Measure Torque With Electronics

All it takes is the right transducer and a 2-transistor circuit

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UP to now, no really simple and practical method of measuring positive and negative torque with any precision has been available. This has been even more true of simultaneous evaluation of torque and rotating speed—that is, power.

In most torque measurement methods, practical installation is delicate because the torque detector or transducer rotates with the shaft. Then the signal coming from the transducer must be sent to fixed instruments. This is frequently done with a brush and slip-ring arrangement, which presents a number of difficulties.

In the proposed system, torque between a driving shaft and a driven shaft is detected by a deformable coupling part between shafts. This part can be made of elastic bars (Fig. 1), which take a helicoidal distortion which is function of the torque. The distance between the two end pieces varies with torque and all we have to do is measure the distance variation to find the torque.

The mechanical arrangement shown in Fig. 1 is one of the simplest possible methods. There are a number of variations designed to avoid axial forces on the shafts, increase precision, improve linearity, etc. The basic principle is to transform a torque variation into a length variation, and to measure the change in length.

Precision length measurement is comparatively easy. But in this case the parts rotate, so new methods or variants of known methods are needed. In one proposed form, the length variation produces an axial displacement of a disc which rotates in front of a fixed-position detector. The output of the detector gives the torque by direct reading. The exact details of the method vary somewhat with the particular application.

For example, in Fig. 2, the rotating and axially moving part is a ferrite-cone magnet. It has alternate N and S poles as shown in Fig. 3, and rotates in front of two magnetic cores carrying windings. The alternating energy produced in the windings by the rotating ferrite ring varies inversely with the air gap between ferrite and magnetic cores. Consequently, this energy is a function of the axial position of the ferrite cone, that is of the torque. In this way, the output signal of the device can be calibrated in terms of torque.

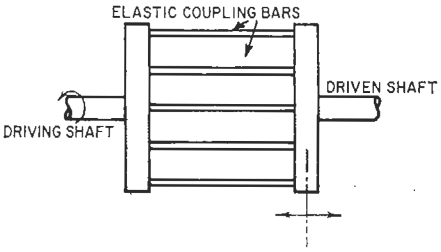

Fig. 1—Torque is transformed into an axial variation of length by elastic coupling bars.

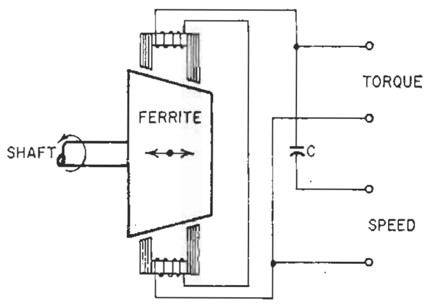

Fig. 2—Displacement detector using a ferrite cone.

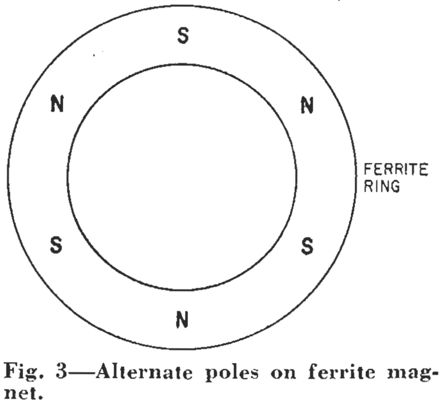

Fig. 3—Alternate poles on ferrite magnet.

By using an extra pair of output connections and a capacitor, the frequency of the signal produced can also be measured directly, giving the rotating speed of the shaft too. Both measurements can be combined in a suitable meter to give a product reading which indicates transmitted power.

The output signal from the device may be large enough to control—without additional amplification — rugged measuring instruments or automatic regulation systems.

In another arrangement (Fig. 4), the axial displacement of a disk is transformed into a capacitance variation. This in turn can be transformed into a frequency variation with the circuit of Fig. 5. The frequency variation can then be processed by standard circuits, depending on the type of application, and used for measurement, regulation, etc. The same principle could be used with an inductance variation. Note that all the proposed arrangements give an indication which is independent of parasitic rotation effects and, in particular, of buckling.

Fig. 6 shows, in somewhat simplified form, a torque measuring instrument that uses only two European transistors. The US equivalents are:

OC76—2N188
OC72—2N188-A

One transistor is a low-frequency oscillator producing a 100-cycle signal with a base-to-emitter coupling. The output signal across the secondary winding of the transformer is applied to displacement detecting coil L, as indicated before. The variable signal, carrying the torque-variation information, is applied to the base of the second transistor, which detects and amplifies it. A meter in the collector circuit reads torque directly. END

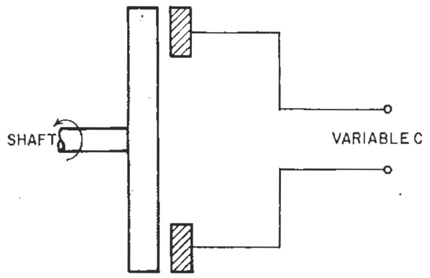

Fig. 4—Capacitance variation type of displacement detector.

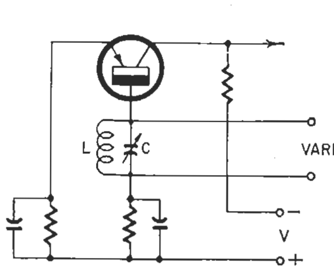

Fig. 5—Variable frequency oscillator.

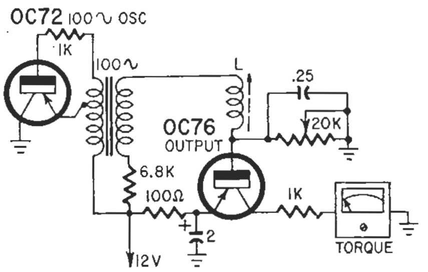

Fig. 6—Transistor torque measuring instrument.