INSTALLATION
AND
INSTRUCTION MANUAL

FOR

KT
TEMPERATURE
MONITORING SYSTEM

SPECIAL NOTE

<u>READ THIS ENTIRE BOOKLET BEFORE PROCEEDING WITH THE INSTALLATION</u>

BOONE CABLE WORKS & ELECTRONICS, INC.
1773-219TH LANE - P.O. BOX 369
BOONE, IOWA 50036 USA
PHONE (515) 432-2010 FAX (515) 432-5262
TOLL FREE (800) 265-2010

2/26/02

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1. General

Boone Cable Works & Electronics, Inc. offers a comprehensive line of temperature monitoring equipment. This complete product range and extensive systems experience allows us to offer effective solutions to a wide spectrum of your practical requirements. Our extensive background in temperature monitoring along with a constant program of innovation and technological development allows us to offer cost-effective and user-orientated solutions.

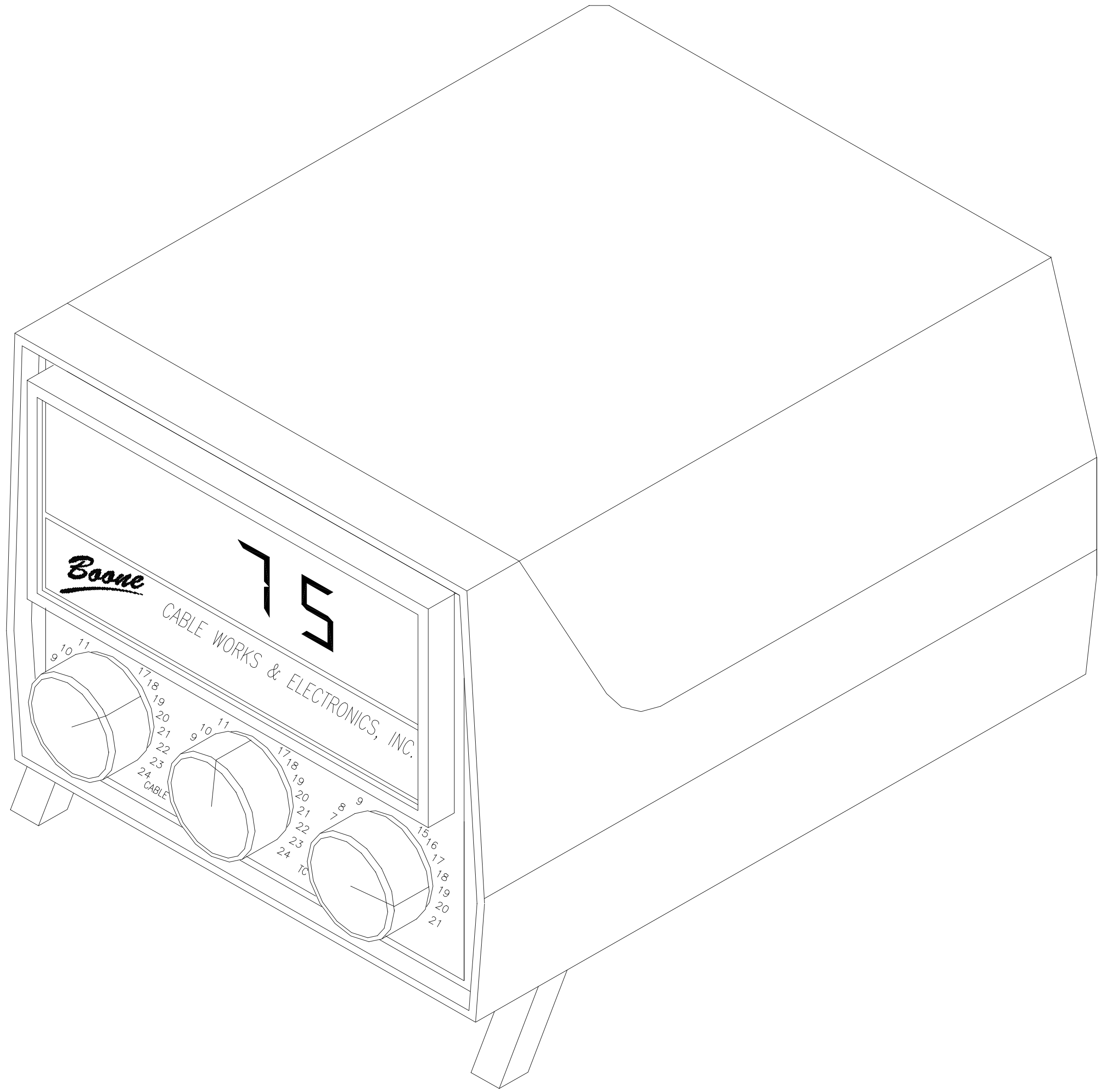
Please read all the instructions for system installation before beginning.

A. KT System

The KT Temperature system is designed to manually select thermocouple temperature sensors for reading. See drawing #180104 & #180105. The temperature sensors are located in cables suspended from the ceilings of grain storage facilities. The suspended temperature sensing cables are available in many different total lengths and thermocouple spacing. The cables on your site will have been selected by determining the requirements of your storage facilities.

The cables are connected through leadwire to remote switches, which select the cable temperature to be read. Each remote switch can accommodate up to 24 cables. The remote switches are connected to the KT Instrument through the control cable.

The KT Instrument controls the remote switch and displays the temperature of the selected cable and thermocouple.



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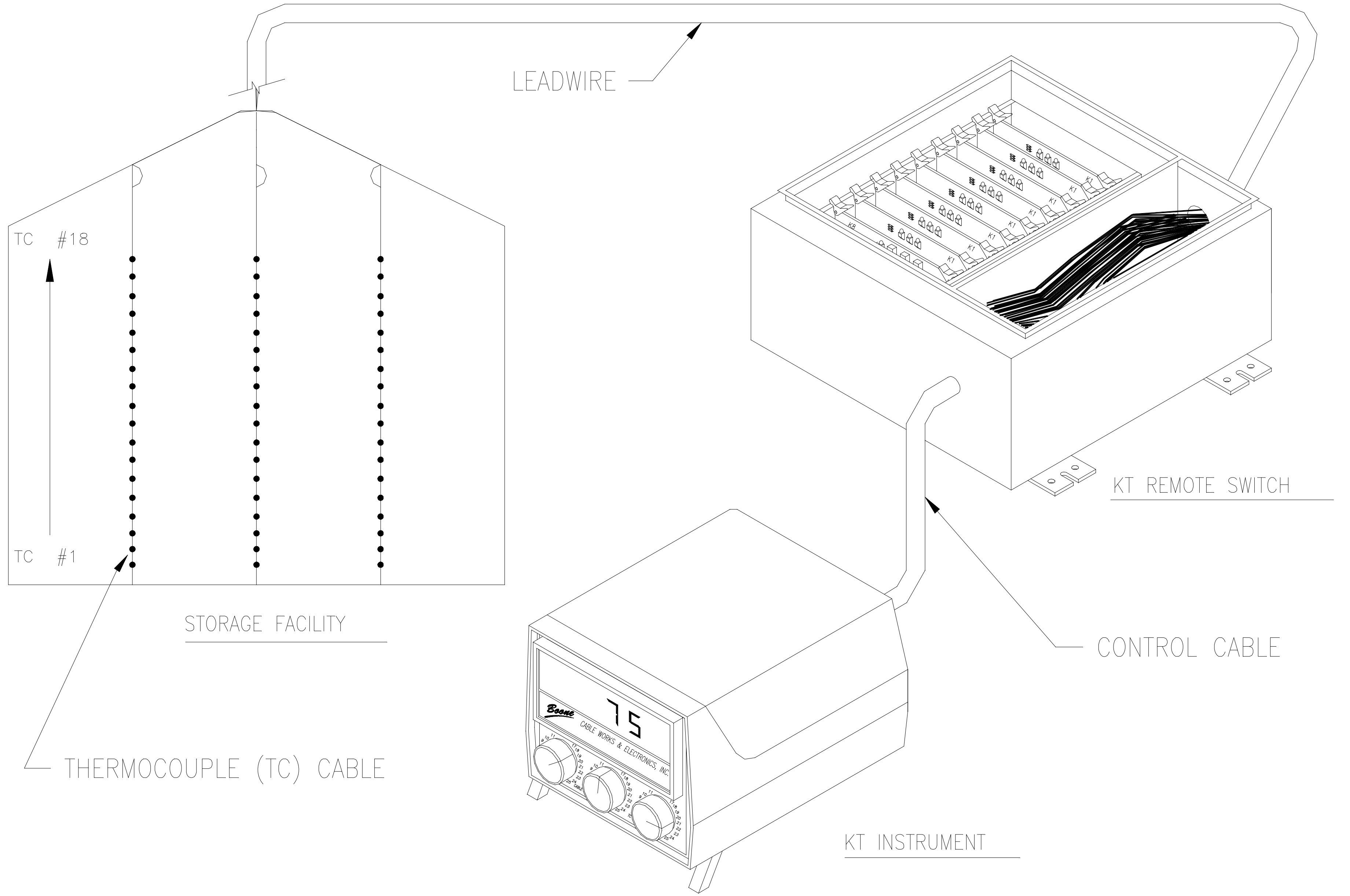
TITLE:	SCALE: NONE	DATE: 12-8-94
REF. KT INSTRUMENT	DWN. BY: R. NELSON	
	DWN. NO. 180104	



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TITLE:	SCALE: NONE	DATE: 12-8-94
REF. KT TYPICAL INSTALLATION	DWN. BY: R. NELSON	
	DWN. NO. 180105	

B. Grain Temperature Systems and Their Use

Stored grain is constantly threatened by the hazards of mold activity, insect infestation and moisture migration. When grain goes out of condition, regardless of the cause, there is almost always a rise in temperature in the critical areas.

All stored grain is infected to a certain extent with various types of grain storage molds. The correct conditions of moisture and temperature will stimulate their activity. The optimum temperature is about 85 degrees Fahrenheit for most prevalent species. The growth of storage mold lowers the usefulness of grain and grain products by the development of off-odors and various types of kernel discoloration. If there is a high percentage of damaged kernels, often caused by "turning", the grain is more likely to go out of condition.

Insect activity is also directly related to temperature and moisture content of the stored grain. Generally speaking, the dampest and warmest part of the bulk, and not the average, is the determining factor with respect to insect growth and reproduction. Infestation can be controlled by fumigants, but reduction in fumigant cost is possible if storage temperature can be maintained at a lower level. Most insects thrive in temperature above 70 degrees Fahrenheit, particularly, in high-moisture grain. Insects not only consume the grain, causing damaged kernels, but also generate heat and ultimately develop a temperature in the grain, which may cause further serious damage. Below 50 degrees Fahrenheit, most insects become dormant and may die of exposure to low temperatures after a few weeks.

When warm grain is put in storage, it is essential to reduce the temperature of the grain as soon as possible. When this cannot be done within a matter of weeks, it is wise to treat the grain with an insecticide if there is any possibility of insect infestation. If the grain is to be stored for any length of time before the temperature is reduced, further fumigation may be necessary.

The moisture in a mass of grain stored at a uniform moisture content may move within the mass because of differences in grain temperature. During the winter, the grain next to the bin wall becomes cooler than that at the center of the mass. Convection air currents pick up moisture from the warm areas and transfer it to cooler parts of the grain mass. The increase in moisture content may cause a corresponding increase in the respiration of the grain and associated microorganisms, and this oxidation of the grain carbohydrates produces added moisture and heat. Heating from one cause may trigger another, which will contribute to the total heat produced; the combined action may result in serious damage, unless the heated grain is removed, or the temperature reduced. When sufficient moisture is concentrated in the top layer of the stored grain, it may mold and cake. This often occurs, even in grain, which was considered to be of safe moisture content when it was stored.

C. Thermocouple Theory

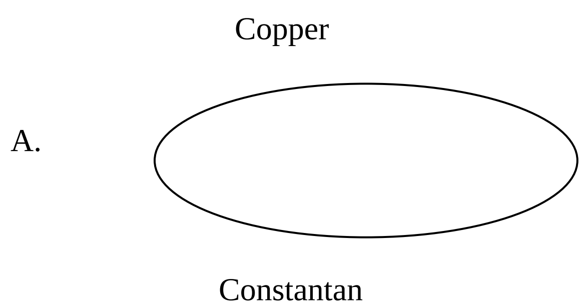
The principles, or theory, underlying thermoelectric effects were not established by one man at one time, but by several scientists working over a span of many years beginning with Alessandro Volta, who concluded in 1800 that the electricity which causes Galvani's frog to twitch was due to a contact of two dissimilar metals. This conclusion was the forerunner of the principle of the thermocouple.

When a circuit is formed consisting of two dissimilar conductors, and one of the formed junctions of these two conductors (A) is at a temperature higher than the temperature of the other junction (B), a minute voltage is generated, and a current will flow in the circuit.

The current will flow in one direction if the temperature at (A) is higher than (B). The current will flow in the opposite direction if the temperature at (B) is higher than (A). No voltage will exist and no current will flow when the temperature of junctions (A) and (B) are the same.

A single junction, such as (A) or (B), is commonly called a thermocouple. The common abbreviation for thermocouple is TC.

Many different metals are used for thermocouples in various applications; however, copper and constantan are the most practical for temperatures below 600 Degrees F. Constantan is an alloy approximately 57% copper and 43% nickel. The junction of copper and constantan is called a type T thermocouple.



2. Cable Installation

Care must be taken to hang the correct length cables in respective bins. Check cable length with print supplied to correspond with proper height of respective bin. See tag on cable for length.

A. Steel Tanks

There are several types of steel tanks and parts of these instructions may be modified to fit the circumstances. Care should be taken in handling the cables and leadwire to avoid crushing, cuts and knots.

The cables must be hung according to the bin manufacturer's specifications. Due to the many differences between steel tanks, no specific location instructions can be given. In most cases, the roof itself is not strong enough to support the cables. Some have beams or trusses; and some have special braces for hanging cables. If the cables are not properly hung, the bin roof and sidewalls can be damaged by the pull of the cables. <u>Refer to bin manufacturer's recommendations to determine the structural strength of the bin or cable supports supplied by the manufacturer to be sure that it is adequate and will not permit damage to the roof or sidewalls. The client is totally responsible that the steel bin is of proper design and strength to support the temperature detection cables.</u>

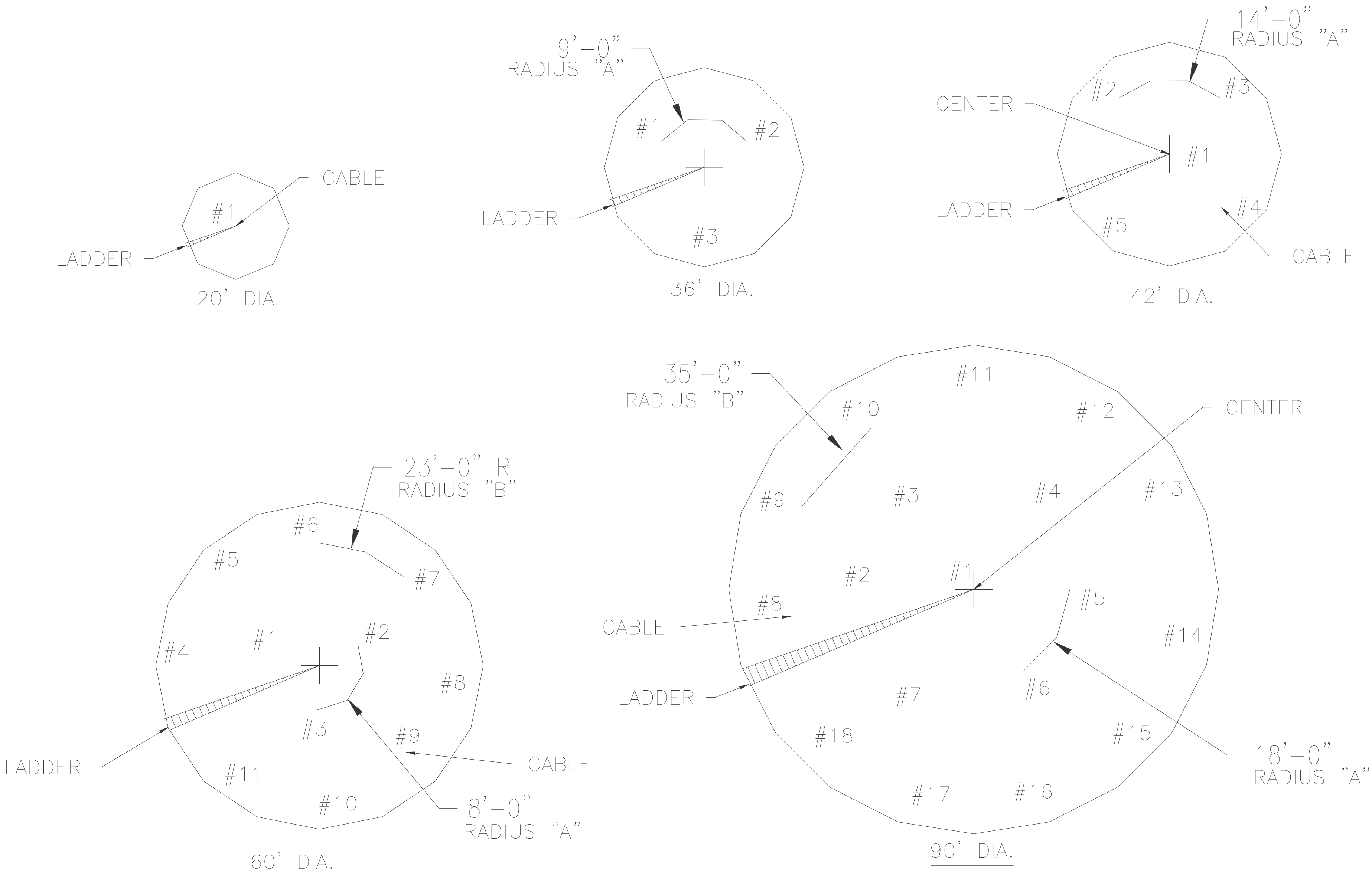
The numbering sequence of cables in steel tanks is standardized. The center cable or first cable clockwise from the ladder is always number 1. If more than one radius is required by the coverage pattern, the inner circle will have the smaller numbers in clockwise sequence and the lowest number of the other radii will be the first cable clockwise from the ladder. See drawing #180010.

Cables should be sorted according to length and put in the respective tanks before adding other hardware.

Locate the position for the respective cables on the bin top, making sure that no cables will be hanging in the grain stream when the bins are being filled.

Arrange the cables according to length. The shortest cables are for the outer circle and the longest are for the inner circle.

Lay the outer circle of cables on the bottom of the steel tank in line with the hanging points, but next to the wall. Lay the inner circle of cables on the bottom of the steel tank in line with their hanging points, but about 10 feet to the outside.



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TITLE:	SCALE: NONE	DATE: 12-8-94
REF. CABLE NUMBERING SEQUENCE OF STORAGE TANKS	DWN. BY: R. NELSON	
	DWN. NO. 180010	

Tape leadwire to the eyebolt. Leave enough slack in leadwire so that the cable may swing without pulling splice at top of cable apart.

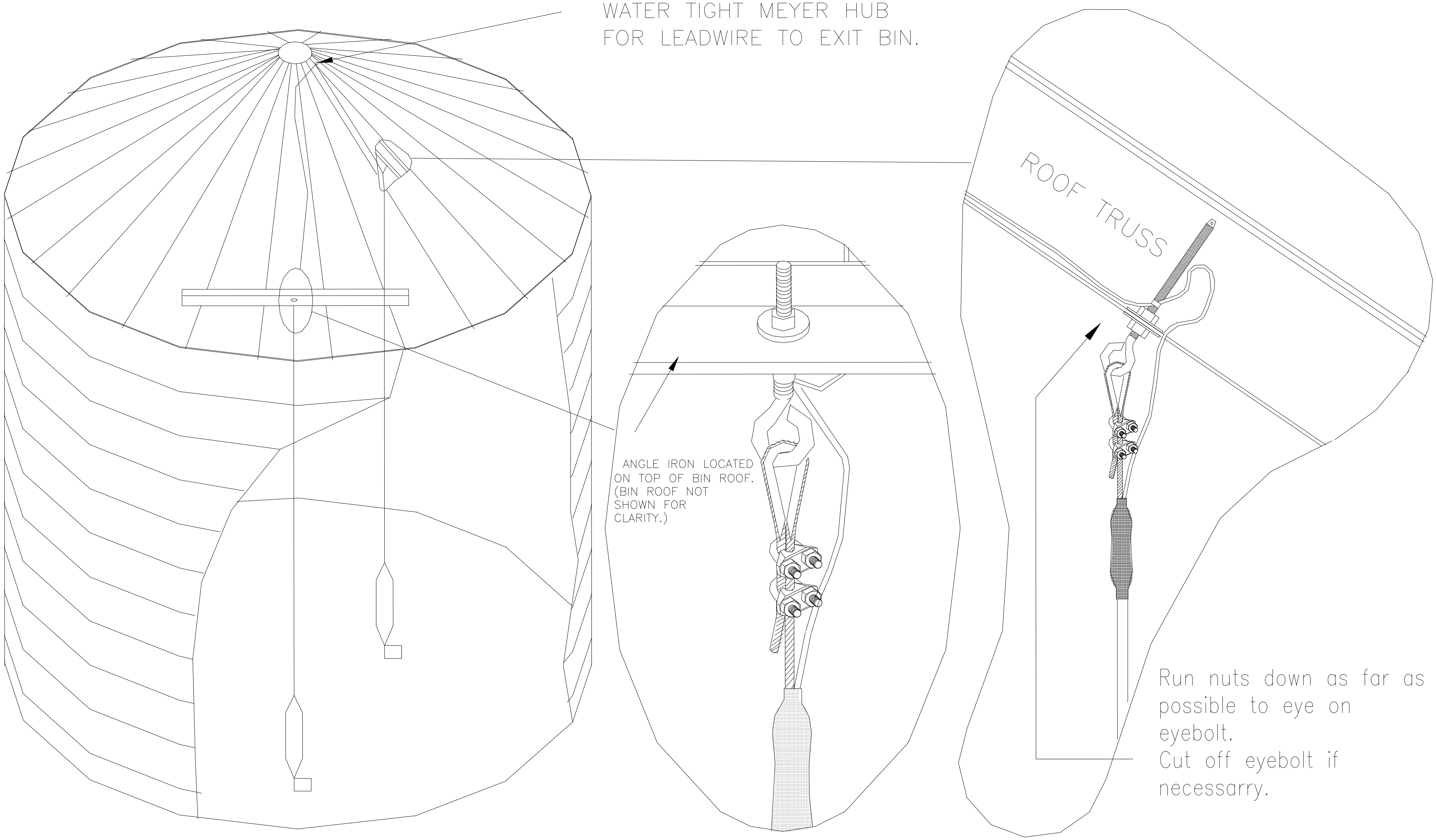
Screw one nut and washer down on the eyebolt just above where the leadwire is taped. Place the eyebolt through the hole, in the beam, roof support or roof where the cable should be hung and secure with a washer and nut. See drawing #180012. In some tanks, angle or channel is used to span roof ribs for load distribution.

Tie the bottom of the cable to the anchor plate, using the loop at the bottom of the cable and hole in the anchor plate. See drawing #180026 for other tie-down methods. Use a maximum of 110-LB fishing line or baling twine. This will hold the cable in place while the bin is filling.

If the roof itself is drilled through, seal the roof, the washer, the nut and eyebolt with roofing cement to prevent water leaks.

Number each leadwire to correspond with the cable layout print with a "Brady" number about 18 inches from each end. Number one will be on the inside circle of cables. Cables are numbered clockwise looking down from the top. This general numbering system is for round steel tanks. See drawing #180010. Specific layouts will be prepared for other buildings.

An ideal time to hang cables in a steel tank is when the roof is assembled on the ground before erection. The cables can be hung either thru the roof with "I" bolts or hung from tank reinforcements. Leadwire can be routed thru reinforcements and fastened with plastic tie bands. Thus, keeping leadwire from sagging and getting into the grain.



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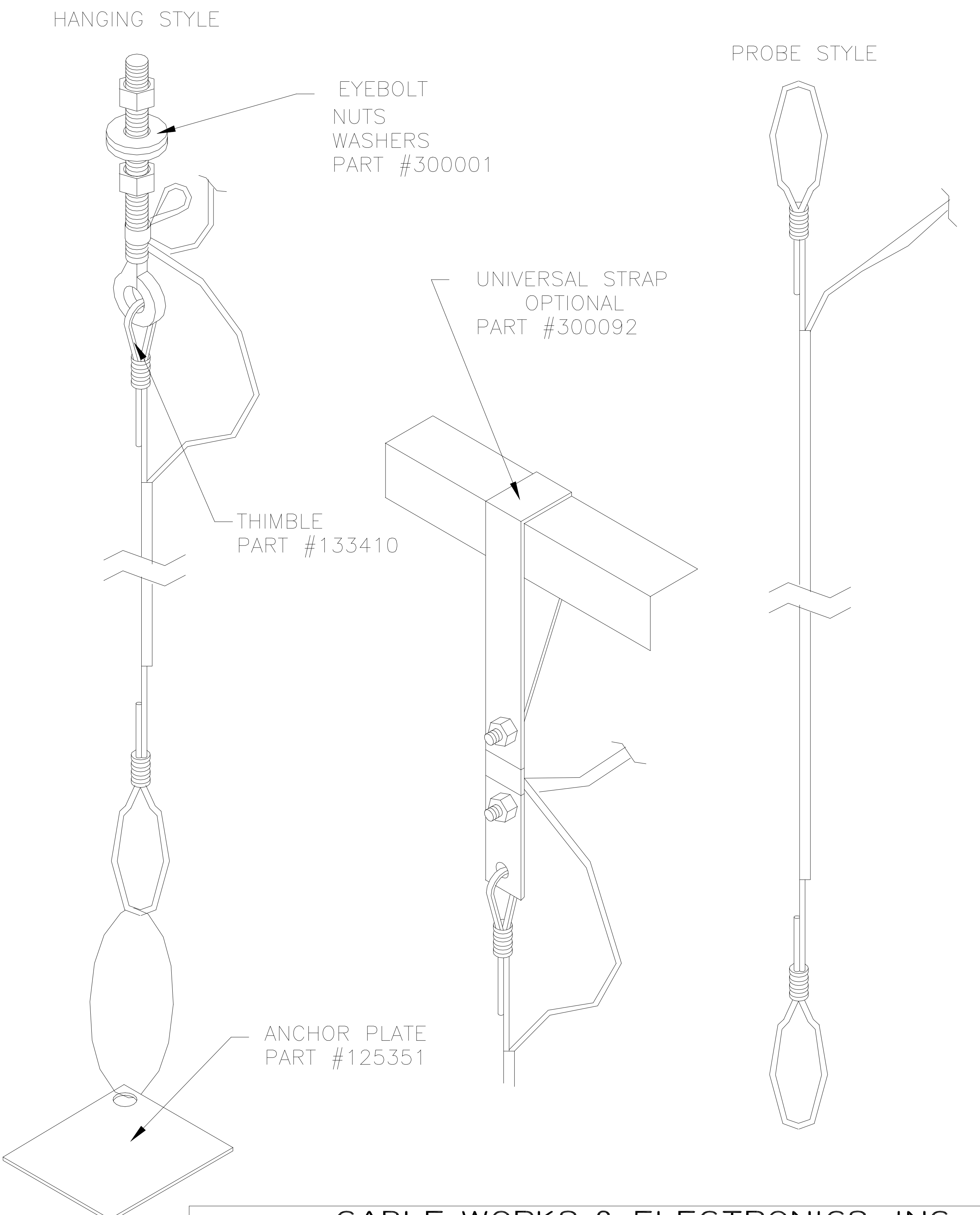
TITLE:	SCALE: NONE	DATE: 1-31-02
REF. STEEL TANK CABLE INSTALLATION	DWN. BY: Rick H	
	DWN. NO. 180012	



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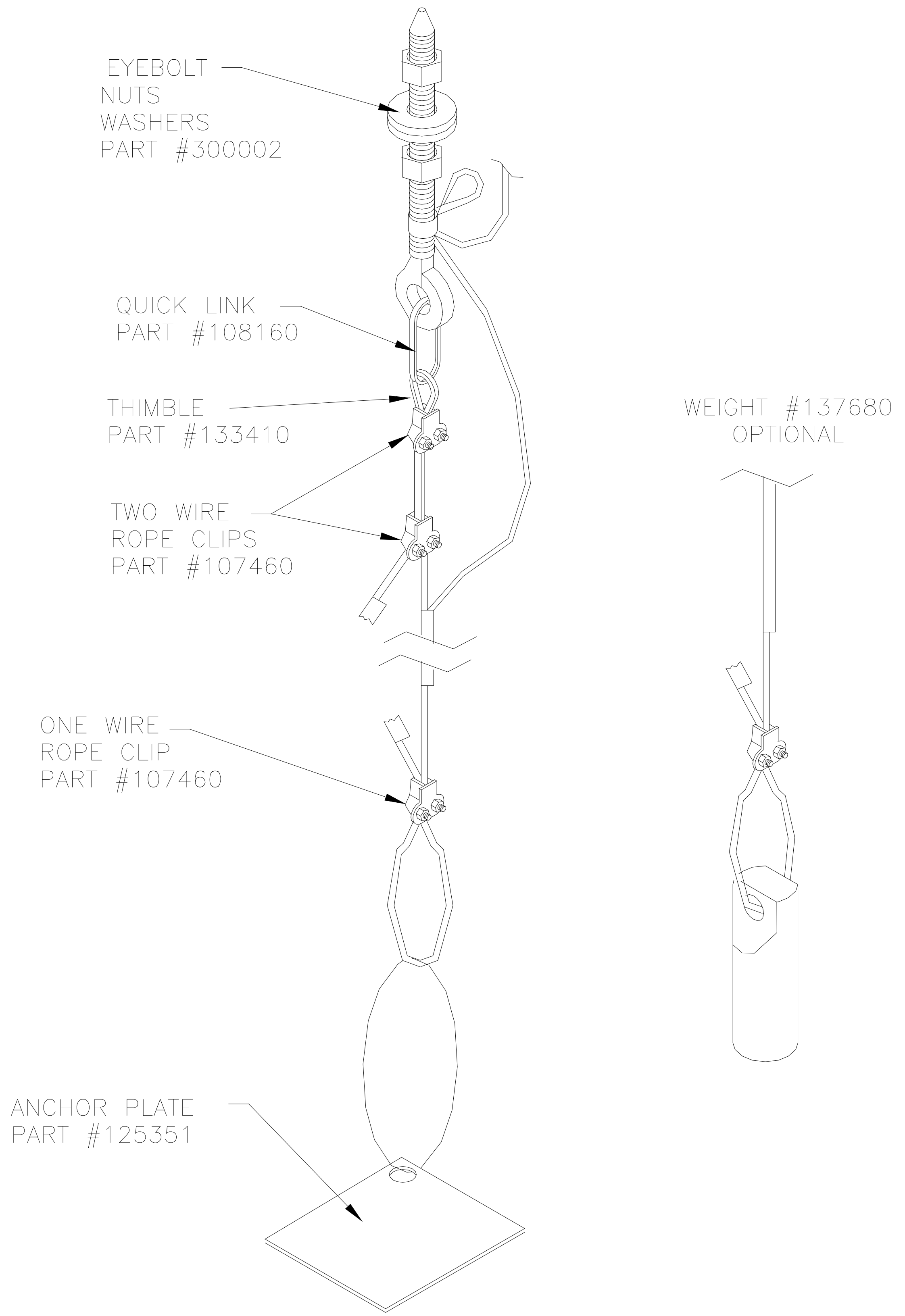
TITLE:	SCALE: NONE	DATE: 12–8–94
REF. TYPICAL 6 TC CABLE	DWN. BY: R. NELSON	
	DWN. NO. 180016	



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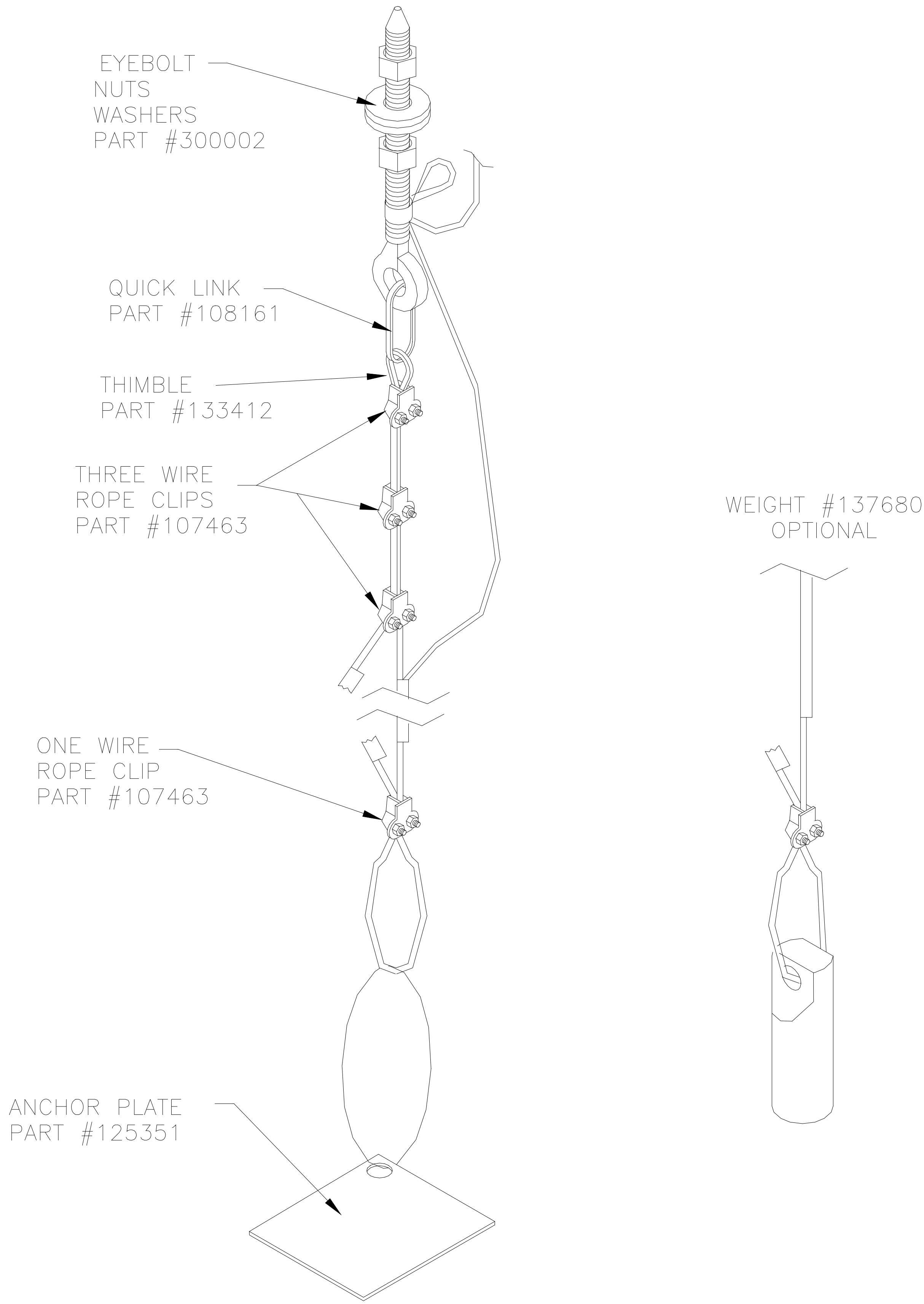
TITLE:	SCALE: NONE	DATE: 12-8-94
REF. TYPICAL 12 TC CABLE	DWN. BY: R. NELSON	
	DWN. NO. 180017	



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TITLE:	SCALE: NONE	DATE: 12-8-94
REF. TYPICAL 18-6 TC CABLE	DWN. BY: R. NELSON	
	DWN. NO. 180018	

B. Concrete Storage Bins

1. Concrete Structure Without Hanger Boxes

Lay out of holes for the hangers is very important. The cable must be hung approximately in the center of the bin, or as per print furnished with the cables. However, the cable must not be hung in the grain fill stream, nor hung nearer than one foot to any obstruction such as a beam. This is so normal movement of the cable will not chafe the cable or leadwire. See drawing #180021.

When drilling the hanger holes, make sure not to drill more holes than can be used in one day without making provision for waterproofing overnight if there is grain in the bin.

In concrete storage, if the hole is inside the gallery or headhouse, the hole must be countersunk enough to allow the eyebolt top to be flush with the floor. After hanging the cable, the holes are to be filled with silicon sealer.

The cable assembly is drawn up with a wire or chain through the eyebolt tip. A large washer and nut are put on top for load distribution. The inside installation is countersunk to keep the bolt tip out of the way. The leadwire is taped to the eyebolt to prevent strain on the splice. When the installation is outside, roofing mastic is applied under and over the washer to make it waterproof.

2. Concrete Structure With Hanger Boxes

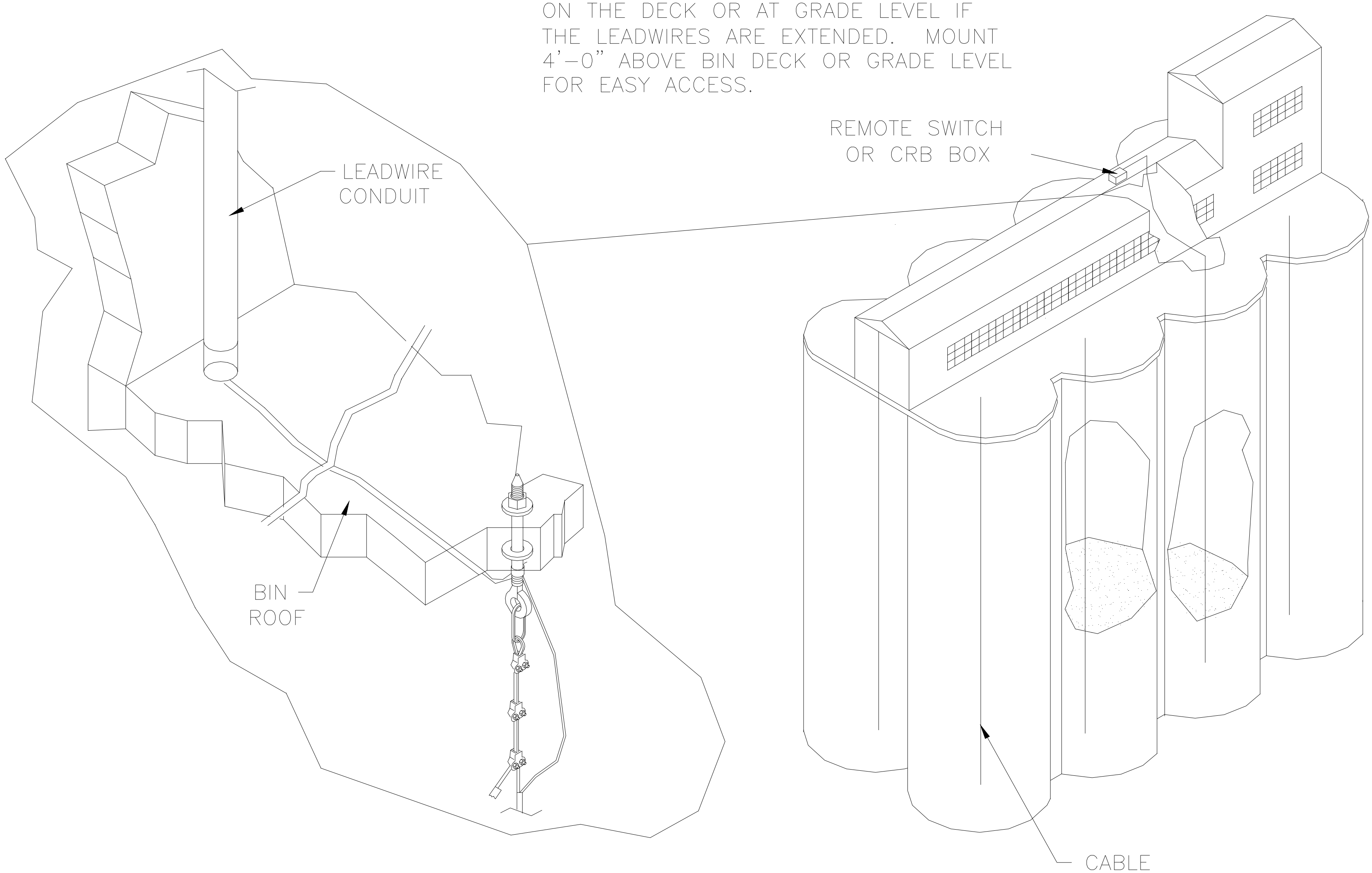
The concrete hanger box is installed during construction. The box is placed on the form in the proper place before pouring. A 5/8" x 30” rod is run through the box for the hanger.

Two types of cable hardware is normally used to hang the cables, strain clamps and quicklinks. If the cable has a strain clamp, remove the cotter key from the pin in the hanger and slip the pin out. If the cable has a quicklink, loosen the opening of the quicklink.

Insert the bottom of the Hot Spot cable through the hanger box on either side of the 5/8" steel rod. Uncoil the cable and lower into bin, being careful not to tangle, scrape, or otherwise damage it.

If a strain clamp is being used, lower the cable hanger slightly below the 5/8" steel rod, then raise it so that an "ear" is on each side of steel rod. Replace pin and cotter key. The design of the cotter key makes it unnecessary to spread the ends. If a quicklink is being, place the quicklink over the 5/8" steel rod and tighten the latching nut.

NOTE: REMOTE SWITCH OR CRB MAY BE MOUNTED ON THE DECK OR AT GRADE LEVEL IF THE LEADWIRES ARE EXTENDED. MOUNT 4'–0" ABOVE BIN DECK OR GRADE LEVEL FOR EASY ACCESS.



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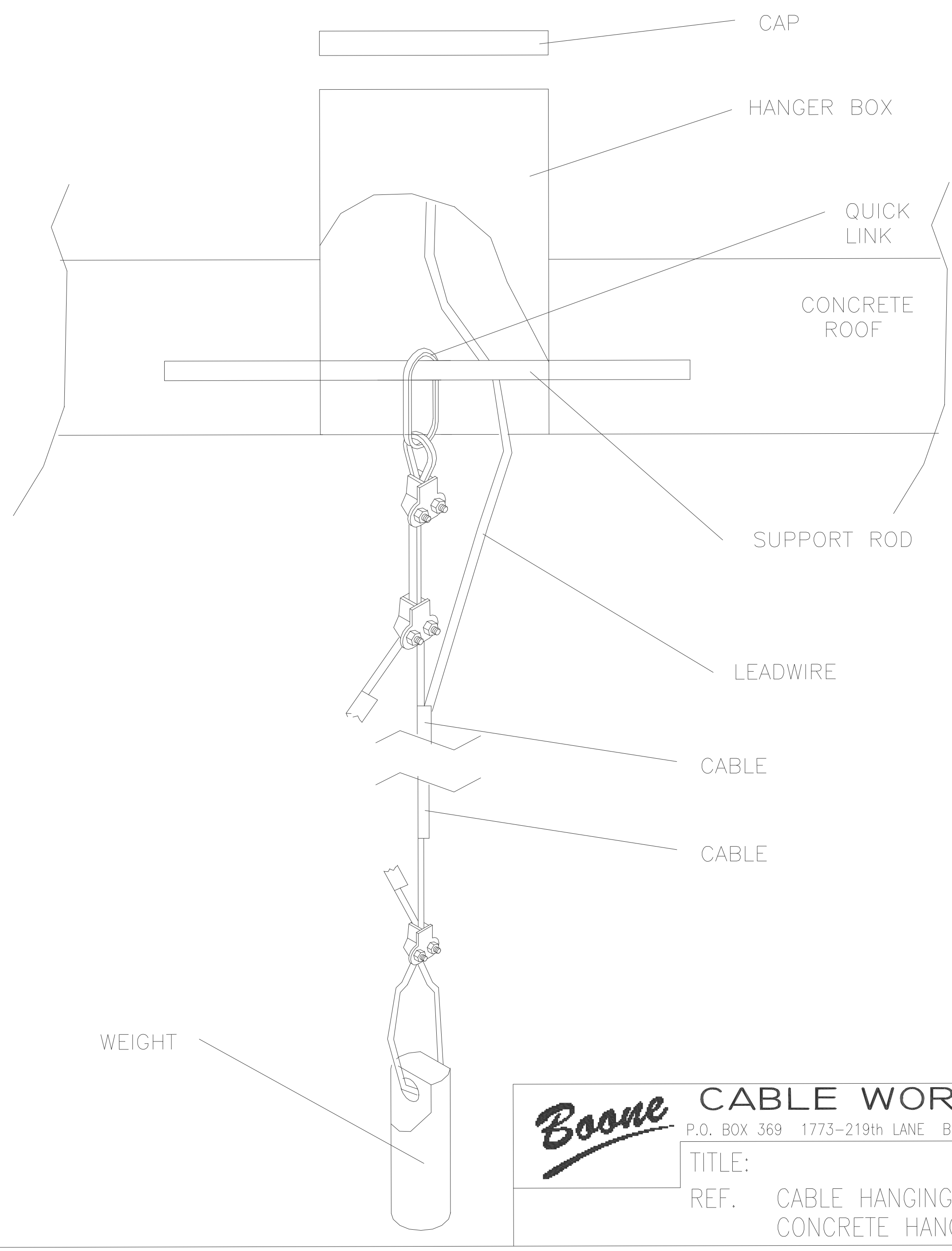
TITLE:	SCALE: NONE	DATE: 12-8-94
REF. CONCRETE TANK CABLE INSTALLATION	DWN. BY: R. NELSON	
	DWN. NO. 180021	



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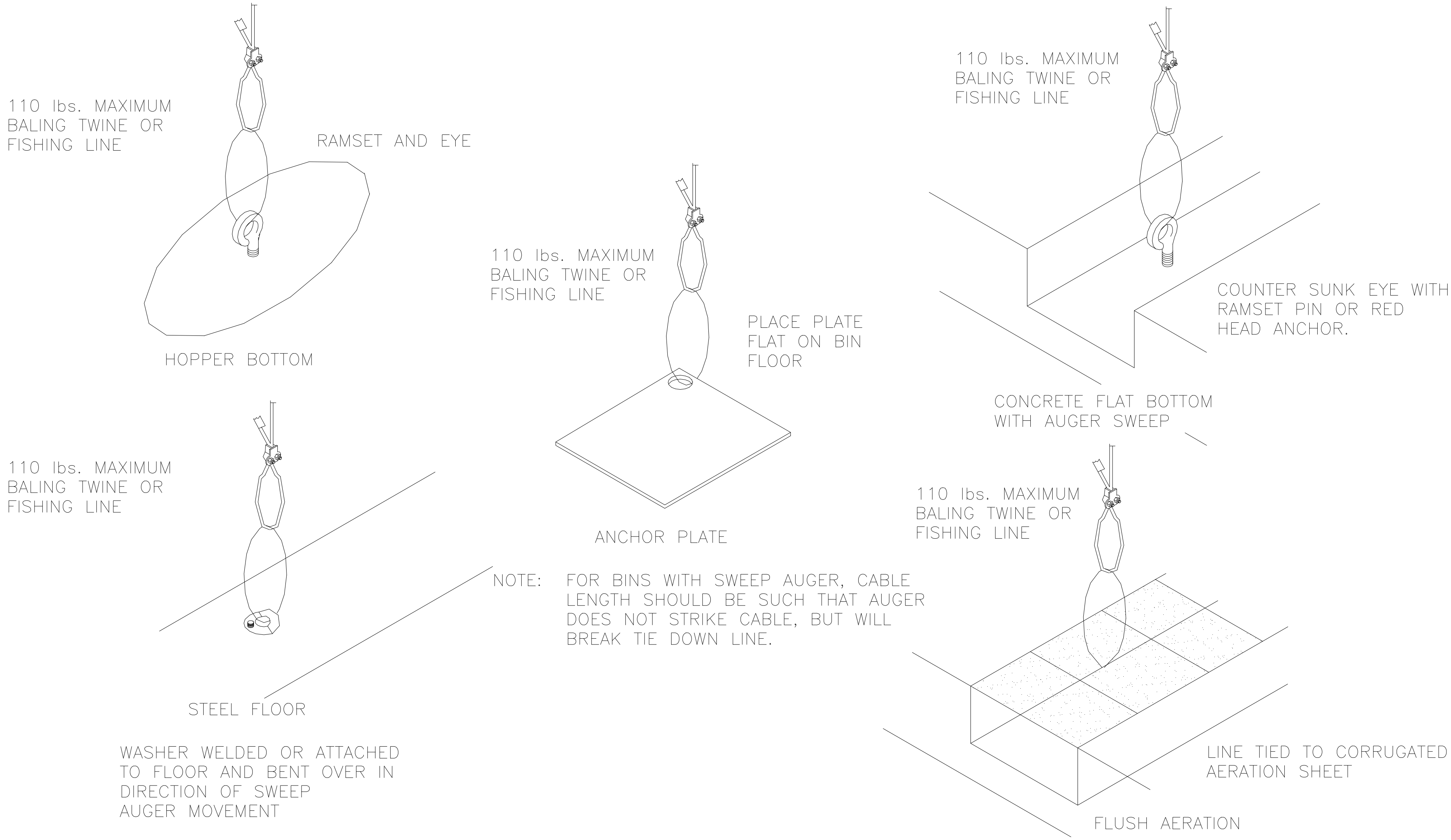
TITLE:	SCALE: NONE	DATE: 12-8-94
REF. CABLE HANGING INSIDE CONCRETE HANGER BOX	DWN. BY: R. NELSON	
	DWN. NO. 180023	

C. Cable Tie-down Methods

On large diameter steel or concrete tanks, there is a tendency for the cables to drift to the outside of the tank during filling. This same thing occurs when truck or rail loadout spouts are located in tank sidewall, only in this case the cables often times come out the spout.

To correct this drift or out the spout condition, it is necessary to tie the cables to the bin floor. This can be done in several ways depending on type of floor, is there a sweep auger, aeration duct or flush duct and is floor flat or hoppered. Refer to drawing #180026.



NOTE: FOR BINS WITH SWEEP AUGER, CABLE LENGTH SHOULD BE SUCH THAT AUGER DOES NOT STRIKE CABLE, BUT WILL BREAK TIE DOWN LINE.

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TITLE:	SCALE: NONE	DATE: 12-8-94
REF. TYPICAL CABLE TIE DOWN METHODS	DWN. BY: R. NELSON	
	DWN. NO. 180026	

3. Remote Switch

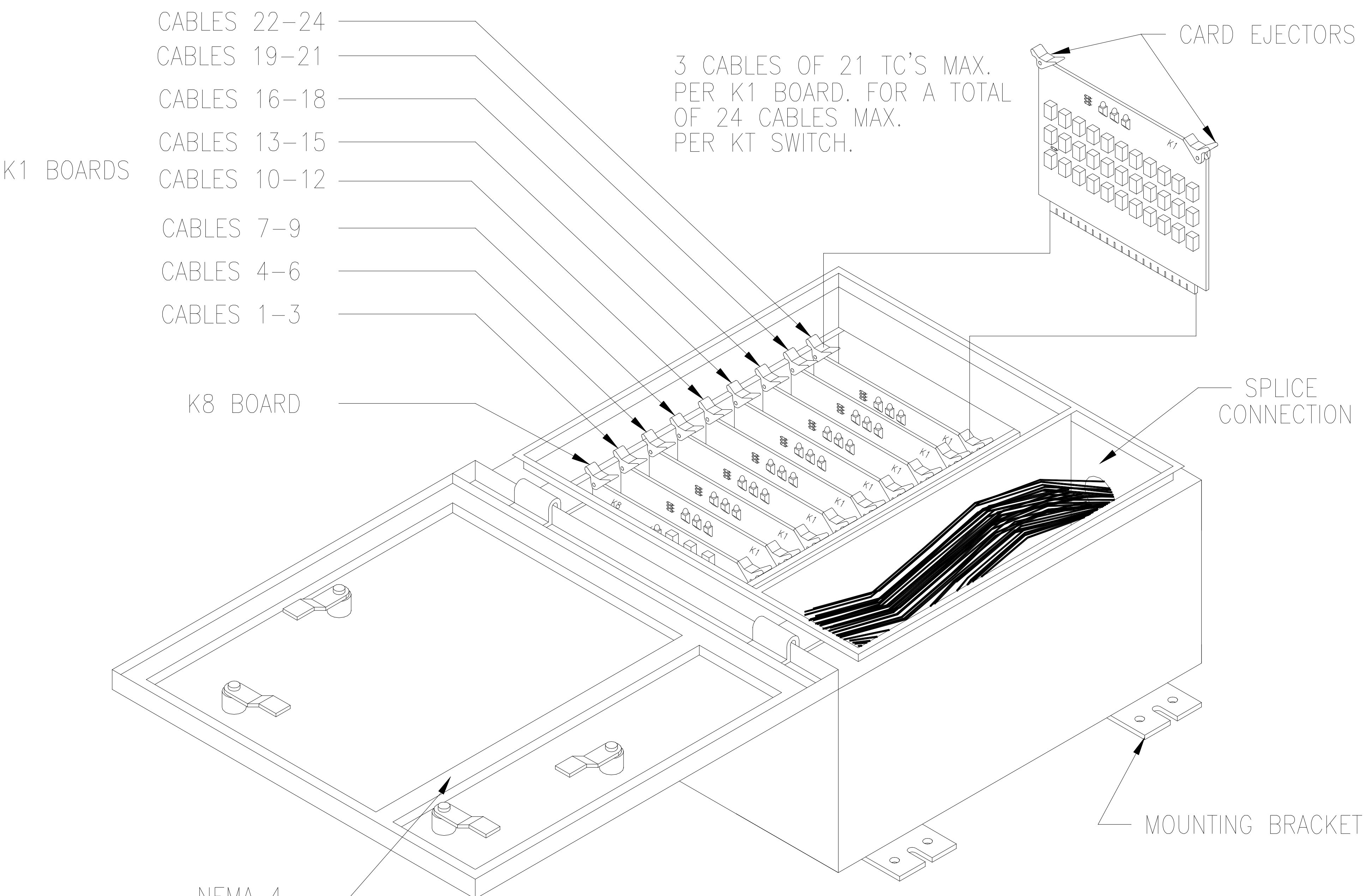
A. Installation

The remote switch should be mounted using its external mounting brackets. (See drawing #180108)

The installation personnel should check the blueprints sent with each job and determine the proper location of each remote switch.

Each remote switch should be easily accessible and free from obstruction.

A fully loaded remote switch consists of eight K1 printed circuit boards and one K8 printed circuit board. These boards and their capabilities will be discussed in detail later.



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TITLE:	SCALE: NONE	DATE: 12-8-94
REF. KT REMOTE SWITCH	DWN. BY: R. NELSON	
	DWN. NO. 180108	

4. Conduit and Leadwire

A. Install Conduit

Conduit is used to protect wires from weather or mechanical damage. Thinwall conduit is usually used for inside runs which will not be exposed to the weather. Threaded rigid conduit must be used for any outside work which will be exposed to the weather, and may be required on some installation for inside runs as well.

Selecting Size of Conduit:

Conduit size is regulated by the mass of wires being housed. The maximum should be 75% filled. Proper type and size of fittings must be used in each raceway for ease in pulling wires.

The conduit size is determined by the maximum number of leadwires which must run through it and the size of the leadwire.

Leadwire and conduit table below:

Conduit Size	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
6TC Leadwire	9	16	27	50	70	100
12TC Leadwire	3	5	12	20	30	60
18 TC Leadwire	3	5	12	18	28	46
21TC Leadwire	3	5	12	18	28	46

Installing Conduit:

All conduit runs must be kept away from high-voltage wires as much as possible to prevent inductance "pick-up".

No more than two 90 degree bends or combination of bends totaling 180 degrees should be in the raceway between pull boxes.

Requirements regarding perpendiculars, horizontal, supports, fittings, and "expansion joints" are the same as for general electrical work.

When conduit is exposed to weather, joint compound and proper gaskets must be used; special precautions should be taken to keep moisture out of the conduit, so control wire and/or leadwire are kept dry.

B. Run Leadwire

Leadwire should be run in accordance with print.

A short length of leadwire is attached to each cable at the factory.

There should be as few splices as possible. All splices must be made in places where they are readily accessible.

Leadwire must be handled with care when installing. Special care should be given so the leadwire is not nicked when it is pulled through the conduit.

Leave extra leadwire where splices will occur to make neat splices. A length of at least 5 feet is recommended at an instrument, switch or CRB.

The Brady numbering tags should be moved up before trimming leadwire. This is important to keep the leadwire labeled correctly.

C. Splicing Leadwires

Leadwire splices are very important to the integrity of the system. Open Thermocouples (OT's) will occur in the system if the splices are not made correctly. Splices must only be made in pull boxes, condulets or where a leadwire run is terminated, such as an instrument or remote switch. The leadwires for a remote switch are numbered from 1 to 24 for easy identification when splicing to cable leadwire. Splices must not be pulled into the conduit. See drawings #180110 for 6TC, #180111 for 6TC Special, #180112 for 12 TC, 180113 for 18 TC and #180114 for 21 TC leadwire splicing.

All leadwire splices made by the installation personnel will be made color to color and group to group. Never change the factory-made connections at the top of the cable. Splices at the top of the temperature cable are not color to color generally.

The detailed steps listed below to make splices use an 18TC leadwire as the example. These same instructions can be crossed over to 6, 12 and 21TC leadwire. 6TC leadwire has only one group and the constantan is white. 12 TC leadwire has to two groups with white and brown constantans. 18TC leadwire has three groups with white, brown and orange constantans. 21TC leadwire is also composed of three groups with the same color constantans as 18TC. 21TC leadwire has 7 wires per group instead of 6, for a total of 21 thermocouples.

1. Splicing with Line B grease filled crimps

The compression tool and crimps are available through Boone Cable Works & Electronics, Inc. and can be purchased with the temperature equipment. The crimps offer a higher degree of insulation from moisture than soldering, due to the grease filled liner. They are also effective in hazardous areas where soldering equipment is not allowed or due to remoteness of electrical power.

The crimps (Boone #109512) are insulated outside and grease filled inside. The grease retards corrosion and resists water, thus making a good conductive splice that is well insulated. The splice, when completed, is taped to improve abrasion resistance and to keep the splice looking neat.

Tool required:
Compression Tool - Boone #109510
Diagonal cutting pliers
Long nose pliers
Knife

Material required:
Line B grease filled crimps - Boone #109512
Electrical tape

Detailed Steps: Refer to drawing #180040

Step 1. Using a sharp knife, cut along the ridge on the leadwire for one inch exposing the ripcord. Do this to both pieces. of leadwire.

Pull the ripcord with the long noise pliers, slitting the outer covering of the leadwire back four inches. Cut off the outer covering. Do this to both pieces of leadwire. (NOTE: Should the ripcord break, then slit the outer covering open along the top of the ripcord ridge.)

Step 2. Tape the two pieces of leadwire together about four inches from the ends with two or three turns of electrical friction tape.

The next steps are important. Remember, a successful splice is one that has the correct wires joined so that the system will read the thermocouples in correct order.

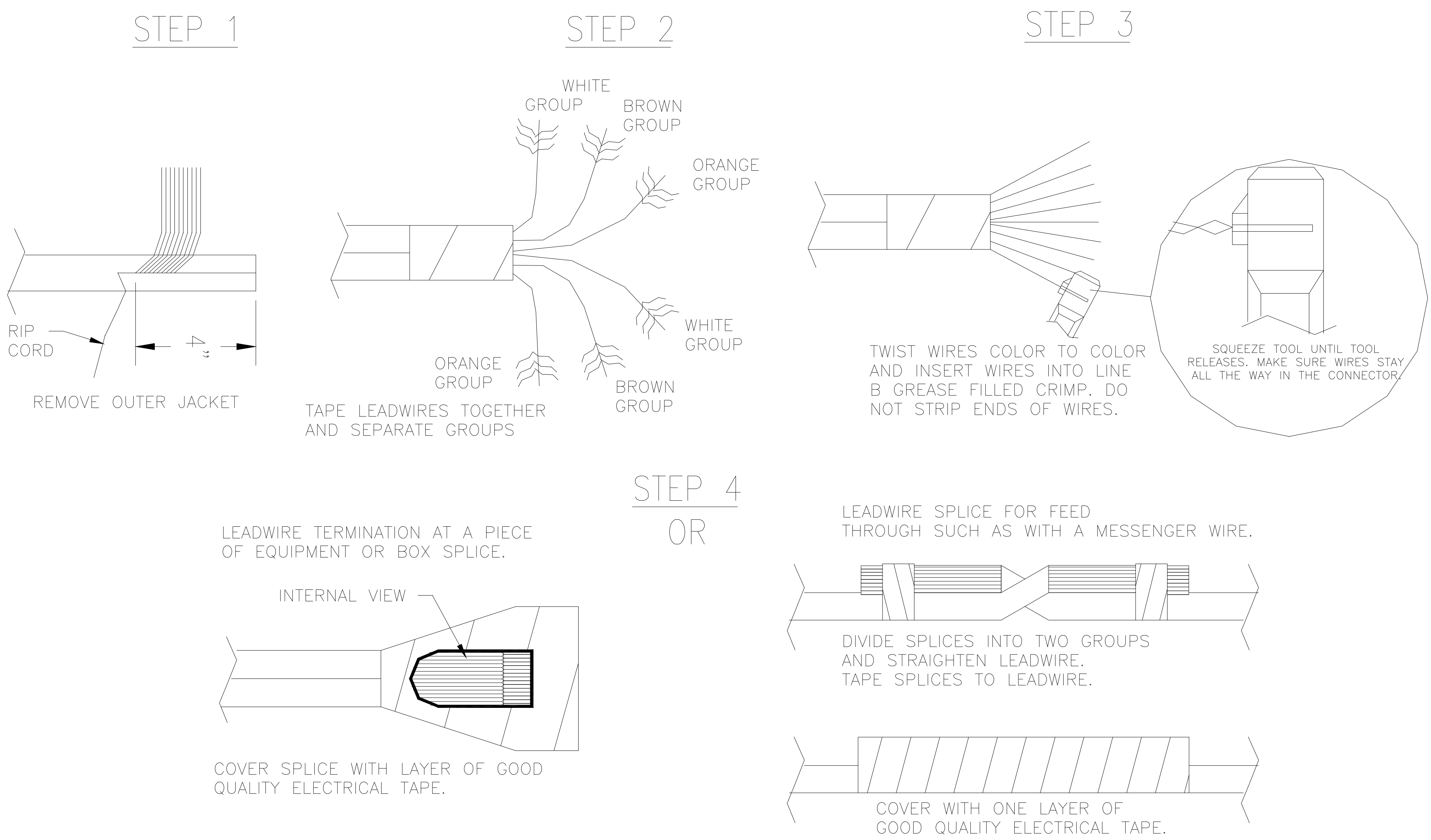
Separate the three groups in each leadwire. Wrap the white, brown and orange wires around the wires in their respective groups. A 6TC leadwire will only have one white group. A 12 TC leadwire will have two groups, white and brown.

Step 3. Separate the individual wires of each group about 1/4" back so that the colors of each individual wire can be clearly seen. Note that all groups have a black, a blue a green, a red, a yellow, and a clear (copper-colored) wire, (21TC leadwire also has a purple wire) as well as another that may be WHITE, ORANGE, or BROWN. These white, orange, or brown wires are the constantan wires and also serve to identify the groups.

Select the two groups (one from each leadwire) that have the WHITE identifying wire. Fold the other groups back out of the way. Check again to be sure the two groups both have the white wire. Separate individual wires.

Select any two wires that have the same color (i.e. black and black). Without removing the insulation, twist the ends tightly at least eight (8) half-turns (should be twisted for a length of about 3/4").

Repeat until all seven (7) wires are twisted, including the white wires.



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TITLE:	SCALE: NONE	DATE: 12-8-94
REF. LINE B GREASE FILLED CRIMP INSTALLATION	DWN. BY: R. NELSON	
	DWN. NO. 180040	

Repeat the process for the two groups having the brown identifying wires. Be sure both groups have the brown wire.

Repeat the process for the two groups having the orange identifying wires. Be sure both groups have the orange wire.

Cut the untwisted wire ends of all the twisted wires off and to approximately the same length.

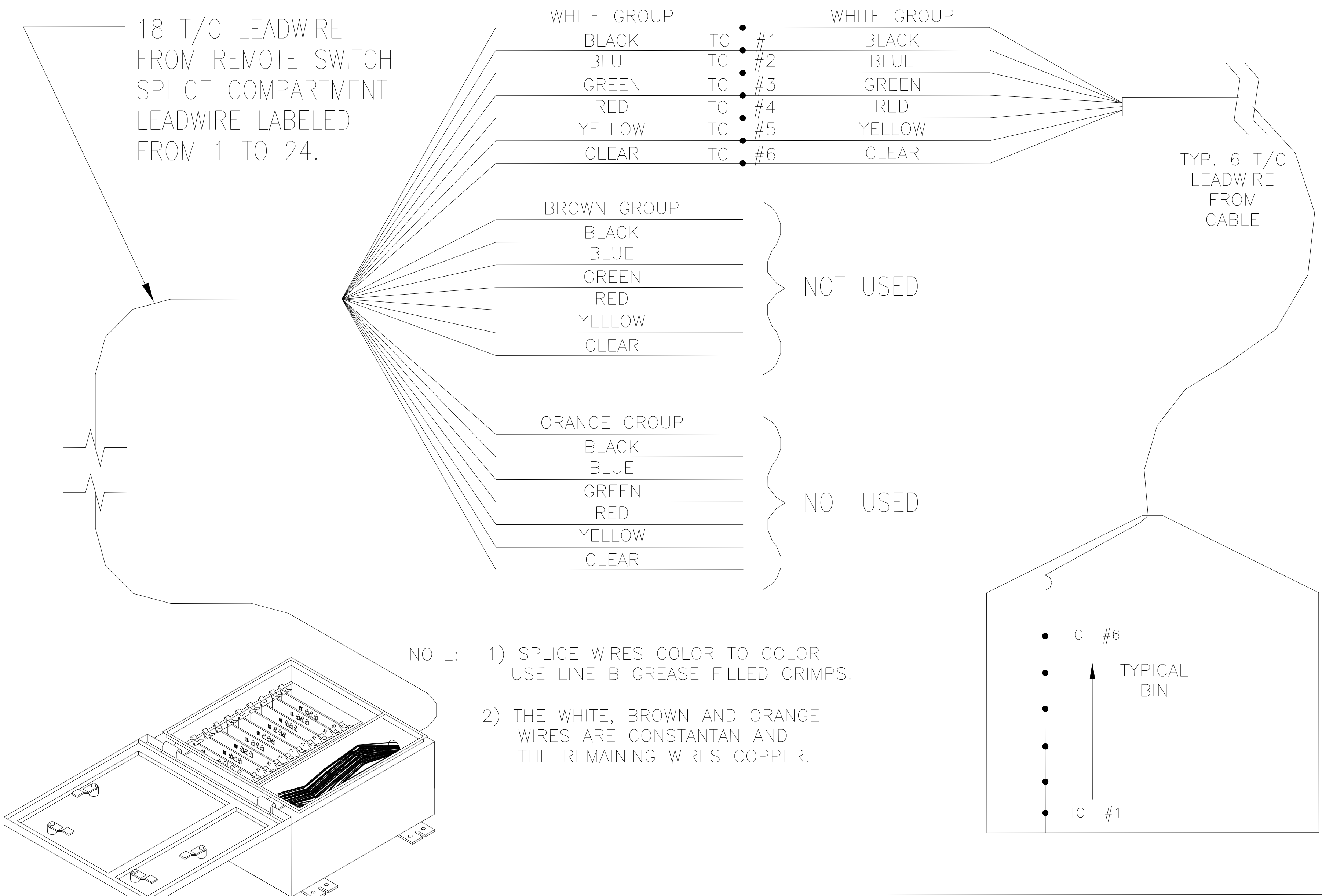
Place the grease crimp over each pair of twisted wires, one from each leadwire. Be sure that the wires are inserted into the crimp as far as possible. This will assure that the wires make good connection after the crimp is compressed. Using the crimp tool, compress the crimp tightly closed. The tool is designed so that it will not open up again until the tool has squeezed the connector fully. Continue this operation until all the connections have been made.

Step 4. This step shows two splicing types. The first type is a leadwire termination at a piece of equipment or splice box. The second is a leadwire splice for feed through, such as with a messenger wire.

For the termination splice, cover the completed splice with one layer of good quality electrical tape. Overlap each turn about halfway to get a good cover. The splice is now complete.

For the feed through splice, gently remove the tape holding the leadwires together. Carefully divide the splices into two groups. Straighten the leadwire out and form the splice into a straight line. Keep the outer covering ends close together, not more than 3/4" apart. Tape the splices to the leadwire.

Cover the completed splice with one layer of good quality electrical tape. Overlap each turn about halfway to get a good cover. The splice is now complete.



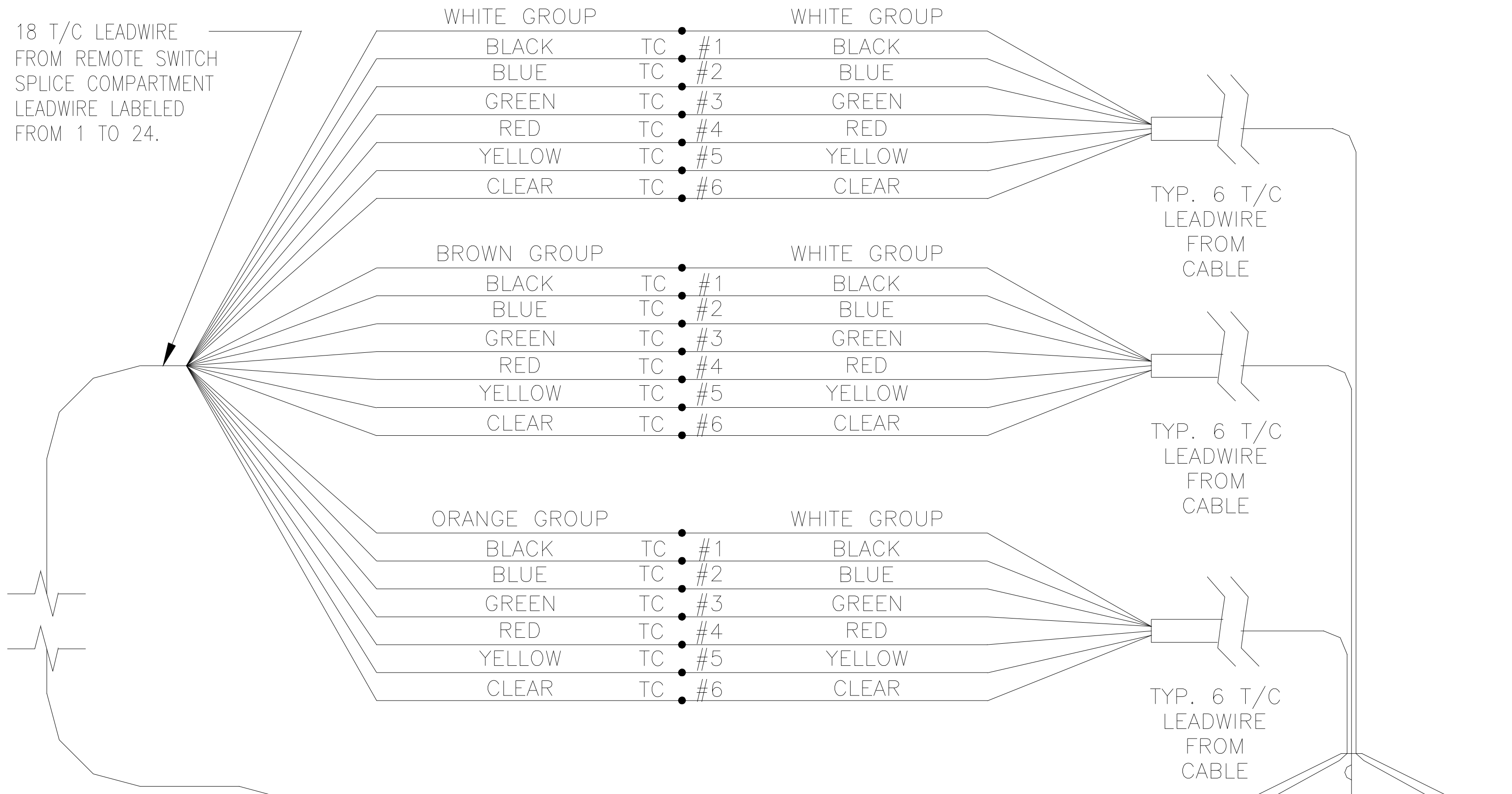
NOTE: 1) SPLICE WIRES COLOR TO COLOR USE LINE B GREASE FILLED CRIMPS.

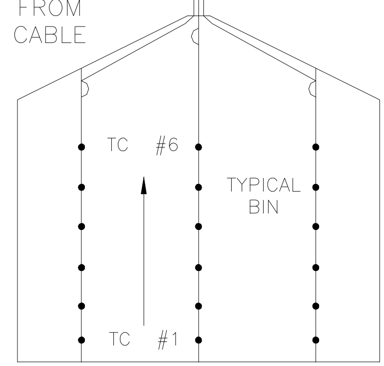
2) THE WHITE, BROWN AND ORANGE WIRES ARE CONSTANTAN AND THE REMAINING WIRES COPPER.

KT REMOTE SWITCH

Boone CABLE WORKS & ELECTRONICS, INC.
P.O. BOX 369 1773-219th LANE BOONE, IOWA 50036 USA (515)432-2010 (800) 265-2010 FAX (515) 432-5262

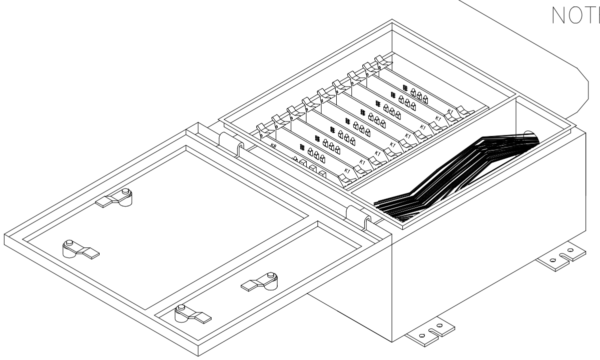
TITLE:	SCALE: NONE	DATE: 12-8-94
REF. WIRING OF 18 TC REMOTE SWITCH TO 6 TC CABLE	DWN. BY: SF	
	DWN. NO. 180110	





NOTE: 1) SPLICE WIRES COLOR TO COLOR
USE LINE B GREASE FILLED CRIMPS.

2) THE WHITE, BROWN AND ORANGE
WIRES ARE CONSTANTAN AND
THE REMAINING WIRES COPPER.



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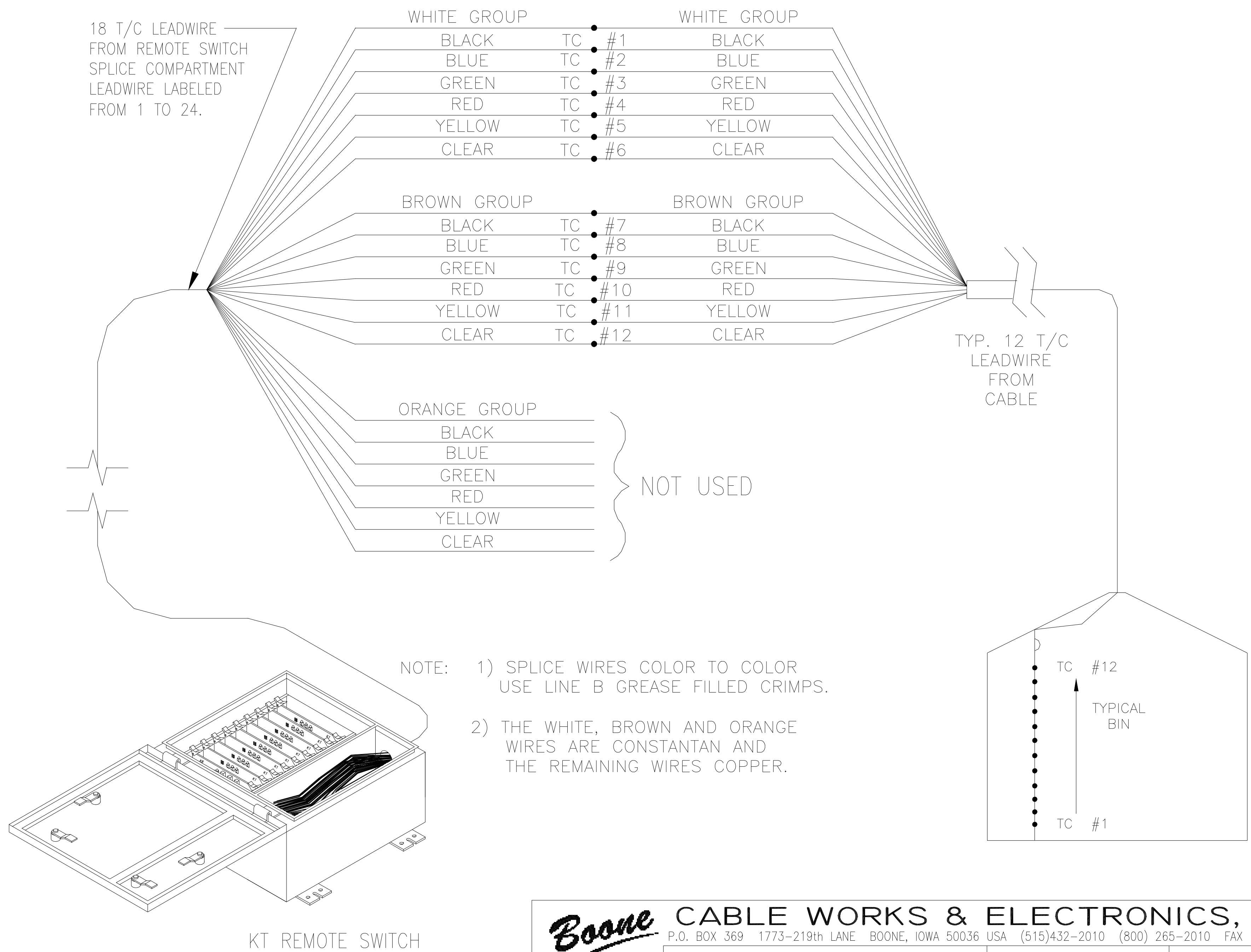
TITLE:	SCALE: NONE	DATE: 12-8-94
REF. WIRING OF 18 TC REMOTE SWITCH TO THREE 6 TC CABLES (6 TC SPECIAL)	DWN. BY: SF	
	DWN. NO. 180111	



NOTE: 1) SPLICE WIRES COLOR TO COLOR USE LINE B GREASE FILLED CRIMPS.

2) THE WHITE, BROWN AND ORANGE WIRES ARE CONSTANTAN AND THE REMAINING WIRES COPPER.

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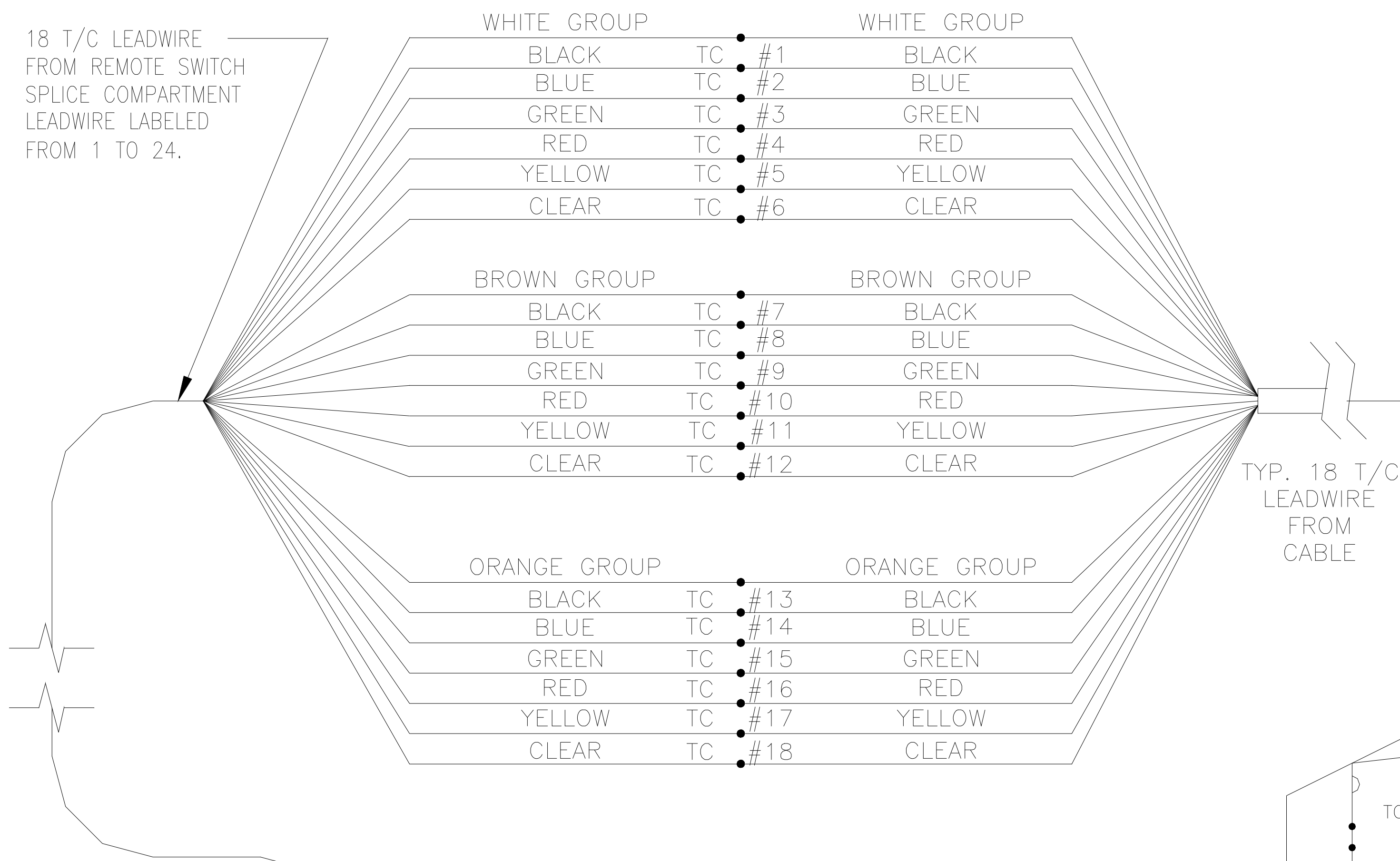
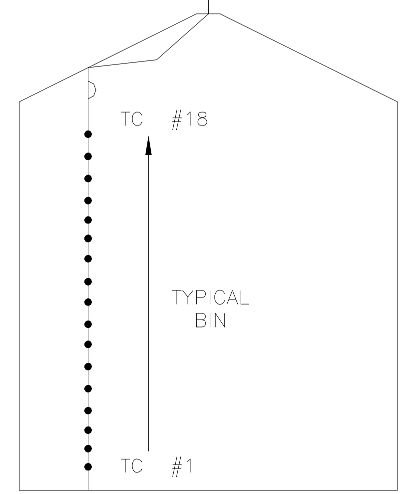
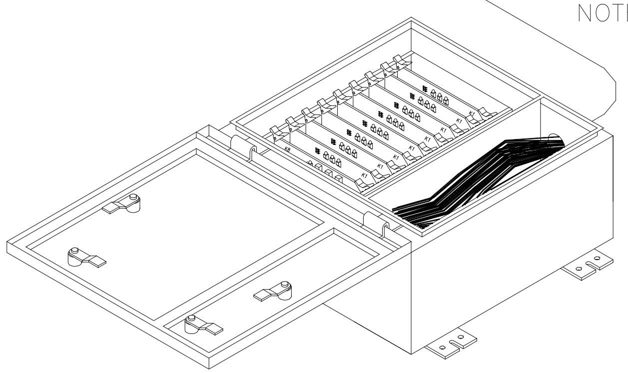
TITLE:	SCALE: NONE
	DATE: 12-8-94
REF. WIRING OF 18 TC REMOTE SWITCH TO 12 TC CABLE	DWN. BY: SF
	DWN. NO. 180112





NOTE: 1) SPLICE WIRES COLOR TO COLOR USE LINE B GREASE FILLED CRIMPS.

2) THE WHITE, BROWN AND ORANGE WIRES ARE CONSTANTAN AND THE REMAINING WIRES COPPER.



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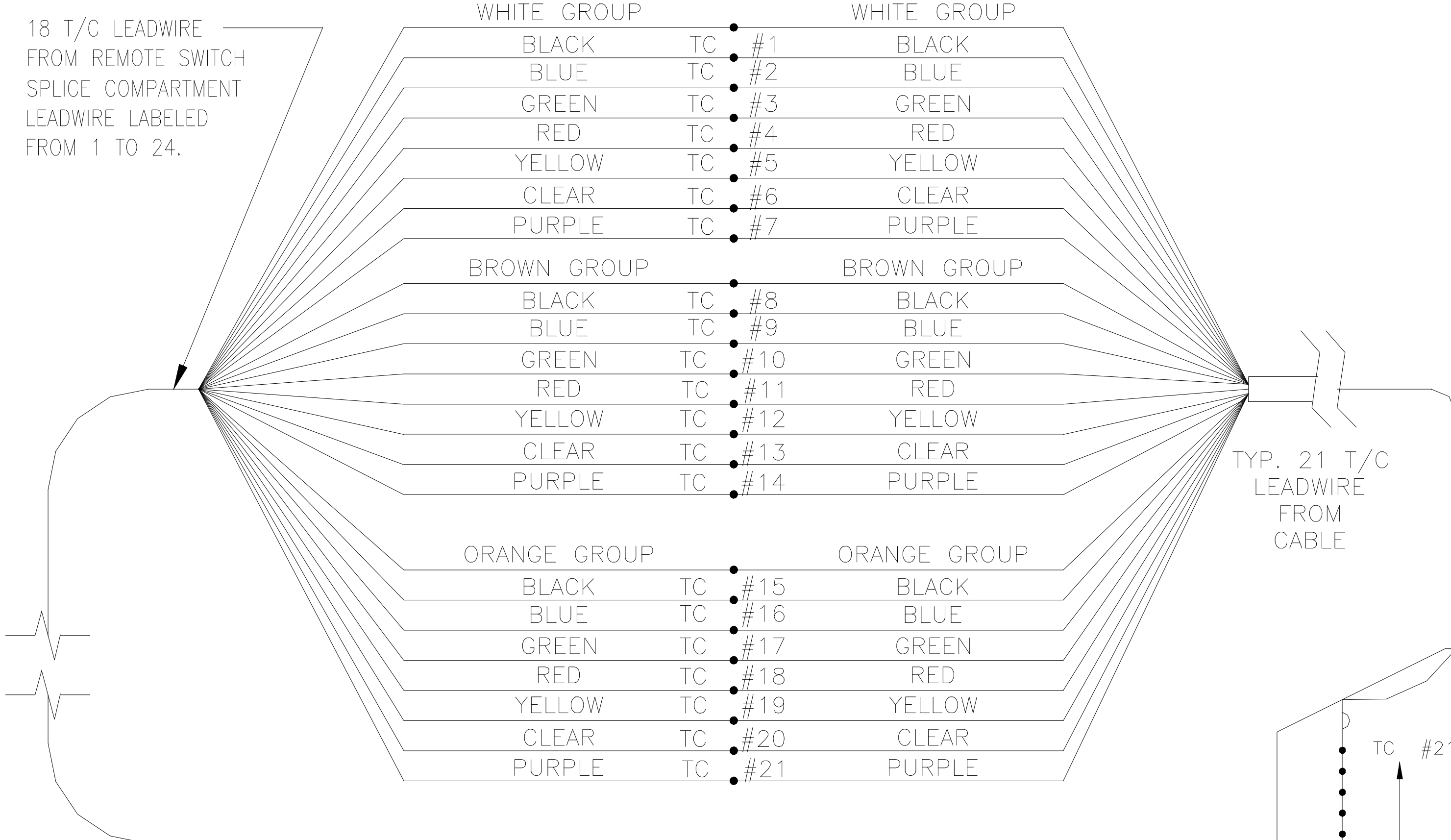
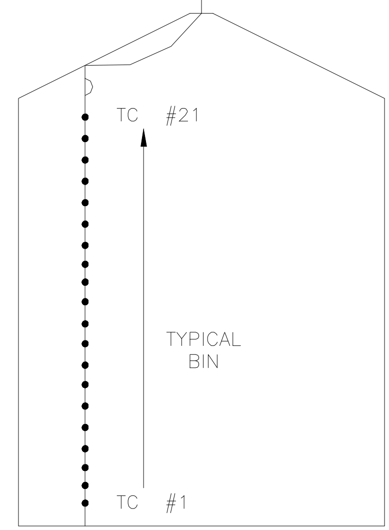
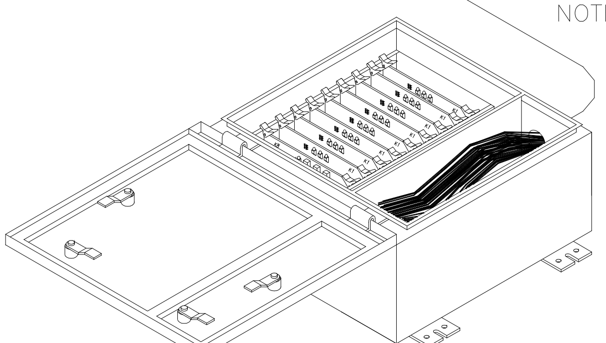
TITLE:	SCALE: NONE	DATE: 12-12-94
REF. WIRING OF 18 TC REMOTE SWITCH TO 18 TC CABLE	DWN. BY: SF	
	DWN. NO. 180113	





NOTE: 1) SPLICE WIRES COLOR TO COLOR USE LINE B GREASE FILLED CRIMPS.

2) THE WHITE, BROWN AND ORANGE WIRES ARE CONSTANTAN AND THE REMAINING WIRES COPPER.



KT REMOTE SWITCH

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TITLE:	SCALE: NONE	DATE: 12-12-94
REF. WIRING OF 21 TC REMOTE SWITCH TO 21 TC CABLE	DWN. BY: SF	
	DWN. NO. 180114	

5. Control Cable

A. Wire

The control wire for KT systems consists of two 18 TC leadwires, a black 18GA and a red 18GA wires. One leadwire is used to bring the thermocouple signal from the switches to the instrument. The other leadwire is used to bring the switch select and cable select logic to the switch. The black 18GA are common for the power supply and the red 18GA are +12volts DC from the power supply at the instrument.

1. Color Code Chart for 18TC Leadwire. (Thermocouple Signals)

TC #	18 TC Leadwire Color Code	
1	Black	
2	Blue	
3	Green	White Group
4	Red	
5	Yellow	
6	Clear	
7	Black	
8	Blue	
9	Green	Brown Group
10	Red	
11	Yellow	
12	Clear	
13	Black	
14	Blue	
15	Green	Orange Group
16	Red	
17	Yellow	
18	Clear	

2. Color Code Chart for 18TC Leadwire. (Control Switch and Cable Logic)

	Logic	18 TC Leadwire Color Code	
	A	Black	
Cable	B	Blue	
Logic	C	Green	White Group
	D	Red	
	E	Yellow	
	1	Clear	
Remote Switch	2	Black	
Select	3	Blue	
Logic	4	Green	Brown Group
	5	Red	
	6	Yellow	
	7	Clear	
	8	Black	
	9	Blue	
	10	Green	Orange Group
	11	Red	
	12	Yellow	
	13	Clear	

Note: The three constantan wires are not used.

B. Conduit

1/2” conduit is required between the KT instrument and all switches. This will handle the control wire used on KT systems.

Reference Charts

Square inches of area per wire types.

Wire Types	Area In Square Inches	Maximum Diameter
THHN #18 AWG	.0069	.094
6 TC Leadwire	.0113	.12
12 TC Leadwire	.0314	.2
18 TC Leadwire	.0346	.21
21 TC Leadwire	.0346	.23

Maximum fill of various conduit sizes.

Conduit Size	Area for Max. Fill in Square Inches
1/2 In.	.12
3/4 In.	.21
1 In.	.34
1 1/4 In.	.60
1 1/2 In.	.82
2 In.	1.34

C. Remote Switch Connections

In the remote switch there is a splice area with a 18 TC leadwire, a 6 TC leadwire, a black 18GA and a red 18GA wires. The 18 TC leadwire is used to bring the thermocouple signal from the remote switches to the instrument. It is marked TC. The 6 TC leadwire is used to bring the remote switch select and cable select logic into the remote switch. It is marked CTL. The black 18GA is common for the power supply and the red 18GA is +12volts DC from the power supply at the instrument. The 18 TC leadwire, black 18GA and red 18 GA wires are identical to the wires coming from the instrument. Splice these wires from the control to the remote switch as listed below.

The black 18GA wire from the instrument is tied to the black 18GA of the control run.

The red 18GA wire from the instrument is tied to the red 18GA of the control run.

The 18 TC leadwire for the TC signal is wired color to color and group to group with the 18TC Leadwire for the TC signal in the control run. See drawing #180106.

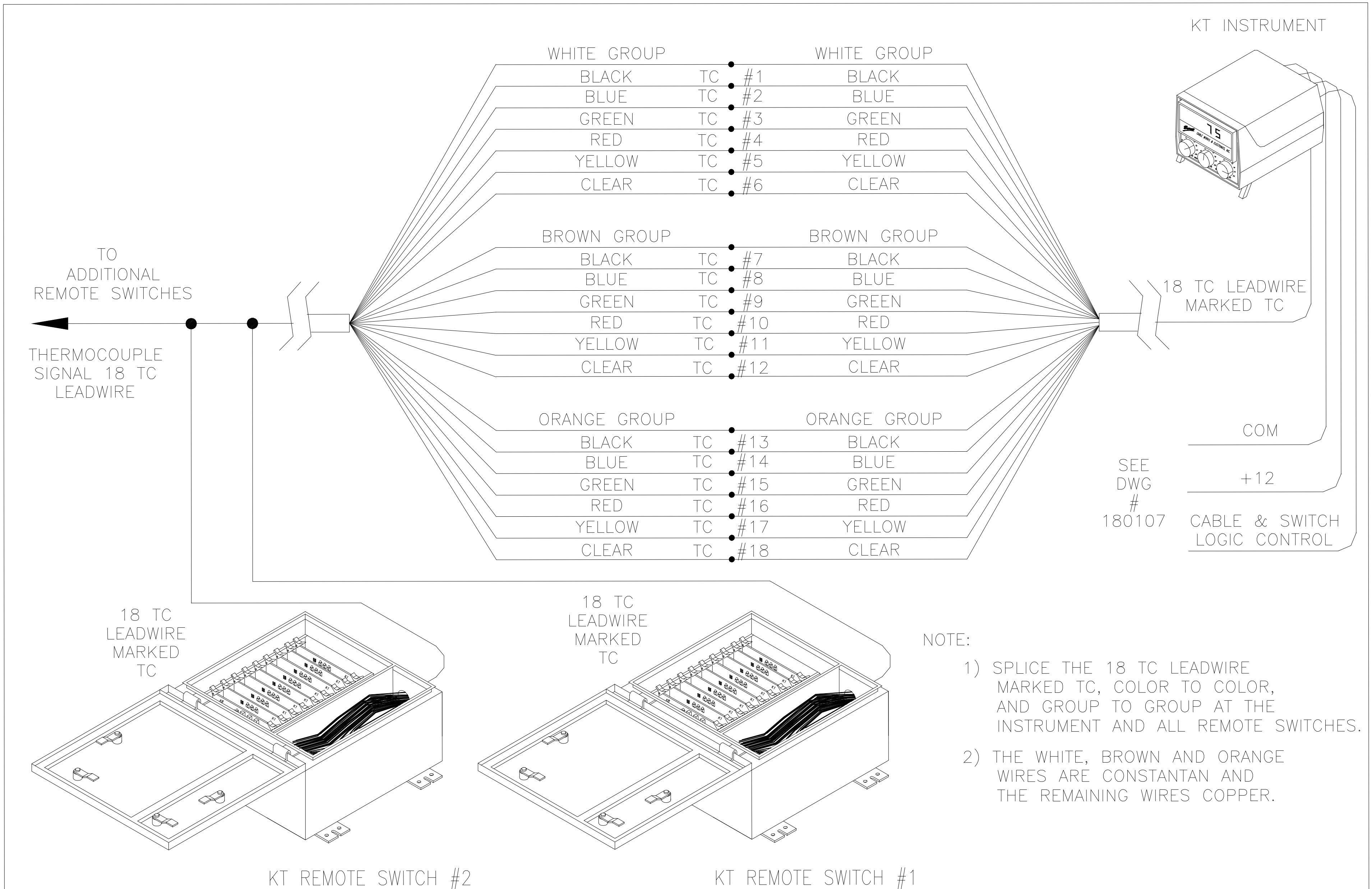
The 6 TC leadwire from the remote switch marked CTL is spliced with the 18 TC leadwire in the control run. This is the 18 TC leadwire for the remote switch and cable logic. See the chart below and drawing #180107.

1. Color Code Chart for 18TC Leadwire at the remote switch. (Remote Switch Select and Cable Logic)

6 TC Leadwire from Switch		18 TC Leadwire Color Code			
White Group	Black			Black	White Group
	Blue			Blue	
	Green			Green	
	Red			Red	
	Yellow			Yellow	
		Remote Switch	#1	Clear	
			#2	Black	Brown Group
			#3	Blue	
			#4	Green	
			#5	Red	
			#6	Yellow	
			#7	Clear	
			#8	Black	OrangeGroup
			#9	Blue	
			#10	Green	
			#11	Red	

*Note:
The Clear attaches to the desired switch number that is designated for that switch.

#12	Yellow
#13	Clear



NOTE:

1) SPLICE THE 18 TC LEADWIRE MARKED TC, COLOR TO COLOR, AND GROUP TO GROUP AT THE INSTRUMENT AND ALL REMOTE SWITCHES.

2) THE WHITE, BROWN AND ORANGE WIRES ARE CONSTANTAN AND THE REMAINING WIRES COPPER.

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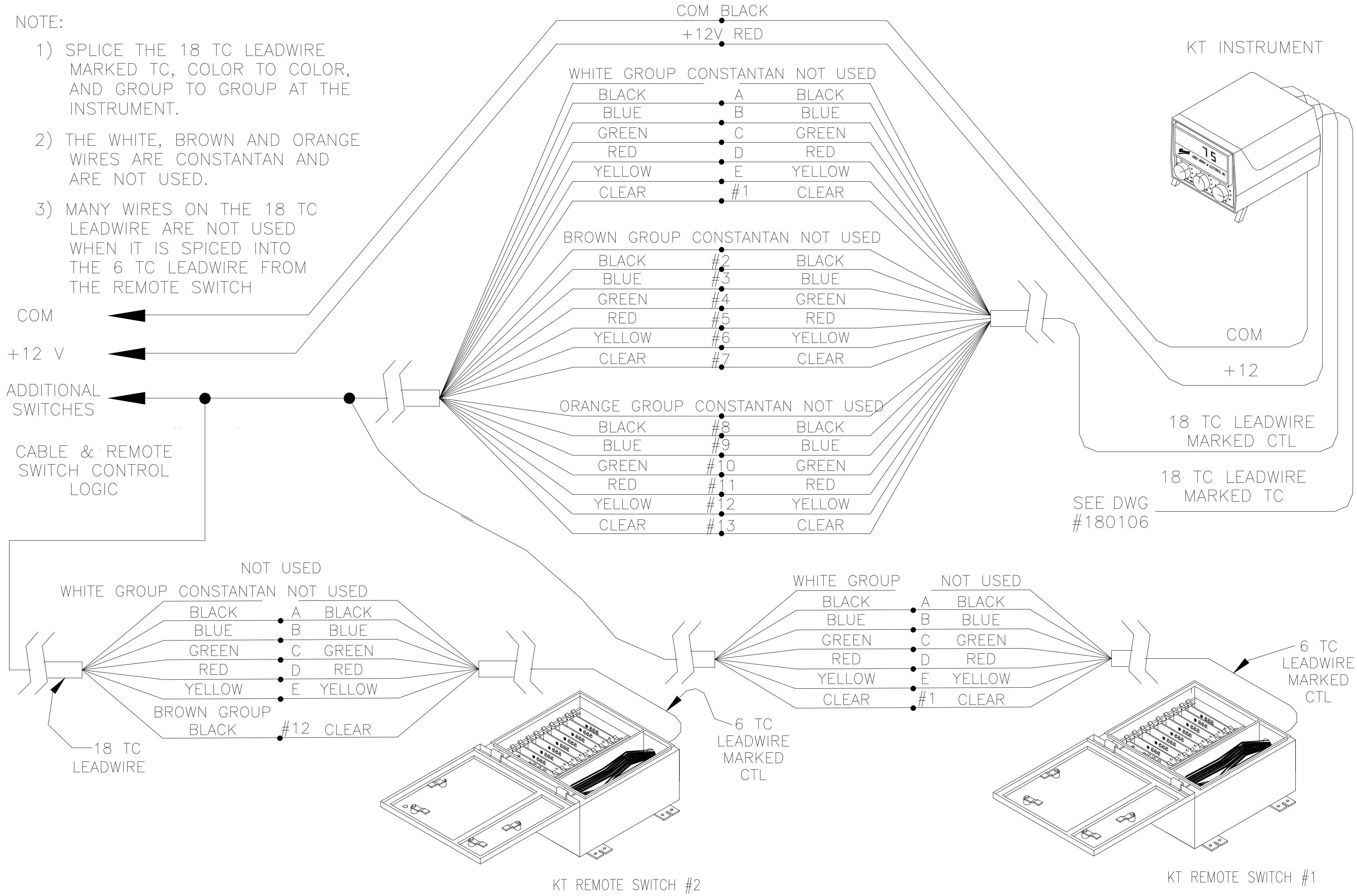
TITLE:	SCALE: NONE	DATE: 12-13-94
REF. KT THERMOCOUPLE SIGNAL CONTROL WIRE SPLICES	DWN. BY: SF	
	DWN. NO. 180106	

NOTE:

1) SPLICE THE 18 TC LEADWIRE MARKED TC, COLOR TO COLOR, AND GROUP TO GROUP AT THE INSTRUMENT.

2) THE WHITE, BROWN AND ORANGE WIRES ARE CONSTANTAN AND ARE NOT USED.

3) MANY WIRES ON THE 18 TC LEADWIRE ARE NOT USED WHEN IT IS SPICED INTO THE 6 TC LEADWIRE FROM THE REMOTE SWITCH



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TITLE:	SCALE: NONE	DATE: 12-13-94
REF. KT CABLE & REMOTE SWITCH LOGIC CONTROL WIRE SPLICES	DWN. BY: SF	
	DWN. NO. 180107	

D. KT Instrument Connections

In the KT splice area are two 18 TC clear coated leadwires, a black 18GA and a red 18GA wires. One leadwire is used to bring the thermocouple signal from the remote switches to the instrument. It is marked TC. The other leadwire is used to bring the remote switch select and cable select logic to the remote switch. It is marked CTL. The black 18GA is common for the power supply and the red 18GA is +12volts DC from the power supply at the instrument. These are identical to the control wires. Splice the wires from the control to the KT Instrument color to color and group to group on the leadwire as listed below:

The black 18GA wire from the instrument is tied to the black 18GA of the control run.

The red 18GA wire from the instrument is tied to the red 18GA of the control run.

The 18 TC Leadwire for the TC signal is wired color to color and group to group with the 18TC Leadwire for the TC signal in the control run.

The 18 TC Leadwire for the cable and remote switch logic is wired color to color and group to group with the 18TC Leadwire for the cable and remote switch logic in the control run.

IMPORTANT NOTICE - MAKE CERTAIN THE 110/220 VOLT POWER IS GROUNDED, OR DRIVE A GROUND ROD AND RUN #12 WIRE TO GND TERMINAL OF THE KT.

6. Remote Switch Theory & Troubleshooting

A. K1 Board

1. Circuit Theory

Each K1 Board can select one of three cables. Selection of a cable is identical for all three, so we will explain the operation of cable A as being typical of all three.

In our example the K8 has energized cable A. Approximately 12 volts is applied to the coils of the bottom row of relays K1 to K11. When the relays are actuated, cable A is tied into the leadwire, through the eleven relays. The leadwire is ran to all remote switches and the instrument. The instrument then must select one of the 21 TC's and display the temperature.

The actual voltage across the relays can be read at test points A, B and C (right side of LED's). This voltage should be between 11 and 14 volts for the relays to operate accurately.

Trouble Shooting the K1 Board

One problem that may occur on the boards is an open TC. Switch the K1 Board with another one to determine if the K1 Board is at fault.

Red Light Emitting Diodes give easy visual indication of which cable has been activated. In some cases the LED may be burnt out but the cable still activated properly. This problem can be checked by testing test points A, B and C.

B. K8 Board

1. Circuit Theory

This board is designed to interface and decode the signals from the control lines from the instrument. All of the signals from the instrument are routed into the enclosure through the control wires. These wires are attached to the card cage backplane and soldered into it on the left side of the K8 board. The signals from the instrument come up into the K8 board through the left edge card connector.

If the switch select line for a particular switch is at 12 volts, that switch will be selected. The five cable logic lines, when decoded, then select one of the 24 cables on the K1 boards.

Trouble Shooting the K8 Board

The Red Light Emitting Diode gives easy visual indication if the mux has been activated. If the K8 is operating improperly switch it with another one to determine if the K8 Board is faulty.

7. Fuse

Inside the case in the splice area is a fuse marked F1. Check this fuse if no temperature readings are displayed and the display is reading horizontal dashed lines.

8. KT Instrument Operation

The Model KT instrument was designed to select and scan groups of thermocouples (utilizing remote switches) from a permanent location.

The power switch is located at the back of the instrument on the right side when looking at the front of the instrument.

The KT Instrument also has three switches and a large LED display for the temperature. The Section switch selects a remote switch. The Cable switch selects one of 24 cables and the TC switch selects one of 21 thermocouples. The temperature is then displayed on the LED display.

On the back left of the instrument is a black and red jack. These can be used to check the ohm readings of the thermocouple cables, which is a good maintenance feature.

Thermocouple Fail-Safe Feature

If an inoperative thermocouple or unconnected position is selected, the temperature display will show dashed horizontal lines. This prevents the recording of an incorrect temperature and notifies the operator of the thermocouple failure.