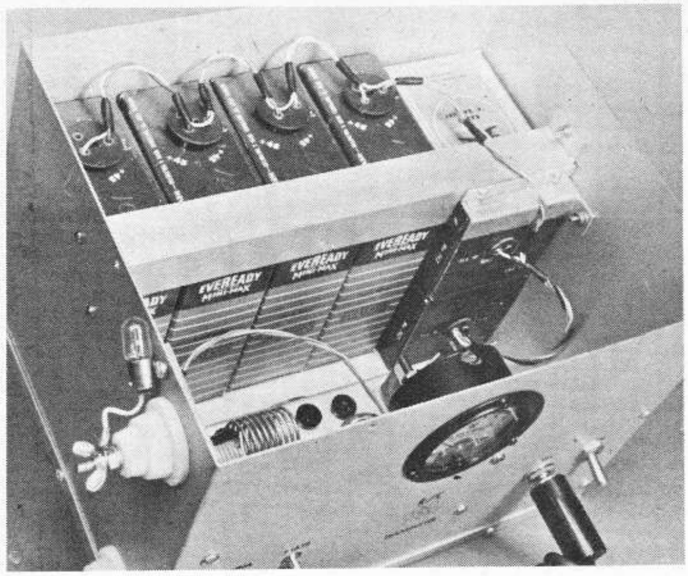


"Solo-Mac"

■ Here is one of the most thoroughly tested transmitters it has been our privilege to present to the radio control modeling fraternity. "Solo-Mac" is a single-tube MOPA Citizens-Band transmitter for the 27 mc "set" of Federally allotted spot frequencies (which range from the low spot of 26.995 to the high one of 27.255 megacycles).

Solo-Mac has good power output and its crystal operates at low power for best stability. It might seem like progress in reverse, going to Solo-Mac after our earlier well-received Mac-II (the "II" meant it was a two tuber).

In fact, why a new transmitter at all? Well, one of the main reasons is the new FCC rules which went into effect last September. They call for frequency tolerances that many earlier transmitters cannot hold. While these same rules specify that all equipment in use on Sept. 1, 1958 can be kept in use until June 15, 1963, builders of new transmitters will have to produce outfits which conform to the new rules. Other R/C'ers, even though they may have older rigs, may want to make something more up-to-date —and incidentally, more stable and thus more reliable.

"Solo" seems to indicate a single tube, and that's all we have. But this tube has two complete triode sets of elements and we use them as two separate tubes. The transmitter qualifies as an MOPA (Master Oscillator, Power Amplifier) which means it is more stable than most xmtrs with a crystal oscillator connected directly to the antenna. Also, though the crystal stage runs at quite low power (necessary to minimize crystal heating and assure adherence to the FCC frequency tolerance figures) the output stage can be run at quite a fair amount of power.

To get a really potent wallop we specify 180 volts on the tube, which is within its ratings, provided the plate currents are held to 14 ma per section or less (they will be if you follow directions). The power input to the output tube sections (V2) is under 3 W, so it is legal to use crystals cut to .01% tolerance. As a matter of fact, most R/C crystals today are cut to the even closer .005% tolerance, which means even more leeway for the user.

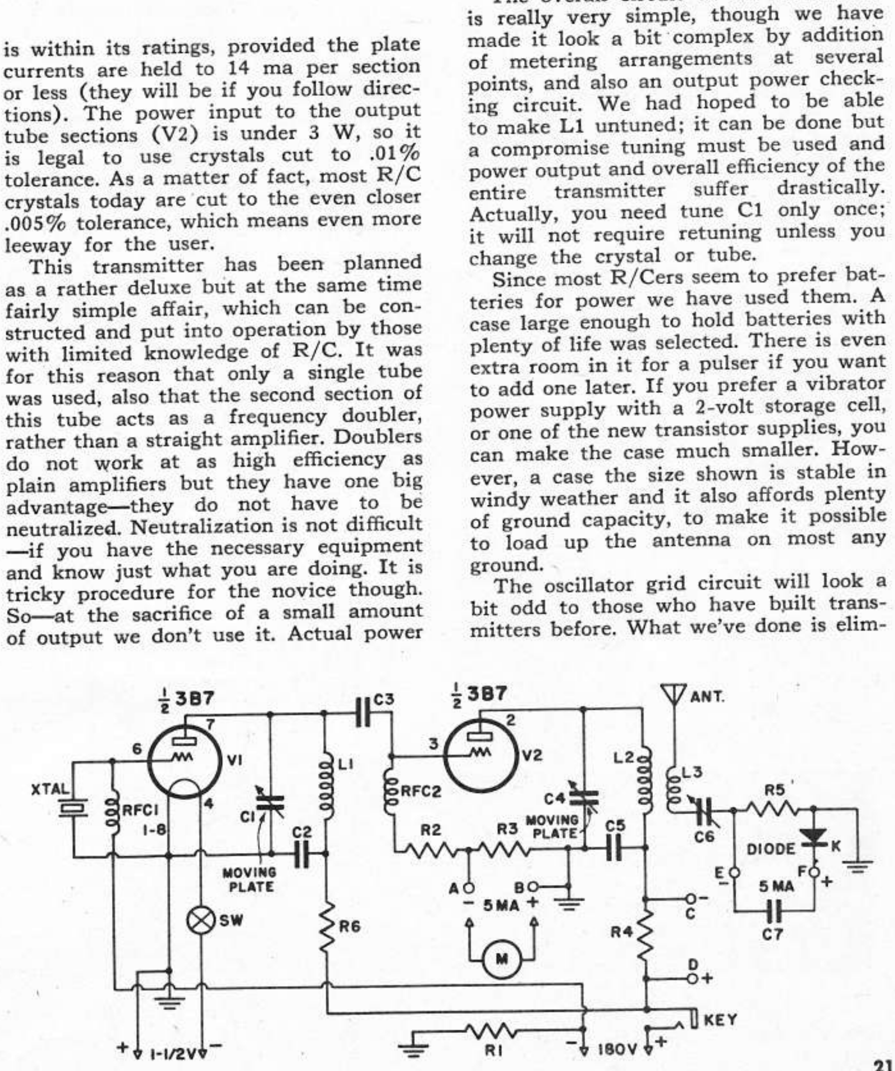
This transmitter has been planned as a rather deluxe but at the same time fairly simple affair, which can be constructed and put into operation by those with limited knowledge of R/C. It was for this reason that only a single tube was used, also that the second section of this tube acts as a frequency doubler, rather than a straight amplifier. Doublers do not work at as high efficiency as plain amplifiers but they have one big advantage—they do not have to be neutralized. Neutralization is not difficult —if you have the necessary equipment and know just what you are doing. It is tricky procedure for the novice though. So—at the sacrifice of a small amount of output we don't use it. Actual power output of the transmitter is just about a watt—more than will ever be needed at the ranges we operate R/C.

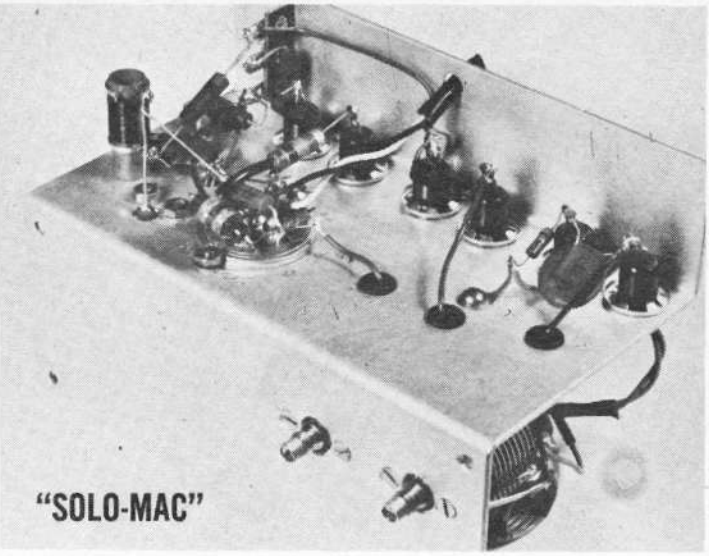
The crystal operates at half the output frequency, and you *must* have such a crystal for this transmitter; most of the R/C concerns can supply them, not only for 27.255 mc output, but also for at least some of the five new R/C spot frequencies. The plate circuit L1-C1 of the crystal oscillator (V1) tunes to the crystal frequency, but L2-C4 tunes to twice this.

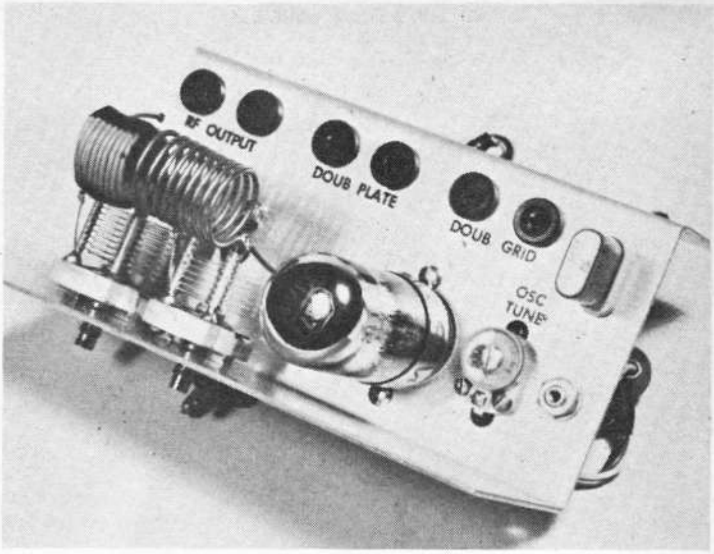
The overall circuit of the transmitter is really very simple, though we have made it look a bit complex by addition of metering arrangements at several points, and also an output power checking circuit. We had hoped to be able to make L1 untuned; it can be done but a compromise tuning must be used and power output and overall efficiency of the entire transmitter suffer drastically. Actually, you need tune C1 only once; it will not require retuning unless you change the crystal or tube.

Since most R/Cers seem to prefer batteries for power we have used them. A case large enough to hold batteries with plenty of life was selected. There is even extra room in it for a pulser if you want to add one later. If you prefer a vibrator power supply with a 2-volt storage cell, or one of the new transistor supplies, you can make the case much smaller. However, a case the size shown is stable in windy weather and it also affords plenty of ground capacity, to make it possible to load up the antenna on most any ground.

The oscillator grid circuit will look a bit odd to those who have built transmitters before. What we've done is elim-







inate the usual grid leak; RFC1 runs to resistor R1, which places a small amount of negative bias on the oscillator tube to prevent it from drawing too much plate current. Note that B-minus and A-minus are NOT connected together in this circuit. The plate current of both tube sections through R1 produces the bias for the oscillator. This circuitry is used in preference to the more standard arrangement in order to lower the power required from the crystal. Our new frequency tolerances make it mandatory that the crystal be run at a very low power level to hold its design frequency.

The filament current is about 220 ma and the total plate current of the tube about 22 ma. With the batteries specified you should get some 70 hours of use from the B's and at least 200 hours from the A's, if continuously used for 2 hour periods per day. The B batteries only supply power when the key is closed so they will last much longer than 70 hours, even if used for proportional control. With an escapement? Maybe a couple of seasons!

When running a tube at its maximum power level, as here with the doubler section of the 3B7, the filament voltage should not be allowed to drop too low before batteries are changed. With this transmitter, you should put in new A's when the voltage with the filaments turned on measures less than 1.3 volts. The B batteries can be allowed to drop to 140 volts or so, before they are renewed (but your power output will be drastically reduced at this voltage).

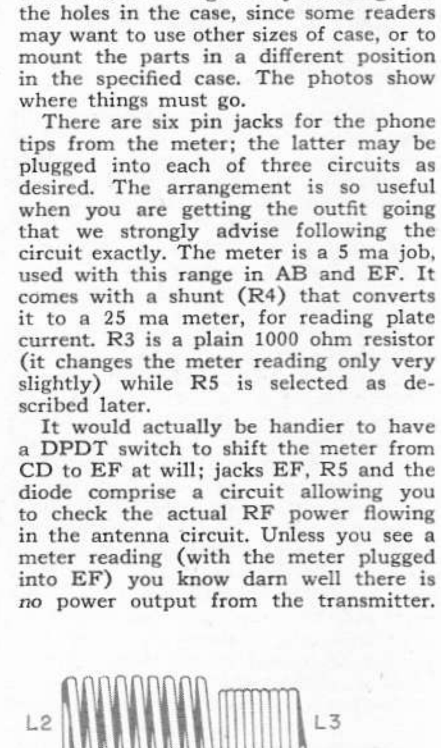
No knobs are shown on C4 and C6; we feel it wiser to adjust these with a screwdriver—knobs are too handy for prying fingers! While you can adjust these once, for average ground, and not have to change them again, we strongly advise that they both be touched up every time you go out to fly. It only takes a moment and then you will know for sure your transmitter is on the button (pun!); with an MOPA circuit, however, you will still get some output even though tuning is quite a bit off the beam —you just lose output power and draw a bit more plate current in V2.

Now let's get down to construction. The chassis is a simple Z-shaped piece of 1/16" thick aluminum. Holes are made according to the drawing, and aside from the tube socket hole only three other sizes are required. If you don't have a cutter to make the 1" hole, just drill a circle of smaller ones, worry the center piece out and use a half round file to smooth up the circle. The chassis is held to the front of the case with four 6-32 bolts in the corner holes. We attached C4 and C6 with flat head screws in countersunk holes; this way you can mount the two condensers and wire them up and the whole chassis is a solid unit with nothing to require loosening.

The meter is mounted just below the case cover line, and the chassis far enough beneath it so the tube has clearance. We do not give any drawings for the holes in the case, since some readers may want to use other sizes of case, or to mount the parts in a different position in the specified case. The photos show where things must go.

There are six pin jacks for the phone tips from the meter; the latter may be plugged into each of three circuits as desired. The arrangement is so useful when you are getting the outfit going that we strongly advise following the circuit exactly. The meter is a 5 ma job, used with this range in AB and EF. It comes with a shunt (R4) that converts it to a 25 ma meter, for reading plate current. R3 is a plain 1000 ohm resistor (it changes the meter reading only very slightly) while R5 is selected as described later.

It would actually be handier to have a DPDT switch to shift the meter from CD to EF at will; jacks EF, R5 and the diode comprise a circuit allowing you to check the actual RF power flowing in the antenna circuit. Unless you see a meter reading (with the meter plugged into EF) you know darn well there is *no* power output from the transmitter.



Unfortunately you can't depend upon exact readings in this output circuit, and furthermore tuning the transmitter for maximum output as shown by EF does not allow you to monitor plate current in V2.

You should keep track of this current, since the tube has a maximum rating of 14 ma per section; oddly enough, if you try to load it to a higher figure than this the power output will actually drop off in most cases—also the tube may be damaged. With a DPDT switch you could touch up the tuning when you got to the field, the meter being at CD to check tube plate current. Then the switch could be snapped to EF to give you a continuous check of actual RF output. The best answer, of course, would be *two* meters, one used for CD at all times, and one you could shift by means of the jacks from AB to EF; the latter would be used at EF all of the time except when doing the preliminary tuneup.

The RF output meter is handy to have due to a peculiarity of the tube we use. Most transmitter tubes fly up to a very high plate current if the crystal stops oscillating, the antenna circuit is overloaded or mis-tuned. The 3B7, however, draws close to the same current whether the crystal is oscillating or not. If you pull the crystal out of the socket, V2 will draw about 15 ma; this is a good safety factor—but your meter (plugged into CD) could show about the same current whether the transmitter was tuned up correctly and pouring out RF or if it had no output at all. It was for this reason that the RF output circuit was added.

The 3B7 is a surplus tube, which we do not believe is manufactured any more. However, there are large numbers of them in surplus stocks, so it seems certain the supply will be ample for years to come. Actually, a 3A5 was used in the preliminary work on this transmitter and it does a very good job. However, when we found that the 3B7 would give more output with a little less B battery drain, and that it costs quite a bit less than the 3A5, we settled on this surplus job. Actually, a 3A5 can be used in the transmitter very nicely, if you use the appropriate socket, and raise R2 somewhat; it should be around 50 to 75K ohms.

Wiring is a simple job; C3 and RFC are mounted right on the socket, using pin #5 of the socket as a tie point for one end of RFC. R3 and R4 mount right on their respective pin jacks. R1 is on a lug strip which also holds an end of

RFC1 and R6. All RF leads should be as short and direct as possible.

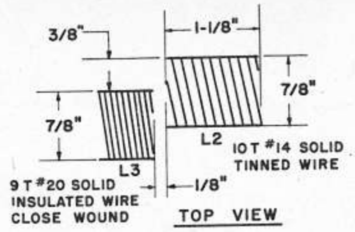
To keep them from getting in a tangle, all leads to the batteries and to the Key jack and SW were formed into a neat cable. If you wire the Key jack, also C1 and C4 as shown, there will be no DC on the moving plates, and the frame of the Key jack will not be connected to B plus unless a closed plug is in it. This jack must be insulated from the panel, using the phenolic washers that come with it.

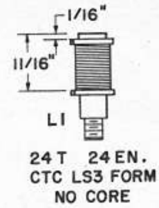
Before we fire up the transmitter, a few words on battery mounting and holes in the case. A single piece of hardware store 1" x 1" x 1/16" aluminum angle holds all the batteries in place; a little cutting and piecing had to be done over the A batteries, as they stick out farther than the B's. Since the batteries are pretty heavy, extra self-tapping screws were put on both bottom and cover of the case, about middle way of each side. Those on the bottom were put forward of center, so they would not dig into the batteries. One screw on the rear bottom of the case does just this, and should be moved; place it so it will project between the two batteries at extreme left.

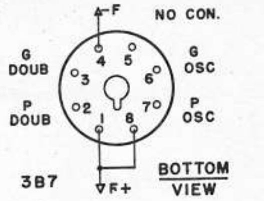
Large holes should be made to clear the two antenna insulators, which have a slight shoulder on the undersides. One insulator comes with a snap connector, which we put in the upper position. Adjacent to this insulator, on the outside of the case is a #47 dial lamp; its brass shell is soldered to a lug which is held by a self-tapping screw on the case. A short flexible lead soldered to the center connection of the bulb allows it to be connected to the upper antenna post, for tuneup purposes. The heavy brass handle on top of the case is offset to the rear so the loaded case will balance for easy carrying.

Before turning on the transmitter put a dot of colored dope on one side of the outer shafts of C4 and C6, and a matching dot on the case; when the dots are adjacent you will know the plates are fully meshed.

R5 must be "made to order," as it has







extremely low resistance. We used a single strand from flexible hookup wire specified—this appears to be about #36 wire—and it is 1¼" long. Start out with a shorter length to protect the meter, and make it longer by trial so the meter will read about 3 ma on the scale when the transmitter is tuned up, using the pilot lamp.

Preliminary tests can be made with the chassis out of the case. With the #47 bulb from the upper end of L3 to chassis, turn on the A power, and plug the meter leads into AB. Use only two B batteries for first tests, in case you have made an error in wiring. With the B circuit closed tune C1, starting at maximum capacity (this is with the half-silvered part of the rotor adjacent to the mounting screw end) and turning slowly till the meter takes a jump. We find it best to leave C1 slightly to the low capacity side of maximum grid current (measured at AB). Be sure you start tuning C1 at maximum capacity rather than at minimum; if the latter, you might use the incorrect peak, but if you tune the right way you use the first peak you reach. Tune past peak grid current, till it drops .1 ma, with the full 180 volts connected.

Still on 90 volts, turn C6 to minimum capacity; shift the meter to CD and tune C4 over its range. At some point the plate meter should take a sudden drop; leave it at the position that gives lowest current and rotate C6. At one point on the range of C6 the plate current should rise somewhat—this point ought to be around mid-range (with the plates about half in).

If everything has worked out as described, you can shift to 135 volts on the B battery. You should have been able to get at least a dim glow in the bulb on 90 volts, but on 135 it will light up quite nicely. On this voltage the test transmitter showed 1.8 ma at AB, 10 ma at CD and 1.7 ma at EF. Try touching up the three controls on 135 volts, and if your readings are within 20% of the above you can shift to 180 volts. If the meter reads too high or too low on EF, change the length of R5 slightly.

It should be noted that you "tune" C4 back and forth over its range, but C6 is not tuned, it is merely "set". The routine is to set C6 at some position (after you have found roughly where it will have to be to load the transmitter) then tune C4 back and forth for best output. Now reset C6 slightly either way and again tune C4. The two controls interact so you'll have to shift back and forth between them, till you find the spot of both that gives about 14 ma plate current on V2 (measured at CD) and also gives the maximum possible brightness of the bulb—also the maximum reading with the meter connected to EF. You'll soon get the hang of this tuning method.

Okay, all is well so far and you have the full 180 volts connected. Turn on Sw and push the button. You should get a really dazzling light from the bulb now. The test outfit produced enough power to light the bulb up noticeably brighter than it would show on a fully-charged 6 volt storage bat-

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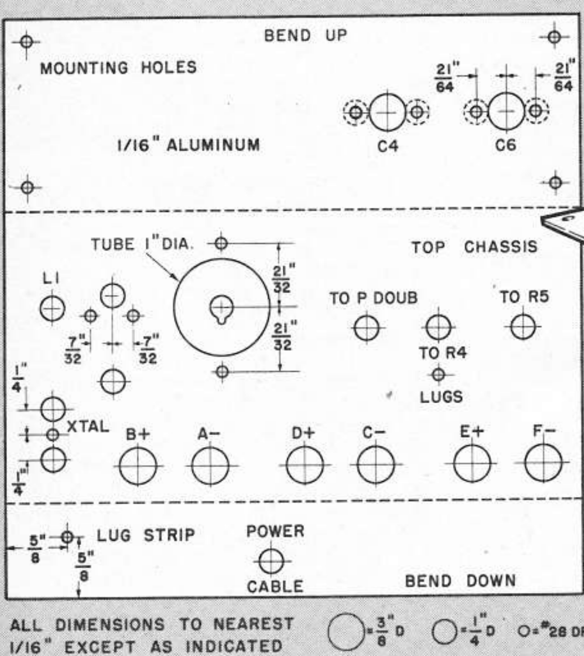
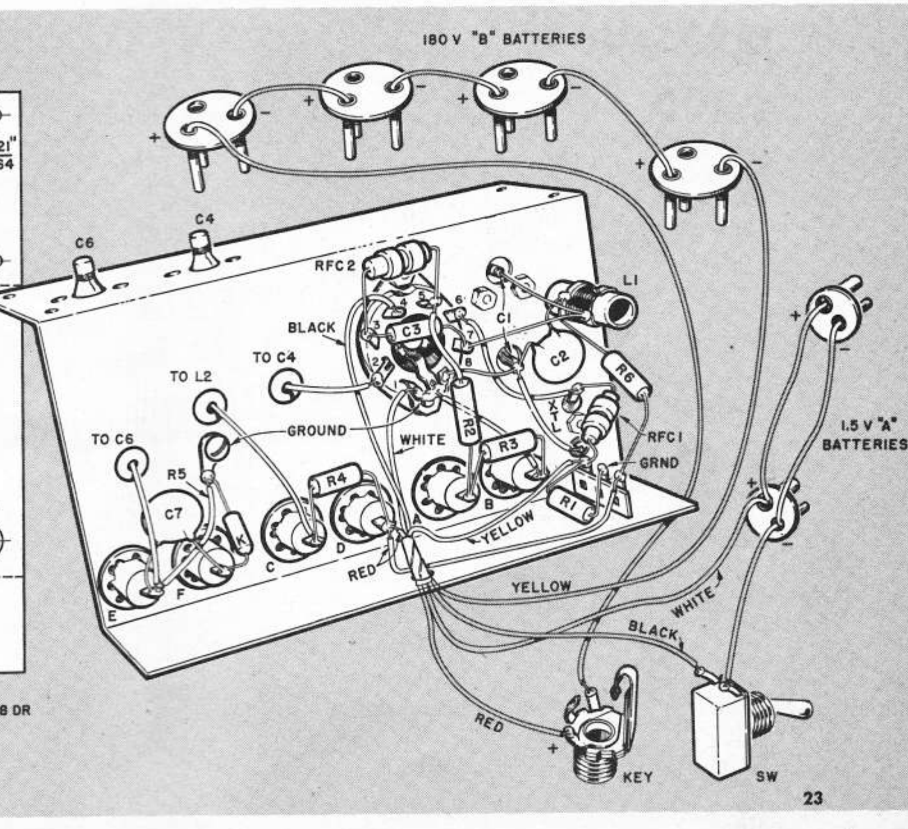


CHASSIS ABOVE IS SHOWN EXACTLY HALF SIZE



really living!" Suddenly you wake up to the fact that the radio set has gone dead or the model has drifted out of range and a couple of hundred dollars worth of model and equipment either flies out of sight or screams earthward like a dive bomber. Yes, quite a way to relax.

Well, since these little gas engines are quite fascinating free flight gas must be the answer. Those power plants and models aren't too terribly expensive and even if you should smash a model up most of the time the engine doesn't get hurt so why not build one of these and enter it in a contest? Whether it's a large or small contest the way these overpowered monsters start smashing up all around you puts a German blitz to shame. This is relaxation?

If after all this you are ready to take up dominoes or checkers—don't—the only true way to relax is to build rubber powered models. The rubber motor is silent and inexpensive. You can always regulate your power by how much of it you use and how tight you wind it. Sure, these motors will break if you wind them too tight, but after a little practice winding along with a little information on how to take care of the rubber you will soon see that this is the one and only way to relax. Outdoors these rubber powered models will climb just as high and fly just as long as any gas powered model.

There is one thing better and that is indoor rubber powered models which are flown in large hangars and auditoriums. With these light, low-powered models flights of more than a half hour are possible without being involved in any chasing. After launching the model you grab a chair or better yet lie down on the floor and watch your model fly. While someone might try to tell you differently you can easily see why I fly indoor and outdoor rubber powered models. It's the only way to relax . . . and if you believe everything I have said then you are not only more relaxed than I, you should also see your doctor.

Solo-Mac

(*Continued from page* 23)

tery. Final readings should be: meter at AB, about 2.3 ma; at CD, no more than 14 ma; at EF, you will get readings according to the length of the wire used for R5. We have not provided any means for monitoring the current of V1; if you can obtain the current specified at AB, you will find V1 running at about 8 to 9 ma. The current of V1 rises quite rapidly as C1 is tuned lower in capacity from the point of resonance, also crystal RF current rises, so as noted previously, set just .1 ma to the low capacity side (as determined by highest current at AB).

The antenna specified is about 9½' long, but only 9' is useful, if connection is made to the top insulator. This still gives very good power output, as you'll find upon checking with a Field Strength Meter. The antenna is a 5-section held to the insulators with a pair of aluminum bands. When using the antenna, the bulb should be disconnected from the screw through the insulator. Generally, the meter reading at EF will be lower with antenna than it is with the bulb. This doesn't necessarily mean that the power into the antenna is greatly reduced over what you get in the bulb —as noted previously, the readings on the output meter are a bit hard to interpret. But you will doubtless get used to your own set and know how to load the antenna, to get maximum output and still keep the plate current into V2 at 14 ma or less. The setting of C6 will likely be quite different with an antenna than it will with the bulb load, and C4 will probably be a little different too. Usually we found it unecessary to retune C1 after it had once been set to the best spot. Remember that you want to tune C4 for minimum current with the meter plugged into CD, but for maximum current at EF.

The approximate position of the coupling coil L3 with respect to L2 is shown in the drawings. In the unlikely event that you can't make V2 draw its rated 14 ma with the antenna at full length, the set on the ground and C6 at any position, you can shove L3 more into line with L2; it is very doubtful if this will be the case however. It should be noted that like most 27 mc transmitters with quarter wave antennas (which is what we have here) the set has to be on the ground to load up properly. And the loading changes when you move from dry to wet ground. However, that's what C6 is for —it makes it a simple matter to compensate for any reasonable condition of the ground upon which the transmitter is placed.

Oh, yes—a couple more current readings. With no antenna or bulb load on the transmitter, you should be able to get a dip in V2 plate current as low as 5 or 6 ma. Under the same conditions but with C4 at maximum capacity (or most anywhere but at the point of resonance, where you get the best current dip) the meter will go up to 20 ma or more. This is as it should be, but don't hold the button down at this high current for more than a quick glance at the meter. It's best always to have a load on the transmitter—either bulb or antenna—and to have C4 always tuned to resonance.

Some close-tolerance parts are called for in the parts list, and we strongly urge builders to obtain them. In fact, unless you are an electronic hotshot stick closely to the parts specified and the layout of the transmitter chassis itself. You can, of course, shift battery position, put the antenna in a different location, etc. But we *know* the RF unit to be a stable, reliable and fairly potent unit . . . changes are made at your own risk!

"SOLO-MAC" PARTS LIST

One 3B7 tube; loctal socket to fit (Ace); 13.6275 mc crystal (or half of frequency you want at output) and socket for same (Ace); one 5 ma meter with matched 25 ma shunt R4 (MC Mfg. and Sales Co.); one SPST toggle switch, SW; one open circuit jack, Key; one 7 x 8 x 10" aluminum case with H3 brass handle and five extra self-tapping screws, Ace #5; four Eveready #482 B batteries; two Eveready #742 A batteries; four plugs for B and two for A batteries; two antenna insulators with hardware, antenna straps and snap connector, Ace; three red and three black pin jacks and two phone tips; aluminum for chassis; aluminum angle to hold batteries; flexible hookup wire, also solid #20 insulated wire for L3; #14 wire for L2; CTC type LS3 form, no core, and #24 enam. wire for L1; two double lug strips to hold ends of L2 and L3, Ace #3; one #47 pilot lamp and lug for mounting; one 1N295 diode; keying lead with plug, Gyro coiled-cord type shown in photos; two National R-33 RF choke, 100 microhenries, RCF1 and RCF2.

Resistors and condensers: C1, 7-45 mmf ceramic trimmer, NPO type; C2, C5, C7, .01 mf ceramic; C3, 470 mmf. 10% ceramic; C4, 35 mmf air trimmer, Ace; C6, 50 mmf air trimmer, Ace; R1, 300 ohm carbon ½ W 5% resistor; R2, 33K 5% ½W carbon; R3, 1000 ohm ½W carbon; R4, comes with meter; R5, see text; R6, 5600 ohm 5%. Hookup wire, hardware, etc. Tekni-Labels used for chassis and front panel lettering.