CQ Reviews: The Millen Model 90652 Solid-State Dipper

BY WILFRED M. SCHERER,* W2AEF

SEVERAL years ago *CQ* reviewed the Millen Model 90651-A Grid-Dip Oscillator,[1] a revised version of the famous original unit, the Model 90651, both of which have become standards in the amateur and industrial field. The Millen people have now come up with a solid-state version, the Model 90652 which overcomes the most objective shortcomings heretofore experienced with solid-state dippers. As a matter of fact, the Model 90652 provides performance equal to or better than that realized with many vacuum-tube jobs; plus some additional features.

It has high sensitivity with deep and sharp dips, Hi-Q with good coupling to test circuits, Q-multiplier setup for increased sensitivity and sharp responses with absorption-type operation at energized circuits (otherwise customarily conducted as straight low-Q diode detection), headphone jack, self-contained battery operation for convenient handling and instant performance.

The instrument case has a 1/4-20 tapped socket hole for attachment of a wrist strap or other retaining device to prevent dropping the dipper from locations such as at antenna towers. A handy polypropylene carrying case also is supplied.

Retained are original attributes such as frequency coverage of 1.7-300 mc[2] overlapping in seven ranges, protected inductors, built-in meter, rugged construction, absence of spurious dips, one-hand operation, 2% frequency calibration on a drum dial, anti-backlash drive mechanism.

Circuitry

The circuitry for the Millen Solid-State Dipper is shown at fig. 1. The oscillator employs a 3N128 single-gate MOSFET operating in a split-Colpitts circuit with the resonating tank connected between the drain and gate of the MOSFET. As usual, the circuit is tuned by a split-stator variable capacitor with its rotor grounded. The MOSFET source is at r.f. ground through a bypass capacitor.[3] The amplitude of oscillation is controlled by a potentiometer, R_3, that varies a d.c. potential appl'ed to the source. This is the DET.-OSC. control which is used for Q-multiplier operation as explained later.

Operating potential is applied to the MOSFET drain which is at an r.f. potential, because one side of the oscillator tank is connected to it. The voltage-supply source must therefore be r.f.-isolated from the drain. In a vacuum-tube job, the isolation (similarly required at the tube plate) can be simply handled by a series resistor of several thousand ohms; however, it cannot be as simply accomplished with a transistorized setup, because the voltage drop would be too high. This could be avoided by use of an r.f. choke, but another problem would arise due to the virtual impossibility of obtaining a satisfac-

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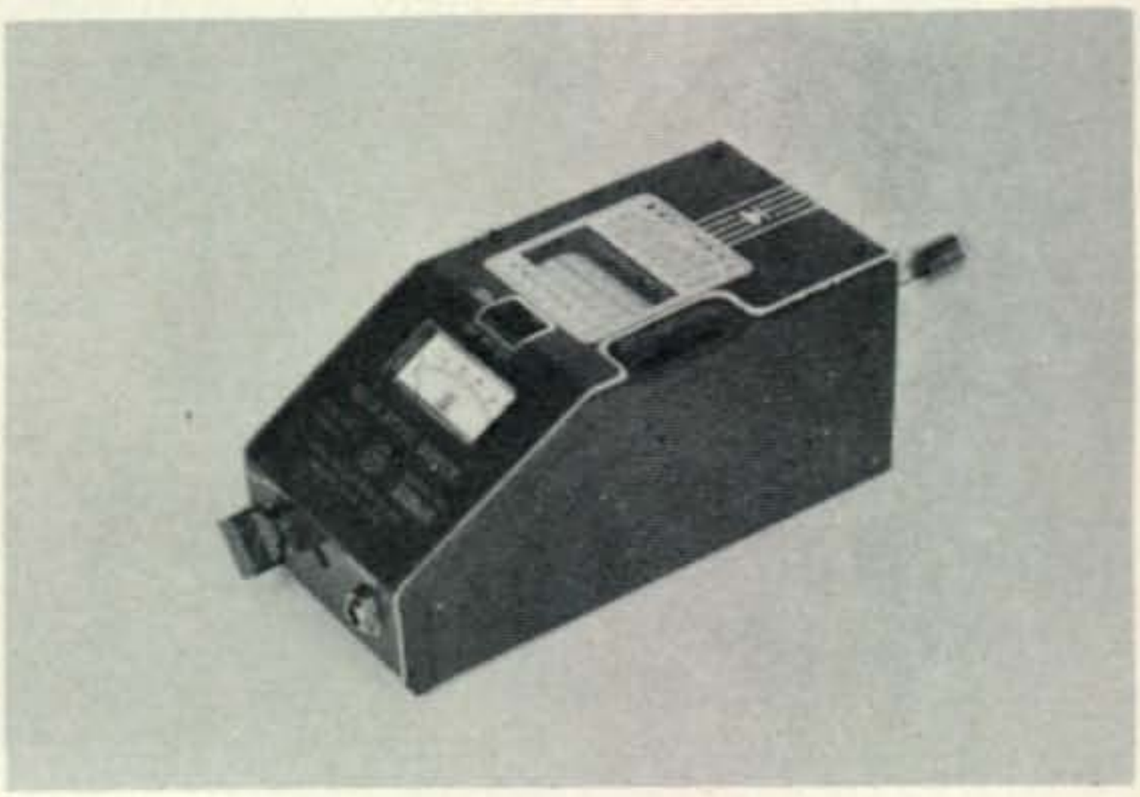
[1]"*CQ* Reviews The Millen Model 90651-A Grid-Dip Meter," *CQ*, May 1968, p. 62.

[2]Extended to 1.6 mc in this model.

[3]This is a specially fabricated capacitor that eliminates erratic operation and avoids spurious dips. It has no leads and is built into the tuning-capacitor frame. It is located directly at the source socket terminal for the MOSFET.



The Millen Model 90652 Solid-State Dipper.

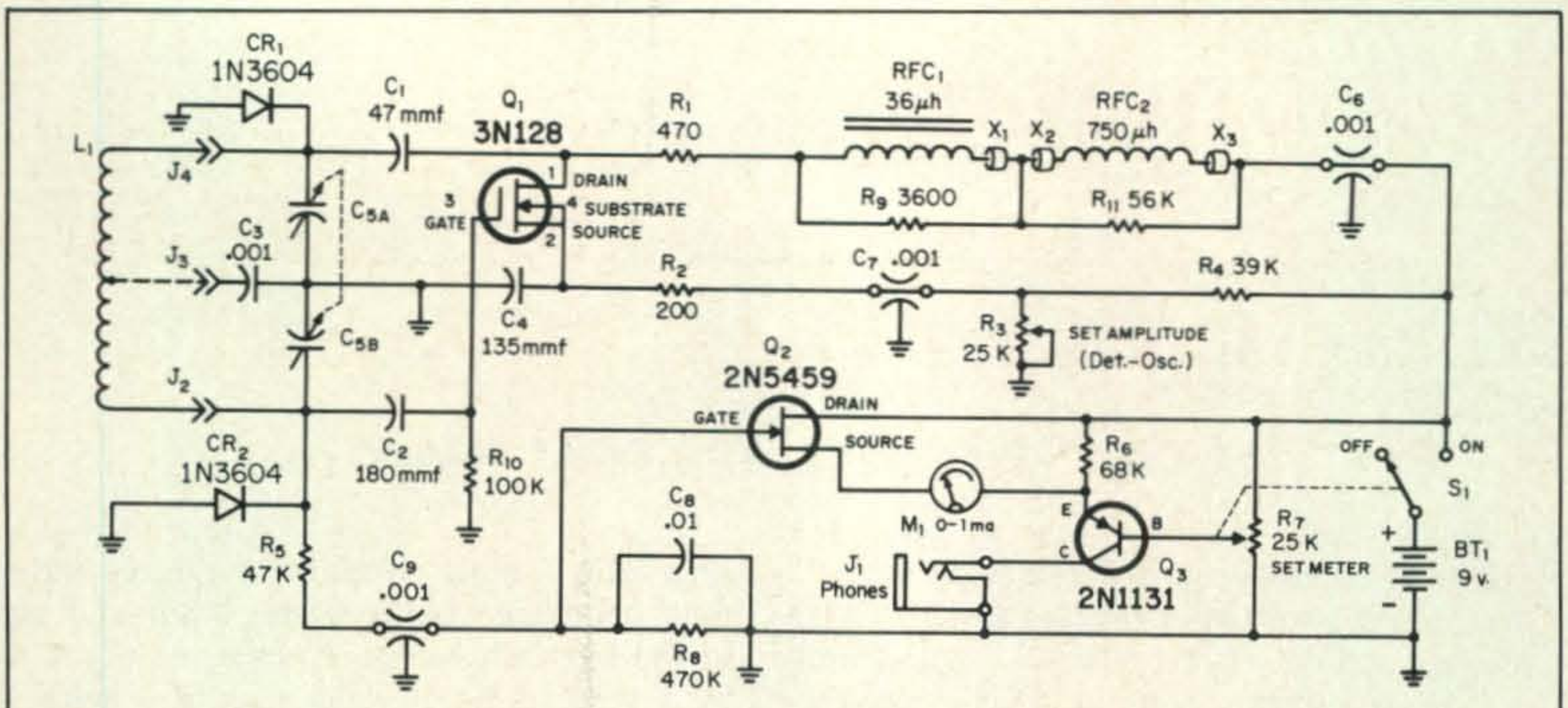


Fig. 1—Circuit diagram for the Millen Model 90652 Solid-State Dipper. Details are given in the text. J_3 is for use with l.f. inductors which will be available on special order.

tory single choke for operation over the wide frequency range of the unit.

In the Millen job the situation is taken care of by a network consisting of a small-value resistor, R_1, in series with two series-connected different-value r.f. chokes, RFC_1-RFC_2, one of which has an iron core, each swamped with a resistor. These primarily handle the isolation at the lower and middle frequencies. Three ferrite beads, X_1-X_3, enhance the required isolation at the higher frequencies. This setup permits a smooth and wide frequency range of oscillation without spurious "holes." As with the Millen vacuum-tube units, spurious dips or suckouts also are avoided by bonding straps between part of the case and selected points on the chassis.

Metering

The r.f. potential across the oscillator tuned circuit is indicated by a meter whose reading dips when the circuit is resonated with the test circuit to which it is coupled. The metering arrangement is activated by a d.c. potential obtained from a full-wave rectifier across the oscillator tank. Two 1N3604 diodes, CR_1-CR_2 are used. This setup provides deeper and sharper dips than those obtainable with a half-wave rectifier at only one side of the tank. The two diodes also provide *some* protection from strong r.f. fields that might otherwise damage the MOSFET.

The d.c. potential is applied to a 2N5429 JFET d.c. amplifier in the source circuit of which is a 1 ma meter. The meter circuit itself is the zero-suppressed type; that is, readings are indicated for only the upper portion of the current range. This, in effect, provides an expanded scale in the useful working area and thus further contributes to deep dip indications.

The suppressed zero, or the delay in readings below a certain current, is obtained with a bias applied to the JFET *source*. This bias is obtained from a stiff voltage divider and is controlled by the emitter-collector junction of a 2N1131 bipolar transistor which forms one leg of the divider in series with the source return of the JFET. The current through the 2N1131 transistor, and thus the bias for the JFET, is adjusted by varying the base bias on the 2N1131. This is handled by the METER-SET control, R_7.

A jack in the source return is furnished for headphone use as may be desired in some applications.

Q-Multiplier Setup

One function usually provided with a dipper is that of diode detection for utilizing the instrument as an absorption-type detector or frequency meter at energized circuits. The Model 90652 goes this one better by allowing the oscillator to function as a Q-multiplier which markedly increases the sensitivity and provides sharper peak readings as the unit is tuned to the frequency of energized circuits. This is realized by setting the DET.-OSC. control to the point just below where actual oscillation commences which is where regeneration is produced.

Construction

The type of construction, size and styling

The Millen Model 90652 Solid-State Dipper with carrying case.

with a sturdy copper-plated case are the same as that of the Millen vacuum-tube models; however, the weight is only 2½ lbs (with battery) compared with 4¼ lbs for the other models.

The meter has a taut-band suspension and thus is less susceptible to mechanical shock or sticky operation.

The tuning capacitor is driven by about a 1.75:1 anti-backlash gear train operated by a knurled thumbwheel attached to the drum-dial shaft in an arrangement that conveniently permits one-hand handling and operation of the instrument.

The inductors for the different ranges have molded form-fitted plastic covers. They are marked as to frequency and are color- and letter-coded to correspond to the related ranges at the drum-dial window where the frequency range for each inductor is also indicated opposite the corresponding scale on the dial.

Hi-Q and efficient operation on the highest range (120-300 mc) is enhanced with a silver-plated inductor. High-Q with better-than-usual coupling to the test circuit on the lowest range (1.6-3.5 mc) also is maintained by a specially-wound inductor with a powdered-iron core.

The instrument is powered by a self-contained 9-volt transistor-radio alkaline battery. The estimated battery life is up to 6 months when the dipper is operated 2 hours per day. The power is turned on with the METER-SET control which is operated by a black knurled thumbwheel that shows a yellow band around its edge whenever the battery is engaged.

Operation and Performance

Except for some of the control adjustments, operation of the 90652 in general is similar to that employed with other instruments of like nature. For conventional dipper use (on de-energized circuits) the DET.-OSC. control is advanced fully clockwise to the OSC. position. The METER-SET control is advanced to apply the battery power and is turned to the point where an initial meter reading of one-half scale or more is obtained. Because of the suppressed-zero, the meter will not produce a reading until the control is advanced quite a way. The instrument is now set for g.d.o.-type operation.

During such operation, good coupling plus positive dips of good depth were obtained on all ranges with our unit. No spurious suckouts or dips were experienced at any time. With the METER-SET adjusted for a full-scale reading at the maximum-obtainable current point on any range, an on-scale reading was indicated at any frequency within the associated range. No readjustment of the METER-SET was necessarily required, although at one end of two ranges the meter reading dropped toward the lower end of the scale in which case, further advancing the control to raise the reading in the particular area might be desirable for more convenient observations. Of no consequence, as far as operation goes, is that because of the type of metering setup, a meter reading may still be had when the METER-SET control is well advanced and no inductor is installed.

Frequency calibration of the instrument, checked with a frequency counter, was within the manufacturer's specification of 2% tolerance. This relates to that when the oscillator is decoupled from a test circuit, inasmuch as the oscillator frequency can be "pulled" by a test circuit, depending on the degree of coupling between the two. For maximum frequency accuracy, the least coupling should be used that still enables a dip indication to be had. This is a requisite with any other similar instrument used in like applications.

Detection Use

As described earlier, absorption-type detection at energized circuits is obtained by operating the dipper as a Q-Multiplier. This function is set up by rotating the DET.-OSC. control toward the DET. position, until the meter reading suddenly drops or fails to continue to fall. This will be at the border of os-

[*Continued on page 96*]

CQ Reviews Millen Dipper [*from page 66*]

cillation and the point of regeneration where the detecting sensitivity and Q are high. In our tests, the sensitivity was five- to ten-times greater than that found with the customary diode-type detection of other instruments.

Furthermore, responses were sharply peaked without the broadening effect otherwise due to the diode-loading effect experienced with the usual g.d.o. or dipper devices. With Q-Multiplier operation a very slight change in frequency calibration was noted; however, this was less than that experienced with a switch between the oscillate and diode mode with conventional instruments.

Diode-type detection also may be had with the 90652 simply by further reducing the setting of the DET.-OSC. control to below the regeneration point.

Headphone operation for detecting beat notes with other signals, while using the oscillate mode, also was considerably more sensitive than with conventional-type units.

As mentioned earlier, the oscillator MOSFET s protected against overload-damage to *some* degree; nevertheless, care should be taken to avoid operation close to very strong r.f. fields. Should any damage result, the 3N128 MOSFET is a low-cost type that is relatively easy to obtain. In addition, it plugs into a teflon socket, making replacement a simple matter. The effect on calibration will be negligible.

The solid-state dippers operate at lower power levels than do vacuum-tube jobs and thus do not put out adequate power to operate the customary r.f. bridges used in the amateur field. They also are weaker as a signal source for other applications such as with receiving equipment, but in some cases this may be an advantage, since stronger signals tend to overload a receiver and generate confusing birdies.

The Millen Model 90652 Solid-State Dipper is priced at $110 with battery and carrying case. Also included are instructions for using the device in various applications.[4] It is a product of James Millen Manufacturing Co., Inc., 150 Exchange Street, Malden, Mass. 02148.

—*W2AEF*

[4]For those not familiar with the applications and methods of use for dippers, a three-part article on the subject may be found in the May, June and July 1968 issues of *CQ* under the title of "Using the Grid-Dip Meter."

C.W. Results [*from page 54*]

to put up a dipole and make Malta availabl to the boys on 28 mc.

You can thank Kjell, SMØCCE for mak ing 4U1ITU available in the contest. He di the operating in both the c.w. and phone sec tions of the contest. (I believe there wa some token operation by others during th phone week-end.)

What do you do when it's so cold in th shack that the Vibroplex is sending out a di when you want a dah? Dick, F2QQ jus QRT, but not before he had run up a winning score on 40. (Me, I have no such problem with the old pump handle I use.)

Here's a potential member for the QCWA Nick UB5OE has been hamming since 1927 so the boys over there date back quite a spell too.

Bob, VS6AE was an ex-VS6 less than a week after his contest operation on 21 mc. He is now back in West Australia so maybe another one in Zone 29 in November.

That winning all-band score by ZS3AW didn't come easy for Jurgen, DJ3KR the station operator, even with the use of a rombic that eventually conked out anyway. The station is located at an ionospheric research center and the high powered pulse transmitters used for sounding purposes raised havoc when they were in operation, 15 minutes out of every hour.

Where was W3MSK in the contest? Oh! they were in there all right, but now signing W3AU. Ed has joined the confusing two letter brigade.

We again want to thank the many European contest managers who processed the logs of their respective clubs. Especially Milos Prostecky OK1MP, Werner Stiehm DJ8SW, Wojciech Klosok SP9PT, J. Matzon HA5FA and Klaus Voight DM2ATL.

The same old crew with two new additions over here. Andy Malashuk W1GYE, Bob Entwistle W1MDO, Freddie Caposella W2IWC, Bernie Welch W8IMZ and two new members, Ralph Nichols W1CNU and Gene Walsh K2KUR. I had better not leave out Joan of the *CQ* staff, or she will not save all those pretty stamps for me when she opens those overseas entries.

That's it for this one, now you can start your letters of complaints, or maybe a few kind words for your hard working Committee?

73 for now, Frank, W1WY