THE BROOKS FLOWMETER-FLOW CONTROLLER

GENERAL DESCRIPTION

A variable-area-type vertical flowmeter-flow controller for farm delivery turnouts has been recently developed and manufactured by the Brooks Instrument Division, Emerson Electric Company, Hatfield, Pennsylvania. The Brooks meter combines into a single unit the capability for (1) rate-of-flow measurement and indication and an integrator for totalized-flow read-out, (2) flow control to limit flow to a maximum preset rate, and (3) starting up and shutting down of the main delivery by simply turning on or off a small (1/2-inch) external valve. Electrical power supply is not required to operate the meter except internal power supplied by batteries is required for the integrator unit that totalizes the flow.

The principle of flow measurement is basically of the variable-area-type. The flow control is essentially a self-regulating hydraulically actuated servomechanism using an internal pressure chamber and sleeve valve arrangement.

The Brooks flowmeter is basically a variable-area-type which takes the form as shown schematically in figure 1. In reference to figure 1, water enters the meter vertically from the bottom, flows
upward and around the "metering float" (actually a weight) in a conically tapered tube, or variable-area throat, whose area increases with height.

Schematic of Variable-Area Flowmeter

Figure 1

The metering float moves upward in response to increasing flow rates and allows passage of the water through a proportionately larger area. The position of the float in the "tapered tube," or "variable-area throat," is determined by the balance of the upward thrust of water flowing and the submerged weight of the metering float. The shape of the float and the tapered tube causes the float
to seek a unique elevation for a given discharge. Therefore, the meter can be calibrated in desired units of flow.

In the Brooks meter, the conversion of the metering float elevation to an indication of the instantaneous rate-of-flow is accomplished by the use of a permanent magnet attached to the top end of the float extension rod. The vertical movement of the float extension rod is guided by bearings and is isolated from the indicator except for the magnetic force produced by the permanent magnet. The magnetic force of the magnet attracts the leading edge of an external helix shaft. The external helix shaft rotates when the vertical position of the permanent magnet changes in direct response to a change of the rate-of-flow through the meter. Figure 2 shows an isometric view of the indicator and integrator unit (the refinements have been excluded for simplicity reasons).
The rate-of-flow of indicator is a pointer attached to the top of the rotating helix shaft. The position of the pointer indicates the flow on a scale calibrated in desired units.

A horizontal cam, also attached to the top of the rotating helix shaft, is used to totalize the flow through the meter. A contact lever timed and operated by an electric clock and motor (which uses batteries as their power supply) touches the cam once every minute. The distance the contact lever travels, from its rest position to the leading edge of the cam, is proportional to the rate of flow.
Each "stroke" of the contact lever taken at the 1-minute time intervals can therefore be converted into a volume of flow and is accumulated by a digital dial counter.

The indicator-integrator unit is housed on top of the meter in a moisture-dust-proof cubical. A window is provided in the cubical lid for a visual read-out of the indicator and the totalized flow counter.

FLOW CONTROLLER DESCRIPTION

The Brooks meter flow controller feature limits the flow through the meter to a maximum preset value. The maximum rate-of-flow (once it is set) is maintained over a wide range of pressure heads from free-flow to the maximum designed head (typically 2-1/2 to 175 feet).

In reference to figure 3, which illustrates the cross-section of the Brooks flowmeter-flow controller, the desired maximum flow is preset manually by adjusting the "pilot valve seat" by means of the "set point handwheel." The set point handwheel is located inside the cubical for the indicator-integrator unit and has its own capacity scale for selecting the desired flow to be maintained. From this point on, the flow control action is essentially a self-regulating hydraulically actuated servomechanism.

Attached to the metering float extension rod is a beveled seat which mates to the "pilot valve seat." The pilot valve acts as a needle valve and regulates flow through the "bypass relief."
Figure 3 - Cross-Section Brooks Flowmeter-Flow Controller
When the pressure head on the main lateral increases, the flow through the meter will increase and the metering float will close the pilot valve stopping flow through the bypass relief. When this happens, pressure builds up inside of the pressure chamber above the control piston which is freely sealed with respect to the meter body by a "flexible diaphragm." As pressure increases on the control piston, the "sleeve valve," which is attached, is forced downwards. The sleeve valve contains orifices which are shaped to restrict flow as the sleeve is lowered. The sleeve valve will continue to lower until a balanced condition is reestablished. Therefore, the increased pressure in the main lateral in excess of that required to just seat the pilot valve and that which caused the controlled action to take place, is consumed as head loss across the resulting smaller sleeve valve opening rather than the meter delivering more water.

When the pressure on the main lateral decreases, the reverse controlled action takes place. The pilot valve is opened wider causing the excess pressure on the control piston to be released through the bypass relief. The sleeve valve then rises creating a larger opening and less head loss and the desired preset value of flow is still maintained.

STARTING UP AND SHUTTING DOWN

To shut off the flow through the meter, all that is necessary is to close a small (1/2-inch) "external valve" on the bypass relief, figure 3. When the external valve is closed, flow through the bypass
relief is stopped (as occurs when the pilot valve closes) and pressure builds up on the control piston, and forces the sleeve valve to lower until it is completely closed shutting off the delivery. To start up the delivery, the external valve is opened decreasing the pressure on the control piston allowing the sleeve valve to rise. The sleeve valve rises until the preset value is reached at which time the self-regulation sequences as described previously takes over.

APPLICATION

The combination of a flow measuring device and flow control to a maximum preset rate over a wide variation of head would require less supervision of the turnout by district operating personnel. The water user, himself, can turn the flow controller on and off (according to his announced schedule) and be limited to the locked preset maximum delivery rate previously scheduled and set by operating personnel of the water district. The metering and control features of the Brooks meter can be adapted for future telemetering to a central operating console for monitoring and/or control of the farm delivery.

The complex Brooks flowmeter-flow controller is expensive by ordinary standards but it offers potential economic advantages from an operating standpoint, provided the meter is accurate enough and is relatively free of maintenance problems.