A De luxe Amateur Radio Station

The de luxe amateur station of W6ITH is one of the most elaborate in existance, and as such is of interest to every amateur. "Reg" is admired by his fellow amateurs because, although he is blessed with the necessary "wherewithal" to purchase factory-built transmitters, he chooses to construct his own equipment.

Having decided to expand from the old transmitter composed of five standard relay racks (see RADIO, June, 1935), D. Reginald Tibbetts, W6ITH, figured that he would have to build a new house. The basement at the old location was not quite large enough, and being but an unfinished cellar, gave an appearance that was not any too pleasing. The only solution seemed to erect a special building just to house the equipment, with room left over for a shop and of course a place to prepare something to eat. As a final thought, a nice comfortable bedroom was included, since amateurs do sometimes break the "all-night of operating" habit.

Many sites in and near Berkeley, California were considered. A chart was drawn up with all the factors. Each factor that would be considered was given a certain maximum number of points and each site given its score. Many things had to be taken into account: height above sea level, the surrounding territory, accessibility, improvements, availability of electric power, nearness to other dwellings and traveled roads, etc. Many other factors were considered, including cost, police and fire protection, taxes, and the expected water charges. After the general points were carefully weighed and the sites were narrowed down to but a few, the radio tests were carried out. These consisted mainly of extensive listening tests with study of the noise level and the general strength of signals received from all directions.

The site that was finally selected and the one that stood head and shoulders above all others is just north of the city limits of Berkeley, over in the unincorporated territory of Contra Costa County. Two choice lots were found on the very top of the ridge and on the highest point north of Berkeley. A clear sweep in nearly all directions is assured. To the west is San Francisco Bay and the Golden Gate, and a clear view also is secured to the north and east. All the property to the north and east is owned by the local water district and as such will never be available for private development or building, thus giving the maximum privacy without being too far off the beaten track.

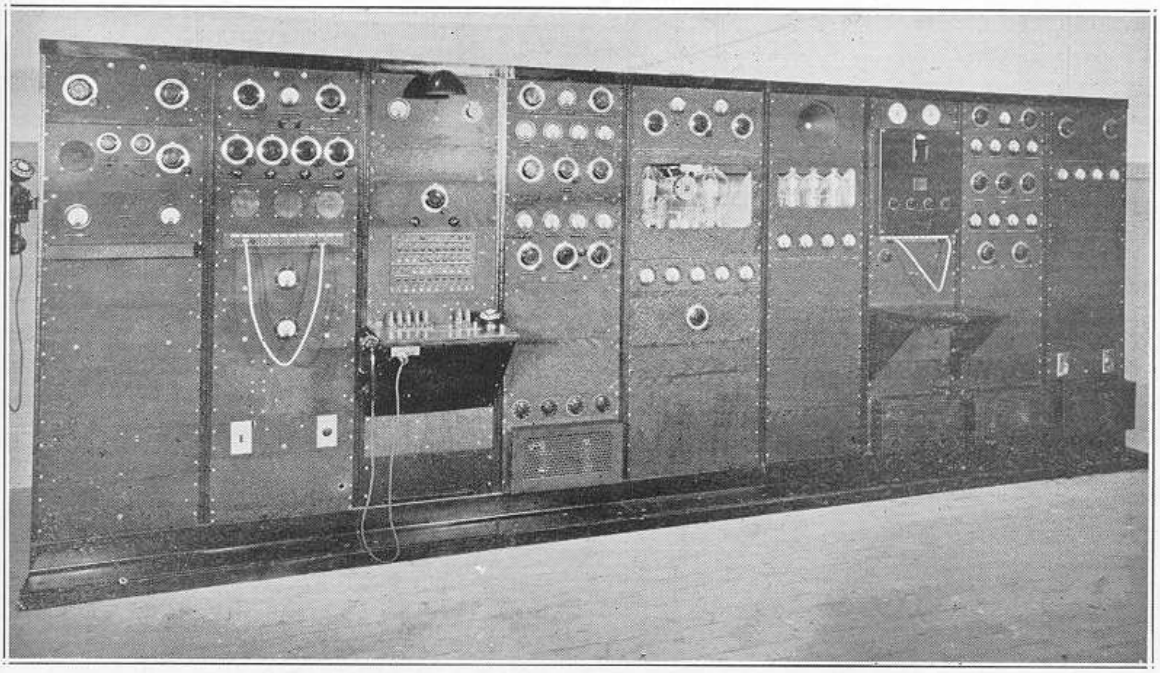
The ceiling and upper half of the walls of the radio room are finished with Insulite, a very heavy sheet insulation material. The lower half of these walls is finished with thick ply-wood fastened with wood screws in order to be removable for wiring. The floor is completed with heavy inlaid tile linoleum and then covered with medium size rugs.

Five separate transmitters compose the equipment. Each transmitter is complete within itself and any or all can go on the air at the same time. All the transmitters are of different power, and, within certain limitations, the plug-in coils allow the use of any transmitter on several bands. However, under normal conditions the transmitters are not switched from one band to another.

The 10 Meter Transmitter

By inspecting the photograph, the equipment can more easily be described. From left to right, facing the racks, the first rack contains the ten meter transmitter. The final stage is in the top unit with the monitor and frequency meter in the next unit. The oscillator, doubler, and amplifier are on the next shelf. The protective cover houses twenty of the flat-type telephone relays; which are used on the remote control switching, for the telephone switchboard, and for the transmitters. The remainder of this rack is used to mount the modulator, the power supplies, and the bias supply.

This medium-power ten meter transmitter utilizes an 802 crystal oscillator with the crystal oscillating on 20 meters. The frequency doubler is a single 53, with the elements in a push-push circuit. The doubler is followed by a single 10 amplifier and the final class C modulated amplifier consists of a pair of 10's in push-pull. This transmitter is modulated by a pair of 46's in Class B. The driver for the modulator is a single 46 in Class A. Two power supplies, each with 83v's, furnish plate potentials. The normal input to the final stage is 75 watts. The antenna used is a half-wave vertical rod fed by a two-wire matched impedance transmission line of 600 ohms impedance.



An amateur layout that makes many commercial rigs look like "small potatoes"

2½ Meters

The next rack, or the second from the left end, contains the 2½ meter transmitter together with four overlapping ultra-high frequency receivers. The four receivers have, together, continuous bandspread from two to eleven meters. Combined volume and regeneration controls are located below each receiver dial. The modulated oscillator and the audio system are on the top deck, the receivers and their speakers below. The next two-unit strip contains the master jack-switching panel. All lines either from the outside or in the building pass through this panel. The jacks are used in vertical pairs, exactly as is done in telephone practice. A line normally feeds through and can be opened in either direction by the use of a patch cord, each end of which terminates on a double plug. The outside exchange telephones and several leased circuits together with all terminating equipment pass through here. The rest of this rack is filled with power supplies, line balancing coils, equalizers, and various other equipment. The tube line-up of the 2½ meter transmitter is very simple, in as much as a single 6A6 in a push-pull "TNT" oscillator circuit is modulated by another 6A6 used in Class B. The modulator is driven by a third 6A6, triode connected in Class A. The power input to the modulated oscillator is 30 watts. The antenna used is another half-wave vertical rod fed by a two-wire matched impedance line with a characteristic impedance of 600 ohms.

The third rack, besides containing the telephone switchboard, also mounts a standby receiver and several speech and bridging amplifiers, power supplies, and other equipment associated with the switchboard. After the lines pass through the master jack panel on the second rack, they go to the switchboard and are there switched in the usual manner. All lines as well as amplifiers, speakers and repeater circuits appear on the board.

The "Ham's Dream"

The next three racks to the right, including the 24" rack in the center, contain the large transmitter which is used on both twenty and seventy-five meters. All racks except the center rack are standard 19" relay racks. All the racks were constructed in the adjacent shop, using only a small mail-order house drill press, a vise, a hand tap and lots of elbow grease. An article will appear in RADIO giving complete constructional details and kinks for building a home rack that will in every respect be as good as a purchased unit and will cost only a few dollars.

The fourth rack contains the 47 crystal oscillator, 865 buffer or doubler, 50T first amplifier, and a pair of Eimac 50T's in the second amplifier, together with their power supplies and protective equipment. The bias supplies for these stages can also be found in this rack.

Each stage is metered in its plate circuit, grid circuit when necessary; and all filament supplies are metered. It will be noted the rectifiers are enclosed in housings at the bottom of this and several other racks. When using 866's, this type of housing is found to be the utmost desirable in as much as the tubes are well shielded, in plain sight of the operator, the cover is quickly removable, and full protection is assured against accidental contact. Just above the housing on this fourth rack is the "Variac" voltage control panel. All filament transformers on all the racks are adjusted from this point for exact filament voltage regardless of line or load conditions.

The center rack holds a pair of 500T's in the final class C plate modulated amplifier. The design of this stage is characterized by symmetry and short leads. The tank coil can be seen directly between the tubes. The tank condenser is right above with its dial in the center of the upper panel. To either side of the tank condenser are the variable condensers for the low pass π section network which couples the final stage to the antenna. The π net coils are on top and the very upper portion of one can be seen back of the left hand antenna leadin. The two meters in the top panel are the

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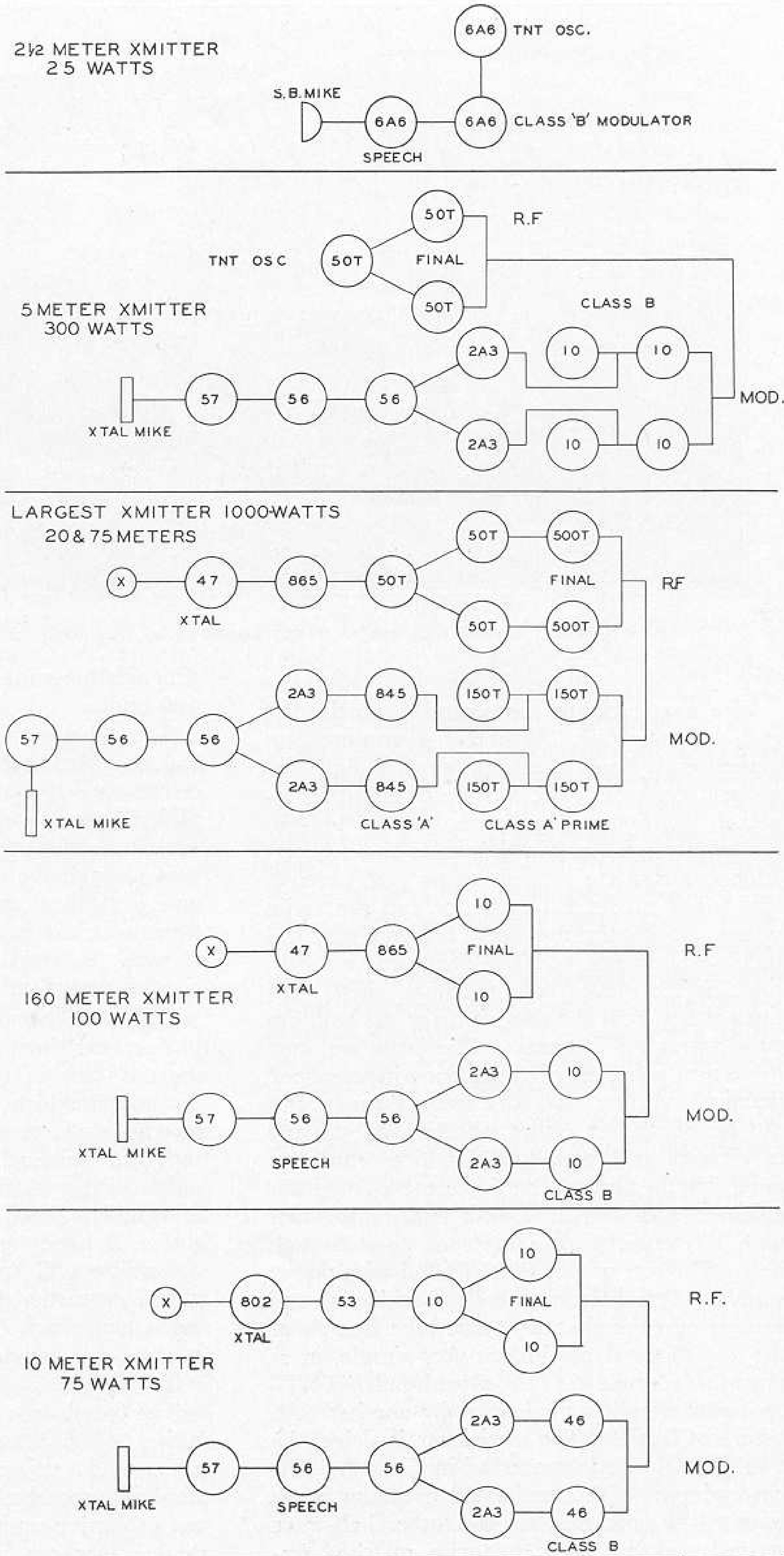

W6ITH

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thermo-couple meters in each feeder. The antenna used is a half-wave horizontal type, one-quarter wave above ground and fed with the usual two-wire matched impedance transmission line. One of the two neutralizing condensers can be seen behind and to the left of the right-hand tube. These condensers are three plate affairs mounted on large stand-off insulators. The spacing between the rotor and either of the stator plates is three-fourths of an inch. One of the blocking condensers can be seen on top of the center of the glass window. There are two of these condensers, one in each feeder, blocking the plate voltage from the antenna. These condensers are 0.002 μfd., 7500 volt mica. The grid tuning of this stage is right below the meter panel and the power supply is on the bottom. The power supply consists of a pair of 872A's followed by a double-section filter network. The strip of five meters holds the plate voltage and plate current meters for this stage as well as the grid current and filament voltage meters. The right hand meter reads the plate current for the modulators in the next rack. These modulators can be seen behind the plate glass window. The tubes are four Eimac 150T's in Class AB push-pull parallel. The remainder of this rack contains the bias supplies and the protective circuits. The large speaker mounted in the top of the sixth rack is used for various monitoring purposes.

The seventh rack, or the third from the right, contains speech and control equipment. The two electric clocks on the top panel show Pacific standard time and Greenwich mean time. The large second panel is the rather new Western Electric 10A high-fidelity broadcast receiver. This receiver is used for broadcast entertainment, the testing of amplifiers, and for recording off the air. Directly under the receiver another patching panel can be seen. This panel mounts the tie circuits to the equipment in the right hand end of the racks and the circuits to the other switching positions. The high-fidelity speech amplifier is next below and is used as the main speech amplifier for all circuits. The overall gain of this amplifier is 132 db and it will deliver a full twelve watts output from a crystal microphone. The shelf below is used when operating equipment from this position. Under the shelf are found the power supplies for the tuner, together with the high level speech equipment for the large transmitter, a pair of 845's in push-pull class A. The power supply for the 845's is on the bottom.

For Local Rag Chews

The next rack, or the second from the right hand end, contains a complete 160 meter transmitter. This transmitter uses a pair of 10's

in push-pull in the final stage, driven by an 865 buffer which in turn is excited from a 47 crystal oscillator. The final stage is modulated by a pair of 10's in Class B. The antenna tuning is on the top unit, then the meter panel for the final stage and the modulator, followed by the output stage and the meter panel for the lower stages. The two-dial unit tunes the crystal oscillator and the buffer stage. The remainder of the rack is taken up with the modulator, bias supplies, and power supplies. The antenna used at present with this transmitter is a half-wave hertz, fed by a single wire line.

The last rack on the far right contains the complete five-meter transmitter. This transmitter uses three Eimac 50T's, one as a t.p.t.g. oscillator and the remaining pair as a push-pull amplifier. The input to the amplifier is 300 watts and this stage works at very high efficiency. The top unit contains the complete radio frequency portion of the transmitter. The next unit right below is another of the many meter panels, measuring filament voltage, plate current of both the oscillator and amplifier as well as the grid current to the amplifier.

Following down one finds the power supply for the modulators, the modulators, and the bias supplies. The modulator consists of four 10's in class B push-pull parallel and their power supply. The remainder of this rack holds the switching and protective panel and the power supply for the radio frequency portion. The antenna used on 56 mc. is another half-wave vertical matched-impedance type, fed by a two wire 600 ohm line.

The antenna systems center around a large 75 foot telephone pole set at the lower street corner of the property. This pole is a standard pole, set in six feet of concrete. There are three ropes on the pole supporting the 160, 75 and 20 meter antennas. The 2½ meter antenna is cleated to the top of the pole, with the ten meter antenna rod right below. The remaining antenna, the five meter rod, is located on top of the building. The ten, five and two and one-half meter antennas are all vertical rods giving a desirable low angle of radiation. The twenty meter antenna is a Johnson "Q".

All transmitters are turned on and off from the control panel on the operating desk, which is located four feet out from the center rack, but was moved aside for the photographer. Placed either side of the control panel are the receiver and the oscilloscope. The receiver in use at present is a National HRO and the 'scope was also made by National. Each new receiver placed on the market is tested under actual operation at W6ITH, and therefore the actual receiver in use at any given time will vary. The oscilloscope gives a continuous check on the radiated signal. To watch the modulation

percentage, besides the 'scope a power level db meter is in operation on the control panel. This meter is calibrated in percentage modulation for each transmitter. To prevent over-modulation, an 879 high voltage rectifier is connected as a reverse current rectifier. No current will flow through this rectifier, the plate of which is grounded, when the percentage modulation is below 100%. Just as soon as the modulation goes over this percentage, the plate voltage is negative with respect to the ground and current will flow. This current flows through a relay which operates and inserts a 10 db loss attenuator in the speech amplifier. This relay is of the slow release type and as such will hold all overmodulation peaks. Thus, excitable y.l.'s who desire to yell "Hello, Toots," haven't a chance of overmodulating.

Though primarily a phone station, c.w. is occasionally used, teletypewriters being utilized to send machine-code up to 60 w.p.m.

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Pressures are exerted by electromagnetic waves on surfaces of an opaque nature. For example: light rays, such as bright sunlight, press upon a opaque black surface to the extent of four-tenths of a milligram for each square meter of surface.

Directive Antennas

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quarter wave the other missing two eighth-waves are folded up in the tuning condenser. The adjustment of the tuning condenser effectively changes *both* of the parasitically excited dipoles at the same time and a very small change in the capacity of the tuning condenser C effects the desired 180 degree shift in the directivity of the whole array. Incidentally, when tuning up the antenna, do not tune C for either maximum current in the reflector-director circuit or maximum loading of the transmitter. It will be necessary to adjust C while in contact with a station more than 500 miles away as field strength tests at closer distances are often badly affected by the ground wave. Once the two points have been determined, some permanent stops can be mounted on the fame of the tuning condenser C which will enable rapid and accurate change-over of the array.

One user of this array uses a relay to cut in a small locked variable condenser across the main locked variable condenser in order to change direction; his shack is several hundred feet away from the antenna.

Incidentally note that the stub can be practically any convenient length, just so it can be resonated with a suitable condenser "C" so that there is high voltage at the points where the stub connects to the two dipole reflector-directors. A line several full-waves long may be used to bring the condenser C right into the shack, but remember that resistance losses in the line detract from the directivity of the array.

Feeding Directional Arrays

Note that practically all directional arrays utilize resonance of a multiplicity of half-wave sections, excepting of course, the aperiodic arrays such as the terminated long wire types which few amateurs use, as approximately half of the power supplied to the array is wasted in the terminating resistor.

Thus some form of resonant matching line is necessary to connect a non-resonant transmission line to the resonant arrays. As all non-resonant lines usually have a characteristic surge-impedance between 60 and 600 ohms, a

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