A Substitute for Meters in Bridge Circuits

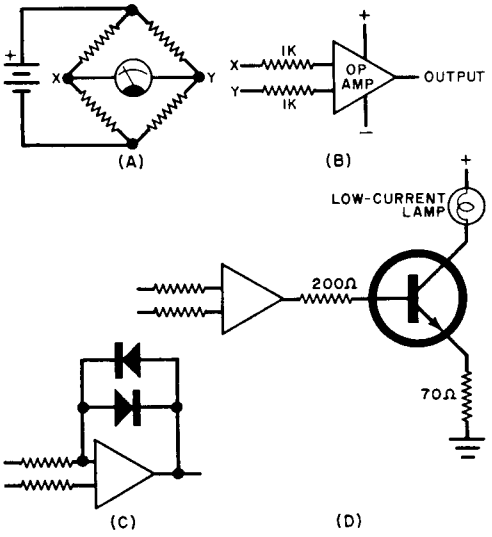
BY ED FRIEDMAN

ONE OF THE MOST common and useful electronic measurement circuits is the Wheatstone bridge (see Fig. 1A). In its usual form, a zero-center microammeter or milliammeter is used to indicate a null when the four legs of the bridge are balanced. There are, however, some disadvantages to this arrangement: the meter face must be relatively large to provide accurate readings, the meter cannot be subjected to much mechanical abuse, and a good-quality zero-center meter is fairly expensive.

If an accurate null indication is all that is required, there is a good, inexpensive way to avoid the zero-center meter. The idea is to use an operational amplifier integrated circuit as a high-sensitivity voltage comparator. The basic circuit is shown in Fig. 1B. Inputs X and Y to the op amp are connected to the same points on the bridge. Polarities are not important. A conventional VOM or VTVM can then be connected to the output of the op amp to indicate when the bridge is balanced (within a couple of millivolts in most cases). The null point is determined by the point that just causes the meter to change indication. The small amount of offset voltage within the op amp can usually be disregarded.

For extreme accuracy, however, a suitable offset voltage can be applied to make this minute correction. To limit the output swing, parallel back-to-back diodes can be connected from the output to the input of the op amp as shown in Fig. 1C. If germanium diodes are used, the swing will be limited to about 0.3 volt; with silicon diodes the swing will be about 0.7 volt.

If you want to eliminate the meter entirely, a lamp driver circuit such as that shown in Fig. 1D can be used. Any switching transistor, capable of handling the lamp current may be used. The emitter resistor which limits the cold filament current flow is optional. The base resistor limits the output current of the op amp when the transistor saturates. Of course, the lamp may be replaced by a low-current relay to control external equipment. The indication of null occurs just as the lamp changes states—that is, goes from off to on in one direction of the balance; and from on to off in the other direction. ◈



The zero-center meter in the standard Wheatstone bridge (A) can be eliminated by using an op amp as in (B) with a VOM. To limit output swing, two diodes are used as in (C). Circuit (D) eliminates a meter altogether by using another transistor and small lamp.