service manual

APERTURE TYPE SOLID STATE METAL DETECTOR

WITH DIGITAL DISPLAY METERS AND AUTO-CAL CIRCUITRY

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SECTION 1 - INTRODUCTION

The service technician should acquaint himself with the functions of the various circuits of the system. The following information should be helpful in understanding the operation of the metal detection system.

CONTROL CABINET:

House the various solid state circuits necessary for operation of the system. The digital unit and its components are illustrated in Figure A.

CABLES:

Carry power to the inspection head and return a reference signal back to the control cabinet.

INSPECTION HEAD:

The apparatus used for exciting contaminated metal in a product and a circuit for sensing any change in a stable reference signal when metal passes through the inspection aperture.

DIGITAL DISPLAY METERS:

The two built in digital display meters in the control cabinet, are contained on a single printed circuit display assembly. The display is held into place in the cabinet by two screws. It is serviceable as a complete assembly or plug in replaceable display elements may be changed as the need arises. The two meters are used in the calibration of the metal detector for operation. They also serve to monitor the units operation, namely the transmitter output power to the inspection head and the receiver balance signal returned from the inspection head. These two "Life Blood" operating conditions can be easily monitored through the see-through plastic window in the cabinet door.

SOLID STATE PLUG IN CARDS:

The electronic circuits necessary for the system are housed in the control cabinet which contains five removable printed circuit cards. Their functions are described in the proper sequence of performance.

Regulator
Oscillator
Driver
Output
Receiver

The cards are mechanically keyed and color coded for proper location in the chassis. Because of this feature, cards cannot be inserted completely in the wrong card guide slot.

REGULATOR CARD:

This card can be identified by the YELLOW pull tab at the top when in the control cabinet card rack, position 4 from the left. It receives a raw AC supply from the power transformers located behind the Auto-Manual Reset Switch panel at the lower left of the chassis. Components on this card rectify, regulate and distribute voltages at the proper level and polarity to the other four cards in the chassis. The voltages are distributed as follows:

Unregulated Voltage:

Approximately 32 V-dc to the relay circuit.

Regulated Voltages:

9 - 10 V-dc positive to the Receiver Card.
21 - 25 V-dc negative to the Driver and Output Cards.
21 - 25 V-dc positive to the Oscillator, Driver and Output cards.

The three regulated voltage supplies can be checked at the test lacks located on the card. This is covered in the "Calibration Section".

This card will normally run warm to the touch.

OSCILLATOR CARD:

The Oscillator Card can be identified by its ORANGE pull tab, position 3 from the left. This card receives a positive 21 - 25 V-dc from the Regulator Card. At this stage, the high frequency signal is generated, amplitude regulated and stabilized. The signal is then fed to the driver stage where it is further amplified.

The circuit is designed to operate over a narrow range of frequencies at high efficiency. The frequency and amplitude are adjustable. The standard arrangement centers around a frequency of 20 kHz normal operation, 10 kHz for Heavy Duty (HD), and 30 kHz for High Frequency (HF) operation. Proper adjustment of the frequency is best accomplished with all cards in operation.

This card also has provisions for meter connections and will be covered later in the manual. The voltage measured will be AC at the frequency stated above.

Very little heat is generated by the components on this card.

DRIVER CARD:

This card is identified by the RED pull tab, position 2 from the left. Its function is that of an amplifier, receiving a low level signal at the frequency of the oscillator, then raising it to a higher level to "drive" the output or power stage. Both positive and negative 21 - 25 V-dc are supplied to this card from the regulator stage.

The amplitude of the driver output is adjustable to match the requirements of the output or power stage. Proper adjustment of this card is necessary for maximum overall operation of the detector. This adjustment is covered under the "Calibration Section". The driver level will vary with different size inspection heads.

The heat generated by this stage is low.

OUTPUT CARD:

This card is identified by the BROWN pull tab, position 1 on the left. The function of the Output Card is that of a power amplifier. The output signal energizes the transmitting coils in the bottom plate of the inspection head. It receives its driving power from the Driver Card. The power output is adjustable and controlled by a potentiometer on the Driver Card.

The output signal to the inspection head transmitter coils from the Output Card, can be read directly from the "Transmitter Output Meter" in the control cabinet. However, the red and black test jacks on the Output Card can also be used for this purpose in the event of a Transmitter Output Meter failure. This will be covered in the "Calibration Section" of this manual.

The Output Card receives both positive and negative 21-25 V-dc from the Regulator Card.

The card will normally run warm to the touch.

INSPECTION HEAD:

The Output Card supplies high frequency power to the Inspection Head. The head has coils in the bottom plate which, when energized, develop the high frequency field that fills the aperture. This field excites the metal particles which are to be detected. The signal developed in the control cabinet is carried through a coaxial cable to the transmitting coils located in the lower plate of the inspection head.

The top plate of the inspection head contains the receiving coils. The receiver coils monitor the high frequency field produced by the transmitting coils and carry a low level signal back to the receiver section of the control cabinet via the second coaxial cable.

The top plate, receiver coil assembly, must be properly positioned relative to the bottom plate, transmitter coil assembly, in order to receive a low level reference signal. A slight physical adjustment of the top plate allows the signal to be brought to the required level for maximum sensitivity of the system. Proper adjustment is covered in the "Calibration Section".

The coil in both the top and bottom plates are carefully adjusted at the factory to their proper positions before the unit is sealed. Care in handling the head should be observed to prevent the possibility of damaging the internal coil assembly.

The cables connecting the control cabinet with the inspection head should also be carefully handled to prevent damage. Polarization of the cable, cabinet and inspection head connections prevents the possibility of wrong connections

RECEIVER CARD:

This card is identified by its GREEN pull tab and is located on the extreme right of the card rack. It acts as an amplifier. detector and control for external functions required of the detector system.

A reference signal is fed from the receiving coils in the inspection top plate to the control cabinet receiver circuit. When metal passes through the high frequency field in the inspection aperture, the field is disturbed and the receiving signal changes. The detection circuit senses this and a change in the steady state reference voltage takes place. A pulse like signal is developed which causes a firing circuit to trigger into conduction, energizing a relay which provides a circuit for controlling external functions that are required such as sound an alarm, supply a visual indication, control a motor or operate a rejection device, etc.

The input to the Receiver Card is brought into resonance or tuned with the transmitting signal for maximum sensitivity. This is accomplished by means of the trimmer capacitor, C-3, located on the control panel directly beneath the card rack. A small thin blade screwdriver is used for this adjustment which is covered in the "Calibration Section".

When tuning C-3 for resonance or "aligning the inspection head", as will be explained under the "Calibration Section", you will use the "Receiver Signal Meter" built into the cabinet as you make these adjustments.

The Red (positive) and Black (common) test jacks on this card may also be used for making these adjustments in the event of a meter failure. The GRAY test jack on this card is primarily for factory tests and is of little concern in the field.

The receiver card generates very little heat.

CONTROL CIRCUIT:

The terminals on the terminal board which is located in the junction box on the lower left side of the control cabinet are connected to the manual Reset Circuit, the Sensitivity Control Circuit and also the contacts of relay K-1. These provide for the connections of external control devices.

The relay provides for a common and one each normally closed and normally open contacts. The contacts are rated at 10 A and are not intended for heavy loads. Remote controls are required for heavy loads. The built-in control relay is for pilot duty only.

The coil voltage for relay K-1 is unregulated. It is supplied from the positive source of approximately 35 V from the Firing Circuit of the Regulator Card, returning through the Receiver Card. This circuit conducts, thus energizing the relay when metal is detected.

For external connections, use the terminals in the junction box as follows:

Terminal 1 Remote Reset
Terminal 2 Remote Reset
Terminal 3 Normally Closed
Terminal 4 Common
Terminal 5 Normally Open
Terminal 6 Dual Sensitivity Control Input (Optional)

Note: When an optional sequence timer board is pre-installed at the factory, the remote reset is deemed not necessary and terminals 1 & 2 become power output connections for the customer reject device. Terminals 3, 4 & 5 are pre wired at the factory and are not available for customer use. No additional wiring is necessary

The relay contacts are not "live". Power terminals must be connected to the appropriate terminals to form a circuit to operate a reject device, energize an alarm or shut down conveyor, etc., depending upon which of these functions is desired to work in connection with the metal detector. Relay contacts are not available for use when a sequence timer is installed in the control cabinet.

SECTION II - MOUNTING

GENERAL:

Care should be used when handling, installing and operating the metal detector inspection head and control cabinet. Although rugged in appearance, the head contains precisely located coils which can be damaged or displaced if the sensing head is dropped or severely jarred.

It is recommended to bench test the detector, prior to installing on the process line. This will insure that the unit has not been damaged in shipment and is functioning properly. Nearly all metal detector malfunctions are caused by improper installation or disturbing elements in the mounting arrangement. Metal particles embedded in the conveyor belt or a poor ground connection are examples of disturbing elements that are not readily apparent. If the metal detector is incorrectly assumed to be faulty, hours may be wasted in troubleshooting the unit before it is discovered that the problems are not in the detection equipment. The bench test will eliminate unnecessary troubleshooting. Perform the test in an area that is not surrounded by large masses of metal. Place the inspection head on a wood bench or similar support. Follow the calibration instructions in setting up and adjusting the equipment. If the unit does not operate properly at this time, contact the factory or our local sales representative.

CONTROL CABINET:

The control cabinet is a NEMA Type 4 (IP-66) enclosure that can be mounted on a wall or column located within the length of the signal cable to the inspection head. The signal cables are part of the balanced circuit and must not be cut or spliced. Choose a location where the cabinet will be readily accessible for service adjustments and allow clearance for opening the door. Do not locate the cabinet in extreme or rapidly fluctuating temperature areas, such as next to ovens, etc. A reasonably stable ambient temperature between 0ºC and 40ºC is recommended. Below 0ºC it is suggested to supply external heat, such as a strip heater, to keep the cabinet in the above range. If possible, the unit should be operated continuously, especially at low temperatures or areas of heavy condensation. Avoid excessive vibration of the cabinet as it can cause faulty operation.

It is recommended that the metal detector be supplied power from a plants lighting circuit when possible. Connect a single phase, 50/60 Hz power of the appropriate voltage to terminals **Cl** and **C2** inside the junction box on the control cabinet. The connections in the terminal box are illustrated in Figure B and also, the inside of the box cover. The required operating voltage is also indicated in the terminal box. Make certain that the line is not connected to terminals 1 and 2 on the terminal block.

The hot side of the line must be connected to Cl. The metal detector has been wired at the factory for either 110/120 or 220/240 V; 50/60 Hz as noted adjacent to terminals Cl and C2. A separate ground terminal has been provided for grounding the unit to a cold water pipe or building framework. A conduit ground is not adequate. The amber signal light located above the fuse inside the cabinet will remain lit when the unit is properly grounded, and when the proper polarity input voltage is applied.

As previously stated, the relay contacts connected to terminals 3 (NC), 4 (common) and 5 (NO) are rated for pilot duty only. The contacts are not "live", therefore power must be connected to the appropriate terminals. If optional sequence timer is installed in the cabinet, then make no connections to terminals 3, 4 & 5.

A toggle switch for manual or automatic reset is provided in the control cabinet. When this toggle switch is down, the detector must be reset manually after it has tripped. The "manual reset" is used for this purpose. When in the manual position and the detector trips, the red pilot lamp on the top of the control cabinet will light and the green pilot lamp will go out. Reset the detector by pushing the "manual reset" and holding it down for approximately 2 s. Provision for a remote manually operated reset switch has been incorporated. By connecting a momentary switch to terminals 1 and 2 on the terminal block, will enable the operator to reset the detector at any remote station when the selector toggle switch is in the

manual position. Hold the reset switch for approximately 2 s. The momentary reset switch should have normally open contacts. Any number of switches may be paralleled for reset at more than one station.

Automatic reset is accomplished with the toggle switch in the up or automatic position. Each time the detector trips, it will reset itself in approximately 300 ms.

All detectors are supplied with a built-in time duration reset circuit. The control for this is adjacent to the reset switch on the front panel. The control consists of a potentiometer which can vary the reset time from the standard 300 ms to approximately 7 s. This, again, is accomplished with the toggle switch in the auto position. The dial numbers on the reset timing control knob are for reference points only. These numbers do not represent any specific time. This duration time can be used to vary the length of time an alarm bell rings, a dye marking system sprays, a diverter valve opens, etc., depending upon which of these external systems are used with the metal detector.

SIGNAL CABLES:

The Signal Cables should not be cut, spliced or changed in length from that furnished with the detector, since they are a balanced part of the circuit. Any unused length should be coiled and fastened securely outside of the control cabinet. The cables should be placed in conduit or taped to a support structure every 500 mm to 1 m to prevent being bumped or jarred by personnel or equipment. If conduit is used, cut the tubing 300 mm from the sensing head to ease connection. The signal cables should be the only wire in the conduit. Other factors to consider are to avoid sharp bends in the cables and do not fasten them to steam or hot water pipes.

INSPECTION HEAD:

A sturdy, rigid mounting arrangement for the Inspection Head is essential for good performance. Movement or excessive vibration in the mounting structure can stress the head and cause false signals. When mounting on a conveyor, it may be necessary to weld additional braces to the framework to increase rigidity. Also, avoid mounting the head directly over pulleys or drive motors.

The use of an independent support stand, as illustrated in figures C and D, is recommended wherever possible because it greatly reduces the possibility of conveyor disturbances generating false signals in the detector. However, a conveyor mounted unit, as in Figure E. will perform as well if installed properly and disturbances are eliminated.

Inspection Heads having apertures wider than 700 mm are more susceptible to stress and vibration. In order to obtain maximum sensitivity, it is recommended that they be mounted on a wood or other nonmetallic beam across the width of the conveyor or independent support stand. This nonconductive beam would serve to tie the side rails together and prevent relative movement. See Figure E.

The sensing field "bows out" of the aperture, therefore, it is necessary to provide clearance from metal objects in line with the opening on either side of the inspection head. This is shown in Figure F, Area 1. This area should be free of metal objects for at least 150 mm or twice the aperture height, whichever is greater. Small objects such as screws and nuts can be within this area if they are stationary. However. metal is not allowed in the aperture itself. Extremely large metal objects should be given additional clearance, if possible, up to 1 m or more. This includes such items as idler rolls, larger metal braces, pulleys, etc. If idler rolls are used, it is recommended that the first idler on either side of the inspection head, be a rubber impact type which reduces the overall mass of metal near the inspection head.

The aluminum plate construction of the head serves to confine the sensing field to the general area of the opening. A weak sensing field does, however, exist all around the aperture as indicated in Figure F, Area 2. In most applications this field is of little consequence, which permits mounting on a sturdy metal support and prevents disturbances from other metal objects in the area. However, a sufficiently large mass of metal directly above or alongside of the aperture could cause interference, depending upon its size and degree of movement. Under no circumstances should objects be mounted on or fastened to the sensing head itself.

The inspection head must be electrically insulated from the conveyor frame of support stand. This will prevent false signals due to change in ground potential. Insulating material and instructions have been furnished with the detector for this purpose. **If the metal detector inspection head is to be washed down with water, additional electrical insulation should be provided under the head to insure that the head remains electrically insulated.** Nothing other than the support arrangement should contact the sensing head. Objects such as the belt, product, guide rails, etc., rubbing on the head can generate false signals. On belt applications, a short slider bed of Plexiglas, Bakelite or other nonconductive material should be used to support the belt through the aperture. The belt support itself should not contact the head. Allow at least 6 mm clearance between the belt support and the bottom member of the aperture for deflection and approximately 12 mm clearance on each side.

All loose members, conduits or controls near the head or in contact with the conveyor or support stand should be welded or securely fastened to the frame to prevent signals caused by the intermittent opening and closing of "conductive loops". This is described in the "Troubleshooting Section". On short conveyor applications, it is recommended to electrically isolate head and tail pulleys, as well as belt idlers, from the conveyor framework.

The inspection head may be disassembled for installation around endless conveyor belts or nonmetallic pipes and chutes. There are no wires connecting the top and bottom members of the head, remove the bolts on the top of the inspection head, leaving the tape wound around their shanks intact. Carefully lift the top plate off. Mount the head in accordance with the above instructions. Before reassembling the head, make sure all contacting surfaces are clean. Replace the top plate, but do not tighten the head bolts until it has been aligned as outlined in the calibration instructions.

SECTION III - CALIBRATION

The operator should be thoroughly familiar with the operating principle and mounting requirements of the metal detector before calibrating the unit.

All of Stearns metal detectors are thoroughly tested and operated for at least 48 hours prior to shipment. The unit will be ready for you to operate after you have made some minor adjustments as covered in this "Calibration Section". The two built-in digital meters are used as you make the adjustments, however a multiple voltmeter may also be used in the event of a digital meter failure as a back-up.

All voltage readings are based on the use of a **high quality** Digital Multimeter (DMM), with a capability of measuring alternating currents at frequencies up to 50 kHz. In order to obtain maximum sensitivity from your detector, it will be necessary to set your meter to the low range scale, such as the 200 mV or 2 V setting. However, the digital built-in meters are the primary and accurate means used to calibrate the unit. The use of a DMM is merely a backup means or for troubleshooting purposes, as will be later discussed.

Insure that the circuit cards are fully inserted to the rear of the card rack. Check to make sure that the proper line voltage has been connected to terminals Cl and C2 and that the control cabinet has been adequately grounded. Turn the power switch in the control cabinet to the ON position. Turn the black sensitivity control full counterclockwise, the OFF position, on the receiver card. Let the unit, then warm up for five (5) minutes, before proceeding to the following adjustments.

STANDARD ADJUSTMENTS

DIGITAL DISPLAY:

The digital display test button located on the built-in meter panel should be pressed to verify that the digital meters are fully operational. When the test button is pushed, it will cause all elements of the display to light, which will indicate all "8's" on both meters. If all "8's" are not present in each segment of the display, a faulty element could make it difficult to read the proper indications from the meters as covered in this section. Replace any faulty elements as covered in the troubleshooting section of this manual.

TRANSMITTING

With the units built-in digital meter, the transmitter output can be read directly from the "Transmitter Output Meter".

Adjust the upper potentiometer (VR1 frequency control) on the oscillator card to produce a maximum meter reading on the "Transmitter Output Meter". When using the digital meter, this is best accomplished by making small incremental changes of the potentiometer and at the same time. observing to note the reading of the meter before each change. In this manner you will remember the reading obtained after each incremental change. so as to know when a maximum reading is obtained.

Now adjust the driver card potentiometer (R5) for a reading of **250** or the highest reading obtainable **below 250** on the "Transmitter Output Meter". Return to the upper potentiometer on the oscillator card and again readjust for a maximum reading on the "Transmitter Output Meter". If necessary, readjust the driver card potentiometer to make sure your final reading then is **250** or the highest reading obtainable **below 250**. This then is the proper power output in milliamps, from the transmitter section of the control cabinet to the transmitter coils in the lower portion of the inspection head. **It is normal for the meter reading to fluctuate slightly as the digital display is "pulsed" every second.**

In the event you wished to calibrate the transmitter section using a DMM (such as in the case of a "Transmitter Output Meter" failure), you would plug your red meter lead, into the output card RED test jack and your black meter lead, into the output card BLACK test jack. Your meter should be set to read a low AC voltage, so set the meter for a reading on the 2 V

scale.

Proceed to make the same adjustments in the same sequence, as previously described as when using the built-in "Transmitter Output Meter", expect your final reading to be obtained on the DMM should be **250 mV-ac** or the highest reading obtainable below **250 mV-ac** by following the sequence of adjustments previously described.

RECEIVING

The receiver signal level can be read directly from the "Receiver Signal Meter" built into the control cabinet. In the event you wished to read this signal level using a DMM (such as in the case of a "Receiver Signal Meter" failure), you would plug your red meter lead into the receiver card RED test jack and your black meter lead into the BLACK test jack on the receiver printed circuit card. Your meter should be set to read a low POSITIVE DC voltage of less than 5 V. The adjustments and readings which follow will be the same for either the built-in "Receiver Signal Meter" or a DMM since the reading from the Red and Black test jacks on the receiver card is the same indication as would be obtained on the built-in "Receiver Signal Meter", indicating direct current voltage.

Adjust trimmer C-3 for the highest possible meter reading, on the "Receiver Signal Meter". C-3 is located and identified on the front panel.

If the meter reading is >2 V or <450 mV the head should be realigned as covered under "Inspection Head Alignment".

IMPORTANT

If realignment of the inspection head top plate is required, be certain that the final reading after the bolts have been tightened down is approximately 1 V and that C-3 had been adjusted for a maximum reading on the "Receiver Signal Meter" prior to the alignment of the inspection head.

If the oscillator or driver adjustments are ever readjusted, the receiver must also be recalibrated. Otherwise, a loss of sensitivity may be experienced. Any changes in the transmitting section will be reflected in the receiving section.

Keeping the detector at maximum efficiency requires only that the receiving section circuits be kept in resonance with the transmitting section and that the top plate of the inspection head is positioned to produce approximately 1 V and C-3 was peaked up prior to the alignment of the inspection head.

SECTION IV - INSPECTION HEAD ALIGNMENT

Assuming that the inspection head and the control cabinet have been installed and calibrated to the previous instructions, proceed with the adjustments as follows:

Set the sensitivity control knob on the receiver card full counterclockwise to eliminate tripping. Loosen the four (4) bolts on top of the head and align the top plate squarely on the side spacer blocks. Move one end of the top plate **slightly** in a direction parallel to line of product travel through the aperture, until a reading of approximately 1 V is obtained on the "Receiver Signal Meter". This adjustment is usually best accomplished by using a screwdriver handle or your hand to **gently** tap the head into alignment. This procedure is referred to as "balancing or aligning the head". It is essential for the proper performance of the metal detector and must be accomplished with extreme care to obtain the proper reading on the "Receiver Signal Meter" for maximum sensitivity. The smaller the aperture opening height dimension, the more critical this adjustment becomes. It will be necessary for the person doing this "head alignment" to develop a "feel" of this particular adjustment. however, after this procedure has been practiced once or twice, the procedure becomes simple to accomplish.

Proper operation will result with a reading of between 0.45 and 2.00 on the "Receiver Signal Meter", but it is recommended that this reading be as close to the reading of 1 V as possible. At 1.00 the metal detector has its normal sensitivity to metal depending upon the setting of the sensitivity control.

If the head top plate is moved too severely, the "Receiver Signal Meter" reading will decrease so quickly, that it will go down past 1.00, perhaps as far as zero, but then come back up again on the other side of a "null" without one even seeing this drop off point on the meter. Therefore make your head top plate movements in small increments and observe the meter readings to watch for the decrease in reading on the "Receiver Signal Meter" to the 0.45-2.00 range. Now go back and readjust C-3 make certain a maximum reading on the meter has been obtained with C-3. Again, reposition the top plate for a 1.00 indication. After the 1.00 reading is obtained, tighten the head bolts by alternating across the head to produce a "X" pattern as you tighten all four (4) bolts. The "Receiver Signal Meter" reading will vary as the bolts are tightened, however by tightening each bolt a little at a time and alternating across the head, your final reading should stay fairly close to 1.00 if the bolts are tightened in this fashion.

There may be some drift in the reading, as heating of components and as the metal parts of the head reach ambient temperature. However, after a few hours, everything should stabilize and as long as the reading remains at 0.45-2.00 proper sensitivity capability can be achieved from the unit. **It will be normal for the "Receiver Signal Meter" reading to fluctuate slightly as the digital display is "pulsed" every second.** Should this reading drift out of range over a period of time, readjustment of the head may be necessary, if maximum sensitivity capabilities from the equipment is to be realized.

ADJUSTING THE SENSITIVITY

The sensitivity control consists of a black knob located at the lower right side of the Receiver Card. Sensitivity to smaller metal particles will increase as the knob is advanced clockwise. The unit should be operated at the lowest setting that will give the necessary protection, or to detect the particles in the test wand furnished with the unit. A second sensitivity control (R41 is located just above the black sensitivity knob. This control is screwdriver adjustable to allow the Receiver Card to be customized to the installation. Turning this control clockwise will increase the maximum sensitivity of the black knob. Movement in the counterclockwise direction will cause the black sensitivity knobs control to become very selective as to the sizes of metal particles that will and will not be detected. **Extreme care should always be used when adjusting this control to prevent unnecessary false detection's and or loss of sensitivity.** This control has been preset at the factory for normal sensitivity performance, assuming a proper installation of the metal detector.

FACTORS AFFECTING SENSITIVITY

Assuming the metal detector has been properly mounted and adjusted, several factors influence the sensitivity of a given metal detector. Among these are size and type of metal, speed of the particle, orientation within sensing field and proximity

to the exciting or pickup coil systems. A complete explanation of all factors is beyond the scope of these instructions, however, all concerned personnel should be aware of the following points.

All metals do not have the same effect upon the detector.

FERROMAGNETIC METALS such as common mild steel are most easily detected. Therefore the smallest particles detected will be of this type.

LOW RESISTANCE NONMAGNETIC METALS such as copper, aluminium and some alloys are more difficult to detect than magnetics and must have 1.5 times more cross-sectional thickness or surface area than that of ferromagnetic metals in order to be detected.

HIGH RESISTANCE NONMAGNETIC METALS such as 18-8 or 300 series stainless steel are the most difficult of these common metals to detect. The thickness or surface area of these metals must be 3 times that of ferromagnetic metals in order to be detected.

CONDUCTIVE MATERIALS

Bear in mind that the detector will react to all conductive matter if a sufficient quantity is present. This includes nonmetallics such as carbon and asbestos. In most applications this well be of no concern.

INSPECTION SPEED

The speed at which the particle is conveyed through the aperture will influence detection. The particle cannot be detected unless it is in motion. Sensitivity decreases at low speeds as well as high. The optimum speed will vary with the size of the inspection aperture, however, maximum sensitivity is generally obtained in a range of 150 mm/s to 1.5 m/s. The unit is of course capable of detecting over a wider range.

ORIENTATIONAL EFFECTS

If the metal does not have sufficient cross-sectional thickness, its detection may be influenced by its orientation within the field. A nail or wire, for example, may be detected if it points in the direction of product travel but escape detection if it is turned 90º horizontally. Surface area can compensate for lack of thickness in some instances.

It is occasionally possible to improve sensitivity to nonmagnetic particles by setting the inspection head on the correct side of "NULL". As you probably noticed when the head was adjusted, it was possible to bring the "Receiver Signal Meter" reading down below 450 mV to near zero by moving the head top plate in one direction or the other, and that the meter went up again as you proceed further in the same direction. The head has then passed through the "NULL". Finding the best position may take some testing on the part of the adjuster. However, its important to know that one can balance the metal detector for 1.00 on both sides of this "NULL".

SECTION V - TROUBLESHOOTING

The following instructions are a guide to troubleshooting and checking the adjustment and operation of the metal detector. Before extensively troubleshooting the detection circuitry inside of the control cabinet, it should first be established that the trouble is not due to external Interferences. If the unit calibrates properly but develops frequent false signals at normal sensitivity settings, it can reasonably be assumed that there are disturbing elements in the mounting arrangement. In such cases considerable time may be saved by reviewing the mounting instructions and checking for external interference's as outlined below. Simple checks should be made to insure cable fittings are tight and circuit cards are fully inserted.

EXTERNAL INTERFERENCES

Follow a logical process of elimination in checking for external Interferences. For example, much can be learned if the unit can be checked out while the conveyor on which it is mounted and other equipment in the immediate area is shut down. If the detector operates properly under these conditions it would verify that the false signals are external. However, if poor operation continues the problem may be power line disturbances, defective circuitry (see control circuit troubleshooting information), or improper calibration.

Some common sources of external interference are:

1.) Moving or vibrating metal objects too close to the inspection head. See inspection head mounting instructions to insure proper clearance from metal objects was accomplished.

2.) Metal particles embedded in the conveyer belt or in cardboard carton liners or package shells.

3.) Excessive vibration of the inspection head, signal cables or control cabinet.

4.) Packages, conveyor or belt support rubbing on the inspection head. Nothing should contact the inspection head other than the support it is mounted to.

5.) The opening and closing of "conductive loops" near the aperture are a difficult source of external interference to locate. Conductive loops are closed metallic paths formed by conveyor framework, idlers, pulleys and other objects mounted on the conveyor. These conductive loops absorb energy from sensing field by acting like a shorted secondary turn on an air core transformer. When this path breaks due to vibration, a bad idler bearing., or loose fasteners, the energy is suddenly released and the entire field pattern shifts causing the detector to trip. It is the opening and closing of conductive loops, rather than their metallic presence, that causes false signals. Intermittent loops can be located by pressing or tapping on suspected areas of the framework and observing the reaction of the metal detector. The remedy is to fasten the loop securely so that it cannot open (preferably by swelling), or open it permanently so that it cannot close by inserting a nonconductive section. For example, rubber pads under pillow blocks, tape or plastic sleeves on the mounting bolts and washers will effectively open a loop formed by a conveyor pulley.

6.) Power line transients generated by inductive devices in reject systems or other equipment on same power line. Placing a 50 nF, 600 V capacitor across the offending solenoid, relay coil or contacts will usually eliminate or reduce the problem. Placing the metal detector on a lighting circuit rather than equipment circuit will generally isolate transient producing equipment from the metal detector.

7.) Lack of insulation between the inspection head and conveyor framework. An insulation mounting kit is furnished with the equipment. If the metal detector inspection head gets washed down with water, additional electrical insulators should be installed under the inspection head to prevent its shorting to ground.

8.) Loose metal objects on conveyor frame. All conduit, controls, chain guards, etc.,, mounted on the detector conveyor should be securely fastened. These objects can generate "closed loops" as described above if they are not securely fastened.

9.) Shorted, open, or defective cables or connectors. Wet cable ends at connectors can short out signals developed in both coil circuits. Remove the fittings from the cabinet and head and check as specified under circuit troubleshooting information.

It may not be possible to troubleshoot the detector while other equipment in the area is not operating. However, many of the above possibilities can still be logically eliminated. Another alternative would be to remove the inspection head from the line and observe its operation when placed on a wood support in an uncluttered area.

TROUBLESHOOTING THE CONTROL CIRCUITRY

Check the power to the circuit. If the green pilot lamp on the top of the cabinet is lit when the unit is on and set for automatic reset, the primary power circuits are functioning up to the Regulator Card. If both pilot lamps are lit, relay K-1 under card rack is not tight or has bad contacts, replace with new relay, if necessary.

If the green pilot is not lit, check for the proper input voltage at junction box, across terminal Cl and C2.

Check the fuse inside the cabinet.

Inspect the pilot lamp for an open filament or loose connection.

Check the signal cables between the inspection head and control cabinet for continuity or shorts. Turn the detector off and remove the cables from the head and cabinet. With an ohmmeter set to the proper range, check either end of the cables for shorts, between the outer shell and inner pin of fitting. Resistance should be infinite; Check the continuity of the center conductor and outer shield of the cable by reading the resistance from end-to-end of each cable. The resistance should be zero.

Reconnect the cables to the inspection head and cabinet making sure that the fittings are securely tightened. This is essential to make good electrical contact and seal out moisture.

The following instructions establish a procedure for troubleshooting the modular circuit cards. When replacing a card found to be defective, it is important to check the remaining four circuit cards to prevent possible damage to the new card. The following checks are made through the use of a standard DMM as described earlier in this manual. The metal detector has been designed to be troubleshot to the "Card Level Only". This permits quick, easy replacement of faulty cards by strictly mechanical type maintenance personnel.

REGULATOR CARD

Insert the voltmeter probes in the upper red and black jacks on the Regulator Card. A reading of positive 21 to 25 V-dc should be obtained. Check the voltage at the lower red jack for positive 9 to 10 V-dc. Reverse the polarity of the meter and check for negative 21-25 V-dc at the blue test jack. Proceed to the Oscillator Card check if the above is functioning as specified. If you are unable to obtain all of the above voltages, remove all cards except for the regulator and recheck. The voltages will be slightly higher with the other four cards removed. If unable to obtain the approximate voltages with the cards removed, the Regulator Card is probably defective and should be replaced. If all voltages are obtainable, the Regulator Card is satisfactory.

Check for a drop in the regulator voltages while reinstalling the cards in the following manner:

With the voltmeter in the upper red and black jacks on the Regulator Card, insert the Oscillator, Driver and Output Cards. Insert these cards one at a time while observing the indication on the multiple voltmeter. Any card that causes a considerable drop in voltage is likely to be defective.

If the negative voltage at the blue jack has changed remove the Driver and Output Cards, one at a time while observing the meter. If removing either of these cards causes the voltage at the blue jack to go back up to the previous level, that card is defective.

Insert the meter probe into the lower red jack on the Regulator Card and install the Receiver Card. If the voltage drops, the Receiver Card is defective.

OSCILLATOR CARD

Set the meter to a low voltage AC scale and insert the probes into the test jacks on the Oscillator Card. The voltage reading should be between 1.5 and 2.5 V-ac, with all the cards in the circuit. If this card checks, okay, proceed to the Driver Card. If it is impossible to obtain the above reading, at any setting of the potentiometer, the Oscillator Card is defective and should be replaced.

DRIVER CARD

Remove the Output Card and check the voltage at the Driver Card test jacks for a reading of between 7 to 1 4 V-ac. Obtain this voltage by adjusting the driver pot, if necessary. If a 7 to 14 V-ac signal is obtained, proceed to the Output Card. If the voltage is low, the Driver Card should be replaced.

OUTPUT CARD

If the voltage at the Driver Card jack drops to zero when the Output Card is inserted, the Output Card is defective and should be replaced. It is normal for the driver voltage to drop slightly as the Output Card is installed.

Set your voltmeter on the lowest AC scale and insert the probes into the jacks of the Output Card. Adjust the potentiometer on the Oscillator Card until a maximum reading is obtained. If unable to obtain a reading, the Output Card is probably defective. However, in the event of no reading, check the inspection head for adequate insulation from ground. If grounded, the signal will bypass the meter circuit. Shorted cable connectors could have the same effect. It is essential to check the Output Card using a sensitive voltmeter with a low range AC scale because of the small voltages involved. 200 -300 mV-ac is typical.

Note: If you decide to replace the Output Card with a spare card, insure that the Output Card **does not** have a small "push to test" type switch on the front of the card. Some earlier Output Card versions had this switch which required one to push the button before a reading was obtainable out of the test jacks, on the Output Card. With that type of Output Card, one would also obtain no reading from the "Transmitter Output Meter" unless the button was continually pressed. Therefore, this test switch has been removed from all present units utilizing digital display meters.

It should be noted that a bad cable connector, cable or lack of adequate electrical insulation under the inspection head can give an indication of a bad Output Card even though the card is good. So check these areas before assuming the Output Card is at fault.

RECEIVER CARD

Set your meter to a low DC Scale and insert the probes into the black and red test jacks on the Receiver Card. Proceed to align the inspection head as previously specified. If a voltage reading cannot be obtained by aligning the head and adjusting C3, the Receiver Card is faulty. **However, here also, a bad receiver cable or connector will give an indication of a bad Receiver Card.**

If the red indicator lamp, on top of the control cabinet, is on continually and the metal detector cannot be reset by pressing the reset button in the control cabinet. The Receiver Card switching circuits may be defective. Simply replacing the Receiver Card with a known good spare receiver, if available, will verify and correct this problem.

DIGITAL DISPLAY

All of the Digital Display elements can be tested by pressing the "Digital Display Test" button located on the meter panel. With the test button pushed, all elements of the display should light, indicating all "8's" on both meters. If all "8's" are not present, a faulty element (5) could be in the display. The actual display elements are plug-in type modules which are replaceable. Simply remove the faulty element module in question and replace it with a new plug-in module element available from Stearns Magnetics. If no display element lights at all or an erroneous reading appears present on the meter, calibrate the metal detector using a DMM as explained in the calibration section. Then consult the factory for service suggestions and /or replacement procedures for the entire Digital Display Assembly.

INSPECTION HEAD

For information pertaining to troubleshooting the inspection head, consult the factory. Generally, this must be done using an Oscilloscope to check the field produced from the inspection head coils.

If the metal detector continues to malfunction, or there are questions regarding the above information, again, please contact the factory.

SECTION VI - MAINTENANCE

GENERAL

The Stearns Magnetics Metal Detector requires very little maintenance. Once it has been placed in operation and properly adjusted for the application, sensitivity will remain quite constant over extremely long periods of time. We recommend that the unit be operated continuously, especially in damp areas. The unit draws very little current so continuous operation is of little consequence in power consumption considerations.

CLEANING THE INSPECTION HEAD

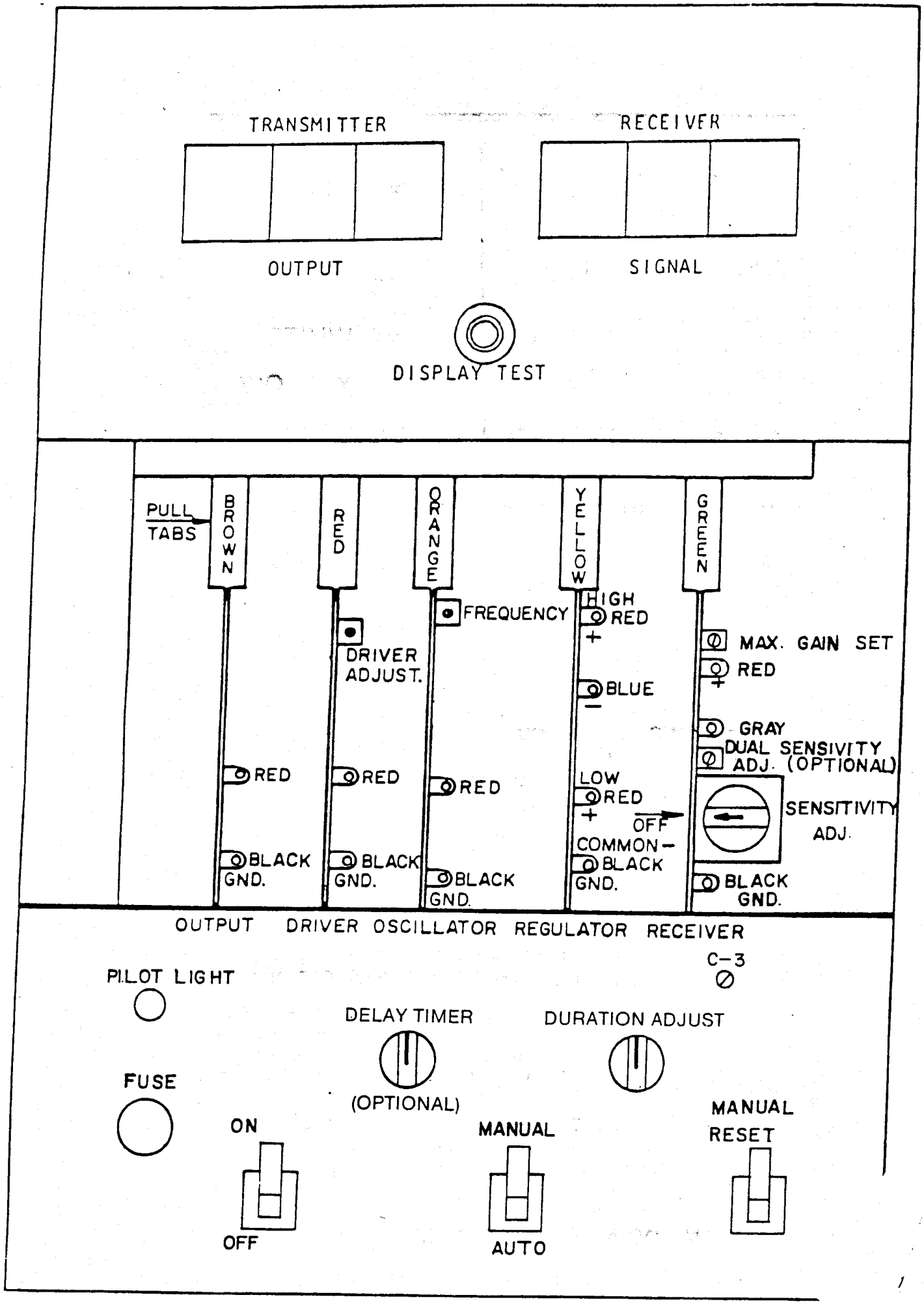
The inspection head can be washed using a sponge or cloth, but it should be dried immediately after washing. Salt solutions, brine and strong detergents are to be avoided since many of these will attack aluminum. Certain cleaning solutions will build up a conductive film on the surface of the head and bridge the insulation between the plate and side members. If this should occur, erratic operation will result. Therefore, the heads must be frequently cleaned with clear water and the insulation checked with a sensitive ohmmeter. Resistance between the top plate and side members should be infinite when the upper signal cable is removed. Also resistance should be infinite between the bottom plate and ground with the lower signal cable removed during test.

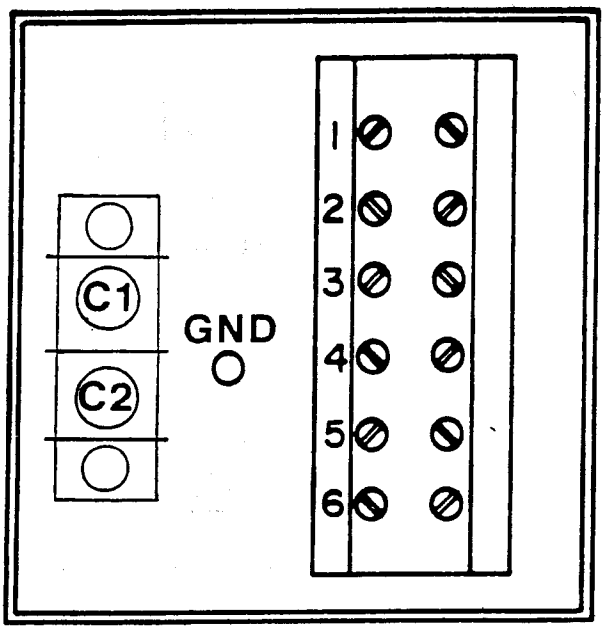
FACTORY SERVICE

Factory service, at the time of installation or for repairs can be supplied at prevailing charges per day plus travel and living expenses. This includes maintenance personnel instruction.

All components including printed circuit cards are stocked at our Maple Heights, Ohio, factory for overnight shipment. Please refer to the unit's serial number and model number when ordering parts.

Factory repair, as well as, trade-in on printed circuit boards is also available.


TRANSMITTER
RECEIVER
OUTPUT
SIGNAL
DISPLAY TEST
PULL TABS
BROWN
RED
ORANGE
YELLOW
GREEN
FREQUENCY
HIGH
RED
+
DRIVER ADJUST.
BLUE
−
MAX. GAIN SET
RED
+
GRAY
DUAL SENSIVITY ADJ. (OPTIONAL)
RED
RED
RED
LOW
RED
+
OFF
SENSITIVITY ADJ.
COMMON −
BLACK
GND.
BLACK GND.
BLACK GND.
BLACK GND.
BLACK GND.
OUTPUT DRIVER OSCILLATOR REGULATOR RECEIVER
C-3
PILOT LIGHT
DELAY TIMER
DURATION ADJUST
FUSE
(OPTIONAL)
MANUAL RESET
ON
MANUAL
OFF
AUTO



JUNCTION BOX

WIRE COLOR

#1 BLUE

#2 GRAY

#3 GREEN

#4 WHITE

#5 YELLOW

#6 VIOLET

FIGURE B

CONNECTING POINT	CIRCUIT
C1	PRIMARY LINE (HOT)
C2	PRIMARY LINE (COMMON)
GND	GROUND
TERM. #1	REMOTE RESET
TERM. #2	REMOTE RESET
TERM. #3	RELAY, N.C. CONTACT
TERM. #4	RELAY, COM. CONTACT
TERM. #5	RELAY, N.O. CONTACT
TERM. #6	DUAL SENSITIVITY INPUT (OPTIONAL)

Note:

When an opticnal sequence timer board is pre-installed at the factory, the remote reset is deemed not necessary and terminals 1 & 2 become power output connections for the customer reject device.

Terminals 3, 4 & 5 are prewired at factory and are not available for customer use.

No additional wiring is necessary.

CAUTION: DO NOT CONNECT LINE TO TERM. 1 & 2

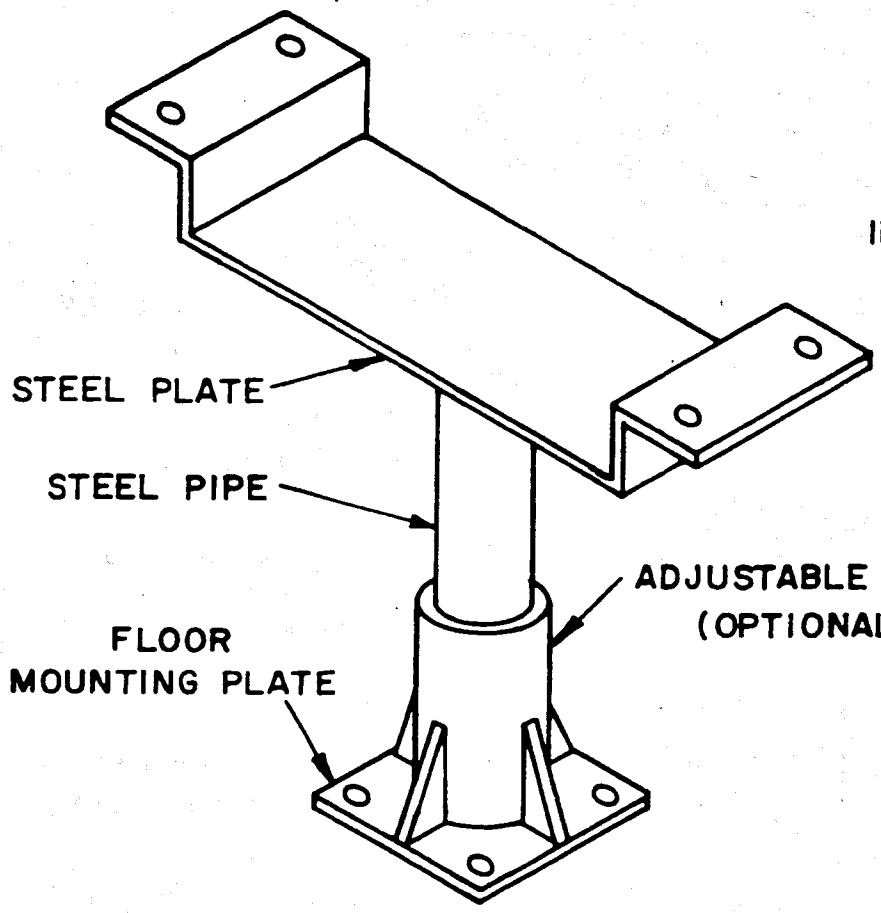


FIGURE C
INDEPENDENT SENSING HEAD
SUPPORT STAND

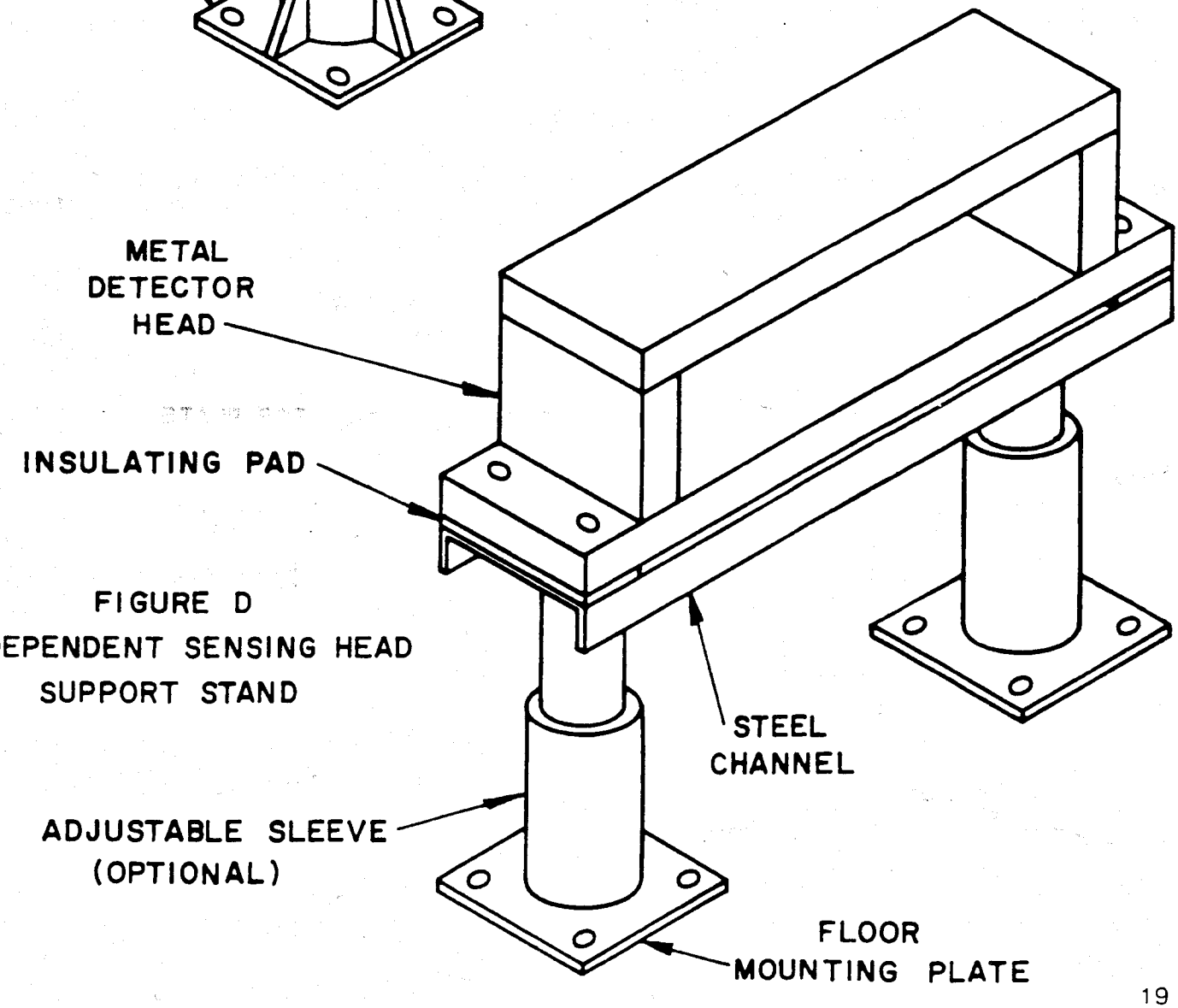
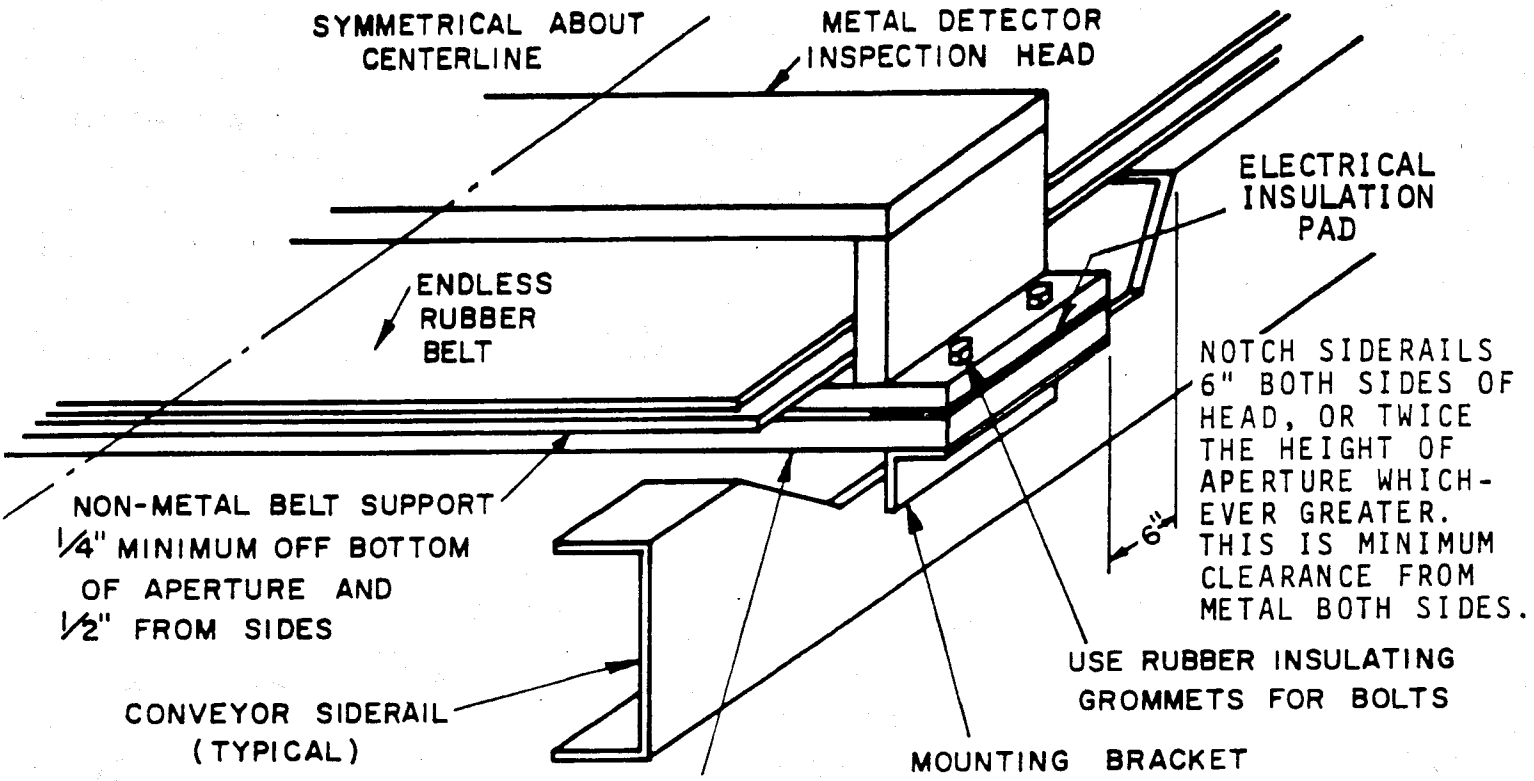


FIGURE D
INDEPENDENT SENSING HEAD
SUPPORT STAND

FIGURE E

CONVEYOR SUPPORT FOR METAL DETECTORS



(NORMALLY RECOMMENDED TO HOLD CONVEYOR RIGID AT THIS AREA AND ALSO PROVIDES ADDITIONAL ELECTRICAL INSULATION FOR HEAD IN WET APPLICATIONS)

FIGURE F

LEAKAGE FIELDS ON METAL DETECTOR

END VIEW OF INSPECTION HEAD