March 15th, 1947
313 W. Seminary Ave.
Wheaton, Illinois

Mr. K. A. Norton
Central Radio Propagation Laboratory
U. S. National Bureau of Standards
Washington 25, D.C.

Dear Mr. Norton:

In line with the second subject of my letter of the 10th, I am enclosing Part I of the specifications on my equipment. Part II covering the electronic apparatus will follow in a week or so. This specification writing turned out to be a larger job than I had expected.

There is one feature of this equipment transaction which bothers me. As long as I am not connected with the Bureau I see no difficulty. However, if time runs on, and I become employed by the Bureau before the transaction is completed will the transaction be clouded legally so that we might be accused of collusion? In other words, is it legal for an employee of the government to sell merchandise to the government?

Recently I have completed a signal generator covering the range 1350mc to 1500mc approximately. An expanded dial scale gives about one megacycle per half inch so tenths of megacycles should be detectable. I believe this machine to be adequate for the proposed development at 1400mc.

During the past two weeks the solar radio noise has been several times normal; no doubt due to the large sunspot cluster. This second time around it was more active than the first. Daytime swishes were quite in evidence but no night time ones could be found. Of all the solar outbursts observed here, the one you witnessed was by far the most intense.

Best regards,

Grote Reber

I. RADIATION COLLECTOR

A. Mirror on Meridian Transit Type Carriage

Mirror

The mirror shall be a parabola of revolution 31 feet 4 inches in diameter having a focal length of 20 feet. The material is to be 24 guage galvanized iron formed in sections of pie. The inside group is to be of nine pieces approximately six feet radius. The outside group is to be of 36 pieces of approximately ten feet radius. One inch overlap is to be provided between sections and sections are to be bolted together along all joints at one foot intervals by 6-32x½" brass nuts and bolts with a brass washer on top and bottom. Sufficient 40/60 solder and flux are to be provided to sweat all joints water tight after assembly. Nine inches of center radius of inside group of sections is to be cut off and the edge folded back one inch so that a hole 20 inches diamter will be formed at center of mirror. Four suitable cutouts in the outside edge of mirror are to be made between sections 45 degrees apart to admit posts for supporting the parapet. Six extra sheets of 24 guage 48" x 120" galvanized iron are to be supplied plus one extra section for the inside group.

Mirror Mounting

Each section of pie is to be mounted on two radial ribs cut from 1"x6" wood strips to the proper parabolic curvature. The sheet metal is to be fastened to the ribs

by 1"x#8 flat head brass wood screws at one foot intervals. Six extra properly cut ribs are to be supplied. Solder and flux are to be provided to sweat heads of screws to sheet metal with a water tight joint after assembly. Supporting the center of mirror is to be a wood ring of laminated construction reinforced with screws, 24" outside diameter and 20" inside diameter. The eighteen inside ribs are to be terminated and fastened to this ring. Each rib is to be supported at not less than two points by vertical steel rib supports made of ¼"x3/16" flat wire stock suitably formed. The ribs are to be fastened to the rib supports by ¼"x1½" steel machine bolts using a suitable washer under each nut. The lower end of each rib support will fasten to a horizontal platform composed of 2"x4" wood beams mounted 4" side vertical. The construction of the mirror, ribs and rib supports is to be sufficiently accurate such that mirror will not depart more than plus or minus one half inch from the above parabola of revolution.

Platform

This platform is to have eight equal sides each 7 feet 4 5/8" long and sufficient criss-cross members to properly uphold the steel rib supports. The top of the platform is to be 1 foot 9 1/8" above the center of a circle 11 feet 4 7/8 inches radius.

Carriage

The platform is to be part of a carriage with two large tracks similar to the tracks on a horizontal drum

concrete mixer, but not a full 360 degrees in circumference. The tracks are to be 11 feet 4 7/8 inches radius and 20 feet 2 3/8 inches apart center to center. Steel rails made of 2½"x1¼"x5/16" angles rolled 11 feet 5 1/8" outside radius with 2½" leg in are to be fastened over tracks. The rails are to be terminated in same size angles rolled 9" inside radius with 2½" leg out. The rails may be supplied in 12 foot lengths. Two 4"x6.25# channels 20 feet long are to be incorporated as reinforcing members in the carriage horizontally 4 feet below center of circle and in plane thereof. The carriage is to be constructed of 2" x 4" and 2" x 6" wood members fastened at all intersections by 1/8"x6" steel gusset plates of suitable design. Wood members and gusset plates are to be held together by machine bolts ½" diameter of appropriate length. Not less than two bolts must hold each wood member to a gusset plate. Gusset plates are to be provided on both sides of each wood member. The carriage must be so designed and the track of sufficient length to tilt the platform 90 degrees from its normal horizontal position in one direction (south) and 45 degrees in the opposite direction (north). Sufficient cross bracing must be incorporated in carriage to limit the deformation to plus or minus one half inch at any position of tilt. The rails and reinforcing channel plus appropriate gusset plates are to be welded together in the field at time of assembly.

Parapet

The track and rails will extend thru the mirror near the edges and terminate in posts with special bent gusset plates. From these posts will rise a four leg parapet. Each leg of the parapet will be along the edge of a pyramid. Instead of a point the parapet will terminate in an aluminum ring 46 1/8 inches inside diameter plus or minus 1/8 inch. This ring is to be made of #3301, 4"x1½"x1/8" channel rolled flanges out and welded at joint. The legs of the parapet are to support the bottom of this ring at a distance of 21 feet 1 inch above the bottom (center) of the parabola of revolution. The legs of the parapet are to be of open wooden frame work made of 1"x2" cross braced with 3/8"x1½" strips. The shape is to taper from 12"x18" at center to 12"x2" at ends. No nails are to be used. All fastenings are to be by screws or small machine bolts and light gusset plates. Hinges are to be provided at both ends of the legs of parapet for ease of assembly.

General

The entire assembly of mirror, carriage, rails and parapet shall be so designed and proportioned that without any counterweights there shall be from 600 to 700 pounds feet turning moment directly below, and opposite the center of rotation from, center of aluminum ring. This is to allow up to 30 pounds of electronic equipment to be installed in ring before it is necessary to add counterweights.

All wood to be of straight grained, free from knots, spruce, fir, hemlock or redwood. It is to be kiln dried with a moisture content not to exceed 15%. All wood members including completed parapet legs to be painted two coats of aluminum paint and all gusset plates to be painted one coat of aluminum paint while separate pieces before erection into machine. The completed mirror, carriage, etc will weigh about two tons. All of the above material with complete supply of machine bolts, screws and fasteners is to be supplied in knock down form suitably marked with complete drawings clearly locating the position of each part so that the entire structure may be easily erected. The erection of the structure is not included in the contract.

B. Turntable for Carriage

Main Frame

The turntable is to be in the form of a square with diagonals intersecting at the center. The members of this figure are to be 8"x18.4# steel I beams. Opposite sides of the square are to be 23 feet 7 1/8 inches center to center of the I beams. The corners of the square are to be cut back approximately 22 inches at an angle of 45 degrees. At each corner is to be installed a one wheel truck.

Truck

This truck is to be made of 8"x18.4# steel I beams and 3/8" steel plate welded top and bottom with two internal welded cross bulkheads of 3/8" plate. The axis of the wheel in the truck is to be parallel to and 2½" below the bottom of the I beam going from the corner of the square toward the center of the square. The wheel in the truck is to be the equivalent of Griffin type Z-118, chilled steel, 135# double flanged crane type wheel 16 inches tread diameter, bored and keyed to a 2 7/16" shaft. Also mounted on and keyed to this shaft is a 20" diameter, 1¼" face, 160 teeth cut semi-steel spur gear. This gear is to be inboard from flanged wheel. The shaft is to be supported below the truck on babbited journal box bearings with grease cups arranged to allow plus or minus ½" end play from mean position of flanged wheel. The center of the flanged wheel in mean position is to be exactly 15 feet from the center of the square.

The 160 teeth spur gear is to be driven by a 12 teeth 2¼" face, 1½" diameter cut steel pinion gear mounted on the equivalent of a Winfield-Smith type 4B, 40 to 1 speed reducer. The speed reducer is to be driven by a 110v D.C, 1/10 H.P. maximum reversable, shunt wound variable speed, 100 to 3000 rpm motor, thru a flexible coupling. Motor and speed reducer are to be mounted on under side of truck and inboard. The truck is to be fastened into the main frame of the square by not less than twentyeight ½" machine bolts of suitable length with nuts.

Center of Square

The intersection of the diagonal I beams at the center of the square is to be held by 3/8" plates 24" square above and below the I beams and fastened to same by eight ½" bolts in each I beam. The bottom plate is to have a hole approximately six inches in diameter cut in the center. The center of the structure will turn on a support going up thru the hole in the lower plate and bearing on the under side of the upper plate. This support is to be made of pipe fittings about 3" diameter. The bottom piece of pipe is to be slit three ways for about 6 inches and the three parts bent out at an angle of 90 degrees. The top piece of pipe is to have a heavy pipe cap on its upper end. This pipe cap will act as bearing on the under side of upper plate holding the I beams. The top and bottom pieces of pipe are to be about 33 inches long overal and to be joined by an extra long coupling for adjustment of length (height of center

of square above ground).

Carriage Wheel Pillars

Near and above each corner of the square is to be mounted a carriage wheel pillar for supporting the wheels upon which turns the carriage. This assembly consists of two 4"x6.25# channels spaced 9" on centers, side by side. They are to be in the form of an open inverted U with flanges rolled in. The channel rises vertically 22", turns an angle of 52½ degrees on a 9" outside radius, continues 9", turns an angle of 90 degrees on same radius, and continues 40". The channels are held sideways at proper spacing by two 1/8"x6" plates welded into position just below the bends of the U. Two internal braces 51" long of 1"x1"x1/8" angle are welded to the inside of flanges on each channel. These braces go from the center of 52½° bend to the far end of 40" leg. At the center of the top 9" flat of the U is to be mounted a 2 7/16" shaft 18" long. Keyed to the shaft is a chilled steel double flanged crane wheel as described above. Four of these carriage wheel pillars are to be mounted by means of not less than 16 bolts each; one on each corner of the square, so that with the wheels in center of assembly, the four wheels will form two coaxial pairs with a distance of 14 feet between axis and a center to center wheel spacing of 20 feet 2 3/8 inches along the axis. Grease cups are to be on the journal boxes. Any extra members which must be added to the frame to support these carriage wheel pillars

shall be made of 8" I beam and 3/8" plate arranged to be bolted into position between sides of square and diagonal members to center of square, with not less than eight bolts per junction. Turning freely on the above shafts at each side of the wheel is to be a clamping plate. The purpose of these plates is to hold tightly (with suitable shim blocks) to the large circular track of the mirror carriage and thus provide a brake or lock to prevent movement of the carriage in the wind. Each clamp plate whall be 1/8"x6"x36" cold rolled steel. A hole 2½" diameter is to be on center 10" from one end. Starting one inch from the other end are to be two rows of ½" diameter holes. Hole spacing 3" center to center; one line an inch in from each edge of plate. Two ½"x6" machine bolts and nuts are to be provided with each pair of clamp plates.

Turning Mechanism

The south pair of wheels are to be free turning with the motion of the carriage. The north pair are to be connected to a drive mechanism for turning the mirror carriage. This is to consist of a differential mechanism similar to the rear axel of an automobile. A removable crank 18" long shall be provided at the transmission shaft. The ratio from transmission shaft to axel (both wheels turning) is to be 5 to 1. The axels of the differential are to be connected via extension shafts and universal joints to the 2 7/16" shafts carrying the north flanged wheels. The axis of the differential axels is to be

parallel to and 10" directly below the axis of the two north wheels. A suitable framework consisting of 4"x6.25# channel, 1½"x1½"x5/16" angle and 1"x1"x1/8" angle is required to support the differential in the proper position. This framework is to be suitably fastened to the main square and diagonals of I beams by bolts.

Cable Supports

At the center of the east and west sides of the square of I beams is to be an outward extension of 3/8" plates 12" from center of I beam. Two plates are required for each side of square; one above and one below the I beam. To these plates is to be welded a 4"x6.25# channel 10 feet long extending straight up. This channel is a cable support. The channel is to be braced by two 1"x1"x1/8" angles 10 feet long going from adjacent carriage wheel pillars to a suitable place near the top of the channel. These braces are to be attached by bolts and the plates at the bottom of channel are to be bolted to the I beam. At north side of frame is to be provided two limit switches for preventing rotation of turntable more than 365 degrees. The weight of the turntable will be about three tons.

Track

Returning now to the wheels in the trucks at each corner of the square. With the wheels in the mean position in the truck there will be a distance of 30 feet, zero inches from center to center of wheels along a diagonal. These truck wheels are to run on a circular

track 30 feet zero inches in diameter. The track is to be made of 40# ASCE section 4040 rail rolled 15 feet zero inches radius, ball up. Probably five sections will be necessary to complete the circle. Thus five pairs of splice bars suitably curved complete with bolts are required. Also supply one half keg of ½"x4" track spikes. Stops for limit switches are to be attached to track at suitable places. The weight of the track will be about threequarter ton.

General

All of the above material with a complete supply of machine bolts, nuts and fasteners is to be supplied in knock down form suitably marked with complete drawings clearly locating the position of each part so that the entire structure may be easily erected. Neither the erection of the structure nor any foundations are included in the contract.

Motor Control Panel

The equipment necessary for the motor control shall be installed on a 13"x17"x3"deep chassis fastened behind a standard 10½"x19"x1/8" relay rack panel with suitable angle brackets. Panel, chassis and brackets are to be black crackle finish. A multipole, three position switch shall be provided on the panel for three main speeds. In low position all four armatures are to be in series; in medium position the armatures are to be in two parallel pairs in series; in high position all four armatures are to be in parallel. In the low position an armature series rheostat is to be provided for

further reduction of the speed. A field rheostat in series with all four shunt fields in parallel is to be provided for control of speeds between steps and to increase speed above high position. The total range of armature speed shall be from 100 to 2000 rpm by the manipulation of these three controls. Thermal overload switch is to be provided in armature circuit.

Provision shall be made for reversing the direction of armature rotation by means of two suitable relays. Pilot lights on panel are to indicate direction of rotation. Two push button switches are to be available for starting, stopping and reversing the motors. One switch is to be mounted on the panel and other supplied with 200 feet of flexible, three conductor, rubber covered cable so that it may be carried into the field.

A normally open single pole relay is to be provided which operates off 110v D.C. and will break ½ ampere A.C, 110 volts. This relay is to be used in conjunction with position marker pen on recorder. Recorder is not to be supplied. Ten paper condensers of 2mfd and 0.5mfd capacity are to be connected across appropriate contacts on relays and switches to reduce arcing. Suitable cable receptacles are to be provided on the panel for all connections to power line, fields, armatures, limit switches, remote control switch, marker relay coil and contacts,etc. 750 feet of six conductor flexible cable are to be provided for making connection between control panel and turntable. This cable is to have two #30, two

#16 and two #12 stranded, color coded, rubber covered conductors; a heavy wraping of woven cotton; a woven tinned shield braid equal to #12 wire in crossection, and a 3/64" rubber covering. Suitable connections are to be supplied. The control panel is to be completely wired and a detailed wire and connection diagram supplied.

II. ELECTRONIC EQUIPMENT

A. 160 MC Apparatus

Focal Device

A drum of half hard 1/16" aluminum with welded and finished seams shall be made with an outside diameter of 45 7/8 plus or minus 1/8 inches. The overal length is to be 60 inches. One end is to be closed and a ½" radius provided at the edge. Three removable and interchangeable aluminum ends are to be provided to go snugly inside the open end of drum. One shall be of 1"x 1"x 1/8" angle rolled, leg in and welded at joint. The other two are to be of 1/16" plate with a 1" flange spun over at outside edge. These plates are to have center holes respectively 15" and 23" diameter with a 1" long lip spun out on opposite side of plate from outside flange. These three ends are to be fastened to drum by four 6-32 brass flat head machine screws. The angle is to have tapped holes and the plates to have inside nuts.

At a distance of 18" from the closed end of drum are to be mounted, by not less than four brass machine screws and nuts each, two aluminum cones of 1/16" stock. The axis of these cones is to be parallel to closed end of drum. The cones are to have a 15½ degree angle of revolution and a base formed as a section of a cylinder 22 7/8" radius. This radius coincides with the projected point of the cone. The actual point of the cone is to be cut back 5/8" to form a flat face. At the center of this face is a 6/32 tapped hole ½" deep. The base of the cone

is to have a 1" lip turned out. When mounted inside of drum the flat faces of ends of cone will be 1¼" apart.

Bolted to the ends of cones are two 5/16" diameter 1/32" wall aluminum tubes. These are parallel and go to a mounting at the center and on the outside of adjacent end of drum. This mounting will hold the amplifier described below. The mounting is bolted to end of drum and provides a suitable lip to attach a watertight cover to be placed over amplifier. The above 5/16" tubes which come up thru a hole in the center of mounting are the antenna terminals and consequently must be held in place by polystyrene insulation. Mechanical and electrical connections for the amplifier are also to be provided in this mounting.

The above drum goes into the aluminum ring at the top of the parapet described in part I of the specifications. Brackets for mounting on the aluminum ring to hold aluminum bands 4" above and below the ring are to be provided. When drum is placed in ring and clamped tightly by the bands , its lower (open) end shall be 13 inches below bottom edge of ring.

160 mc Amplifier

This amplifier is to consist of five cascade amplifier stages using type 954 acorn tubes. The output stage is to work into a type 9004 diode rectifier. Interstage couplers are to be of double tuned type and provide an overal bandwidth at the 3DB down points of 156 to 164 megacycles. The primary, secondary and

coupling elements of these interstage couplers are to be of the distributed constant, coaxial transmission line type. Primary and secondary lines are to be of copper 3½" diameter outer conductor. The inner conductor is to be about 6½ or 7 inches long and of copper wire from #24 to #36 guage. The coupling stub is to be of copper and have an outer conductor 7/8" diameter. The inner conductor is to be 3 5/16" long and of a diameter approximately 3/8". By proper proportioning of the inner conductors of the primary, secondary and coupling elements the desired band pass is to be achieved without the use of any coupler damping resistance other than the input resistance of the acorn tubes. Such design will give the maximum gain and bandwidth possible to secure with these tubes.

The five interstage couplers are to be arranged para-axially around a circle of 3 1/8" radius from center of circle to axis of coupler. The tubes mount on copper partitions between couplers; successive stage tubes to be at opposite ends of the assembly. The interstages are to be fastened at top and bottom by a suitably cut sheet of 1/16" copper. All permanent joints in the assembly are to be silver soldered. The input coupler is a single tuned coaxial circuit 6" long at the center of the assembly. Its outer conductor is 2 inches diameter copper tube. Antenna power is coupled to this circuit by means of two large loops connected in series aiding located at the bottom of coupler and at opposite sides of the inner conductor. Proper proportioning of these loops will give

optimum coupling for best signal to noise ratio and at the same time properly terminate the antenna line coming from the drum. Adequate radio frequency bypass condensers and chokes are to be incorporated in all power and diode return leads so that any of these may be brought into close proximity to the antenna lead with no trace of feedback. Adequately tight and easily removable covers must be provided to all openings so that no trace of regeneration exists due to external feedback. The gain measured from first grid to diode rectifier shall be 90 DB or greater. The mechanical mounting shall be such that it may easily be attached to mounting plate on end of drum by three thumb nuts. When this is done it shall be rigidly held in place and all power and antenna connections automatically made. The diode return line however is to terminate separately in a microphone connector attached to side of the assembly. When the amplifier is mounted on drum it shall be protected from the weather by a water tight can made of 1/16" thick aluminum with welded and finished seams. This can is to be 16" long and 10 5/16" O.D. The inside is to be lined with insulating cloth so that no part of can may touch amplifier assembly. Can is to be fastened to amplifier mounting on end of drum by six 6/32 brass screws and be freely and easily removable. A total of 30 type 954 and 10 type 9004 acorn tubes are to be supplied with the amplifier. Complete wiring diagram, performance data, parts drawings and all special tools and jigs used in constructing the amplifier are to be supplied.

Cable

A cable 100 feet long is to be provided for connecting the amplifier described above to the power supply described below. Four conductors of this cable are to be #10 flexible rubber covered weather proof wire equal to Belden type "Embargo". The remaining two conductors are to be high grade microphone cable, rubber covered and a heavy cotton braid overal. It is important that a good grade of heavy cotton wrap with wax impregnation be applied over all rubber insulation to reduce the decomposing effect on the rubber of ultraviolet solar radiation. Suitable cable connectors are to be provided at both ends of the cable.

A ground wire consisting of three twisted #14 enameled conductors is to be provided for carrying along same leg of parapet as power cable. The ground wire is intended to be connected at top end to aluminum ring and at bottom end to metal work on carriage. Mirror is to be bonded to carriage metal work at four corners.

Ten ½" diameter pointed copperweld ground rods 8 feet long with clamps are to be supplied for driving into the ground near circular track at 36° intervals.

Power Supply

The power supply for 160mc amplifier shall be built onto a standard 17"x 13"x 3"chassis mounted behind a 10½" x 19"x 1/8" relay rack panel by suitable brackets. Panel, chassis and brackets are to be black crackle finish. Five metal case Weston type #301 and #476 meters are to be provided as follows; 300v DC (plate voltage),

50ma DC (plate current), 15ma DC (screen current), 150v DC (screen voltage), 10v AC (heater voltage). The 300v and 150v DC instruments are to have 1ma movements. Plate and screen voltage is to be provided from a well filtered electronically regulated supply using 90 volts of batteries as a reference. Regulator is to be a 6A3 tube controlled by a 6J7 DC amplifier tube. Two extra heavy duty 45 volt "B" batteries are to be provided external to the power supply and connected thereto by a suitable cable which will plug into a receptacle on the panel. Separate ten point step switches are to be provided for controlling the plate and screen potentials. Ripple is not to exceed 0.1% into the 6A3 regulator.

The heaters are to be regulated by a saturable reactor type of regulating transformer with bucking winding. Enough paper condensers are to be mounted under the chassis to completely correct the power factor of this heater transformer. Heater potential control is to be provided by a shunt rheostat across the heaters. Heater regulation to be not more than 0.1% for a plus or minus 2% change in line voltage. Separate heater and plate power switches are to be provided on panel. Receptacles for cable to amplifier, cable to batteries and cable to line are to be provided on panel. A line cord 8 feet long is to be included. Also a Sola 120 watt regulating transformer is to be provided as an external attachment. Complete wiring diagrams, parts drawings, performance data and two sets of spare tubes are to be supplied.

Signal Generator

A signal generator covering the range of 140mc to 190mc approximately is to be provided in a black crackle cabinet 19" wide, 13" deep and 8¼" high with hinged cover. A WE 316A tube is to be used as oscillator giving 1 volt maximum output across a 30 ohm cable. The attenuator is to be of the inductive type and provide any attenuation up to 120DB with no trace of leakage. Controls for frequency, attenuation (direct reading in decibels) and calibration level are to be provided on panel. Three Triplett 3" square meters reading 1.0v DC (100microamps full scale) for calibration level, 100ma DC for plate current and 3v AC for filament voltage are to be mounted on panel. Also on panel is to be power switch and receptacle for power line cord. A power line cord 8 feet long is to be provided. No modulation is to be incorporated. The plate voltage is to be rectified and thoroly filtered but not regulated. The output of attenuator is to go into a 30 ohm flexible cable about four feet long. At end of cable is to be a R.F. head with flexible probe suitable for inserting into various stages of the above amplifier at the grid terminal of the tubes. The R.F. head is to contain the line terminating resistor and a RCA type 6048 diode tube for measuring the calibration level. Heater power to and rectifier DC leads from the diode tube are to be incorporated into the cable. A bucking battery (for diode velocity potential) and DC calibration zero set potentiometer are to be mounted on chassis in cabinet. Complete wiring diagram,

parts drawings, calibration sheet, three spare 316A tubes and two spare 6048 tubes are to be supplied.

Suitable wooden jigs for holding the amplifier in position for bench tests and cables for connecting amplifier to power supply and test equipment are to be supplied.

Wavemeter

A lecher wire type frequency meter consisting of two aluminum tubes 5/16" diameter spaced approximately ¾" is to be supplied. The tubes are to be about 40" long and fastened together with a clamp at one end. The other ends are to run thru a short circuit bearing fixture with pressure contact balls and then to a 6/32 threaded screw drive. The drive is to be mounted on a handle and be adjustable by a thumb nut for a distance of about six inches. Handle to be of wood about 10" long, 2" wide and 5/16" thick.

B. 480 MC Apparatus

Focal Device

A container composed of a cylinder 13" radius and 3" long with one end closed by a hemisphere of 13" radius shall be made of copper 1/16" thick. Within the container are to be mounted and soldered water tight two coaxial copper cones having a 15 degree angle of revolution. The tips of the cones shall be identical with the center of the hemisphere and the axis of the cones is to be parallel to the plane of the container opening. Around the outside of the open end of the container is to be soldered a steel ring of 1"x 2"x 1/8" angle rolled 1" leg out. The container is to be mounted by four aluminum brackets to the aluminum ring at top of parapet described in part I of the specifications. The center of the hemisphere (and tips of cones) is to be 13" below the bottom edge of the aluminum ring and on a vertical line thru the center of the ring.

Going up toward the closed end of container from tips of cones are to be two copper bars $\frac{1}{2}$" wide and 1/16" thick spaced 1/16" apart with $\frac{1}{2}$" faces parallel. These bars are to terminate in a mounting plate fastened to center of end of hemisphere. This plate is for attaching the amplifier described below. The bars form the antenna transmission line for delivering energy to the input terminals of the amplifier.

480 MC Amplifier

This amplifier is to consist of a push pull input

stage using a pair of 2C43 tubes in grounded grid circuit. The antenna line is to be tapped at the optimum distance up the parallel copper rod line which composes the input circuit. The input circuit is to be in a 1/16" thick copper container about 6"x 4"x 3" with a 3"x 2" inspection opening. It is to be provided with a suitable fitting to plug into the mounting plate on the end of hemisphere described above. This connector shall be of such design and so proportioned that a minimum amount of disturbance will be added to the antenna line from tips of cones up to place where the bars connect to input cathode line. A suitable opening is to be provided in container for inserting a probe from signal generator so that a balanced test signal may be applied from cathode to cathode of input stage.

The next coupler shall be made of copper and proportioned to transform from symmetrical push pull plates of input stage to the cathode of a single 446B tube operating grounded grid. The mechanical design shall be such that it will fit in with the following cascade stages easily. Mutual from primary to secondary is to be of a value to give maximum gain. An inspection opening is to be provided on plate side of coupler.

Following the first 446B tube are to be six more couplers proportioned to couple one 446B tube to another. The last coupler is to end up in a type 9005 diode rectifier. Mutual of the various couplers is to be proportioned for maximum gain. The last coupler is to be over coupled to produce peaks 3 DB up at a distance of

plus and minus 4 megacycles from the center of band when a 100,000 ohm diode load is used. These couplers are to be tuned by means of vanes in both primary and secondary sides. They are to be constructed of hard copper water pipe 3 5/8" O.D. and 0.083" wall. Mutual inductance between primary and secondary is to be a double concentric stub with the plate DC wire coming out one leg of stub and the cathode and heater wires coming out the other let of stub. Stub is to be built integral with a partition between primary and secondary sides. Inner line of primary (plate) side to be #26 enameled wire. Inner line of secondary (cathode) side to be 5/16" copper tubing with tube socket mounted on end. Inner conductor of diode side of output coupler to be #26 wire. An inspection opening 1 3/8" diameter with sloted screw cover is to be incorporated in plate side of coupler. Last coupler is to have inspection openings in both plate and diode sides. Adequate bypasses and filters are to be provided in all the tube element return leads so that no trace of R.F. can leak out of couplers.

The various couplers are to be screwed together by partitions thru which mount the lighthouse tubes. The grids of the tubes are not to be grounded directly to the partition, but rather to a ring which is at center of two short adjustable lines mounted in plane of partition. These lines provide a suitable small amount of inductive reactance to properly neutralize the stage and prevent beedback or oscillation. The neutralizing circuit consists of a bridged T as follows. One side of

the top of the T is the cathode-grid capacity of tube; the other side of top of T is the grid-plate capacity of tube. Bridged across the top of the T is the very small cathode-plate capacity which induces the unwanted beedback. The leg of the T is formed by the two small lines in parallel. By proper proportioning and adjustment, the bridge may be balanced at center frequency of band for practically infinite attenuation. At plus and minus 10mc an attenuation of at least 40 DB is to be achieved over the un-neutralized condition. Also provided on these tube partitions is a small opening suitably placed so that a probe from signal generator may be inserted to contact the tube cathode right up near glass seal. A cap is to be provided for opening when not in use.

The diode is to mount inside a cover which screws into the end of last coupler. All couplers, tube partitions and diode cover are to screw together by means of $3\frac{1}{2}$"x32 threads. Lock nuts are to be provided at all joints. The entire assembly from input stage thru diode is to be mounted on, by means of a light but strong steel bracket to,an aluminum base plate $\frac{1}{4}$" thick. This base is to have upturned edges so that a suitable easily removable water tight cover may be slipped over it when amplifier is in position. Cover is to be of 1/16" aluminum approximately 40" long by 11" x 6" with welded and finished seams. It is to be fastened to base by eight 6/32 brass screws. The amplifier mounted on base plate with cover attached shall mount to brackets on large aluminum ring of parapet (described in part I of

specifications) and top of metal hemisphere by three thumb nuts. A weather sheild made of 0.020" aluminum is to be provided for covering the cable connectors after cables are attached. Also mounted on base are two size 22 type AN six prong receptacles, one female and one male. Heater and plate wires go from these to amplifier stages. A separate microphone cable receptacle is fastened to base and connected to diode return by microphone cable. Near top (diods end) of amplifier is a circular wooden bracket so that amplifier will be suitably supported inside of cover at top end.

The overal gain of amplifier from antenna terminals to diode shall be not less than 110 DB and internal noise shall not be more than 6 DB above KTB when a 300 degree dummy is used. The overal band width is to be approximately 8 MC at the 3 DB down points. A complete set of parts drawings, performance data, wiring diagrams, 18 type 446B tubes, 26 type 9005 diodes and four type 2043 tubes are to be supplied with amplifier. All special tools and jigs used in construction of amplifier are to be provided.

Cable

A cable 100 feet long is to be provided for connecting the amplifier described above to the power supply described below. This cable is to be composed of two flexible six conductor cables and one microphone cable covered by waxed cotton covering. This six conductor cable is to have two #20, two#16 and two #12 stranded, color coded, rubber covered conductors; a heavy wraping of

woven cotton; a woven tinned shielded braid equal to #12 wire in crossection, and 3/64" rubber covering. It is important that both six conductor cables and microphone cable be covered by a waxed cotton wrap to reduce the decomposing effect on the rubber of ultraviolet solar radiation. Suitable cable connectors are to be provided at both ends of the cable.

Power Supply

The power supply for the amplifier is to be built onto a standard 17 x 13 x 3 chassis mounted behind a 21 x 19 x 1/8 relay rack panel by suitable brackets. Chassis, panel and brackets are to be black crackle finished. Fourteen bakelite case Weston type 301 and 476 meters are to be provided on panel as follows; Eight 25ma DC (individual plate currents of various tubes); 110v AC (line voltage); 2 amps AC (line current); 15v AC (heaters of cascade stages); 150v DC with 200 microampere movement (with rotating switch for reading individual plate voltages); 250v DC with 1ma movement (plate supply potential) and 100ma DC (plate supply current). Individual controls are to be provided for each tube plate voltage. Controls are to be provided for heater voltage and plate supply voltage. Plate power is to be supplied from a well filtered electronically regulated supply using 45 volts of batteries as a reference. The regulator is to be two 6A3 tubes controlled by a 6J7 DC amplifier tube. Two extra heavy duty 45 volt B batteries connected in parallel are to be mounted on a 17 x 13 x 3 chassis fastened behind a 10½ x 19 x 1/8 relay rack panel by

suitable brackets. Chassis, panel and brackets are to be black crackle finished. This assembly is to mount below the 21" panel and batteries are to connect by a flexible cord to receptacle on back of main power chassis. Ripple not to exceed 0.1% into 6A3 regulators.

The heaters are to be regulated by saturable reactor type of regulating transformer with bucking winding. Two of these transformers are to be provided; one for the heaters of the two input tubes connected in series; and the other for heaters of six cascade stages connected three parallel in a bank and two banks in series. The panel 15v AC meter is to connect across the cascade stages. Enough paper condensers are to be mounted under the lower battery chassis to completely correct the power factor of these heater transformers. These condensers are to connect by flexible cable to receptacle on back of main power chassis. Heater regulation to be not greater than 0.1% for a plus or minus 2% variation of line voltage.

Separate heater and plate power switches and pilot lights are to be provided on panel. Receptacles for cables to amplifier and power line are to be provided on panel. A line cord 8 feet long is to be included. Also a 250 watt Sola regulating transformer is to be provided as an external attachment. Complete wiring diagrams, parts drawings, performance data, two sets of spare tubes, eight pilot lights and 100 spare 1/32 ampere Littel fuses are to be included.

These above two panels respectively 21" and 10½" and accompanying apparatus is to be mounted in a closed metal

cabinet with 42" of available panel space and a hinged door with snaps on back. The cabinet is to mount on a suitable four wheel dolly with swivel castors. Cabinet and dolly are to be black crackle finished.

Signal Generator

A signal generator is to be provided similar to an RCA type 1026A with range of 360mc to 560mc except that the attenuator is to be removable from the front panel and sufficient output shall be available for the calibration level to be 0.316 volts. Two sets of spare tubes are to be supplied. Three separate attenuator slides are to be provided as follows. One with pickup loop and 36" of RG8U cable terminating in a 50 ohm resistor mounted on a probe for inserting into cascade stages. One with pickup loop and balanced 38 ohm rigid line 12" long terminating in two 19 ohm resistors with center tap grounded, mounted on a suitable probe for inserting into input cavity from cathode to cathode. One with a 50 ohm pickup resistor and 50 ohm balanced line 12" long terminating in a suitable fitting for attaching to amplifier antenna terminals.

A separate antenna termination shall be provided for receiver consisting of a light bulb with 50 ohm resistance at 2700 degrees absolute. The bulb shall be connected across the antenna terminals and provided with chokes and bypasses such that an external DC source may light up bulb to 2700 degrees without affecting the R.F. balance of antenna terminals to ground.

Two suitable wooden jigs are to be provided for holding the amplifier in position for bench tests. Cables for connecting amplifier to power supply and test apparatus, wiring diagrams, performance data, calibration sheets, test lamp and power cables are to be supplied.

Wavemeter

A Lavoie type 105 frequency meter covering the range 300 to 600mc is to be supplied.

C. RECORDER SYSTEM

D.C. Amplifier

A General Radio type 715A DC amplifier is to be removed from its case and mounted flush in the center of a 15¾"x 19"x 1/8" relay rack panel using same four thumb nuts that mount amplifiér in original cabinet. Across the back of panel at top and bottom of amplifier are to be 1"x 1" x 1/8" steel angles 17" long, for stiffening. Suitable insulating bushings and washers are to be provided so that frame of amplifier is insulated from panel.

At left of amplifier is to be mounted near top of panel a 50 microampere Triplett DC meter in a 3" square bakelite case. Scale on meter is to read 5 volts DC. Below meter is to be an eleven step switch with ten 500 ohm wire wound resistors between points; below switch is a 750 ohm potentiometer and below it an off-on switch. These three items make up a bucking control circuit to counteract any desired amount of potential indicated on meter.

At right of amplifier and behind panel is to be mounted by brackets a small subpanel about 7" deep and 3" wide. On this chassis is the bucking battery, blocking condensers and diode load resistors. At rear of chassis are receptacles for power and series connection to output terminals of DC amplifier. On front of panel is an audio volume control and two jacks for listening by headphones.

Two sets (one Frost standard and one Trimm light weight) of headphones are to be supplied. Below headphone jacks is the input receptacle for microphone cable from diode of amplifier.

An external Weston type 301 5ma DC meter in metal case mounted in slant type portable table case is to be supplied with headphone type plug attachment to back of table case. This is for observing output of DC amplifier at a remote location. 100 feet of two conductor heavy duty rubber covered cord with standard power line type fittings is to be supplied, as an extenstion cord. A wooden frame for winding up extension cord is to be provided. Adaptors to convert line fittings to microphone fittings are to be supplied for use with portable 5ma meter.

An extra Triplett 200 microampere meter in square bakelite case and scale reading 3 volts DC is to be provided to replace the installed 50 microampere meter. Likewise two extra 15000 ohm diode load resistors are to be supplied to replace the installed 100,000 ohm diode loads. Two complete sets of spare electron tubes, five spare ballast tubes, six spare fuses and a dozen spare pilot lights are to be supplied for DC amplifier.

Recorder

A front of panel Esterline-Angus type AW 5 milliampere DC recorder is to be mounted on front of a 15¾" x 19" x 1/8" relay rack panel. The recorder is to be supplied with a marker pen in right margin.

At left of recorder are to be mounted on panel

switches for turning on and off the recorder movement (550 ohm dummy to be cut in the off position); marker pen, and recorder drive motor. At right of recorder is to be mounted by brackets behind panel a 7" x 3" chassis. On this chassis is to be mounted sufficient paper condensers for correcting line power factor of General Radio DC amplifier. At back of chassis is to be provided receptacles for power and output terminals of DC amplifier. At front of panel below chassis is the input power line receptacle and above chassis the receptacle for leads from marker switch on turntable (not supplied) to marker pen on recorder.

An extra set of syringes, three extra pen points, an extra pint of red ink and 30 extra rolls of 4305X chart paper are to be supplied. Since the used chart is cut up in small lengths and the many small rolls occupy much more space than the original roll 1000 extra empty chart roll boxes are to be included.

The recorder panel is to be mounted above the DC amplifier panel in a closed steel cabinet having 42" of available panel space and a rear hinged door with two catches. The cabinet is to be mounted on a steel dolly with four swivel castors. Dolly, cabinet and panels are to be black crackle finished. Interconnecting cables between panels and a line cord 8 feet long are to be supplied. Complete wiring diagrams, parts drawings (except of DC amplifier and recorder) and performance data are to be supplied.