aid measures when proper medical facilities are not available.

1. Apply a tourniquet to the vein, if the wound is so placed that a tourniquet can be used. If a tourniquet is used, remember to loosen every 15 to 20 minutes to restore circulation.

2. Remove glass fragments, if any, and start mild bleading about the wound by manual pressure or by suction cups.

3. The wound should be washed with soap and large amounts of water.

4. If the wound is of the puncture type or if the opening is quite small, an incision with a sterilized instrument should be made to allow free bleeding and to insure complete flushing of the wound with soap and water.

5. Secure proper medical attention as soon as possible.

(3) CRYSTALS.- Great care should be used in handling crystals to prevent destruction or faulty operation due to static electricity or shocks. The frequent passing of crystals from person to person should also be avoided for this may damage it, particularly in cold dry weather. Crystals are centrally suspended in the package or wrapped in a manner to provide sufficient protection. The crystal itself is packed in a lead capsule. They should be kept in these capsules until ready for use. Before handling a crystal, the technician should always ground himself to the crystal holder, by touching a finger to a metal part of the holder. This will prevent a static charge (accumulated on the technician's body) from discharging through the crystal.

(4) MAGNETRONS.- These tubes are individually packaged in a cardboard carton or wooden box. The tube is completely wrapped in a waterproof barrier, and suspended by a spring frame or a die cut device in the box. In the case of a wooden box, instructions for unpacking are printed on the box.

Complete mechanical protection should be provided for magnetron leads, particularly if they are not surrounded by a pyrex shield. The glass-to-copper vacuum seals are easily broken if the leads are treated roughly. Furthermore, a slight bending of the soft copper tube may alter the cathode-anode alignment completely changing the properties of the magnetron.

The magnetic field in many ship installations is provided by a permanent magnet. When not in use, these magnets should be provided with keepers. When in use, the magnetron replaces the keeper. Under these conditions, it is important to keep ferromagnetic material away from the magnet. This should be kept in mind when using a screwdriver or a pair of pliers around a magnetron installation. New installations are provided with an aluminum shield to overcome this difficulty.

(5) PHOTO TUBES.- Care should be taken to protect the tube from high light levels and high temperatures when they are not in operation, as either of these may cause faulty operation of the tube.

(6) LARGE GLASS TUBES. - Large glass tubes require special handling because of their size. These tubes are usually individually packaged in wooden boxes. Instruction for unpacking these tubes are given on the outside of the box. These instructions are given for the safety of personnel as well as for maximum protection of the tube. Instructions for unpacking should be closely followed.

In the case of tubes having fins, do not bend or strike the fins. If the fins seem to be crooked or bent, do not attempt to realign them as this may destroy the properties of the tube.

4. STOWAGE OF TUBES.

a. INITIAL TESTING PROCEDURES.- When tubes are received aboard ship, they should be checked for obvious breakage or rough handling. If the tube is received in a damaged condition, notify the activity from which the tube was requisitioned and send a copy of the correspondence to the Bureau of Ships.

All new spare tubes should be checked in a tube tester, or in the equipment, where possible. Tubes should be checked again before use. Test the larger tubes and tubes stocked in small numbers for at least filament continuity and shorted elements.

Although not a sure test for gassy tubes, where a gas detector is available, tubes should be tested for gas leakage. It is important that gas filled or mercury filled rectifiers are not disposed of because of these tests, since these tubes should show gas under such a test.

b. STOWAGE BINS.-Since the inauguration of the Shipboard Integrated Electronic Maintenance Parts System, most ships have been supplied with stowage bins for electron tubes.

Tube lockers with adequate shelves or bins in the store room are recommended; however, arrangements should depend on the conditions existing on the individual ship. Tubes should be stowed in original cartons in proper sequence according to Standard Navy Stock Number. See Figure 17-6.

Ship electron tube allowances provide for an adequate supply of tubes for satisfactory continuous operation of electronic equipment. Tube allowances are usually based on a three months supply. If a ship is scheduled for an extensive cruise it is permissible to over stock on tubes.

As spare tubes are used, requisition for replacement should be made.

Excessive tubes should also be returned to stock.

Some special types require special instructions for stowage.

c. RADIO-ACTIVE TUBES. -A list of tubes containing radio-active material is given in Table 17-4.

Tests of 2800 radio-active tubes packed in individual cartons, with 100 packed in turn in corrugated cartons indicate intensities which would not be dangerous according to AEC tolerance levels even if personnel were in bodily contact with it for eight hours. However, if 100 such tubes were piled together without cartons, it would present danger to personnel by radiation. Although most activi-

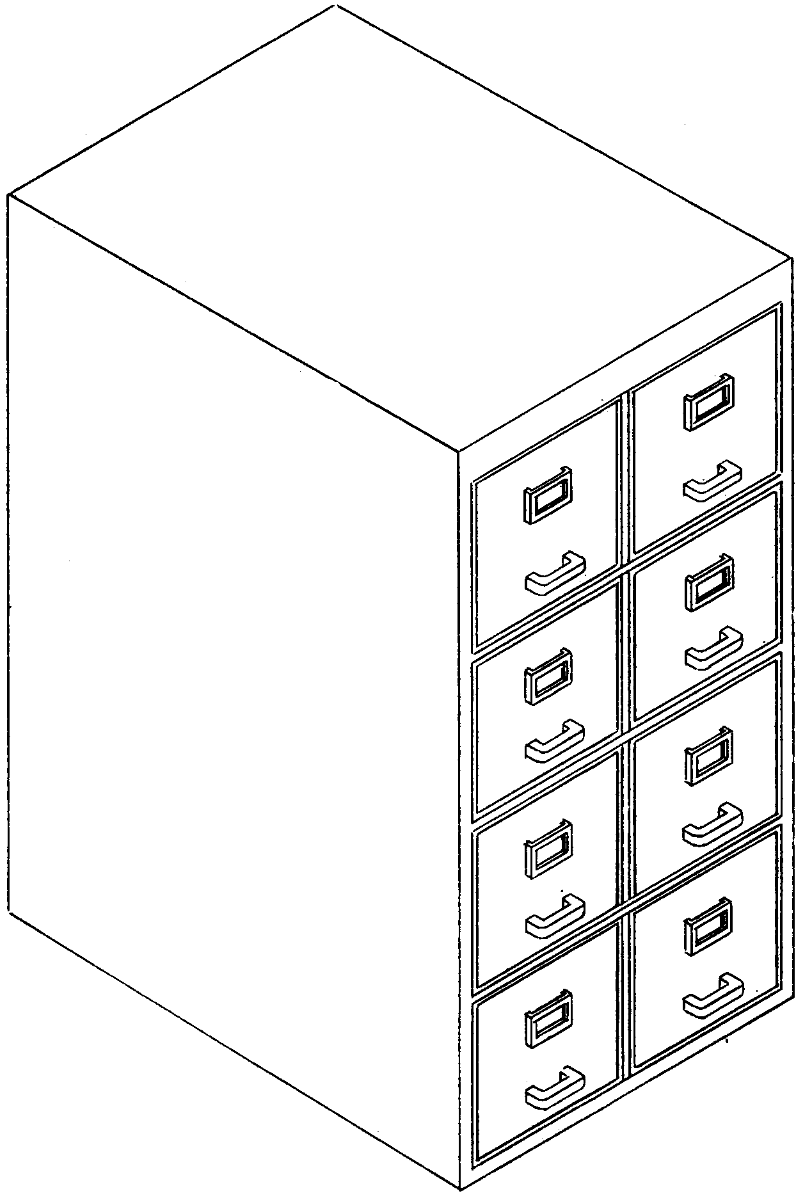


Figure 17-6. Typical Stowage Bin for Tubes

ties will not be required to stow such large numbers of these tubes, it is important that they be stored in their individual cartons, for the reasons pointed out above.

Paragraph 3, gives recommended procedure in the case of accidental breakage of a tube of this type.

d. CRYSTALS.- When the crystals are not installed in equipment they must be protected from fields and currents induced by sudden current changes in neighboring wires. This can be accomplished by storing the crystal in a metal container or wrapping in metal foil when not in use.

e. MAGNETRONS. - These should be protected from magnetic fields which may be generated by equipment or wires located too near the tube. Care should also be taken to prevent the interaction of two or more magnets. In general, a safe rule is to allow at least 6 inches between magnetrons while in stowage.

f. PHOTO TUBES.- As mentioned before, these are to be protected from strong light levels and high temperatures which may ruin the properties of the tube.

5. INSTALLATION AND REMOVAL.

a. GENERAL. - Most receiving and transmitting tubes are of the metal or glass envelope, pin-type socket and may be readily installed as described below.

Other special types require special consideration and cannot be installed unless the technician refers to the instruction book that comes with the particular piece of equipment.

Most of these tubes may be mounted in any position unless noted to the contrary on the tube package or in the instruction book for the particular piece of equipment.

Tubes should not be removed while a circuit is energized and suitable interlocks should be provided for protection of personnel. Even with equipment off, be sure capacitors are discharged. When installing or removing tubes in equipment that has been in operation, be sure the tube is cool before handling it. If it is hot, wear gloves, or use a clean, dry, cloth to remove the tube.

To facilitate the removal of tubes, a pair of tube pullers can be made from strap metal and sponge rubber. A strip of metal about 1-1/2" wide can be bent to the shape shown in Figure 17-7. Sponge rubber should be added to protect the glass portion of the tubes which are to be removed. An adjustable clamp can be added to the upper part of the pullers to insure a good grip. The points of the puller are for insertion under the tube and should be sharpened to a point.

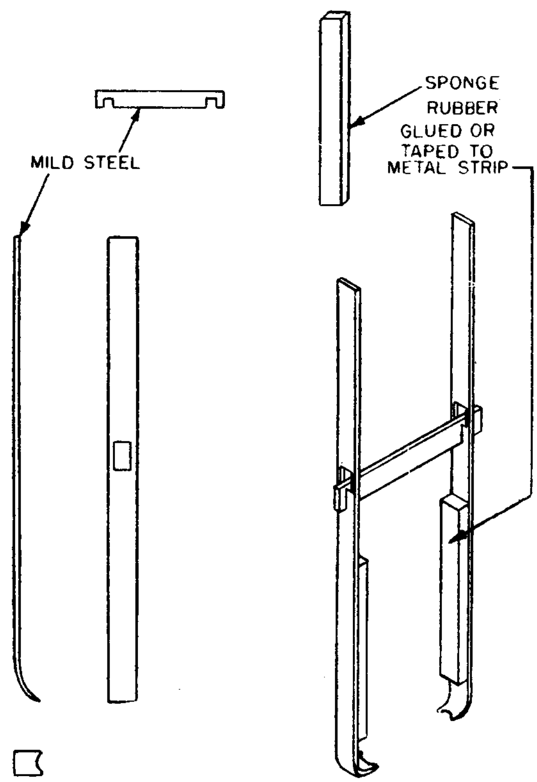


Figure 17-7. Tube Puller

Lockin tubes cannot be removed by this method as they are locked into the base and must be rocked to be released.

b. TUBE CLAMPS.– Naval specifications call for most electron tubes to have a clamp above the tube socket which is to be used to hold the tube rigidly in its socket.

Loop type clamps are equipped with a handle, which in the closed position, follows the curvature of the clamp itself. To open, the handle should be flipped away from the tube. To close, the handle is pushed toward the tube. See Figure 17-8.

Top hat clamps are designed to hold tubes in sockets under all conditions of vibration and can be used in confined spaces. See Figure 17-8.

The spring type clamp gives support to the tube in two ways. It maintains a direct axial pressure downward, plus a sideways support that keeps the tube upright and perpendicular to the chassis. See Figure 17-8.

c. PIN NUMBERING.– For tubes having two sizes of pins, hold the tube with the base upward and the larger pins toward the body; the first large pin to the left of the base center line is the number one pin. The other pins are numbered from the large pin in a clockwise direction.

Octal, duodecal or other base designs having a locating lug, have their pins numbered in the following manner: Numbering begins at the first pin to the left of the locating lug when the base is viewed from the bottom with the locating lug toward the observer. The first pin to the left of the locating lug is the number one pin. The other pins are then numbered from this pin in a clockwise direction. In this type base, the first pin is the grounding connection on tubes requiring it. See Figure 17-9.

d. GLASS ENVELOPE. 4, 5, 6, or 7 PIN BASE. – This group is easily recognized by their general design. These are the so called "regular" glass types, and are characterized by the style of glass envelope (ST style) and the standard bakelite base of four, five, six or seven pins, as required, and the absence of any locating lug. Usually two or more of the pins will be larger than the remaining pins. The socket into which these tubes are to be inserted will have holes that correspond in size and num-

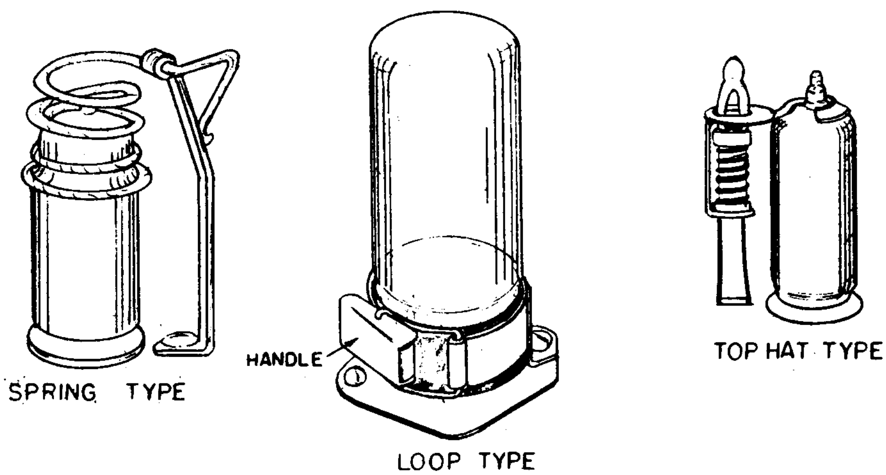


Figure 17-8. Tube Clamps

ber to the base pins. Correct insertion is insured by aligning the larger pins with the larger socket holes in such a manner that the remaining pins are also aligned with holes corresponding to their size. See Figure 17-9.

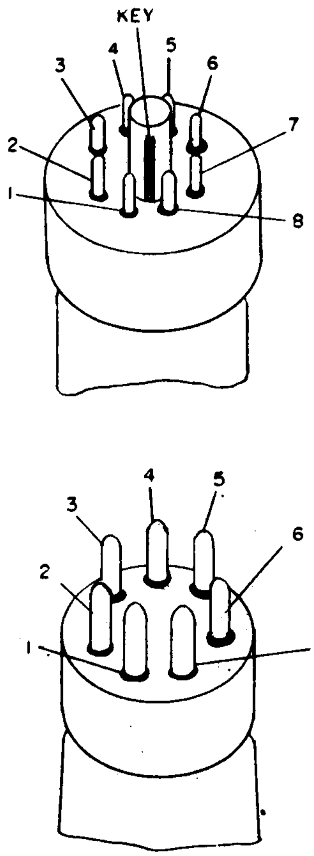
These tubes are installed with a tube clamp.

e. GLASS ENVELOPE OCTAL BASE.- This group of tubes are readily recognized by their glass shell and octal base with a bakelite locating lug. Top caps, if required, are of miniature style.

The octal base may or may not have eight base pins. In some instances, where pins have no internal connection, they will be omitted from the base of the tube. Correct installation is insured by the key on the bakelite center prong. The tube socket will have a corresponding keyway in its center. Insertion of the key on the tube into the keyway on the socket insures correct installation.

These tubes may be installed with tube clamps.

f. METAL SHELL OCTAL BASE TYPE.- This group is easily recognized by the metal shell and octal bakelite base. The method of installation is the same as for glass octal base tubes given above. See Figure 17-9.



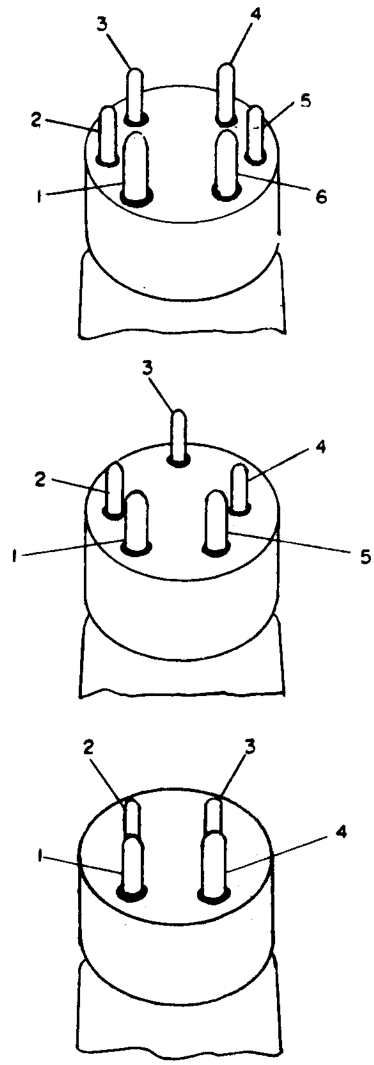


Figure 17-9. 4-5-6-7 Pin and Octal Pin Bases and Numbering

g. LOCK-IN TYPE TUBES.- These are small all-glass tubes without the familiar bakelite base. The contact pins are sealed into the glass bottom permitting single ended operation as no top cap connection is necessary. The lower portion of the tube is fitted with a metal shell and guide pin. This unit acts as a shield and makes possible the lock-in feature, employing a groove around the bottom of the locating pin which fits into a catch on the socket. A key on the locating pin and a corresponding keyway in the socket insures correct installation. See Figure 17-10.

The locking arrangement holds the tube in the socket securely, assuring good contact at all times. These tubes are not easily removed by a direct upward pull. A slight offside pressure, however, releases the socket lock and the tube is readily removed.

Tube clamps may be used with this type tube.

h. MINIATURE TUBES.- One of the more recent trends in tube manufacture is the reduction in size of tubes required for given performances. Miniature type tubes are a result of this work. Tubes in this group have either a seven or nine pin base. A space between the first and last pin on the tube base is used as a guide for correct insertion. There is a corresponding space on the tube socket. Alignment of the first pin and last pins with the corresponding pin holes on the socket insures correct installation.

Tube diameters correspond to socket diameters insuring that a seven pin tube cannot be inserted in a nine hole socket.

These tubes are held rigidly in place by a metal spring type shell, or a top hat or spring clamp. The shell receptacle is of the bayonet type and is attached to the tube socket. The shell itself is installed by placing the two keyways over the receptacle pins, pressing down lightly and turing a sixteenth of a turn clockwise. To remove the shell, press down lightly, turn it a sixteenth of a turn counter-clockwise, and lift. See Figure 17-11.

i. SUBMINIATURE TUBES.- A further reduction in tube sizes has resulted in the subminiature design. These are glass tubes of about 1-1/2 inches in length having four, five, six, seven, or eight thin flexible wire connection leads. Because of their size, they are very useful where compactness is essential.

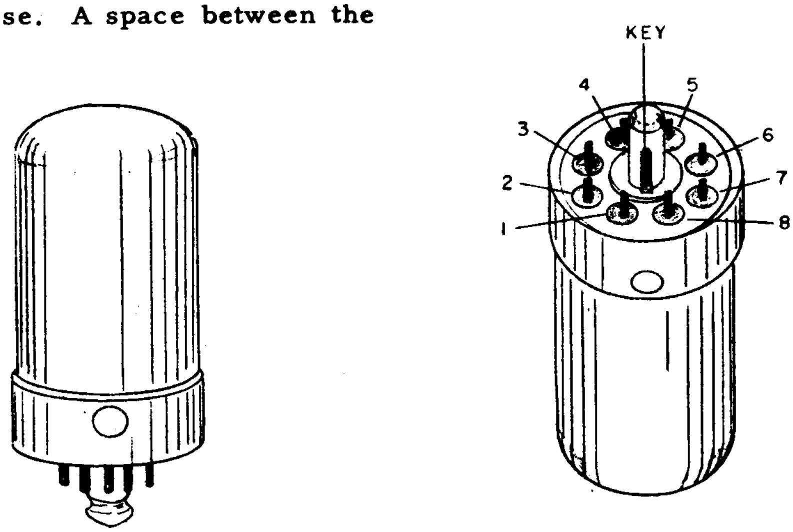


Figure 17-10. Loctal Type Tube and Base Numbering

These tubes are of two styles; flat press type and round type. A small red dot near the base of the flat press type of tube provides a guide for lead numbering. The lead nearest this dot is lead number one, the second lead is number two, etc. See Figure 17-12. The round type has a space between the first and last lead. Here as in the miniature type, the leads are numbered in a clockwise direction from the space.

The flexible terminal leads of both types are designed to make installation possible by any of the four methods listed below.

(1) Plugged into standard subminiature sockets.

(2) Soldered directly to circuit components.

(3) Spot welded directly to circuit components.

(4) Plugged into individual contacts which can be made an integral part of the equipment assembly.

In methods two and three above, after the circuit is wired, it is usually completely enclosed by pouring a resinous substance over the whole unit. The substance hardens and the unit is shockproof. When some part of the unit becomes defective the whole unit must be discarded. Units of this type are usually prepared by the manufacturer.

In methods one and four, installation and removal of tubes must be considered.

METHOD 1. –The socket size will depend on the number of lead terminals of the tube. Four, five, six and seven hole sockets are used extensively. The socket may be mounted in any position, the two most common being parallel to the chassis and at right angles to the chassis.

The terminal leads, as supplied, are usually 1-1/2 inches long. For socket mounting with the tube plugged straight into the socket, the proper lead length is 0.2 inches. If the tube is to be mounted at right angles to the socket, or other methods of connection are to be used, the leads can be cut to a suitable length and bent as sharply or as close to the press as desired.

METHOD 4. –The "Flea" contact presents a method of mounting on a chassis in applications where socket mounting is not desired, but ease of tube replacement is required. These contacts (see detailed blowup in Figure 17-12) are

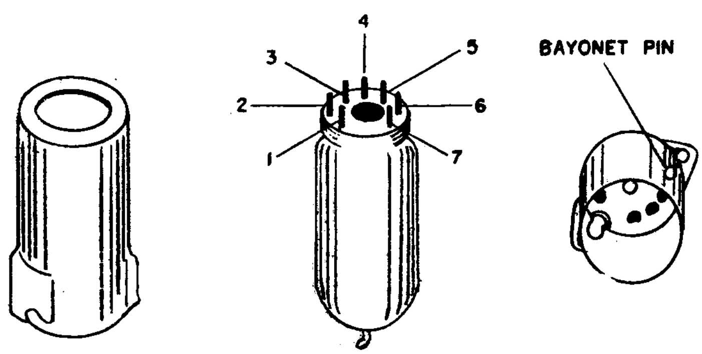
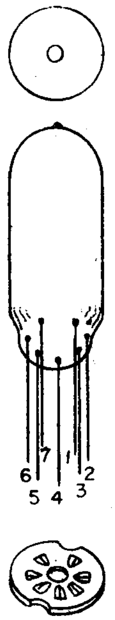
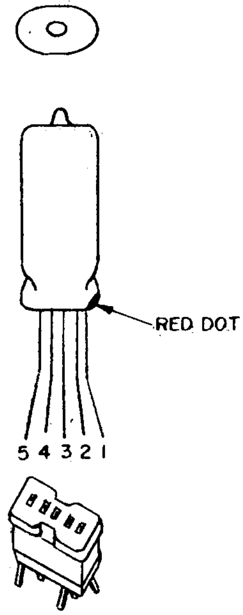


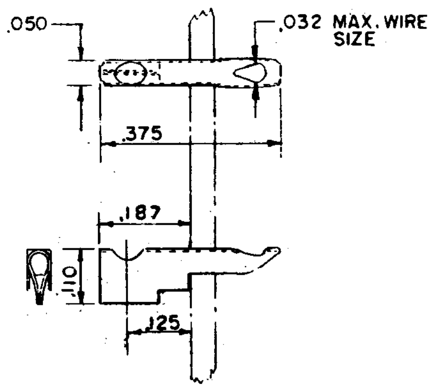
Figure 17-11. Miniature Type Tube and Clamping Arrangement



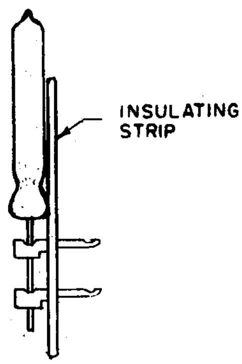
ROUND TYPE SUBMINIATURE TUBE SHOWING METHOD OF LEAD NUMBERING SOCKET



FLAT PRESS SUBMINIATURE TUBE SHOWING METHOD OF LEAD NUMBERING AND SOCKET



FLEA CONTACT DETAIL



FLAT PRESS SUBMINIATURE TUBE USING FLEA CONTACTS

Figure 17-12. Subminiature Tube, Showing Method of Lead Numbering, Flea Contacts, and Typical Socket individual lead clips made of silverplated beryllium copper. The bottom end of the contact is an open U section which will automatically wedge the clip in place when inserted in a 0.05 inch square hole. The upper end of the contact is formed into a thin tear drop shape with an aligning hole in its leading edge. When mounting a tube, the terminal lead is passed through the aligning hole and is securely gripped by the two springs which form the sides of the tear drop. See Figure 17-12.

j. FOUR NUB BASE TUBES.- These tubes have metal or bakelite bases and four short stubs or nubs instead of pins. A short pin or "bayonet" is located on the side of the tube base. The bases are of two sizes, 1.8 inches in diameter (jumbo) or 1 inch in diameter (small).

(1) JUMBO.- Many large glass tubes of this base type are in use today. They are inserted in a socket having an extended metal holder. The holder has a slot into which the bayonet pin on the tube is inserted. Turning the tube in a clockwise direction for 1/8 of a turn and tightening the knurled knob on the holder locks the tube securely in place.

(2) SMALL.-Tube sockets for these tubes have a slot into which the bayonet may be fitted. A 1/8 clockwise turn and tightening of the clamp locks the tube in place. In some cases, a knurled knob for locking may not be present. Here the spring contacts of the tube socket are sufficient to insure locking. See Figure 17-13 for knurled knob types.

k. CRYSTAL DIODES.-Although differing in internal arrangement, depending on the manufacturer, most crystals are mounted in crystal cartridges whose external dimensions have been standardized so that all makes fit the same holder.

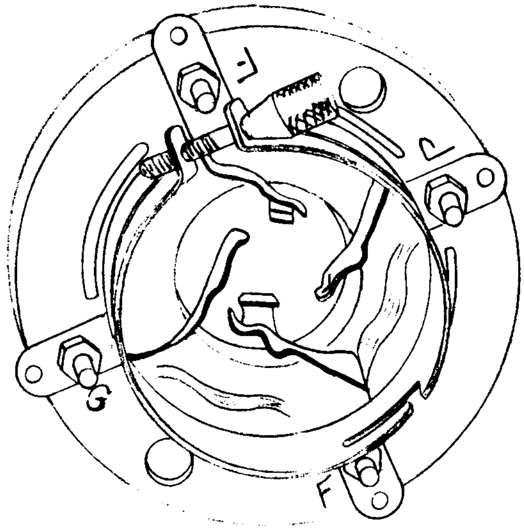
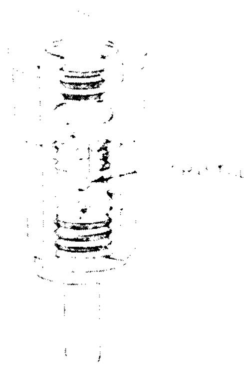


Figure 17-13. Jumbo Nub Socket and Base

The polarity of Silicon crystal cartridges has been standardized for simplicity of application. In terms of an equivalent diode, the base of the cartridge in the cartridge type and the outer sleeve in the coaxial type corresponds to the anode. The pin in both types corresponds to the cathode. See Figure 17-14.

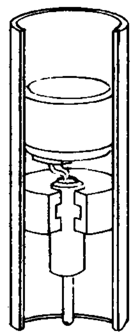
Instructions for handling crystals as given in paragraph 3a (3) should be followed.

Germanium may be enclosed in crystal cartridges in which case they are polarized as shown above, or they may be supplied with tinned wire leads, one to two inches long. These are soldered to the components for which they are intended. When soldering crystals, care should be taken to protect the component from excessive heat. Grip the leads between the point of soldering and the crystal with a pair of pliers, or a clamp. This will act as a conductor of heat and thus prevent the crystal from becoming overheated. See Figure 17-15.



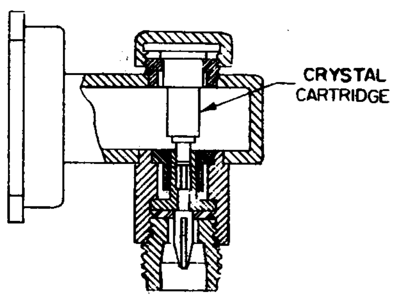
CUTAWAY VIEW OF CARTRIDGE TYPE CRYSTAL

PICTORIAL VIEW OF CARTRIDGE TYPE CRYSTAL

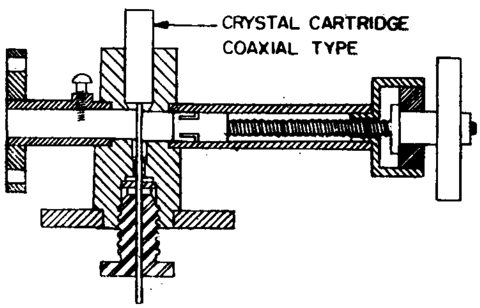


CUTAWAY VIEW OF CARTRIDGE COAXIAL TYPE CRYSTAL

PICTORIAL VIEW OF CARTRIDGE COAXIAL TYPE CRYSTAL



TYPICAL WAVEGUIDE CRYSTAL HOLDER



TYPICAL WAVEGUIDE CRYSTAL HOLDER COAXIAL TYPE

Figure 17-14. Two Types Silicon Crystal Cartridges and Typical Installation

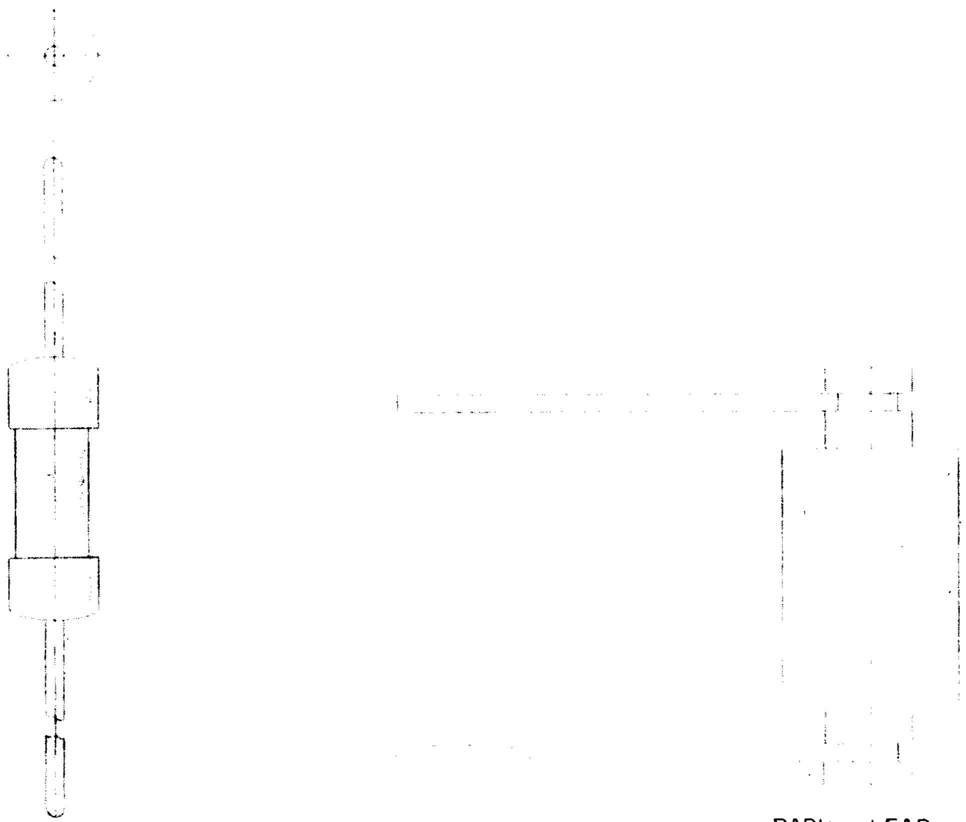


Figure 17-15. Typical Germanium Crystals

In general, the installation of crystals will depend on the equipment to be serviced and instructions as given in the instruction book for that equipment should be followed.

l. **PHOTO TUBES.**- These tubes are usually of the glass shell octal base type and can be installed and removed as outlined in Paragraph 5 of this section. A few of these tubes, however, are of the cartridge type. These are about 1-3/4 inches in overall length and have an exterior cathode and an anode terminal. The cathode terminal is a square buttoned knob and the anode terminal is the rounded flat end. The design of the cathode terminal insures correct installation See Figure 17-16.

These tubes should be protected from high temperatures and excessive light levels.

m. **TR AND ANTI-TR TUBES.**- Shipboard antenna systems use the same antenna system for transmission and receiving of radar signals. However, this arrangement could cause damage to the receiver because of the high power of the transmitter, unless some device is used which would by - pass the signal around the receiver input. The T-R tube is such a device.

The initials stand for Transmit-Receive Tube. A pre-TR is often used to insure proper operation of the TR tube.

The Anti-Transmit-Receive Tube (abbreviated ATR) is used to prevent reflection of the transmitted pulse back into the transmitter while the T-R tube is in operation. See Figure 17-17.

The installation of TR and ATR tubes will depend on the specific equipment involved and instructions for installation and removal will be given in the instruction book for that equipment. In general, the information given below will apply to most installations.

In coaxial systems, the TR and ATR tubes are installed in cavities which are inserted in the coaxial line. The tubes are accurately fitted to the cavity by two coupling flanges. A potential is usually applied between one of the fins of the cavity and to the keep alive electrode on the tube.

In waveguide systems, the TR and ATR tubes are mounted in cavities on the top or side of the waveguide, or they are fitted into cavities which are inserted in the waveguide.

When installing or removing these tubes in either of the systems, care should be taken not to damage the alignment of the fins, as this may prevent the tube from operating properly.

n. MAGNETRONS.–The resonant cavity magnetron is the most widely used source of high frequency power in pulse radar transmitters above 1000 megacycles. It is an electron tube in which the movement of electrons in crossed electrical and magnetic fields is used to convert DC energy to AC energy at the desired frequency.

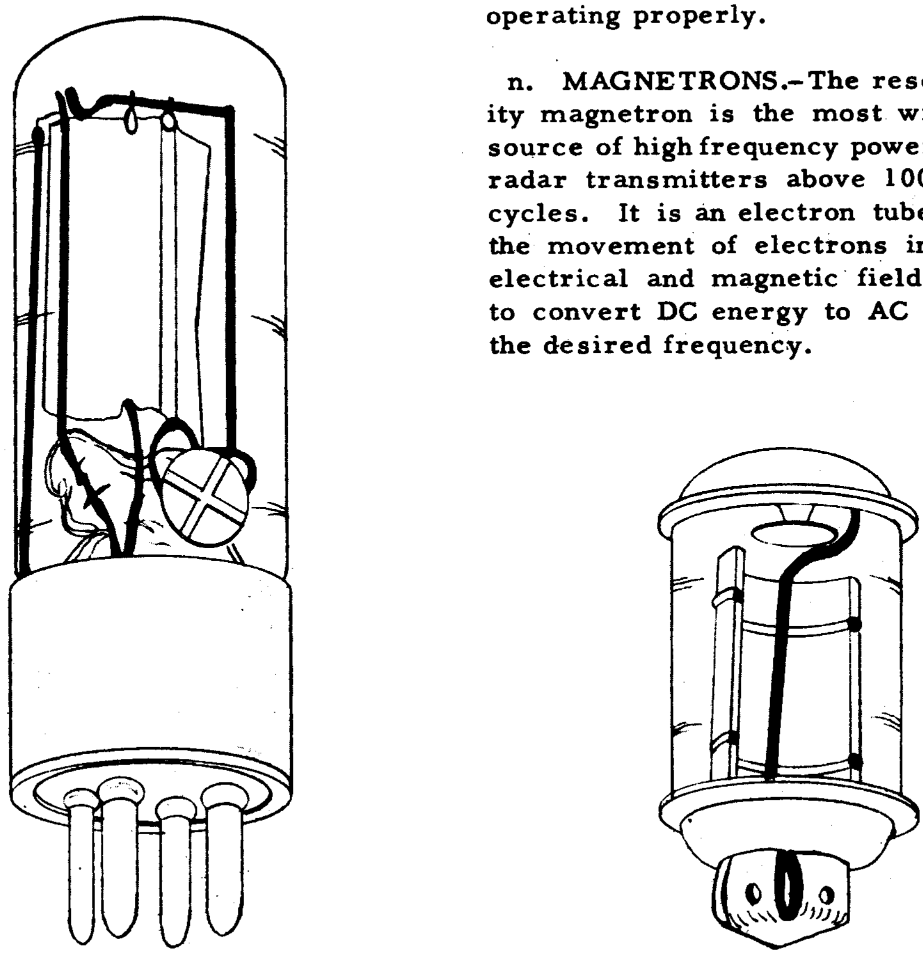
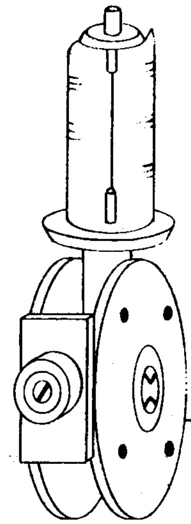


Figure 17-16. Typical Photo Tubes



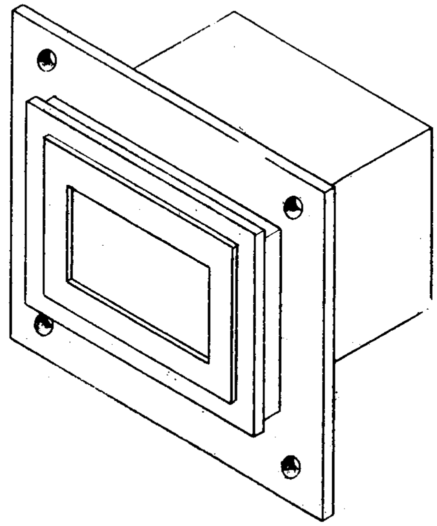


Figure 17-17. Typical TR and ATR Tubes

Package type magnetrons are those equipped with a permanent type magnet as an integral part of the tube. Care should be taken in the installation of this type tube to prevent the magnet from being damaged.

Magnetrons not equipped with permanent magnets require electromagnets or detachable permanent magnets before they can be operated. If permanent magnets are used, great care must be taken in inserting the magnet in the equipment so that no metal scraps will be attracted to the magnet. These permanent magnets are provided with keepers. When in use, the magnetron replaces the keeper. Be sure to replace the keeper when the magnetron is removed. It is important that the magnet never be touched with ferromagnetic material as this may affect the operation of the tube.

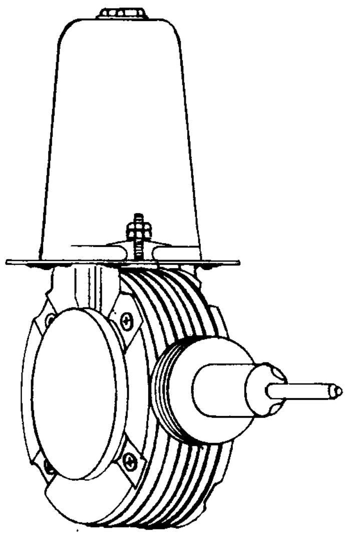
Attention should be given to the fact that there is a preferred direction for the magnetic field. This is usually noted on the tube. See Figure 17-18. A magnetron should never be pulsed without a magnetic field as this will not only alter the properties of the magnetron but may result in damage to the modulator tubes.

Magnetrons are installed in the transmitter unit, at the beginning of the waveguide or coaxial system. In general, what is said above will apply to most classes of magnetrons, However, specific installation practices will depend on the equipment to be serviced and procedure as given in the instruction book for that equipment should be closely followed.

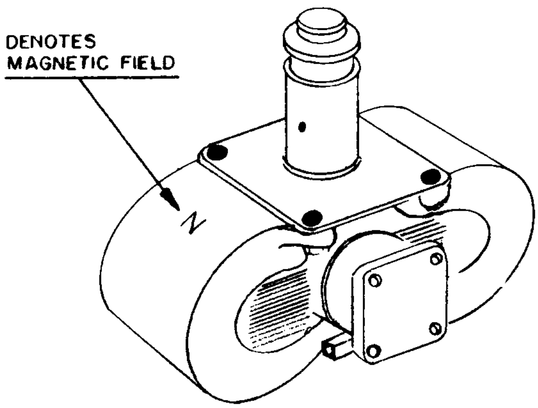
Some magnetrons which appear to be defective upon initial installation may only require seasoning for their proper operation. Seasoning should be done in the equipment, according to instructions given in the equipment instruction book. If, after the first seasoning attempt, the magnetron fails to stabilize, do not assume the tube to be defective. Repeat the seasoning process a number of times before replacing the tube.

If any evidence of corona (blue flashing between insulators) is present, the magnetron may be considered defective.

The tube may usually be mounted in any position but should be rigidly clamped to insure proper contact of the tube and to guard against excessive strains on the output line.



2J TYPE MAGNETRON



4J TYPE MAGNETRON

Figure 17-18. 2J and 4J Type Magnetrons

Tubes that are received from stock or replaced that have corroded fins should be reported to the Electronics Office. Specifications today call for an anti-corrosion finish on fins. Never install a magnetron having corroded fins. Gold plated or uncorroded fins should be cleaned with Trichloroethylene (Standard Navy Stock No. G51-T-5751). This solvent must be used in a well ventilated location. If a clean dry cloth cannot be used for wiping, blow compressed air across the fins after cleaning with this solvent. If silver plated fins are corroded on older type tubes, they should be cleaned gently with a neutral silver polish, washed with mild soap and water, rinsed with clear fresh water then wiped dry with a clean soft cloth or blown dry with compressed air if the fins are very close together.

o. KLYSTRON.-Klystrons are sometimes referred to as Velocity Variation UHF Oscillators. The most common klystrons used today are the 2K types. These are metal shell octal base tubes, and usually have 5 pins. The number 4 pin is usually an extra long coaxial output lead. See Figure 17-19.

The tube is installed in a modified octal socket. The usual key on the tube and key-way in the socket is provided. The number 4 pin will fit a larger hole in the octal socket. This pin is fitted to a coaxial connection below the socket. A repeller cap at the top of the tube may be fitted with a cap connection. The integral cavity type klystron has a tuning screw on the side of the tube. This screw enables the klystron to be correctly tuned for the specific equipment it is to be installed in.

Care should be taken when installing klystrons so that the coaxial output probe is not bent or the polystyrene insulation is not cracked or broken off.

After installation, be sure to check that the repeller cap is not shorted to

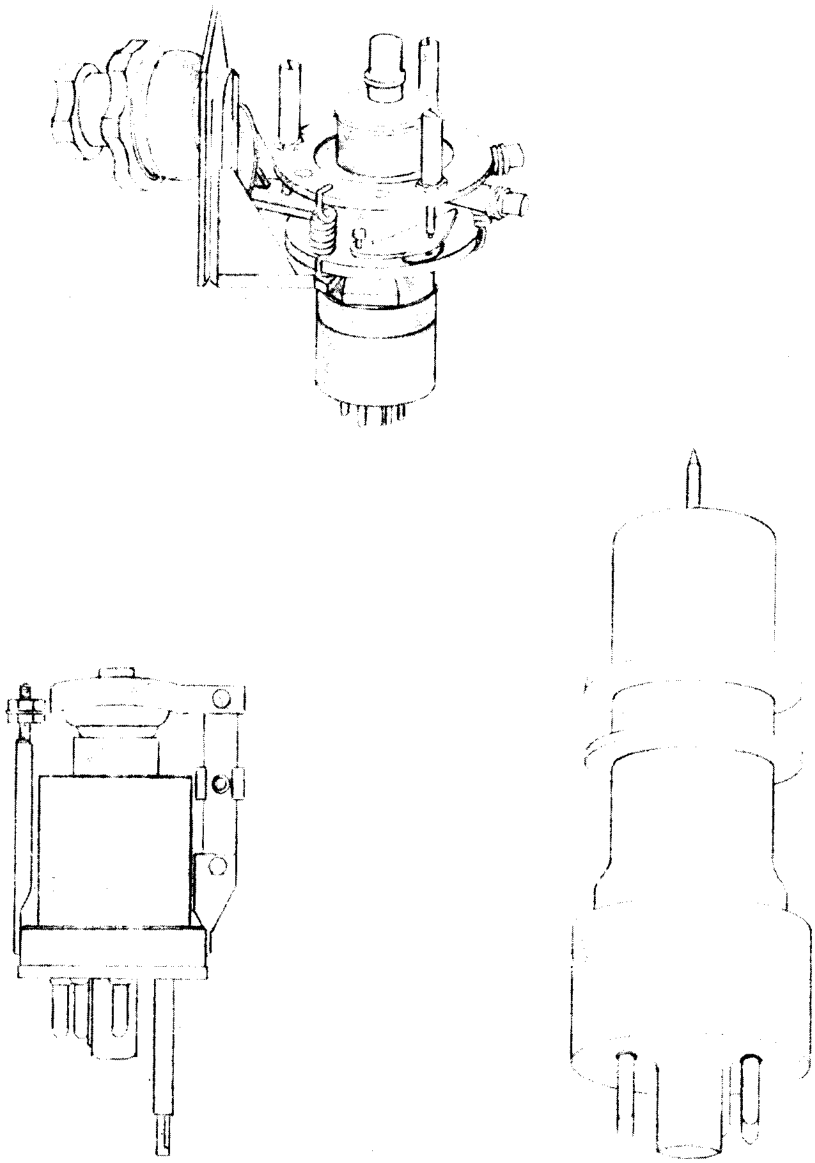


Figure 17-19. Typical Klystrons

the body of the tube. In many systems the body of the tube is operated at other than ground potential; be careful that it is not shorted to the shield can.

p. MERCURY VAPOR TUBES.-Tubes containing mercury vapor should always be mounted in a vertical position with the filament connections down. In this position no filament sag will occur nor will metallic mercury be deposited on the active elements of the tube. See Figure 17-20.

Mercury vapor tubes are designed to operate between certain definite limits of ambient temperature. This temperature should be measured in the tube compartment as near as possible to the tube. If the temperature exceeds the prescribed limit, forced air cooling is necessary.

q. THYRATRONS.- The thyratron is a three electrode tube containing inert gas or mercury vapor under low pressure. Thyratrons are built in many sizes and ratings. Many low-current capacity thyratrons are enclosed in glass tubes and use an inert gas while many high-current capacity thyratrons are contained in metal tubes and use mercury vapor. Miniature and sub-miniatures are sometimes used as control tubes. See Figure 17-21.

Installation and removal will depend on the base design. Octal 4, 5, 6 or 7 pin bases, miniatures and sub-miniatures and NUB bases are installed in the same manner as mentioned before. In many cases exterior cap connections must be made. Where more than one exterior connection is present the anode is at the

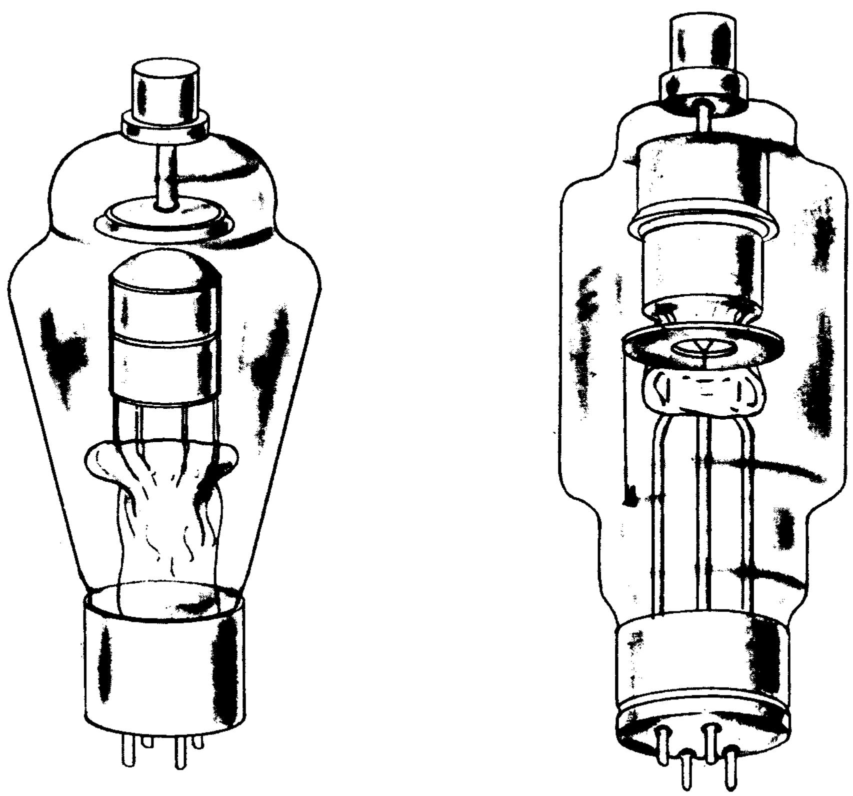


Figure 17-20. Typical Mercury Vapor Tubes

top and the grid is at the side of the tube. The grid is usually placed on the side of the tube when high impedance grid excitation is necessary. When these connections are necessary, cap connectors will be available.

Metal type thyratrons have three flexible external beaded leads. The beads supply insulation. The ends of the leads are fitted with wire connectors. The anode terminal is the lead from the top of the tube. The two leads from the base of the tube are the heater terminal, designated by the letter "F" and the heater and cathode terminal designated by the letter "K". The control grid terminal protrudes from the side of the metal shell. It is a threaded connection.

When removing a metal type thyratron, it is important to remember that the leads are a part of the tube. Do not cut these leads to remove the tube.

r. IGNITRONS. - The ignitron is another three electrode type of tube utilizing mercury vapor.

Because of the heat developed in larger tubes, water cooling is necessary. However, smaller size ignitrons may be found aboard ship in some installations. These tubes will be the metal type with flexible leads extending from the top and bottom of the tube. The anode connection is a braided wire extending from the top of the tube. It has a wire con-

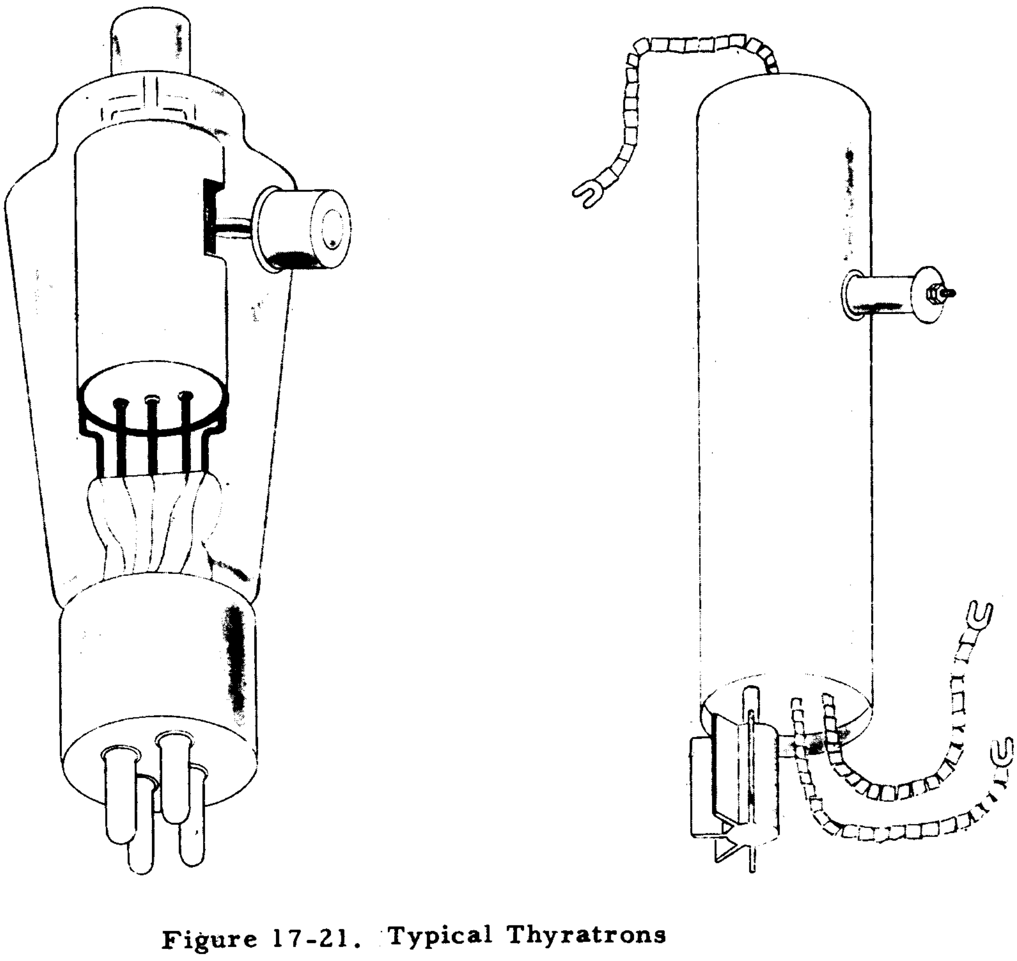


Figure 17-21. Typical Thyratrons

nector attached to it for easy installation. The cathode connector is a thin flexible wire extending from the base of the tube, having an attached wire connector for easy installation. The ignitor connection is a thick metal bar extending from the tube base. This tube must be operated in a vertical position. See Figure 17-22.

s. CATHODE RAY TUBES.–In the installation and removal of cathode ray tubes it is important that the handling instructions given in Paragraph 3a (1) be closely followed.

Cathode ray tubes may be subdivided into electrostatic or magnetic deflection types depending on the method used to deflect the electrons into their proper course. Electrostatic deflection tubes use a system of accelerating anodes and deflecting plates while magnetic deflection tubes use heavy magnetic deflection coils. See Figure 17-23.

The base on cathode ray tubes can have from five to sixteen pins. Tubes having a few number of pins will have pins varying in sizes to insure correct installation. Where a large number of pins are present there will be a key and a corresponding keyway in the socket to insure correct installation.

Some of the larger tubes, because of the high voltage at which they operate, have a snap button connection on the bell part of the tube. A button pin will be available and can easily be installed by applying a light pressure to it, causing it to snap into the button on the tube.

In the cathode ray tubes, the socket alone should not support the tube. Additional support such as a yolk or saddle arrangement near the screen end of the tube and a padded mechanism near the neck of the tube should be used. Tube clamps should not be used with cathode ray tubes.

The bulb should be enclosed by a grounded shield if the tube is operated in the presence of a magnetic field. This will prevent distortion of the image when the tube is in operation. It is often necessary to insulate the high voltage end of the tube from the shield to avoid leakage currents.

In unpacking these tubes attention is again called to Paragraph 3a (1) on Handling.

Installation and removal will depend on the equipment to be serviced and the instruction book for that equipment should be followed.

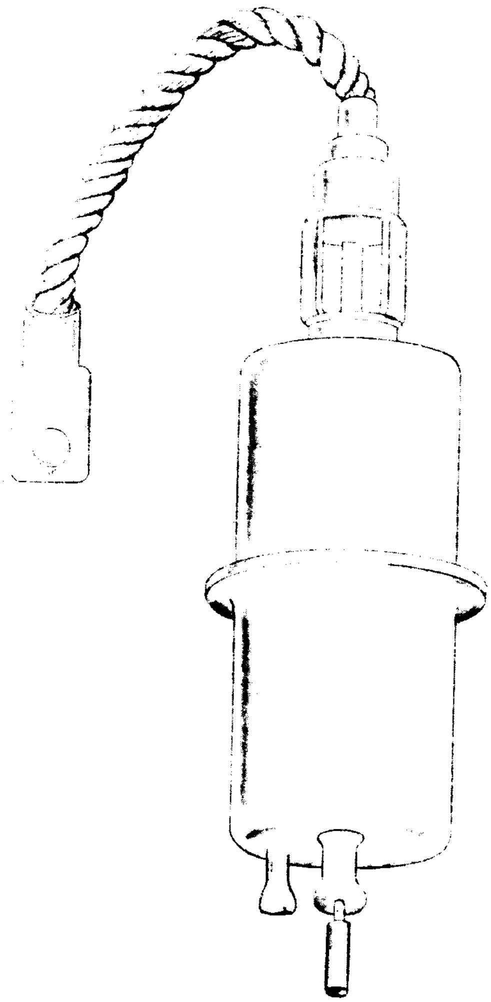
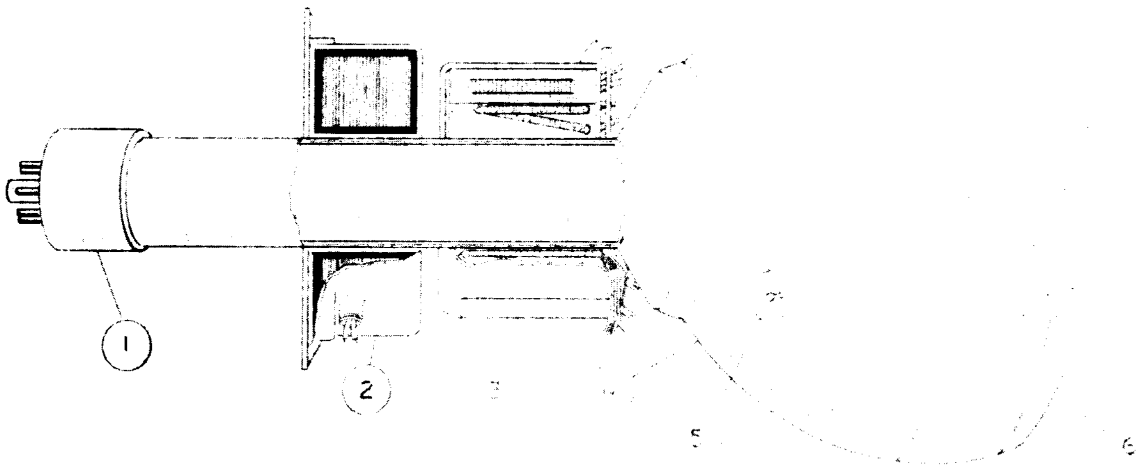


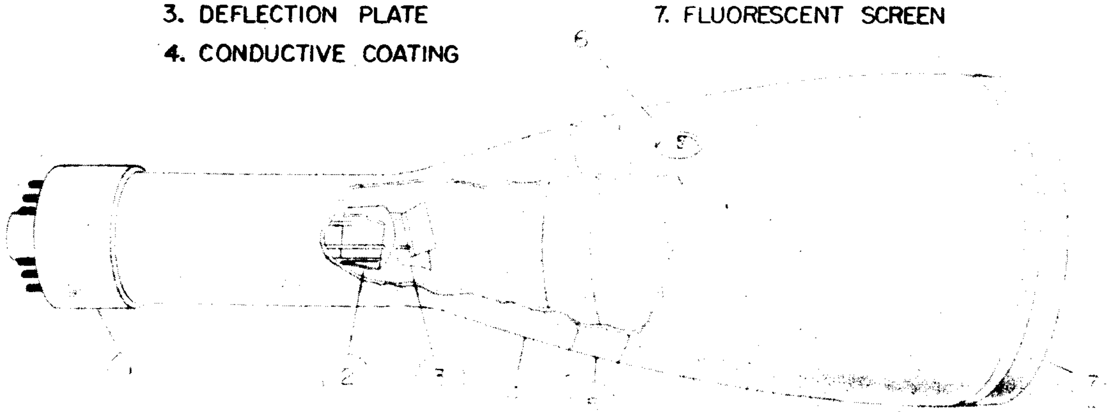
Figure 17-22. Typical Ignitron

1. BASE
2. FOCUSING COIL
3. DEFLECTION YOKE
4. ANODE CONDUCTIVE COATING
5. ANODE TERMINAL
6. FLUORESCENT SCREEN



TYPICAL CATHODE-RAY TUBE WITH
MAGNETIC FOCUSING AND DEFLECTION

1. BASE
2. DEFLECTION PLATE
3. DEFLECTION PLATE
4. CONDUCTIVE COATING
5. INTENSIFIER GAP
6. ANODE TERMINAL
7. FLUORESCENT SCREEN



TYPICAL CATHODE-RAY TUBE WITH
ELECTROSTATIC FOCUSING AND DEFLECTION

Figure 17-23. Magnetic Deflection and Electrostatic Deflection Type of Cathode Ray Tubes

t. ACORN TYPE TUBES. - Current tube lists mention twelve acorn type tubes in use at present. These are JAN type numbers 6F4, 6L4, 6Q4, 954, 955, 956, 957, 958A, 959, 9004, 9005, A4466.

Of these the 954, 956, 959, A4466 are pentodes, the 955, 957, 958A are triodes, and the 9004, 9005 are UHF diodes.

All tubes of this group have 5 connections extending from the ring of the tube. In the case of the diodes, no connection is made in the center prong of the 3 grouped set of prongs.

In addition to these 5 prongs the pentodes have a plate connection extending from the top of the tube and a control grid connection extending from the base of the tube. The top of the tube is easily recognized since it is the large blunt end of the tube. The bottom of the tube is a short tipped end. See Figure 17-24.

These tubes are usually installed in ring shaped sockets. When installed in such sockets, they should be inserted so that the short tipped end rests in the mounting hole. This places the large end on the same side of the socket as the clips.

The design of the socket will not prevent the tube from being accidentally inserted upside down. If this occurs, probably the tube and a grid circuit resistor would burn out.

There is but one correct way to insert acorn tubes in their sockets. A simple rule to remember is to always grasp the large end of the tube in the fingers and insert the 2 grouped tube prongs in the 2 grouped socket clips.

In the case of pentodes, an alligator clip is attached to the top plate connection.

The 6F4, 6L4 and 6Q4 are triodes having 7 pins extending from the ring of the tube. The above rule for correct insertion of the 5 pin type can be applied to this type, however, because of the special arrangement of the two extra pins.

Great care should be exercised in installing or removing all acorn type tubes

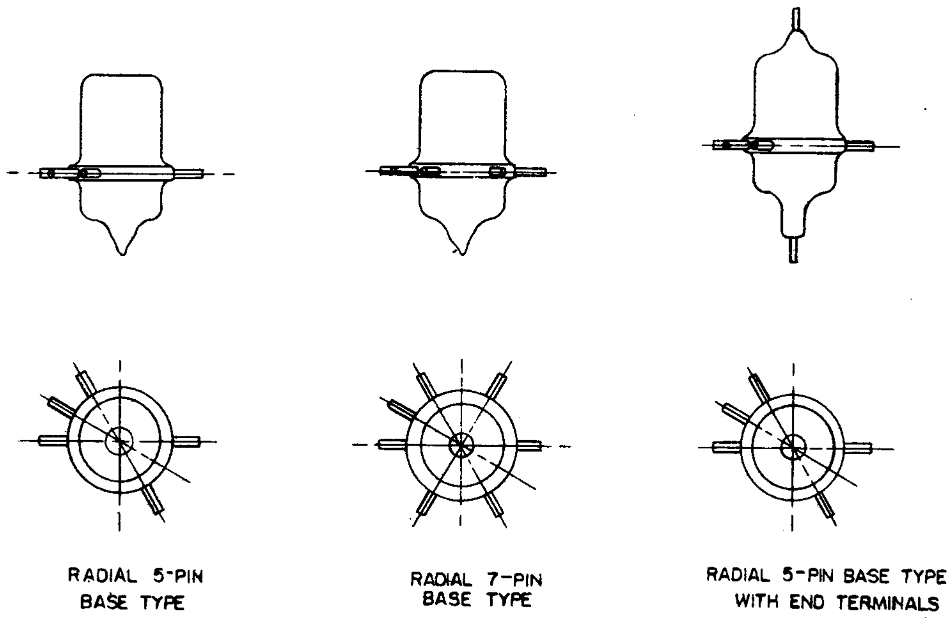


Figure 17-24. Typical Acorn Type Tube

as the glass to metal seal at the pins can crack very easily.

u. PLANAR TYPE TUBES. — Planar type tubes are a development of World War II. Because of their internal structure they are especially useful as local oscillators in receivers and oscillators in low power transmitters. They are of two general types, lighthouse tubes and oil can tubes.

(1) LIGHTHOUSE TUBES. - These tubes receive their unique name from the external structure. It resembles a lighthouse, or five-piled cylinders whose diameters increase from top to bottom. This unique design permits exterior connections to each of the cylinders. For the connections on this type tube see Figure 17-25. These connections are usually made by inserting the tube in a coaxial line. Tube bases are of the octal design having the familiar center prong and key to insure correct installation.

(2) OIL CAN TUBES.-These are another type of disk seal tube which is usually inserted in a coaxial line. Their upper portion resembles a lighthouse tube in that connections are made to the cylinders of the oil can. For these connections see Figure 17-25. It is important to note that the cooling fins on the base of this tube are common electrically to the anode.

v. TRANSMITTING TUBES.- Transmitting tubes, because of the high heat which they dissipate, are usually cooled in one of the following ways: water cooled, forced air cooled, or convection air cooled. See Figure 17-26.

(1) WATER COOLED TYPES. - In tubes of this type, care should be taken that the water supply is correctly installed as improper installation may affect the proper operation of the tube. It is important that any special instructions received with the tubes be closely followed.

(2) FORCED AIR COOLED TYPES.- Briefly, the forced air cooled tube consists of an arrangement of fins which are connected to the anode by a heat conducting mounting. This mounting may be a cap wire or rod. A flow of high velocity air is forced through the radial fins of the unit by a blower. A simple, low head type rotary fan is used as the blower. These tubes are usually characterized by a large number of thin fins.

(3) CONVECTION AIR COOLED TUBES. - These tubes are usually of a standard design and rely on their position in the unit to allow proper cooling. Some may have exterior fins to promote cooling.

(4) INSTALLATION AND REMOVAL. -The bases of Transmitting Tubes may have from two to eight pins. External anode and plate connections may also be present. In general, installation of these tubes will fall into one of the classifications discussed in the preceding paragraphs. Exterior cap connections are made in accordance with instructions given in the equipment instruction book. It is important to note that where side and top connections are present, the cap at the side is usually the grid connection.

Care should be taken in the installation of tubes having thin pin connections to guard against breaking the metal to glass seal, as this will destroy the vacuum in the tube and render it useless. These tubes are usually inserted in a spring type contact socket or they may be soldered to a component.

Where exterior fins are present, care should be taken not to bend or strike these fins as this may destroy the proper operation of the tube.

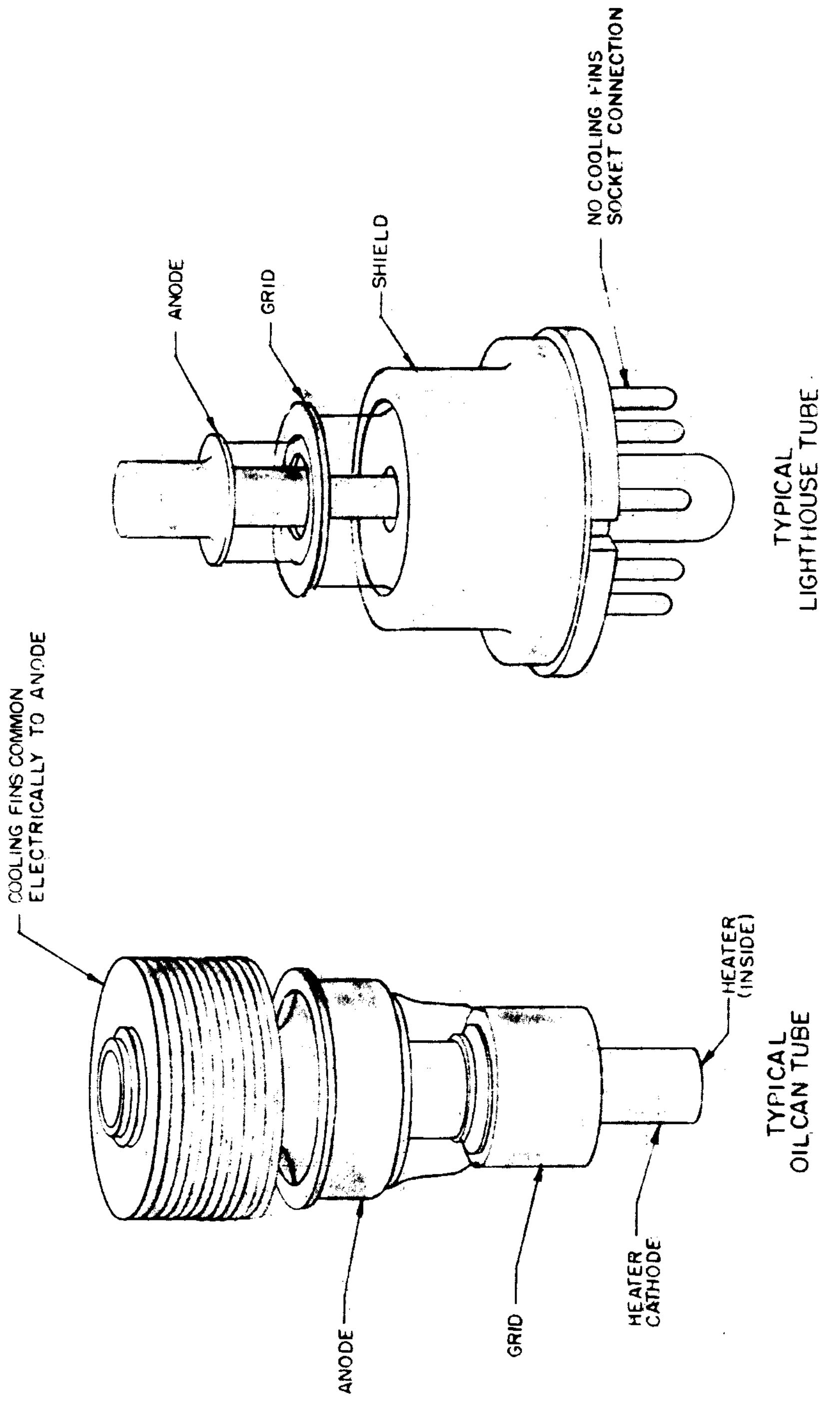


Figure 17-25. Typical Planar Tubes

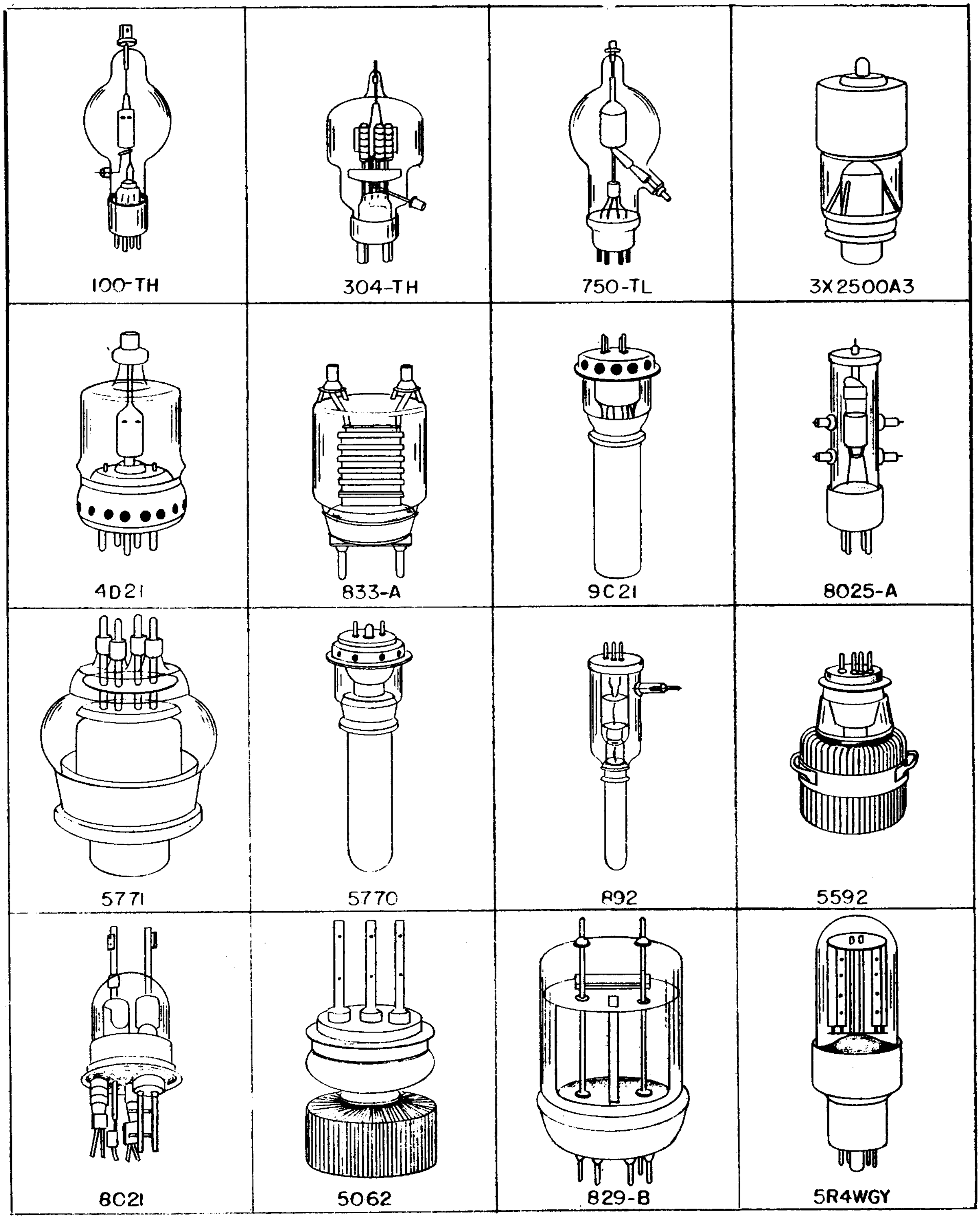


Figure 17-26. Typical Transmitting Tubes

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