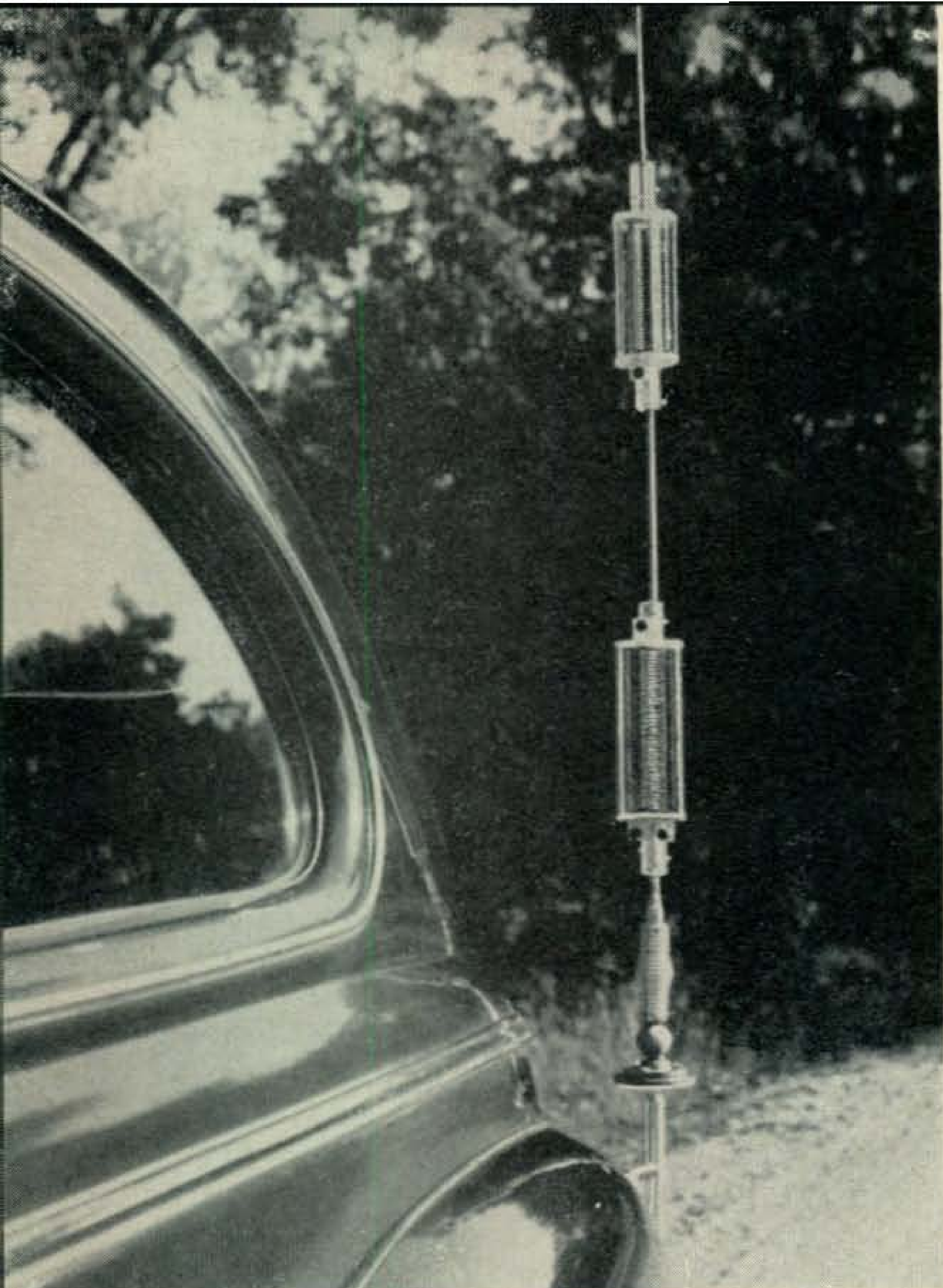

Fig. 1. The two high-Q loading coils shown here are important factors in the operation of this versatile antenna.

a Six Band Mobile Antenna

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In This Article a Well Known Author Describes the Step by Step Construction of a Novel and Efficient Multi-Band Antenna

The number of amateur mobile installations which include band-switching transmitters has recently shown a marked increase. However, despite the ease with which gear of this type can be shifted from one frequency to another most mobileers still operate on only one band. This is true because the process of altering the resonant frequency of a loaded mobile antenna is usually so complicated that the average Ham shies away from the task.

After building a multi-band transmitter and installing it in my car I was faced with this same dilemma. I wanted to work several different bands, but I didn't care to load the trunk compartment with numerous coils and wrenches just so I could change the operating frequency of the antenna.

The most convenient way to have solved the problem would have been to construct an antenna with a remotely operated bandswitch controllable from the driver's seat. Unfortunately, most switching schemes that I could devise put too much metal near the loading coil and seriously reduced its Q. Although not remotely switched, the mobile antenna I finally settled for is relatively inexpensive to construct, works well on all Ham bands from 3.7 Mc. to 29.7 Mc. and can be changed from one frequency range to another with a minimum of inconvenience. It is truly a six-band mobile antenna.

The most efficient mounting position for a mobile antenna is reputed to be in the center of the car's roof. Trees, trolley wires and XYL's, however, make it impossible for the majority of amateurs to utilize such a location. Bumper mounting may be slightly less efficient, but it was decided on because it is certainly much more practical.

Total length, including loading coils, is slightly more than 8 feet. Although a longer antenna would work somewhat better on 75 meters, the 8-foot length was chosen as a good compromise between performance and appearance.

The Base Sections

As shown in *Fig. 2*, the lower part of the antenna is a 13″ length of ¾″ galvanized pipe which is fastened, by means of fiber insulators, to a bumper bracket of aluminum angle. A floor flange on the threaded top of this pipe provides a solid foundation for a body-mount style of antenna spring. Placing the spring part way up the antenna results in greater mechanical stability, thus reducing antenna sway while the car is in motion. This is an important factor when two loading coils are made a part of the radiating system.

Threaded into the spring is the bottom 4½" of an Army surplus *AN-131-A* antenna. Although the lower portion of any mobile whip can be used at this point, the section of *AN-131-A* works out nicely because its fairly large diameter helps to provide good support for the rest of the antenna.

One end of a 12" length of 1" diameter polystyrene rod is drilled to a depth of 2" to accept the short piece of *AN-131-A*. A 14" section of ⅜" dural tubing is next cut and fitted into a hole drilled for it in the top end of the 12" poly rod. Another poly rod, 11" long, is drilled on the lower end to provide a tight fit with the dural tubing. The top 4 feet of a good spring steel mobile whip is then placed in a hole drilled at the top of the 11" poly rod. To insure that the sections of antenna are held firmly together, a number of *6-32* set screws are placed in holes drilled and tapped for them in the poly rods, as shown in *Fig. 5*.

The operating frequency of the antenna can

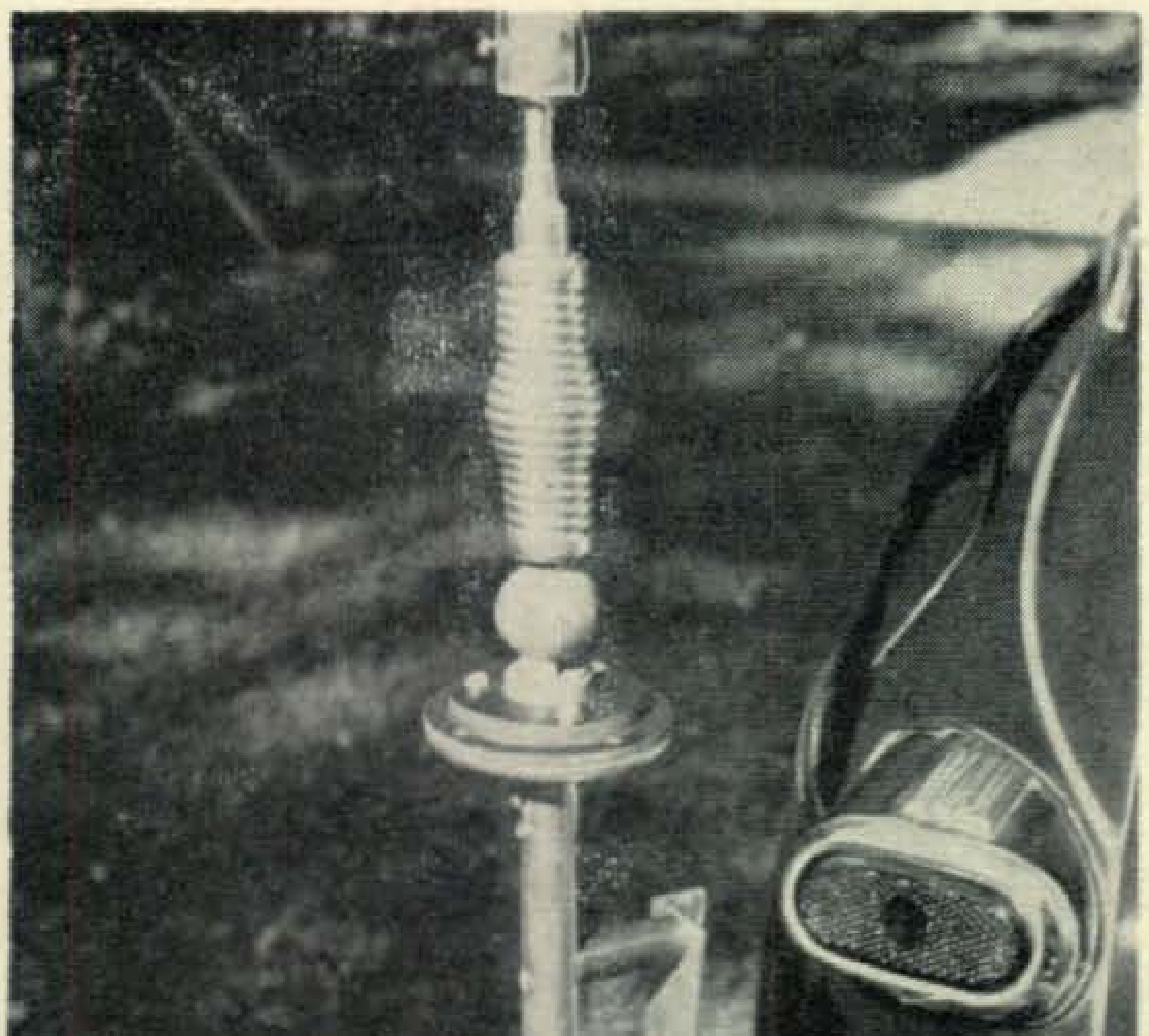


Fig. 2. A floor flange, atop a 13-inch length of ¾-inch galvanized pipe, provides a suitable location for the body mount type of antenna spring. A ¼-inch thick fiber disc acts as a shim between the spring mount and the flange to provide adequate clearance for the stud protruding from the bottom of the mount.

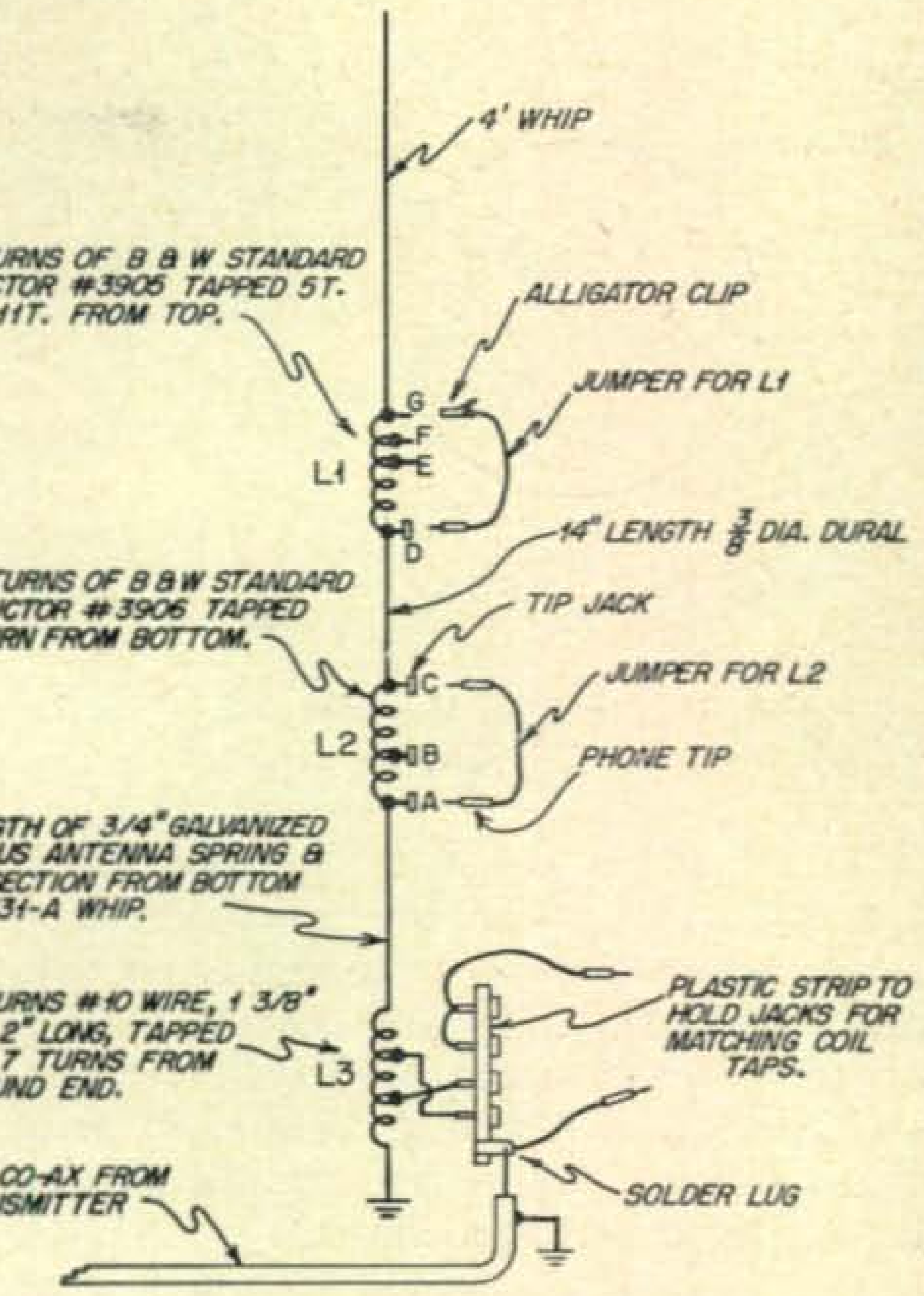


Fig. 3. Wiring schematic of the antenna.

be changed by shorting either *L1* or *L2* with a couple of 12" jumpers made from test lead wire. One jumper should have phone tips on both ends while the other jumper should have a phone tip on one end and an alligator clip on the opposite end. The jumper with two phone tips is for use with *L2*. The one with an alligator clip is for *L1*.

Making the Coil Formers

Four 2 ⅝" diameter discs with 1" center holes are cut from ¼" sheet polystyrene. The discs slip over the poly rods and help to hold the loading coils in place. Holes must be drilled in the discs for the screws that fasten the plastic mounts of the shorting jumper tip jacks. These mounts can be 4 pieces of ¼" polystyrene, ¾" by 1" in size. A hole just large enough to accommodate a tip jack should be drilled in each of these pieces. A smaller hole that can be tapped to take the *6-32* screw which fastens the mount to the plastic disc should be drilled in one edge of each mount. A drop of polystyrene cement put on this edge of the mount, just before it is screwed to the disc will provide a good strong bond between the two pieces of plastic. The tip jacks, by the way, should contain strong springs which firmly grip the tips of the shorting jumpers to provide good, low resistance contacts.

When working with polystyrene, patience is very important. Without it, Ole Man Friction will heat your tools to the point where the plastic melts into a sticky, unmanageable goo. A supply of water should be kept on hand for cooling drills and saws.

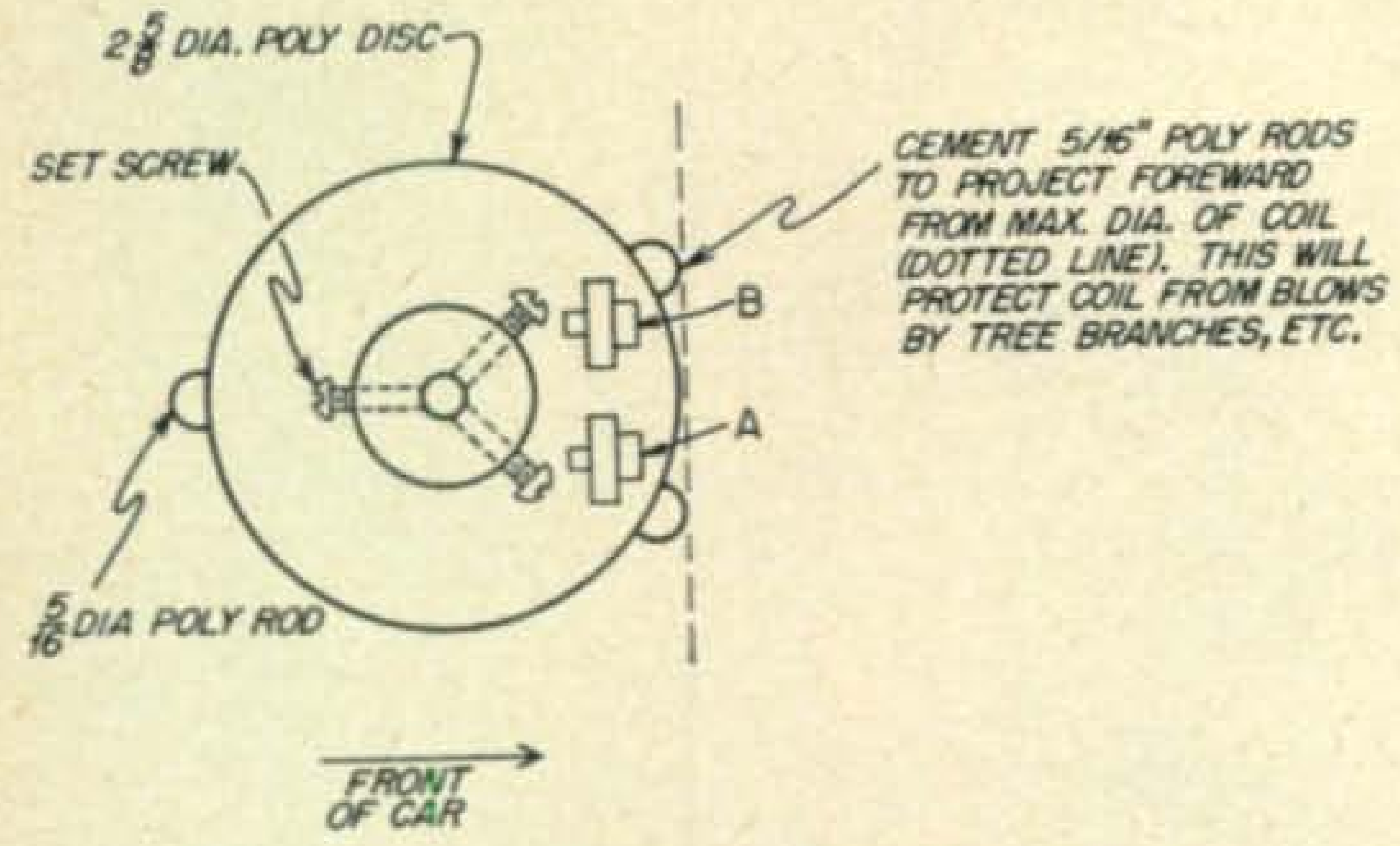


Fig. 5. This is a bottom view of L2 to show the positions of the rods to strengthen the coils.

The loading coils are modified B&W standard inductors. For preliminary tune-up purposes, be on the safe side and leave a few more turns on them than are shown in *Fig. 3.* The exact inductance required differs with each installation, and it is much easier to prune a coil that's too long than it is to add turns to a coil that's just a little too short.

Matching the Antenna

Matching the antenna to the coaxial feed line is accomplished by means of a small tapped coil, *L3,* connected between the base of the antenna and the car body ground. This coil can be closewound with 12 turns of #10 wire using a size *D* flashlight cell as a form. After the coil is wound, remove it from the battery and carefully stretch it to a length of 2″. The coil may then be strengthened, as shown in *Fig. 4,* by cementing thin plastic strips to it.

The importance of this base matching coil can hardly be overemphasized. It answers the problem of incorrect loading which so often is encountered with pi-network finals operating on 40 and 75 meters. Furthermore, a matching coil makes possible the use of an inexpensive standing wave bridge to correctly resonate the antenna and produce a very low standing wave ratio on the feed line.

As can be seen in the photographs, the matching and loading coils are exposed to the weather. Normal precipitation has had little effect on the antenna and so no protective covering appears necessary for the inductance. It takes a very heavy downpour to put the unit so far out of resonance that it is no longer possible to load the transmitter on 75. Operation on the other bands is little affected by anything short of a deluge.

All exposed metal parts should be protected from the weather. The ¾″ pipe and pipe flange can be given a coat of aluminum paint. The screws, and other pieces of hardware may be protected by spraying them with *Krylon.* The plating of these items isn't always too good and so the liquid plastic is used to help keep them from rusting.

Do not attempt to tune the antenna by guesswork. Either a standing wave bridge[1] or an Antennascope[2] must be employed during the process of adjustment if satisfactory performance is to be obtained.

Mount the antenna on the car with the loading coils temporarily held in position between the plastic discs by means of Scotch tape. The discs, in turn, should be taped to the plastic rods to keep them from slipping down during the preliminary tune-up. Once the antenna is working properly, the discs and coils may be permanently cemented in place. At the same time three 5/16″ polystyrene rods should be cemented to each coil as shown in *Fig. 5* to provide a certain amount of mechanical protection. The rods can be so positioned that they will help to absorb any blow from a tree branch or other obstruction which may be encountered when the car is in motion.

One satisfactory method of antenna tune-up employs a standing wave bridge as shown in *Fig. 6.* With the antenna temporarily disconnected from the output of the bridge, feed in just enough r.f. to give a full scale reading on the indicator meter. If your mobile rig can't be decoupled sufficiently to prevent overloading the meter, some other source of low power

1. "Bridge Construction," p. 480, The Radio Amateur's Handbook, 30th edition, 1953.
2. Scherer, W. M.: "Building and Using The Antennascope," CQ, September, 1950.

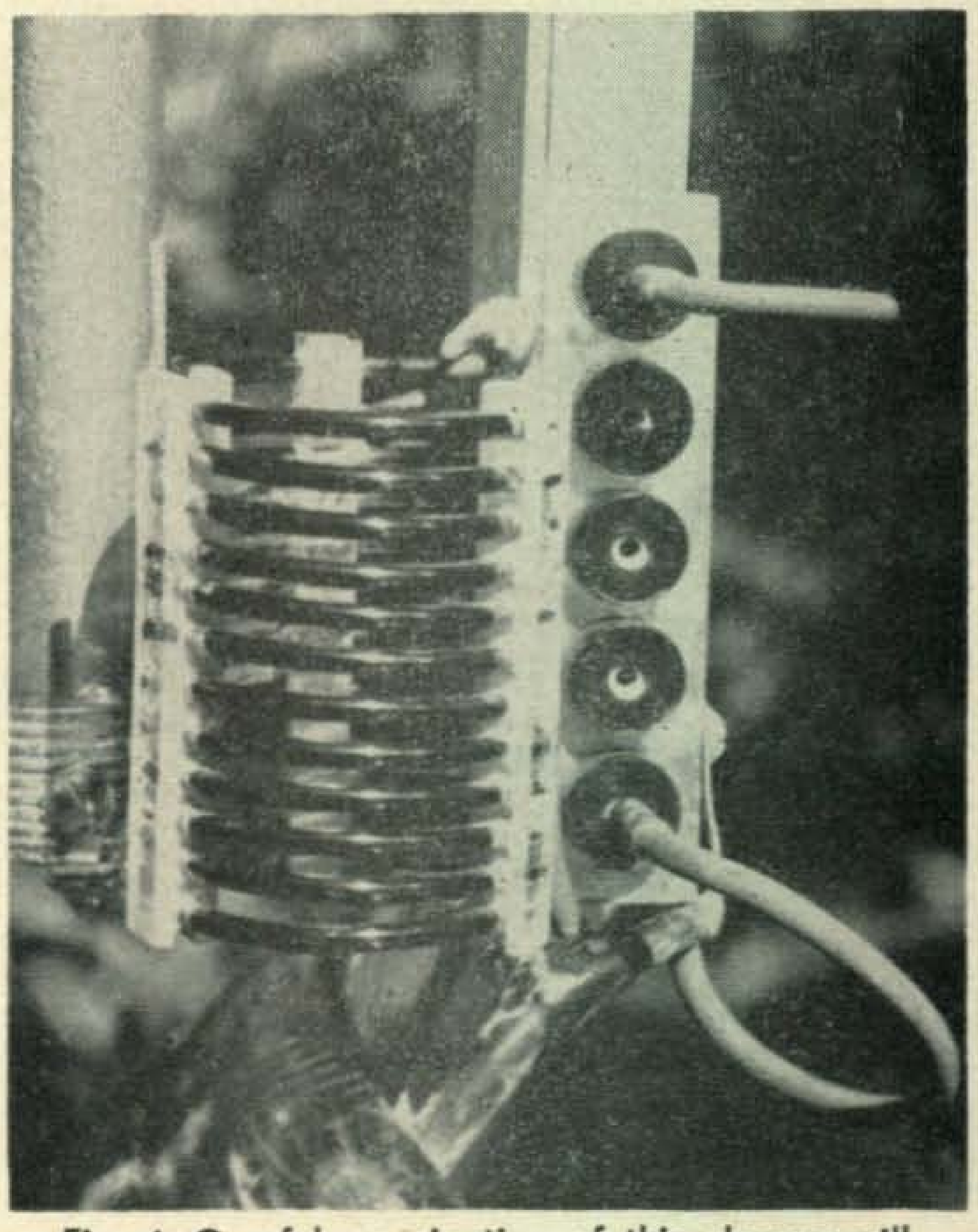
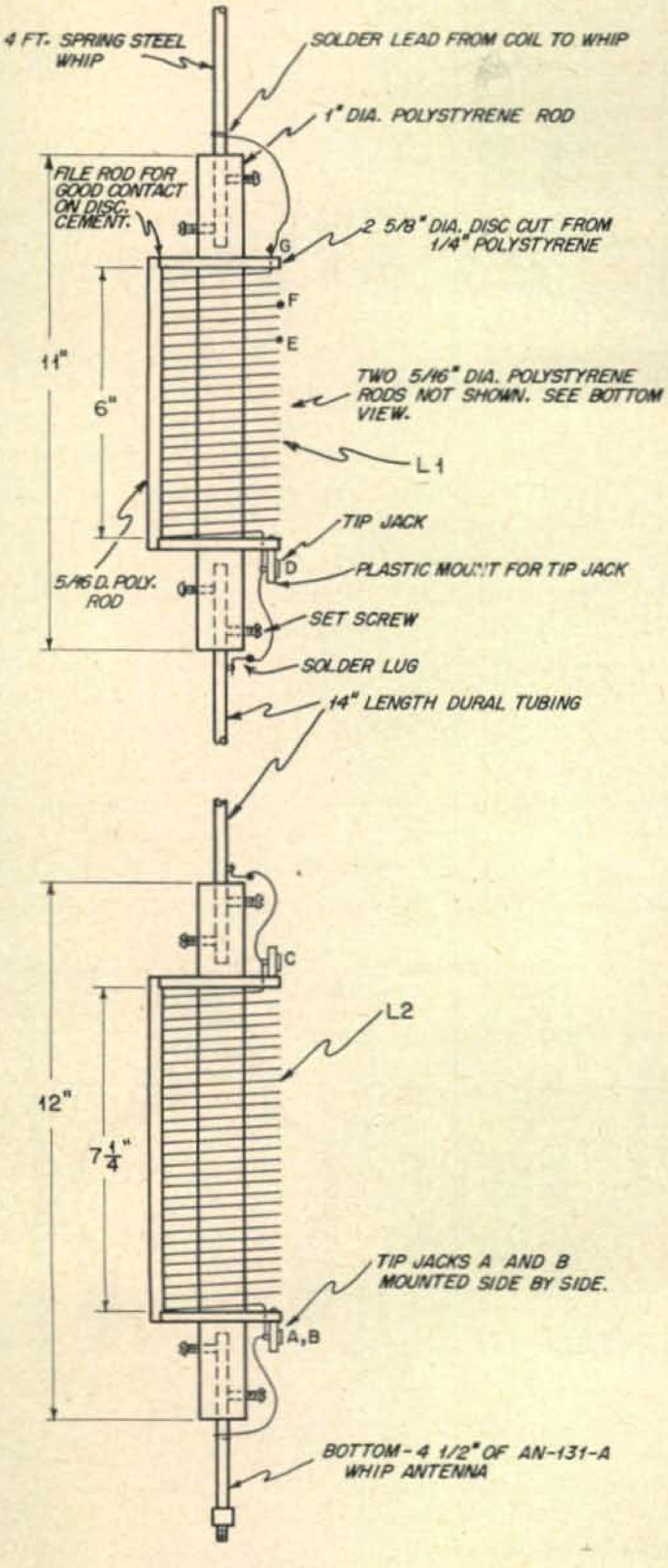


Fig. 4. Careful examination of this closeup will reveal that matching coil, L3, is mounted upside down. The top is grounded to the aluminum angle mounting bracket, while the bottom is connected to the base of the antenna. The center tip jack on the plastic strip to the right of L3 is not used, and so may be omitted by the constructor.



Mechanical assembly details of the antenna.

r.f. will have to be found. In my case, Command transmitters, a BC-458 for 75 and a BC-459 for 40 and 20, were pressed into service. When powered with a small a-c supply, the output from one of these rigs can be made very low by reducing the coupling to minimum and, at the same time, slightly detuning the final plate condenser.

Once the indicator reads full scale, the coaxial lead from the antenna may be attached to the output terminal of the bridge. The meter reading will drop, but it won't go to zero. Short the bottom loading coil, *L2,* and set the matching coil for 40 meters. Plug the jumper with an alligator clip into the jack in the base of the upper loading coil, *L1*. Using the jumper, start at the bottom of *L1* and short out a turn or two. Note the reading on the standing wave indicator and then short out a few more turns. After several trials, some point will be found where the reading on the meter will drop to zero. This denotes antenna resonance and a correct match between the feed point resistance of the antenna and the coaxial line. If no position can be found where the meter goes all the way to zero, move the 40-meter tap on the matching coil, *L3,* up or down a turn or two and repeat the shorting process on *L1*. When the meter finally reads zero, disconnect the alligator jumper and remove almost all turns which had to be shorted out on L1. Then, carefully prune the coil a turn at a time until the antenna is resonant at 7250 kc. as shown by a zero reading on the standing wave meter.

Tuning Up on 75 Meters

Disconnect the antenna and feed enough power at 3850 kc. to the bridge to produce a full scale reading. Reconnect the antenna and set matching coil, *L3,* for 75 meters. Leave *L1* unshorted, and plug the alligator clip jumper into the jack at the bottom of *L2*. Proceed to tap up on this coil until a resonant condition is noted. As with the 40-meter adjustment, it may be necessary to make a slight change in the position of the matching coil tap before exact resonance can be achieved.

If you wish to operate at a higher frequency in this band, you can tap up one or two turns from the bottom of *L2* and bring this tap out to another tip jack at the coil's base. By plugging a jumper between this tap and the bottom of *L2* the resonant frequency of the system will be raised a number of kilocycles. Another method for QSYing on 75 is to resonate the antenna near the high frequency end of the band. Then a short pigtail may be clipped to the whip where it emerges from the top of *L1*. The added capacity of the pigtail will lower the resonant frequency by a significant amount.

To tune the radiator for 20 meters, disconnect the antenna and feed r.f. to the bridge at

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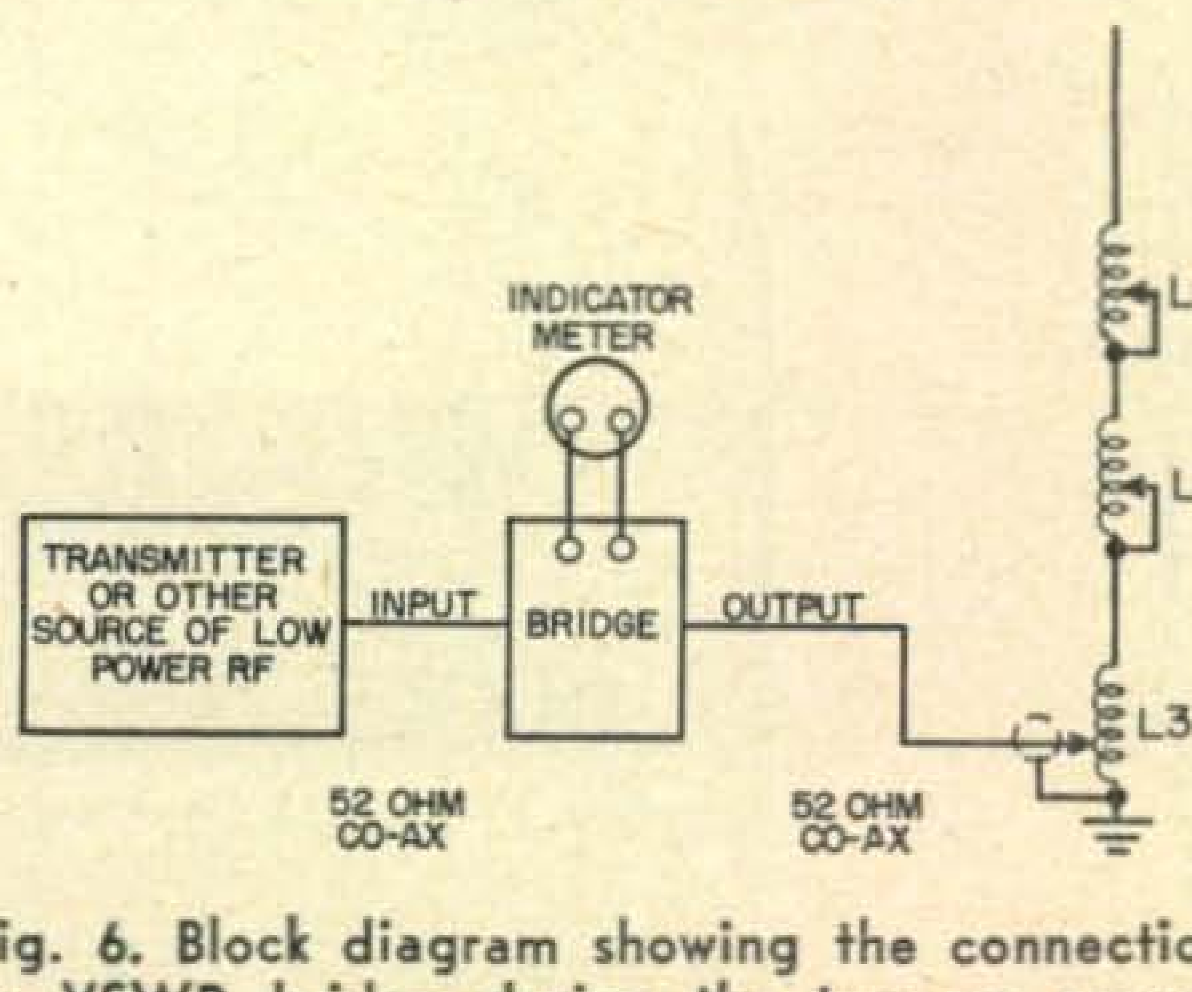

Fig. 6. Block diagram showing the connections to VSWR bridge during the tune-up process.

6-BAND ANTENNA

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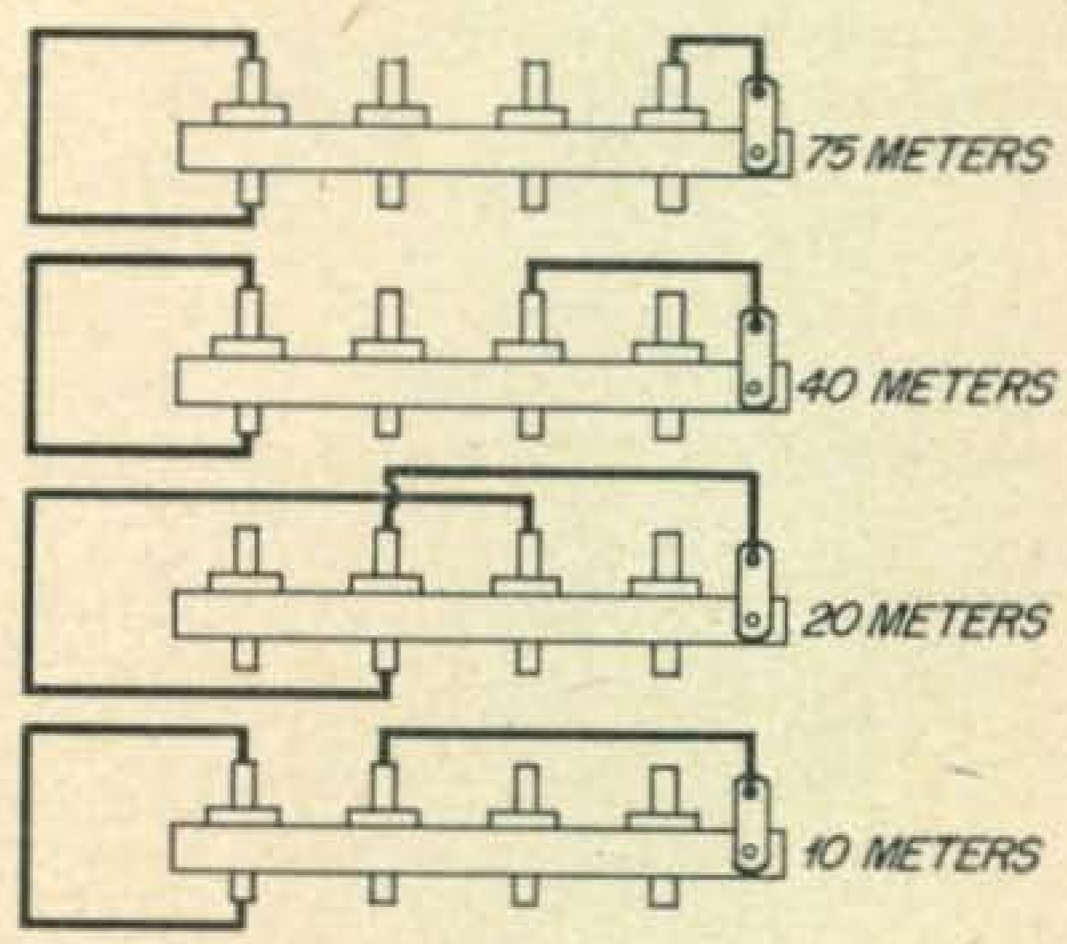
a frequency of 14,250 kc. Reconnect the antenna and short *L2* with the appropriate jumper. Plug the alligator jumper into the jack on *L1* and set the matching coil, *L3*, for 20 meters. Run the alligator clip up and down *L1* until resonance is indicated by a zero reading on the bridge indicator. As soon as the optimum tap position is located, solder a loop of wire on *L1* at this point. Then, whenever 20-meter operation is desired, the alligator may be clipped to the same spot with no difficulty.

The adjustment for 15 meters is quite simple. Put the matching coil on the 10-11-15 meter position. Remove the bridge from the circuit and feed 15-meter energy directly from the transmitter to the antenna. Find the tap position on the top coil which provides maximum



This sketch shows the correct positions of the jumpers on L3, the matching coil at the base of the antenna. Compare this drawing with Figures 3 and 4.

field strength as shown on a nearby sensitive field strength meter tuned to 21 Mc. As with the 20-meter tap, solder a loop of wire at this point so that it may be easily identified in the future.

No loading coil adjustment is required for either 10 or 11 meters. On both of these bands *L1* and *L2* are completely shorted out.

A word of caution regarding the foregoing adjustments is in order. Before tuning the antenna make sure that the trunk lid is closed and that the whip is fairly well in the clear—well away from power wires and tree limbs.

Since installing this multi-band antenna, I've overheard numerous comments regarding it and have been asked a great many questions about it. Wide-eyed youngsters inquire if I have TV in my car, while curious Hams are anxious to know if the contraption works.

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Despite a transmitter input of only 15 watts, the antenna does a good job on the bands for which it is designed. Most contacts made on 75 are of a ground wave nature with reports equal to or better than those given nearby mobiles employing single-band commercially built transmitting antennas. When conditions have been favorable, satisfactory 75 meter QSO's have been made at distances up to 250 miles.

FREQ. KCS	L1	L2
3850	NO JUMPER	NO JUMPER
3950	NO JUMPER	JUMPER FROM A TO B
7250	NO JUMPER	JUMPER FROM A TO C
14250	JUMPER FROM D TO E	JUMPER FROM A TO C
21350	JUMPER FROM D TO F	JUMPER FROM A TO C
27000	JUMPER FROM D TO G	JUMPER FROM A TO C
28750	JUMPER FROM D TO G	JUMPER FROM A TO C

Loading coil tap positions for various frequencies in the six amateur bands.

Almost all 40-meter contacts are with stations more than 300 miles away. Reports have ranged from S5 to S9. Although not too much 20-meter operation has been attempted, a number of excellent ground wave contacts have been made. Little skip has so far been worked. It seems as though every time I try 20 it is either dead or else is loaded with DX. Neither condition is good for long haul mobile work.

At those times when 15 and 10 are open, QSO's via skip can be had with little difficulty. Due to lack of activity on the band, no 11-meter work has, up to now, been attempted.

If you've been looking for an inexpensive, efficient and highly versatile mobile antenna—one which can be constructed with ordinary hand tools—this 6-band job should adequately meet your requirements. Build it and enjoy the fun denied those unfortunate fellows whose antennas restrict them to one narrow segment of the radio spectrum.

TEST EQUIPMENT

(from page 29)

the coils, for overlapping bands, and the calibration. The coil winding problem can be reduced somewhat by the use of a circuit such as that shown in *Fig. 1*. With this type of circuit the coils require no taps or secondaries, which makes pruning easy. For the low ranges almost any pie or bank wound r-f chokes may be used as tuning coils. To isolate the output and give greater stability the oscillator may be followed by a cathode-follower type amplifier.

Calibration

Even though we have reduced the headache of coil winding, calibration is still a difficult