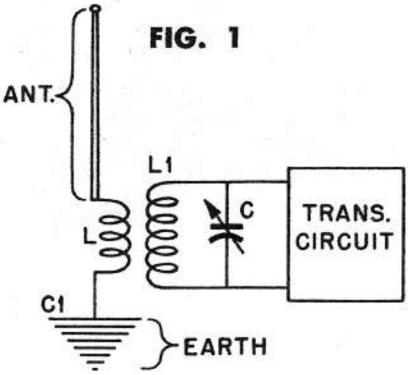
# Primer on Power Loading

## Having trouble tuning up that transmitter? Then you're sure to welcome this down-to-earth how-to-do-it dope

■ Nope—we are not talking about the lead or old booster batteries you pile in your PAA-Load planes! The loading referred to here concerns R/C transmitters; a transmitter is said to be properly loaded when some circuit is coupled to the plate coil to take out the optimum amount of RF power. You can overload a transmitter—it will then usually stop oscillating—or underload it, in which case you don't get the amount of signal out into the air that you should.

And there are still other penalties to improper loading; too much load can very easily ruin the tube, and will run down the B batteries very rapidly. If the circuit is not loaded enough, you can ruin your crystal. So you see, it pays in many ways to know the rudiments of transmitter loading and how it is accomplished.

First, let's see what loading is. You know that a flashlight cell has a certain amount of power in it; if you hook too heavy a



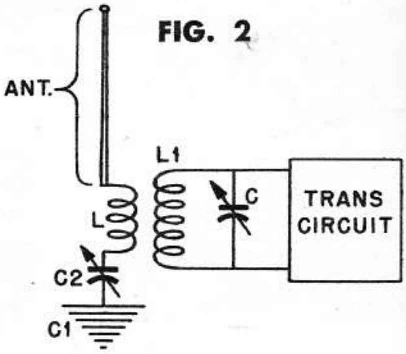

load to it—a glow plug, for example—it will simply refuse to work. You can consider the tube of your transmitter as a battery, too, but this one does not produce direct current like your dry cell—it puts out radio frequency power, or RF. In order to do this, the tube is made to "oscillate," by connection to certain circuit elements, such as the crystal and tuned plate circuit. If you overload it, it too refuses to work; it stops oscillating, and the plate current goes up much higher than the tube can handle. If you do not load it enough, the tube (if it is a triode) wil not be harmed; if it is a pentode, though, the screen grid current will rise to overload proportions. Also, the RF that is circulating in the circuit builds up to a high value in the crystal—and there goes your costly "rock"!

O.K., we'll agree that the transmitter should be loaded to the correct value; what is this value and how do we reach it? If you have a commercial transmitter, or make one from a kit, the instructions will undoubtedly give an operating value for the current. Make sure that you do not exceed this value, and if the current goes higher, turn the rig off till you can collect your composure and find out why.

If you are using a homemade transmitter, better check with someone who owns a well-known make, which uses the same tube and B battery voltage as yours, and do not exceed his current values. As a very rough guide, the common battery transmitter tubes such as 1S4, 3S4, 3V4 should not be used at higher plate current than 12 ma. The 3A4 can go up to about 17 ma., as can the 3D6. If the tubes are used as triodes (with screen grid hooked to plate), you can run the current up another 20%. The 3A5 will stand 15 ma. per section, or a total of 30 ma. for the tube. Heater type tubes that work on 6 V. will generally take quite a lot more plate current safely.

Now, what about the "how" of loading? Remember that the tube is an "RF battery"—it will produce a lot of RF power; you have to get it out and into the air. This is done simply by coupling an output circuit to the tube, tuned to the same frequency. All transmitter antenna systems must be tuned, to operate correctly. You can't consider the *antenna* simply as "that rod you attach to the top of transmitter case"; it is this rod, *plus* the coupling coil, the antenna tuning condenser, if any, and the capacity between the transmitter case and ground. Also to be added in here is the capacity between the key lead and ground—and you yourself are involved in this. That is why the meter may wiggle a bit as you move the key lead.

The simplest coupling systems utilize just the antenna rod, and a coupling coil, as in Fig. 1. Because the antenna is cut to a carefully chosen length, it will be tuned (very broadly to be sure) to the transmitter frequency. For 27¼ mc., we use an antenna about 9½' long; this is known as a "quarter wave antenna," because it is about one quarter as long as the frequency (27¼ is roughly 11 meters, or 37 feet). Some transmitters, especially the hand-held jobs, have shorter antennas than this, but they have other tricks incorporated that allow good operation with these undersized rods.




As you turn the plates of condenser C (Fig. 1) slowly from minimum capacity (plates open) toward full capacity (plates closed or meshed) the current should drop down to a minimum, then rather suddenly jump up quite high. See Fig. 3. The sudden jump shows the tube has stopped

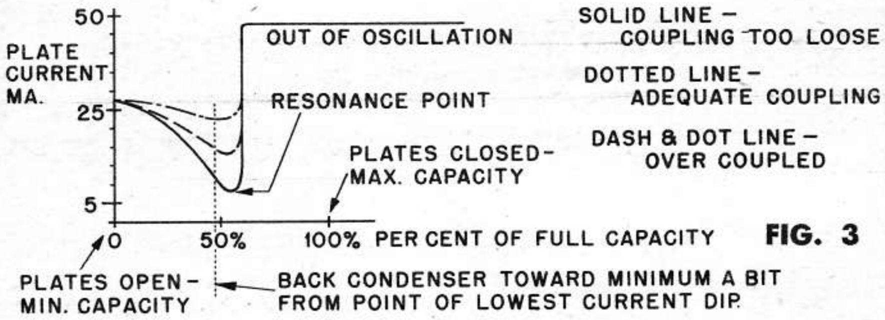



**FIG. 3**

oscillating—get that condenser back to lower capacity in a hurry! If your transmitter uses a pentode connected 3A4, for example, and the current dips down lower than about 15 ma. (with 135 V. B supply) it's a sign you need closer coupling; in other words, you are not loading the tube enough. So you just shove L closer to L1, and retune C. The current dip should not now be as low. Continue till you get the current up around 15 or 16 ma. If it won't go up this high, then you may have to add a turn or two to the coil L.

Suppose you increase L till it has about half the number of turns of L1 and the current still won't go up to 16 ma? Then you will have to check C1, which is the capacity between the transmitter circuits (including case, key lead, etc.) and actual ground, or earth. Try setting the transmitter on the hood of your car, or on a yard square piece of hardware cloth or even metal. You will doubtless now have to back L away from L1, to get the proper plate current.

And if this *still* fails to raise the plate current—brother, you've got real troubles, and we can't diagnose them from this distance!

Now take the same 3A4 pentode circuit, but with the circuit of Fig. 2. It's the same as Fig. 1, but we have added another condenser, C2. This makes it much easier to properly load the transmitter, especially when it is to be operated on different types of surfaces (and more about *this* a little later). In this case, the ant., L, C2 and C1 are all chosen to add up to approximately the transmitter frequency, or 27¼ mc. Actually, we make L, C2 and C1 all larger than necessary; then in the field, all we have to do is to reduce C2, till the plate current is normal. This is the system that was used in the Mac II transmitter, and is mainly responsible for the exceptional range of this unit. It can be applied to most any other transmitter just as well.

We suggest that the reader refer back to the circuit of the Mac II (and the tuning instructions on A. T. Plan 553) to see just how this tuning system is applied to a representative transmitter.

With a correctly designed system as in Fig. 2, you don't need to have the antenna exactly 9½' long, for good results. It can be as much as a foot shorter, and you can still get pretty good output. It can also be longer, but little or nothing is gained in the way of power output, and the antenna just gets that much more ungainly.

Now a word about those "different types of surfaces" we mentioned a while ago. The reason we have stressed capacity to ground—which is represented by C1 in Figs. 1 and 2—is that the earth plays a vital part in the operation of the quarter wave ant.; without going into the technical reasons why, just take our word that a *half-wave* antenna is the ideal simple radiator.

Sure, we specify a *quarter* wave for our whips—the ground actually acts as the missing quarter. That is why it is so important to have good capacity to ground —C1, you'll remember—in our output circuits.

If you doubt this, just tune up the transmitter sitting on the ground, then raise it up four or five feet on a wooden table. Right! The tuning goes all haywire, and you can't load the transmitter. Ground varies quite a bit in conductivity—and hence in its inability to be capacity-coupled to your transmitter case. That is why it is a good idea to use a large metal case, or to put an extra plate on the bottom of the case as was done on the Mac II. It allows you to get good loading, even if you are over very dry ground. Moist ground, lush grass, metal surfaces like a

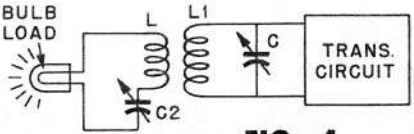



**FIG. 4**

car hood, all allow easy coupling and loading. On the other hand, very dry ground, sand, concrete runways, and macadam surfaces are poor ones from a loading standpoint.

We have often mentioned the use of a pilot lamp, to show power output, when you are tuning up a transmitter. If one is connected as in Fig. 4, it serves as an ideal means of adjusting the transmitter, when you are first getting it set up. After this, the pilot lamp is of little use; you can connect one in series with the antenna and it might light up, but it will not prove a lot about transmitter output. Also, all the power that is required to light it is just subtracted from that going out in the air to your plane. Hook the bulb as in Fig. 4 for test purposes only—or to impress your friends with mighty power capabilities of your transmitter—but take it entirely out of the circuit for actual radio control operation.

The final word on how your transmitter "puts out" can only be had with a field strength meter. Build one like that in the new Air Trails Model Annual, or purchase one of the many low cost units on the market, and you can quickly check what is coming out of that whip atop your transmitter box. You just can't fool the FSM; if your buddy has a peanut-whistle half watt transmitter, and he can make the FSM read higher at the same distance than you can with your "5 watter" . . . well, just read the foregoing paragraphs once more!