6-METER CD RCVR

Specialized Six-tube Superhet for CD Use

Fig. 1. Side view of the 6-Meter CD Receiver

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This six-meter receiver is a companion unit to the six-meter transmitter described in the January—February 1952 Ham News. It is identical in size and shape. The two units together make a great trans- mitter—receiver combination for civil-defense use.

The September—October 1951 issue of Ham News described a six-meter receiver useful for civil-defense purposes. This receiver had excellent sensitivity, and yet was relatively simple, design-wise. Many civil-defense amateurs throughout the country, recognizing the design merit of this receiver, wrote in asking if it could be redesigned specifically for CD use. The six-meter CD Receiver described in this issue is in answer to these requests.

DESIGN CONSIDERATIONS

The original receiver design, while quite simple, was still too complex for CD use. For example, there were nine front-panel controls or jacks. These included tuning, a.f. gain, r.f. gain, BFO pitch control, BFO on-off control, ANL limiter control, ANL on-off switch, AVC on-off switch and headphone jack. In itself an unsaturated amateur, or at least an unsaturated unfamiliar with the controls, in front of such a receiver would be like asking a pilot who has just learned to fly a B-36 bomber. In civil-defense work almost any amateur may be called upon to operate a given installation. For this reason controls must be kept to a minimum. The six-meter CD Receiver uses only three front-panel controls: namely, tuning, gain and ANL control. Despite this, practically none of the original features have been omitted. The BFO on-off switch is available by removing the top cover. In this position it cannot accidentally be turned on, and yet if you want to use BFO on another portion of the band the receiver can be tuned to the proper BFO frequency. Similarly, the BFO pitch control is a slug-tuned coil. This coil can be replaced by an open coil if desired. The redesign has been carried out in two directions. As just explained, the mechanical layout has been greatly altered to provide a functional receiver. Further, the circuit has been simplified. The original receiver tuned from 50 to 54 megacycles. This required that the r.f. stage track with the oscillator. The tracking problem has been eliminated by designing the CD receiver so that it covers only a small portion of the six-meter band. Two civil-defense segments of the six-meter band, as specified under the new RACES rules, are: 56.35 to 56.55 and 53.35 to 53.75 megacycles. Each segment covers 400 kilocycles, or can be considered to cover twenty 20 kilocycle channels. The six-meter CD Receiver has been designed to cover 200 kilocycles in either of the two segments. However, note that normally the receiver will be built to operate in only one of these two segments. That is to say, the coils will cover either the high or the low segment, but the receiver must be tuned to just one of the segments. The tuning control will then cover any 20 kilocycle portion of the 400 kilocycle wide segments.

RECEIVER FEATURES

Six tubes are employed in a full superhetronde circuit. A noise limiter and a BFO are included in the circuit. The output tube will drive a speaker, although headphones may also be used.

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**Electrical Circuit**

![Circuit Diagram of the 6-Meter CD Receiver](image-url)
Sensitivity is excellent, and the receiver has a noise figure of approximately 5 to 7 db.

Selectivity is adequate for CD use. Considering twenty-kilohertz channels, selectivity is not good enough for adjacent-channel rejection. However, this situation will rarely be found in CD operation. The actual band width is in the order of plus or minus twenty-five kilohertz, to the half-power point.

Current drain is approximately fifty milliamperes, and the voltage required is 250 to 300 volts.

All transistors specified have adequate safety factor, similar as wattage and voltage rating is concerned. For CD reason, continuous, slow-drain operation, at 24 hours per day, is easily possible.

DETAILS

Refer to the circuit diagram. Fig. 2. The 6ARS tube serves as a broad-band f.m. amplifier. C14 and C15 will resonate in the middle of either the high-frequency or the low-frequency segment of the meter band, depending on how the slug is adjusted. The 1N27 tube serves as the local oscillator and the major portion of the tube being used for each tuning band. A 150-ohm resistor is taken out of cathode and coupled through C14 to the grid of the oscillator section. The tuning condenser is placed in axies with a small capacitance, C14, so that the tuning range is confined to 200 kilohertz. Effectively this series circuit makes C14 look as though it has a very small capacitance.

The mixer lends a 6BQ6 which acts as the If. ampli-

fier stage. This tube, in turn, feeds a 6AS7 tube which acts as the sound detector, and also serves as the noise limiter stage. One section of a 6ARS tube is the first audio amplifier stage, while the other section is the heat-frequency oscillator. The output stage is a 6ARS which is capable of a power output of approximately one watt.

The oscillator is designed to work on the high-side of the received signal in order to avoid receiving troubleless images. The only image that can possibly cause trouble, with the oscillator working as shown, is the video signal from a channel 3 television station, but inasmuch as this falls at 31.25 megacycles, and is outside the two CD segments, this is not serious.

The intermediate-frequency chosen for the I.f. stage is 5 megacycles. The reason for this is thoroughly discussed in Hum Busters for Broadcasters October 1951.

Because no regular i.f. transformers are available for this frequency, they must be home-made. The details of this will be discussed in the letter. As was not desired necessary, Audio "loudness" in the speaker or headphones is controlled by the I.f. gain control. Of course, if it seems desirable, an audio gain control can be added. Merely replace R11 with a 0.5 megohm potentiometer, connecting the grid of the 6ARS to the arm of the potentiometer.

The noise limiter is a parallel diode circuit whose clipping level is adjusted by means of R12. The sounder is inserted into this potentiometer. Insertion of a noise limiter in the receiver circuit is the result of requests from transistors, and especially around a radio circuit, there will be many cases where their noises limiting. A noise limiter is a necessity in a CD receiver.

The circuit for this receiver contains everything which is necessary for civil-defense work, and yet contains nothing which is unnecessary. It is strictly a down-to-business communication receiver, designed to do a given job well.

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CIRCUIT CONSTANTS

(Available by f.m. frequency on 20% to 50% of specified chauveurs)

C1, C2, C, C5, C9, C10, C12, C15, C16, C17 .150 micromicrofarad or larger 5% tolerance.

C3, C7, C8, C11, C13, C14 .250 micromicrofarad or larger 5% tolerance (Maced M.S. 250 K)

C4, C6 .100 micromicrofarad, paper or large 5% tolerance.

C18, C20 .500 micromicrofarad paper or large 5% tolerance.

C19 .1000 micromicrofarad paper or large 5% tolerance.

C16, C17 .2500 micromicrofarad paper or large 5% tolerance.

C18 .2500 micromicrofarad paper or large 5% tolerance.

J1, J2 20-7 No. 15 enamelled wire close wound, 5 inches No. 4994 coil form—top at 5 feet from ground 500.

L1, L2 No. 32 enamelled wire close wound on 5 inches No. 4092 form 2 and 1/2 feet from ground 500.

L3, L4, L5 12 turns on No. 4092 form, one-half inch in diameter, Nichrome wire.

L6, L7, L13, 17000 ohms, 6 volt (two 15500 ohms 2 watt in parallel)

R1, R2, R10 .6200 ohms 1/2 watt (two 9200 ohms 1/2 watt in parallel).

R3 .47000 ohms 1/2 watt.

R4, R5 .47000 ohms 1/2 watt.

R6 .10000 ohms 1/2 watt.

R7 .33000 ohms 1/2 watt.

R8 .68000 ohms 1/2 watt.

R9, R11, R12, R13 .100000 ohms 1/2 watt (Melfar).

R14, R15 .33000 ohms 1/2 watt (+ 20%)

R16, R20, R21 .10000 ohms 1/2 watt.

R17, R18, R19 .10000 ohms 1/2 watt.

R22 .220000 ohms 1/2 watt.

R23 .100000 ohms 1/2 watt.

R24 .100000 ohms 1/2 watt.

R25, R26, R27, R28, R29, R30 .100000 ohms 1/2 watt.

R31, R32, R33 .50000 ohms 1/2 watt.

R34, R35, R36, R37 .100000 ohms 1/2 watt.

R38, R39, R40 .100000 ohms 1/2 watt.

R41, R42, R43, R44 .100000 ohms 1/2 watt.

R45, R46 .50000 ohms 1/2 watt.

R47, R48, R49, R50 .100000 ohms 1/2 watt.

R51, R52, R53 .50000 ohms 1/2 watt.

R54, R55, R56 .100000 ohms 1/2 watt.

R57 .50000 ohms 1/2 watt.

R58, R59 .100000 ohms 1/2 watt.

R60, R61, R62 .100000 ohms 1/2 watt.

R63 .50000 ohms 1/2 watt.

R64, R65, R66 .100000 ohms 1/2 watt.

R67 .50000 ohms 1/2 watt.

R68, R69, R70 .100000 ohms 1/2 watt.

R71, R72, R73 .100000 ohms 1/2 watt.

R74 .50000 ohms 1/2 watt.

R75, R76, R77 .100000 ohms 1/2 watt.

R78 .50000 ohms 1/2 watt.

R79, R80, R81 .100000 ohms 1/2 watt.

R82 .50000 ohms 1/2 watt.

R83, R84, R85 .100000 ohms 1/2 watt.

R86 .50000 ohms 1/2 watt.

R87, R88, R89 .100000 ohms 1/2 watt.

R90 .50000 ohms 1/2 watt.

R91, R92, R93 .100000 ohms 1/2 watt.

R94 .50000 ohms 1/2 watt.

R95, R96, R97 .100000 ohms 1/2 watt.

R98 .50000 ohms 1/2 watt.

R99, R100, R101 .100000 ohms 1/2 watt.

R102 .50000 ohms 1/2 watt.

R103, R104, R105 .100000 ohms 1/2 watt.

R106 .50000 ohms 1/2 watt.

R107, R108, R109 .100000 ohms 1/2 watt.

R110, R111, R112 .100000 ohms 1/2 watt.

R113 .50000 ohms 1/2 watt.

R114, R115, R116 .100000 ohms 1/2 watt.

R117 .50000 ohms 1/2 watt.

R118, R119, R120 .100000 ohms 1/2 watt.

R121 .50000 ohms 1/2 watt.
COMPONENT PARTS

Most of the resistors specified may have a tolerance of 20 percent. A few of them, however, must be ten percent tolerance. These are in boldface type in the Circuit Constants list.

Condenser C3, C6, and C8 are specified as 2 mm silver mica transmitters. Reliability is needed and silver mica condensers are recommended. However, if you wish, you may substitute a length of twisted wire in each case, as long as you make sure that the capacitance stays fixed.

The output transformer may be any type you can find which will match a 10,000 ohm load to a greater voice coil. This item is not critical in any respect.

CONSTRUCTIONAL DETAILS

The chassis and chassis are home-made, and are of a size to match the chassis and cabinet employed in building the 6-Merc Transformer described in the January-February 1952 Ham News. Cabinet size and shape is not too important, although you should follow the layout of the parts as closely as possible. There is no substitute for a tried and proven mechanical layout.

Fig. 5 shows the layout of the major parts on the chassis. Most dimensions are not given in most cases as they will vary depending on type of socket used and the condenser schematic. The final layout is indicated in Fig. 7. No layout is given for the rear panel, as no provision of the coaxial connector and the bolt for feeds is shown clearly in Fig. 1.

Chassis size is ten by six by three inches. Material is 0.032 or 0.040 aluminum. Front and rear panel size is six inches wide and seven and a half inches high. Material is 1/4 gage iron. Bottom plate size is ten by six inches, and the material is 20 gage iron. The top cover plate is in the form of an inverted "U," and of a size that completely covers the box. Material is 32 gage iron. All pieces are held together with sheet-metal (self-tapping) screws.

Meanwhile as five-megacycle 1-F transformers of the desired type are virtually unobtainable, it is necessary to purchase 450 kilocycle 1-F transformers and convert them. Practically any low-frequency 1-F transformer is suitable which does not have an iron core. Blown-out transformers would be ideal, as long as the micro trimmer condensers in them are in good condition. The transformers used in this receiver are Microcal "Plastic" 1-F Transformers. The transformers are 1/2 inch square and 1/2 inches high and are rated for the frequency range from 400 to 550 kilocycles. Three types are available, input, output, and interstage, any of which can be used because you are going to remove the coils anyway. The numbers of these three transformers are: 16-6639, 16-6639 and 16-6649.

Regardless of the type of transformer you procure, make certain that you do not get up iron-core units. Further, try to get transformers that have a coil form 1/2 to 1/2 inch in diameter. The coil form in the Meisner transformers just described has a 2 inch diameter.

It is not necessary to replat this to 1/2 inch diameter, but this is easily done by winding the form with paper until it is the right diameter, then putting on a final layer of transparent tape. Now, follow the sketch of the windings shown in Fig. 8, and wind each coil with 40 turns of No. 26 nickel enamelled wire. The spacing between coils is 1/8 inch, as shown, and the wire is close-wound. The outer turn of 10-wound No. 30 wire should just take up the 1/4 in. winding space shown in Fig. 8. However, the actual size and position of the coil is not critical. The form is shown in Fig. 8. After the coils are wound, a certain amount of cement may be applied to them in order to bind the wire in place. If the 1-F transformers do not react to the voltage, then the necessary changes may be made to the trimmer condensers, leaving the coil as specified.

In the under chassis view, Fig. 9, a terminal strip will be seen. This is the main terminal housed for the receiver, and is the point to which external voltages are connected. Only five of the six points are used.

These five terminals are: two speaker terminals, B plus ground, and filament No. 9 which is group 6 for the 7 plus voltage, because these installations will have a relay or a switch for this purpose on the
In the same photograph you will see a 2-watt resistor connected across the speaker terminal points on the terminal strip. This resistor is not shown in the circuit diagram. It is a load resistor of approximately ten ohms which is used to provide a load for the secondary of the output transformer. This resistor must always be in place when headphones are being used, unless a speaker is being used simultaneously. The secondary of the transformer must never be unloaded when in use.

TUNE-UP PROCEDURE

If you have a grid-dip meter its use is highly recommended. Set L<sub>1</sub> to either 50.55 or 53.55 megacycles. Do the same with L<sub>2</sub>. Next, set C<sub>3</sub> to half-mesh and tune C<sub>1</sub> until L<sub>1</sub> is resonant to either 53.55 or 56.55 megacycles.

Next, apply filament and plate voltage, after connecting an antenna and a speaker (or a loud resistor across the speaker terminals). Connect an output meter across the speaker terminals, or across the grid resistor. Set the grid-dip meter at 50.55 or 53.55.
megacycles, or use any stable signal at this frequency as a signal source. You may now align the I.F. transformers, adjusting the four trimmers for maximum deflection of the output meter. The r.f. gain control should be set as low a point as possible to avoid overload. Increase the intensity of the i.f. signal, either by moving the grid-dip meter closer to the receiver, or by advancing the grid on the signal generator, and make certain that the output meter shows an increase in reading. This is a check against overload. If an increase in r.f. signal doesn't produce an increase in meter reading, you are overloading the signal generator. A slight increase in gain is permitted.

The two I.F. transformers will now be operating approximately on the same frequency, so the next step is to set this frequency to 50 megacycles. Use a signal generator capable of operation on 50 megacycles. You may check its frequency against WWV if you so desire. Connect the output of this signal generator to pin 2 of the 12AT7 through a 100-meg ohm condenser, and advance the control on the signal generator until you get a suitable deflection on the output meter. Now adjust the four trimmers in the two I.F. transformers again, in order to get a maximum reading on the output meter. If the output meter tends to go off-scale, reduce the input by the control on the signal generator. The I.F. strip should now be aligned.

Next, remove the I.F. signal generator and put a signal into the receiver with an r.f. signal generator, and if you are using an adjustable condenser of twisted wire for C2, adjust this until you get a maximum signal on the output meter. This capacitance can be too low or too high, so search for the optimum point. Finally, retune L4 and L5 slightly to achieve maximum reading on the meter.

The next step is to turn on the BPO and tune the receiver for maximum deflection of the signal generator, and listen to the best note obtained. Adjust C6, removing you are using a twisted-wire inductance for L4, until you obtain the best note. If you do not hear a note, adjust L4 until a tone appears. Tune L5 carefully, as the frequency shift is quite rapid when tuning this coil. The receiver should now be ready to put on the air.

If you find that the tuning range is not sufficient to cover the receiver, then you must readjust the value of C4. The larger you make C4, the greater the frequency range, and vice versa.

OPERATING INFORMATION

Use a good antenna, and one with the proper impedance—50 ohms. When properly constructed, this receiver will have a noise figure of about 6 db, which means that it is a sensitive receiver.

The noise limiter is the threshold type, which means it must be adjusted according to the strength of the received signal. If you experience noise, turn R2, until the switch operates, and advance the control until the noise is just equal to the received signal. If the control is advanced further, you will clip the signal as well as the noise, and the receiver may block.
With this issue the G.E. Ham News starts its seventh year of publication. Almost two and a half million copies of this publication have been printed in that time. In the past 36 issues I have tried to cover most of the phases of amateur radio. If you feel that any subject has been slighted, write and tell me.

The Ham News is available, free, from your nearest General Electric Tube Distributor. In the event that you find it difficult to obtain in this manner, a subscription plan is in effect. For $1.00, the Ham News will be sent to you for one year. (This offer open only in continental USA, Alaska and Hawaii.) Address all inquiries and subscriptions to me in Blag, 2667, General Electric Co., Schenectady, N. Y.

One of my readers, WH5M of Sturgeon Bay, Wisconsin, wrote in to voice his 6-meter receiver, and at the same time mentioned that he suspected that I wasn't too interested in the vote, but that I just wanted to get some mail. I'm glad my secretary didn't see that note! Honestly though, Murray, the last thing we need here is more mail. Around the Christmas season I was literally swarmed under with mail, and I'm just getting out from under that group of letters now. Fortunately, the votes that came in didn't require any answer, so I was glad to get all of them.

Another one of my readers, 11XMB of Colorado Springs, Colorado, writes in asking how he can possibly get his vote in by Feb. 15 when he didn't receive the news. Well, you had better talk to your secretary, because as far as I'm concerned I brought that up, Jim, because it gives me a chance to explain something. The January 1953 issue was due to be shipped to 2-wattians and subscribers on January 2. The printing had been completed, and the issue was all set to be shipped, when for some inexcusable reason the gears didn't mesh in the shipping routine and the issue did not get shipped until February 3. I regret the shipping delay. Does the fact that you received your December issue on time help any?

Rather down in the real mud I found a letter from a Call of Record reader. His comments on civil defense work are so interesting that I want to quote them in full. I'm sure Mr. A. A. Carson, Civilian, right here, living and working in an area surrounded with lockheed, Newport News, Virginia, will appreciate this writer's points, naval bases, Norfolk, Newport News, Ft. Monroe, and even last—testing fields, key refineries and atom-light plants—it all blindly slipping—perfectly correct that it could not happen here.

I, personally, have been quite pleased at the way the amateurs in many communities have begun to do a first-class job of civil defense communication work. I was also quite overwhelmed at the number of votes I received asking that the 6-meter civilian-defense receiver information be published as soon as possible. Thanks in those of you that took the time to write.

A recent news release from Electronics Park (the home of General Electric's Electronic Division in Syracuse) tells about the new microwave communica-
tion systems G.E. is using for the Transcontinental Gas Pipeline Corporation. The microwave system is being built by General Electric in New Jersey. Further, the news release goes on to say that about 15,000 miles of microwave relay systems are currently in operation or under construction for some 20 oil and gas pipeline corporations and other utilities. G.E. now manufactures and has available two types of microwave equipment. One operates in the 2000 megacycle band and the other in the 800 megacycle band. The reason for telling you this is not to sell you any microwave equipment, but to for your attention that at least one company (G.E. in this case) is doing a serious business of selling commercial gear to operate at these frequencies. Here is the control where the amateurs are coining to be an important. A commercial company is selling equipment for use at 2000 megacycles, and yet very few have even been on the air in this portion of the spectrum. The 2200 megacycle amateur band was first used for two-way communication by W2WMA and W3TNT on April 29, 1946. Since that time other experimenters have had equipment in use on that frequency, but it seems to be very small. If you, as an amateur, are looking for fields to pioneer in, don't forget the UHF spectrum.

The tiny two-way wire radio used in the Dick Tracy comic strip may be nearer to reality than you think. Mr. E. J. Kear, manager of engineering for Electronic Division said that the development of tiny electronic components known as transistors have brought tiny radio tubes like those used by the comic strip character within the realm of possibility. He said that a ready personal radio of hearing size running independently on one set of battery cells might be possible at a near future. These tiny transistorized radios are not hearing aid size but much less. Only, 15/64 of an inch of GL-410 transistor or GL-411 transistor resists the pressure of the ear tip before we can get a klink stick to fit our ear.

—Lighthouse Log
RADIO-FREQUENCY AMPLIFIER PENTODE

GENERAL DESCRIPTION
Principal Application: The 6BJ6 is a miniature, remote-cutoff pentode designed for use as a high-gain radio-frequency or intermediate-frequency amplifier. Features of the 6BJ6 include low grid-plate capacitance and relatively high transconductance. The low heater current of 100 milliamperes makes the tube particularly suitable in applications where conservation of heater power is important. The electrical characteristics of the 6BJ6 are similar to those of the 6BA6.

Cathode: Coated Unipotential
Heater Voltage (A or D-c): 6.3 Volts
Heater Current: 0.15 Ampere
Envelope: T-516 Glass
Mounting Position: E3-1, miniature button 7-pin

Direct Interelectrode Capacitances:
Grid to Plate (Max) With Shield*: 0.0035
Input: 4.5
Output: 5.3

* With external shield #5B connected to pins 2 and 3.

PHYSICAL DIMENSIONS

BASED DIAGRAM

TERMINAL CONNECTIONS
Pin 1—Grid Number 1
Pin 2—Cathode
Pin 3—Heater
Pin 4—Heater
Pin 5—Grid Number 2
Pin 6—Grid Number 2 (Shunt)
Pin 7—Internal Shield
Grid Number 3 (Suppressor)

FROM: