inertia loads and severe transients it is high time to consult an expert. Some important literature sources are:

MacColl, L. A., "Fundamental Theory of Servomechanisms," New York, D. Van Nostrand Co., 1945.

Bode, H. W., "Network Analysis and Feedback Amplifier Design," New York, D. Van Nostrand Co., 1945.

Batcher, R. R., and Moulic, W., "Electronic Control Handbook," New York, Caldwell-Clements, 1946.

Smith, E. S., "Automatic Control Engineering," New York, McGraw-Hill Book Co., 1944.

Greenwood, I. A., Holdam, J. V., and MacRae, D., "Electronic Instruments," New York, McGraw-Hill Book Co., 1948.

The mathematical treatment of transient response is still an active field of research. Practical designs have not lagged too greatly behind the theoretical advances and the late war provided many examples of high power servos controlled by relatively feeble primary impulses. These included fire control, gun-laying, and numerous position stabilizing systems.

A great convenience is the extensive number of components available for translating linear or angular displacements into equivalent electrical quantities or simple mathematical functions thereof. These include synchros, rotatable transformers, differential synchros, etc. Several companies and numerous consultants can design servosystems to meet almost any requirement.

The velocity of sound through liquids and gases has been measured time and again since Kundt's early work and usually with so much attention to elementary definitions that few new approaches have arisen. Conventionally, one toots into one end of a tube and measures the time for the sound wave to reach the far end. Alternatively, one locates nodes by a movable receiver and by these and other modifications can get a reading relating to the composition of the medium. To play safe, one calibrates the entire system empirically. General Electric feeds an impulse into one end of a resonator, picks it up at the far end, amplifies slightly, and feeds it back at the input. The system soon resonates at a period governed by the speed of sound in that medium. A frequency meter in the amplifier circuit provides the information. This is the equivalent of the old trick of holding a telephone receiver in front of the transmitter mouthpiece.

A simple balance can be loaded progressively and the beam deflection can be measured photoelectrically. To follow the progressive change in weight as a function of time, would require a constant light source, stable phototube and amplifier, and uniform deflection sensitivity of the balance. The servomechanism principle would pass the amplified photocurrent through a solenoid in the core of which a soft iron counterweight was hanging, suspended from the opposite pan of the balance. The solenoid current would be recorded in this case. The sole drawback of this improved technique lies in the very careful design required to produce a solenoid in which the pull on the suspended core is strictly proportional to the current, even over a limited range.

The self-balancing potentiometer of Gilbert and as used in the General Electric Autopot admits the e.m.f. to a mirror galvanometer and projects a beam of light on a twin phototube. The amplified photocurrent may be used as an accurate measure, of the input voltage provided this current is used to generate an R_i drop, through a resistor, which is applied back to the galvanometer in series-opposition to the unknown e.m.f. This principle has been improved to the extent of removing the residual disadvantages of a delicate galvanometer. In place of the latter a deflection vane moves in the plane of two oscillator coils. For an oscillator frequency of 30 megacycles or more, a vane motion of a few thousandths of an inch is sufficient to stop oscillation and produce large changes in the D.C. plate current. These are fed back to the vane deflector coil for cancellation. It has been found advantageous to use a separate compensator coil in order to isolate output from input. Even temperature compensation is achieved by temperature sensitive shunting networks. This system is immune to severe shock or vibration.

Null methods have long enjoyed their place in precise measurements. What is relatively new is the general concept that a power device can detect errors, evaluate sign and magnitude, and apply corrective forces much more rapidly than an operator.