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GRISWOLD FLOW CONTROL VALVE—HYDRAULIC TESTS

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16. ABSTRACT

Four different Griswold flow control valves were tested and evaluated; they are anticipated for use on a pressurized sprinkler irrigation system. Tests were performed on each valve to observe discharge characteristics. Discharge accuracy was compared to the manufacturer's specifications. Debris conveyance was observed in two valves. Several kinds of debris were used and observed during the testing. Manufacturer's recommendations for screening debris were evaluated.

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UNITED STATES DEPARTMENT OF THE INTERIOR ★ BUREAU OF RECLAMATION

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PURPOSE

At the request of the Bureau's Pacific Northwest Regional Office, tests were conducted to evaluate the operational characteristics and maintenance requirements of several Griswold flow control valves. The valves were proposed for the Yakima Project, Tieton Division in the Yakima-Tieton Irrigation District in Washington State. Tests were performed to verify the manufacturer's specifications of performance and suitability for a pressurized sprinkler irrigation application.

INTRODUCTION

Flow control valves have been used on sprinkler irrigation systems for many years. However, their performance has not consistently satisfied the needs of both the user and system operator. Griswold flow control valves — Griswold Controls of Irvine, California — were tested to determine the capability for delivering a constant flow rate within a ±5 percent band over a design pressure control range.

The valves operate on the principle of orifice control. They respond to pressure differential by using a calibrated spring that adjusts the orifice area exposed to the flow which keeps the flow constant. Basic valve components are shown on figure 1.

These valves are available in four differential pressure ranges (1.3 to 20, 2 to 32, 4 to 57, and 8 to 128 lb/in^2) and have flow rates ranging from 0.5 to 12,750 gal/min. Four valve models were tested:

In the 8- to 128-lb/in² range, two flow control valves were tested:

- a 1½-inch threaded minivalve model (fig. 2) rated at 24 gal/min, and
- a 3-inch threaded cluster model (fig. 3) with three flow cartridges:
  - — a 95 gal/min,
  - — a 100 gal/min,
  - — a 150 gal/min, and

  having discharge ratings of: 100, 245, and 345 gal/min.

In the 4- to 57-lb/in² range, two flow control valves were tested:

- a 3-inch threaded inline model (fig. 4) rated at 100 gal/min, and
- a 10-inch flanged cluster model (fig. 5) with ten 100-gal/min flow cartridges delivering a total flow of 1,000 gal/min.

In addition to these discharge tests, the 3-inch threaded cluster valve and the 3-inch threaded inline valve were tested to obtain operational characteristics and to check maintenance rquirements under different debris loads at a flow rate of 100 gal/min at 50-lb/in² pressure differential.

SUMMARY

1. Discharge tests on the 1½-inch threaded minivalve compared with the manufacturer's specifications of a constant flow (±5 percent) over the 8- to 128-lb/in² differential pressure control range. The only major departure from acceptable values were data below the ±5-percent band by an additional 28 percent at the low end of the differential pressure range (10 to 15 lb/in²).

2. Discharge tests on the 3-inch threaded cluster valve showed varying degrees of comparison with that of the manufacturer — depending on the flow cartridges used. Flow cartridge combinations of 100 and 245 gal/min compared well at the lower back pressures applied to the valve. However, at 50- and 75-lb/in^2 back pressures, most data points fell above the ±5-percent band. The 345-gal/min combination was mostly above the manufacturer's ±5 percent band at all back pressures tested. An additive error effect in the discharge was noticed when each additional flow cartridge was inserted in the valve to obtain a higher flow rate.

3. Discharge tests on the 3-inch threaded inline valve compared fairly well with the manufacturer's specified flow accuracy. About one-half the data points fell above the ±5-percent band at all back pressures tested for the upper half of the pressure control range.

4. Discharge tests results on the 10-inch flanged cluster valve indicate excellent comparison with the manufacturer's flow accuracy. All data points fell within the ±5-percent band throughout the pressure control range.

5. Debris tests performed on the 3-inch threaded cluster valve and the 3-inch threaded inline valve affirm the manufacturer's debris recommendations. Using a U.S.A. standard sieve No. 20 upstream of the valve appears adequate for most debris loads. One should consider smaller sieve sizes for an irrigation project location subject to heavy silt or sand loads. The study showed the No. 20 sieve screened sand indicated a discharge reduction of 15 percent. Sand particles also fouled and hindered movement of the spring-controlled piston; consequently, the piston required cleaning to obtain design discharge. Pine needles and aquatic weeds plugged orifice areas and flow rates reduced as much as 70 percent. Test data from comparing the two 3-inch valve models subjected to similar debris loads showed no significant differences. Maintenance was not a problem on the 3-inch threaded cluster valve assembly; fouled or damaged flow cartridges could easily be removed and cleaned or replaced.

TEST FACILITY

Testing was done at the Bureau of Reclamation's Hydraulic Laboratory in Denver, Colorado. A high-head pump was used. Each of the four valves was placed in series with the pump (fig. 6). Pressure measurements upstream and downstream of the test valve were made with pressure transducers as indicated on figure 6. Transducer outputs were recorded on a chart recorder. The method for recording discharge through the flow control valves depended on the flow rate magnitude.

- Low flow rates (24 and 100 gal/min) were measured with a weighing tank.
- Midrange flows (245 and 345 gal/min) were measured with a calibrated orifice meter.
- The high flow rate (1,000 gal/min) was measured using a calibrated 8-inch venturi meter.

Upstream and downstream pressures could be adjusted by throttling gate valves on either side of the test valve.

Debris testing was done on the same piping arrangements as the discharge tests. A standard 6-inch tee was modified to hold a 200- to 400-mL debris sample which was injected into the flow (fig. 7) after a steady-state condition was achieved.

TESTING

Discharge Accuracy

1. The 1½-inch threaded minivalve was in the 8- to 128-lb/in² differential pressure range and had a 24-gal/min flow cartridge. Tests were run at five *back pressures* ranging from 0 to 75 lb/in² through the entire differential pressure range. Test results are in table 1 and on figure 8. Approximately two-thirds of the data points fell within the band (±5 percent of design discharge) set by the manufacturer. The only major discrepancy was in the lower end of the differential control range (10 to 15 lb/in²). In this range, data were below the acceptable operating range where some points were 33 percent below design discharge.

2. The 3-inch threaded cluster valve was in the 8- to 128-lb/in² differential pressure control range and had three flow cartridges that were tested at three design discharges; i.e., 100, 245, and 345 gal/min. These test results are in tables 2, 3, and 4 and on figures 9, 10, and 11, respectively.

- One 100-gal/min flow cartridge and two blanks were used during the 100-gal/min test. One-third of the data points fell above the ±5-percent band. These points occurred at *back pressures* of 50 and 75 lb/in² above 60-lb/in² pressure differentials.

- The 245-gal/min tests had two flow cartridges and one blank. Again, one-third of the data points were above the ±5-percent band. These points occurred at the 50-and 75-lb/in² *back pressures* but within the range of 25- to 110-lb/in² pressure differentials.

- The 345-gal/min test had all three flow cartridges in place. About two-thirds of the data points fell above the ±5-percent band. These occurred in the 30- to 110-lb/in² pressure differential range at *back pressures* of 40, 50, and 75 lb/in².

3. The 3-inch threaded inline valve was in the 4- to 57-lb/in² differential pressure control range and had a 100-gal/min design discharge. Test results are in table 5 and on figure 12. One-half of the data points fell above the ±5-percent band. Data indicate flow through the valve at a rate greater than design discharge at all *back pressures* applied (12 to 60 lb/in²) through differential pressures ranging from 20 to 57 lb/in².

4. The 10-inch flanged cluster valve was in the 4- to 57-lb/in² differential pressure control range and was set at 1,000 gal/min. The valve contained ten 100-gal/min flow cartridges and one blank. Test results are in table 6 and on figure 13. All data points fell within the ±5-percent band.

Debris Tests

Because of the operating concept of the Griswold flow control valve (adjustable orifice area), debris is a serious concern. The manufacturer recommends screening water to the valve with at least a U.S.A. standard sieve No. 20. Debris tests were run to verify the No. 20 sieve and to observe how the valve functions when larger debris enters it.

Debris tests were done on the 3-inch threaded cluster and the 3-inch threaded inline valves at a steady state of 100-lb/in² pressure *upstream* of the valve and 50 lb/in² *downstream* of the valve. A 100-gal/min flow cartridge was in place in each valve. In the cluster valve, the 100-gal/min flow cartridge was positioned below and slightly off center of the incoming supply line. A debris sample of 250 to 400 mL was placed in the injection chamber and, when steady-state operating conditions were obtained it was injected into the flow. After injection, pressure and discharge were monitored over a duration of 20 to 30 minutes.

Several types of debris samples were used in the testing. Sand was tested for several sieve sizes; i.e., U.S.A. standard sieve Nos. 6, 10, 14, and 20 (0.141-, 0.065-, 0.0331-, and 0.0168-inch openings), respectively. Dry pine needles in about 1-inch lengths were tested and some debris collected from traveling water screens in the project area. The latter debris consisted mostly of moss and other aquatic weeds.

All sand sizes were tested through the 3-inch threaded cluster valve; results are in table 7 and on figure 14. Clogging of the orifice areas is evident as shown on figure 15. However, clogging did not seem to be the major problem. When the flow cartridge was cleaned and replaced in between test runs, about 15-percent decline in maximum discharge was noted. This temporary loss in flow rate was due to fouling of the spring-loaded piston. Apparently, small sand particles lodged between the movable piston and the valve body and restricted piston movement. After more thorough cleaning, the valve operated at design discharge (before debris injection).

In addition to the sand sizes tested, dry pine needles and field collected debris were tested in the 3-inch threaded cluster valve. Results are in table 7 and on figure 14. Major portions of the orifice areas were plugged by those two debris (fig. 16). It is noted this material was unscreened and tested strictly to observe operation.

Several tests were run on the 3-inch threaded inline valve. Sand passing through a No. 20 sieve, dry pine needles, and field-collected debris were each tested in this valve. Results are in table 8 and on figure 17. Nearly identical results were found for the two 3-inch valves tested. Flow rate reduction was slightly less through the 3-inch threaded cluster valve (versus the 3-inch threaded inline valve), probably due to the increased turbulence near the flow cartridge caused by the larger chamber area (fig. 18).

Table 1. — *Discharge test results, 1½-inch threaded minivalve, 24-gal/min design discharge*

Pressure differential lb/in²	Discharge gal/min	Back pressure lb/in²
4	4.2	0 to 2
10	18.9	"
25	23.5	"
50	23.1	"
73	21.9	"
98	21.5	"
123	22.1	"
150	25.7	"
6	16.5	9 to 12
10	21.8	"
16	24.4	"
50	24.1	"
75	23.4	"
100	23.6	"
123	25.5	"
141	26.0	"
5	4.1	22 to 27
13	21.8	"
24	24.5	"
51	23.8	"
73	22.3	"
100	21.3	"
125	24.8	"
151	26.6	"
4	3.6	47 to 52
9	16.0	"
28	24.7	"
75	22.1	"
100	23.5	"
123	24.8	"
6	13.6	72 to 76
11	19.7	"
28	25.2	"
49	23.4	"
73	22.8	"
99	25.3	"

Table 2. — *Discharge test results, 3-inch threaded cluster valve, 100-gal/min design discharge*

Pressure differential lb/in²	Discharge gal/min	Back pressure lb/in²
5	83.1	2 to 5
10	98.1	"
25	101.9	"
50	100.9	"
75	102.4	"
100	101.9	"
125	101.9	"
150	110.1	"
6	81.3	19 to 26
10	93.4	"
25	103.3	"
50	102.7	"
75	104.3	"
100	104.3	"
124	102.4	"
164	116.3	"
5	72.2	49 to 50
11	98.1	"
25	103.6	"
48	104.0	"
76	107.5	"
101	105.8	"
125	106.0	"
150	114.9	"
6	83.1	74 to 76
10	98.7	"
25	103.9	"
51	103.3	"
74	107.8	"
125	107.2	"
150	116.2	"

Table 3. — *Discharge test results, 3-inch threaded cluster valve, 245-gal/min design discharge*

Pressure differential lb/in²	Discharge gal/min	Back pressure lb/in²
10	232.5	10 to 12
25	249.9	"
52	243.7	"
66	236.5	"
75	237.8	"
95	234.4	"
127	236.5	"
10	230.2	24 to 26
24	241.8	"
50	248.5	"
72	243.4	"
101	239.8	"
126	239.8	"
10	236.2	49 to 51
24	256.2	"
53	261.7	"
74	259.9	"
105	255.1	"
130	252.3	"
10	237.1	74 to 75
24	258.8	"
50	259.9	"
77	263.3	"
101	261.1	"
125	253.8	"

Table 4. — *Discharge test results, 3-inch threaded cluster valve, 345-gal/min design discharge*

Pressure differential lb/in²	Discharge gal/min	Back pressure lb/in²
4	234.8	15 to 17
5	275.2	"
8	298.2	"
10	309.1	"
12	332.8	"
25	349.8	"
27	364.7	"
28	361.1	"
20	357.1	35 to 42
29	362.5	"
50	362.5	"
75	368.6	"
100	365.6	"
120	355.8	"
153	368.9	"
7	257.6	49 to 51
9	305.1	"
25	360.7	"
51	369.5	"
75	374.3	"
101	270.4	"
124	360.3	"
150	379.8	"
5	263.7	75 to 76
9	305.6	"
10	332.4	"
24	367.6	"
50	369.3	"
76	377.7	"
99	377.3	"
124	366.5	"
150	389.9	"

Table 5. — *Discharge test results, 3-inch threaded inline valve, 100-gal/min design discharge*

Pressure differential lb/in²	Discharge gal/min	Back pressure lb/in²
10	103.1	12 to 16
20	104.6	"
30	105.9	"
41	102.5	"
52	108.9	"
60	115.5	"
70	120.4	"
1	97.0	18 to 23
26	100.6	"
12	102.1	"
20	104.0	"
27	104.0	"
40	104.0	"
48	105.9	"
60	114.9	"
70	118.5	"
0	100.2	30 to 32
6	104.6	"
10	105.9	"
21	107.4	"
31	107.1	"
38	106.8	"
50	110.0	"
60	116.9	"
70	124.6	"
0	96.0	60 to 42
5	100.9	"
10	101.2	"
19	106.2	"
31	108.3	"
39	107.1	"
50	113.5	"
60	119.8	"

Table 6. — *Discharge test results, 10-inch flanged cluster valve, 1,000-gal/min design discharge*

Pressure differential lb/in²	Discharge gal/min	Back pressure lb/in²
4	1000.9	9 to 12
10	1036.8	"
20	1036.8	"
30	1027.8	"
40	1018.9	"
51	978.5	"
60	1036.8	"
68	1104.1	"
5	996.4	18 to 22
8	1023.3	"
20	1041.3	"
30	1032.3	"
40	1032.3	"
52	996.4	"
60	1059.2	"
69	1131.1	"
1	987.4	29 to 32
5	1000.9	"
9	1023.3	"
19	1036.8	"
30	1032.3	"
40	1032.3	"
51	1005.4	"
58	1050.3	"
69	1144.5	"
0	942.6	38 to 41
6	1018.9	"
10	1032.3	"
20	1041.3	"
30	1036.8	"
40	1036.8	"
52	1009.9	"
59	1068.2	"
70	1144.5	"

Table 6. — *Discharge test results, 10-inch flanged cluster valve, 1,000-gal/min design discharge* — Continued

Pressure differential lb/in²	Discharge gal/min	Back pressure lb/in²
1	978.5	49 to 52
3	996.4	"
10	1027.8	"
20	1032.3	"
29	1032.3	"
39	1032.3	"
50	1005.4	"
60	1081.7	"
70	1166.9	"
0	978.5	60 to 62
3	991.9	"
9	1018.9	"
19	1032.3	"
29	1032.3	"
40	1036.8	"
52	1018.9	"

Table 7. — *Debris test results, 3-inch threaded cluster valve, 100-gal/min design discharge*

U.S.A. standard sieve No.	Debris type	Discharge, gal/min		
		Preinjection	Injection	Postinjection
6	screened sand	107.1	89.0	—
10	screened sand[1]	90.5	63.4	67.2 at 30 min
10	screened sand[2]	104.3	77.3	69.5 at 41 min
14	screened sand[3]	91.6	77.7	73.0 at 44 min
20	screened sand	102.0	88.8	88.8 at 49 min
1-inch dried pine needles		108.9	38.9	45.4 at 30 min
Field collected aquatic weed and fish eggs		106.6	71.9	76.7 at 15 min

[1] Reduced preinjection discharge because of piston fouling.
[2] Normal preinjection discharge - rigorous cleaning between runs.
[3] Reduced preinjection discharge because of piston fouling.

Table 8. —*Debris test results, 3-inch threaded inline valve, 100-gal/min design discharge*

Debris type	Discharge, gal/min		
	Preinjection	Injection	Postinjection
U.S.A. standard No. 20 sieve sand	99.6	96.7	91.5 at 20 min
1-inch dried pine needles	107.7	25.38	31.1 at 20 min
Field-collected aquatic weeds and fish eggs	108.2	71.6	72.7 at 25 min
Field-collected aquatic weeds	105.8	70.2	68.2 at 20 min

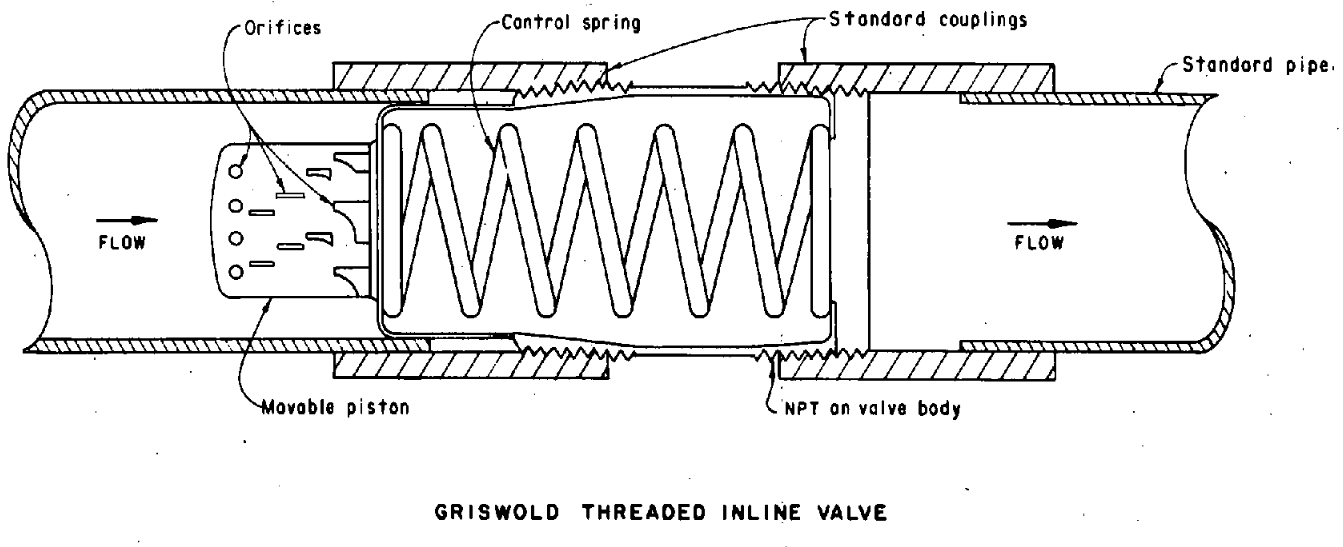


Figure 1.—Griswold threaded inline flow control valve.

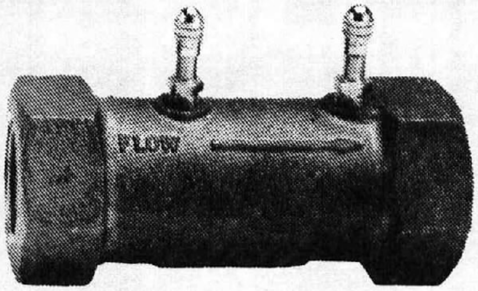


Figure 2.—One and one-half-inch threaded minivalve (flow control).

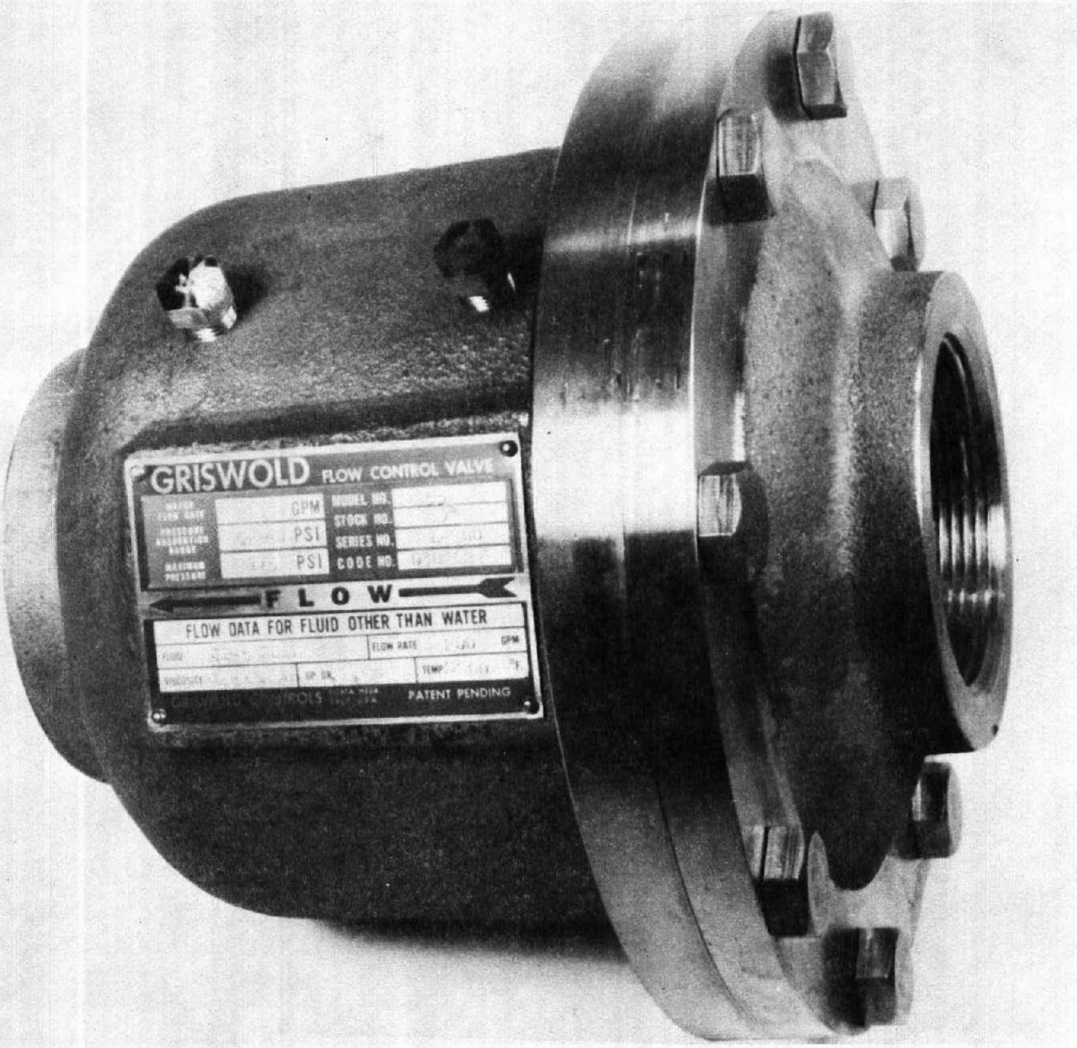


Figure 3.—Three-inch threaded cluster flow control valve.

Figure 4.—Three-inch threaded inline flow control valve.

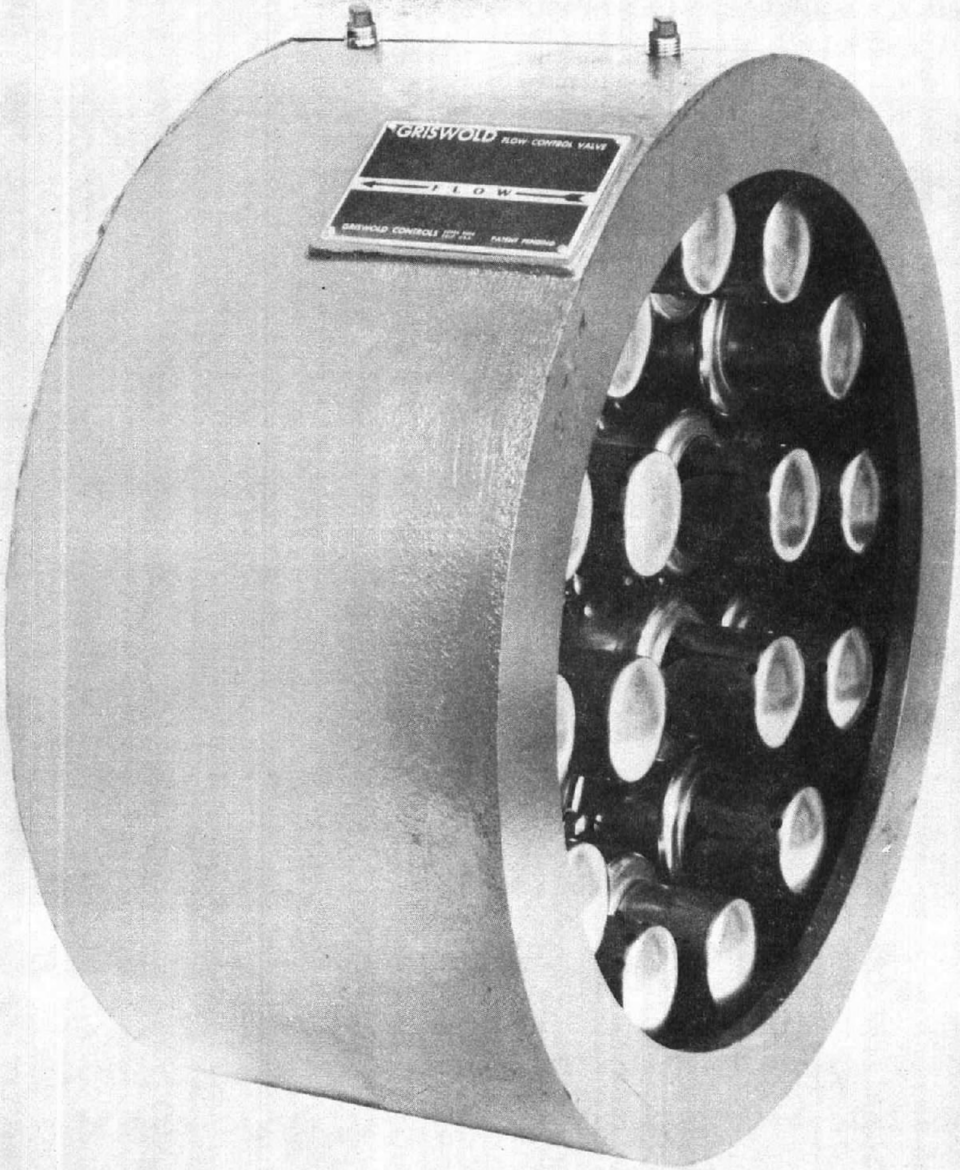


Figure 5.—Ten-inch flanged cluster flow control valve.

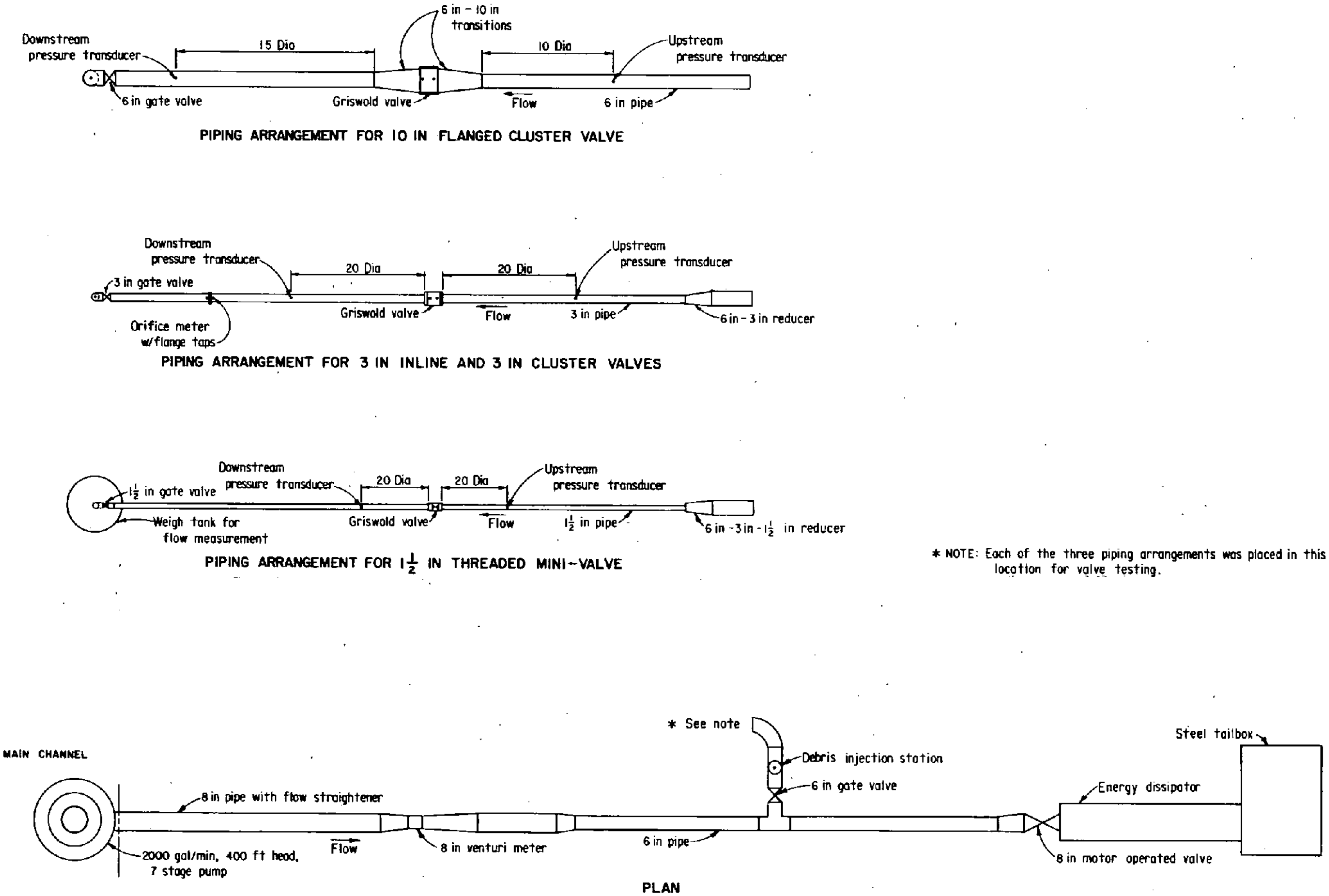


Figure 6.—Flow control test facility layout.

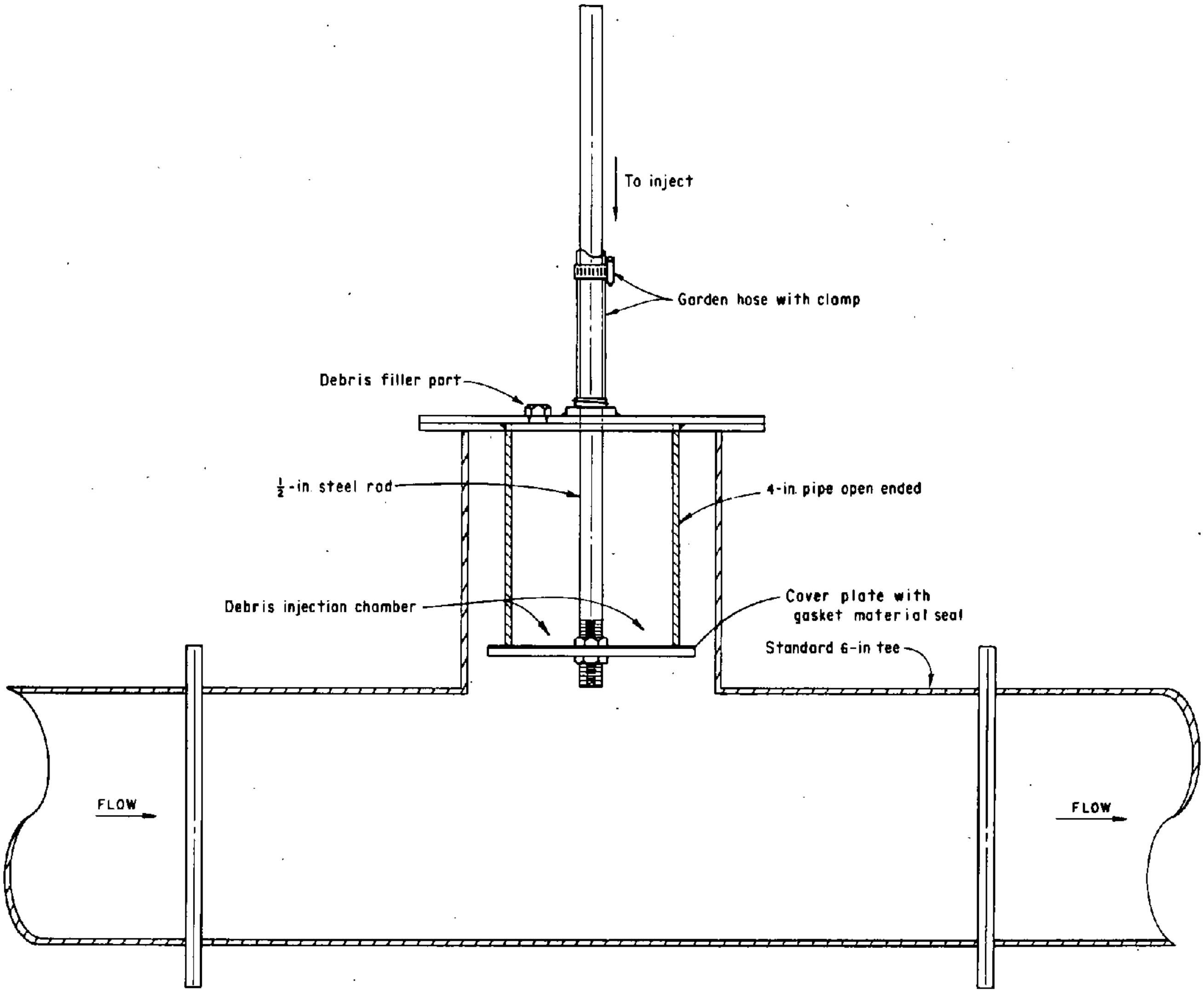


Figure 7.—Debris injection station.

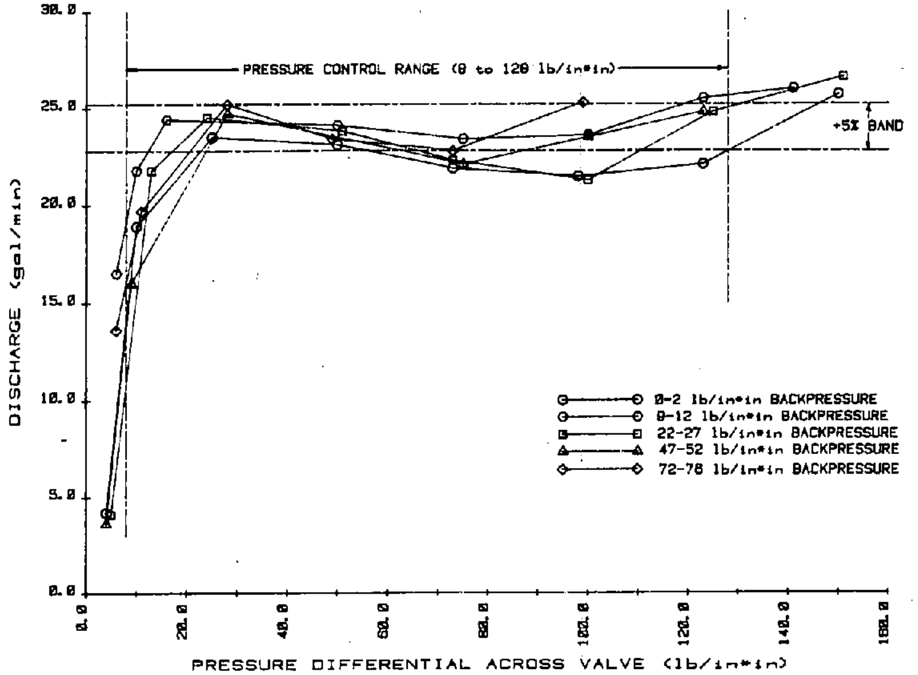


Figure 8.—Discharge test results of Griswold 1½-inch threaded minivalve—design discharge 24 gal/min.

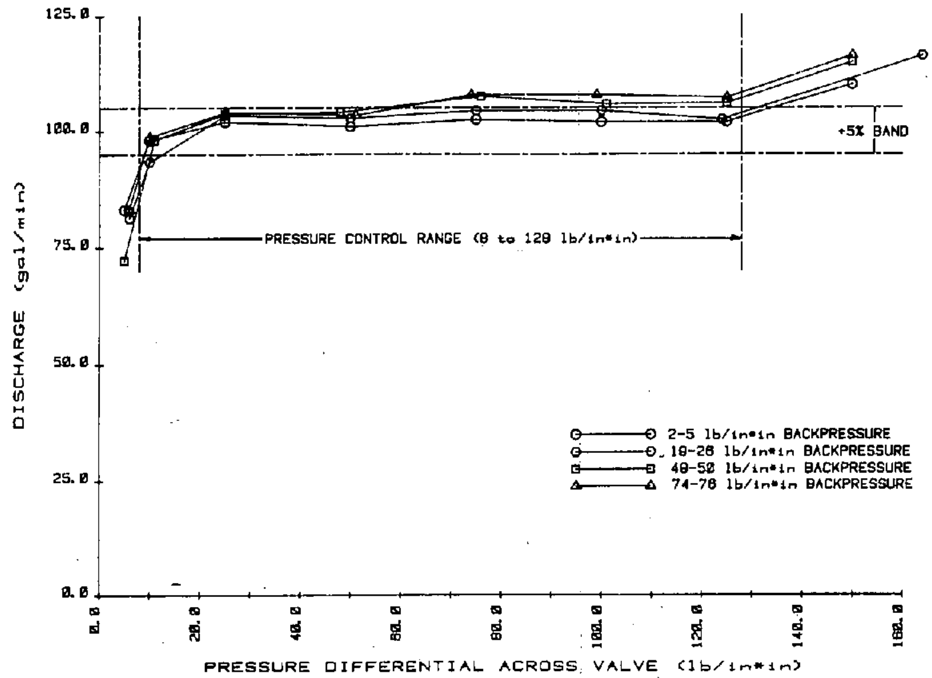


Figure 9.—Discharge test results of Griswold 3-inch threaded cluster valve—design discharge 100 gal/min.

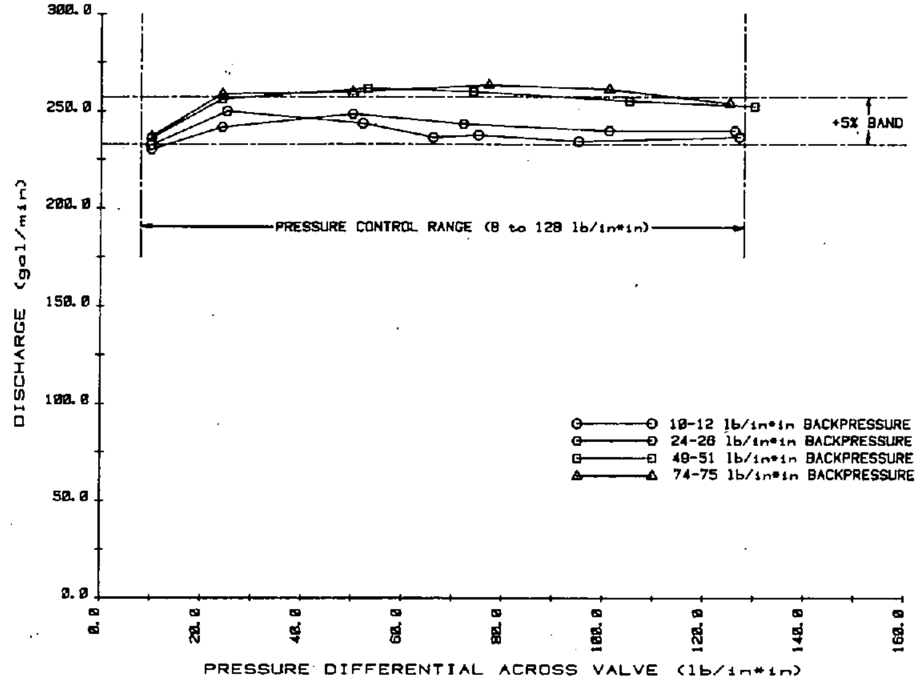


Figure 10.—Discharge test results of Griswold 3-inch threaded cluster valve—design discharge 245 gal/min.

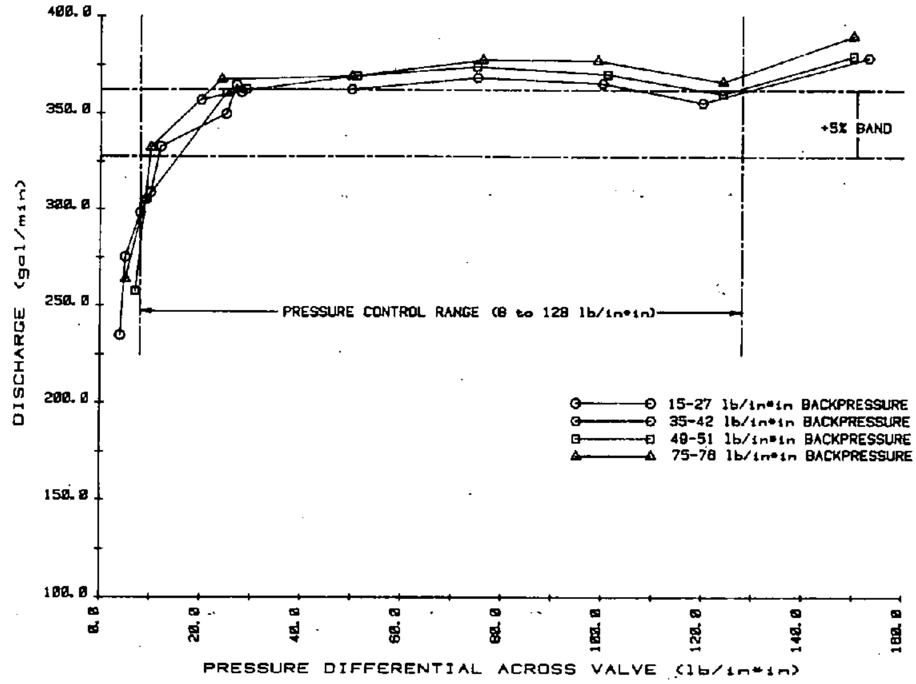


Figure 11.—Discharge test results of Griswold 3-inch threaded cluster valve—design discharge 345 gal/min.

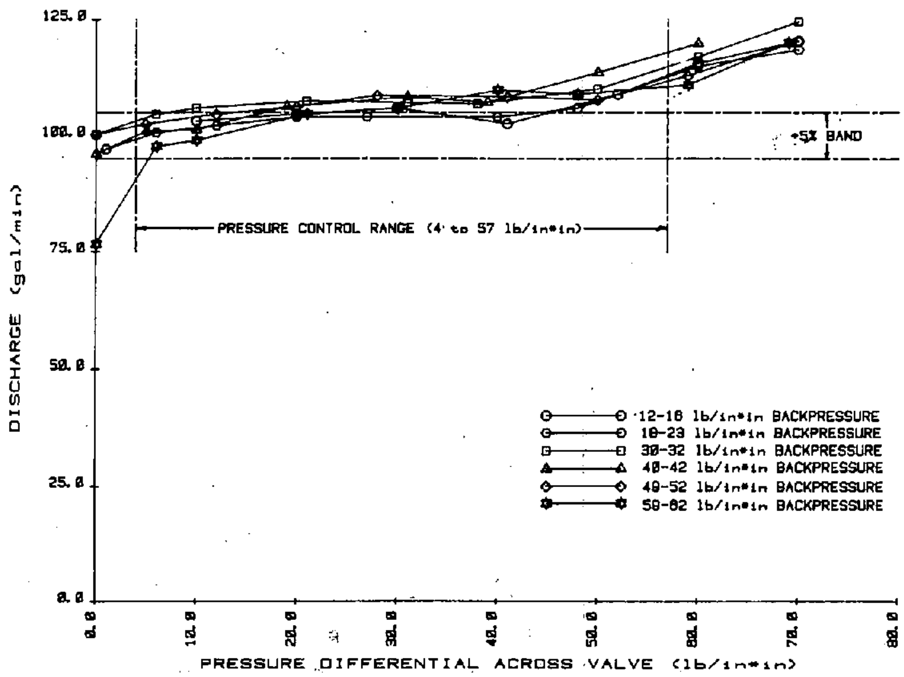


Figure 12.—Discharge test results of Griswold 3-inch threaded inline valve—design discharge 100 gal/min.

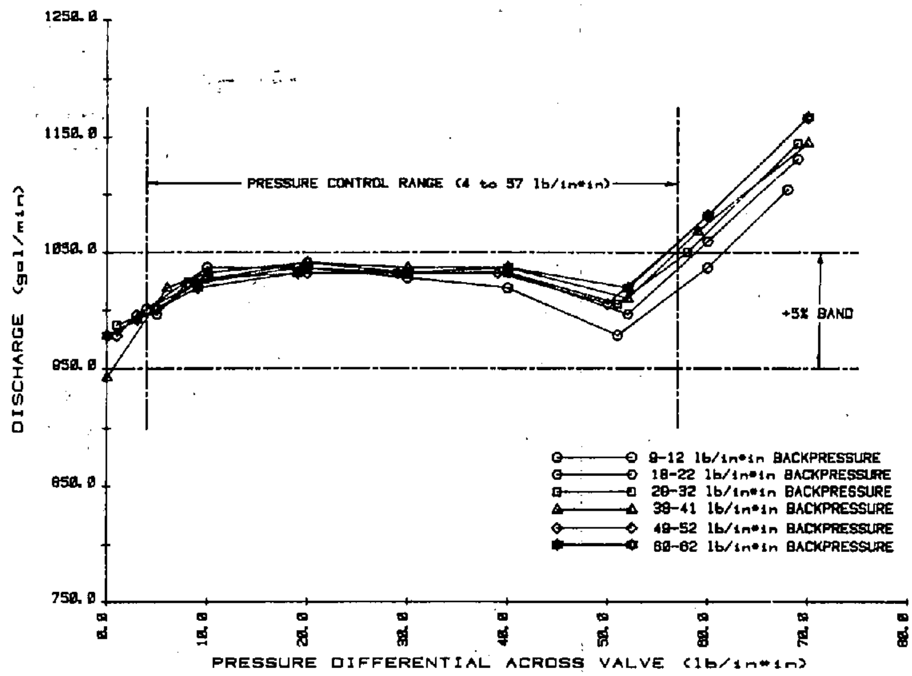


Figure 13.—Discharge test results of Griswold 10-inch flanged cluster valve—design discharge 1,000 gal/min.

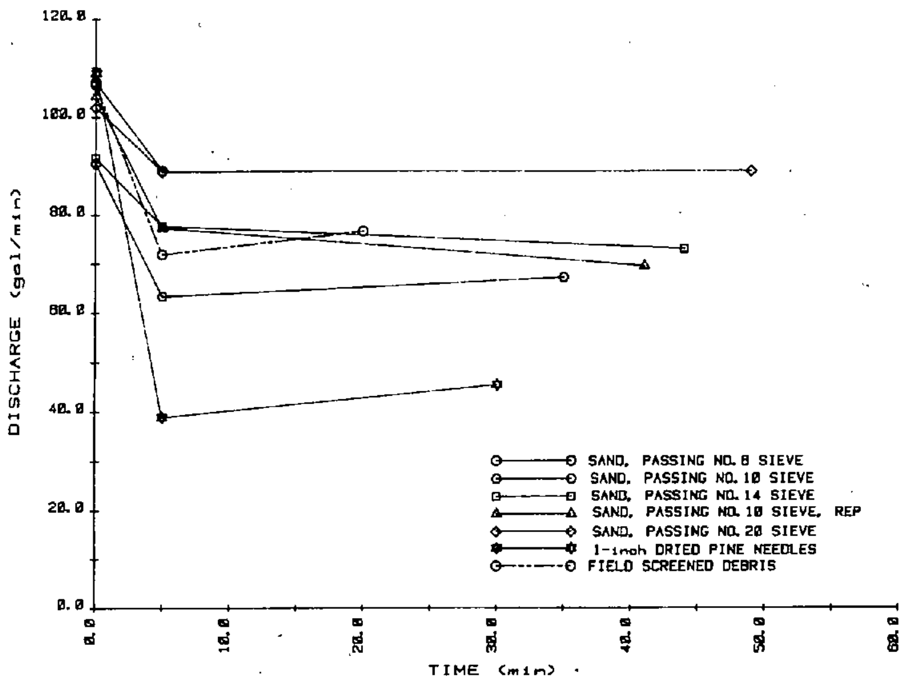
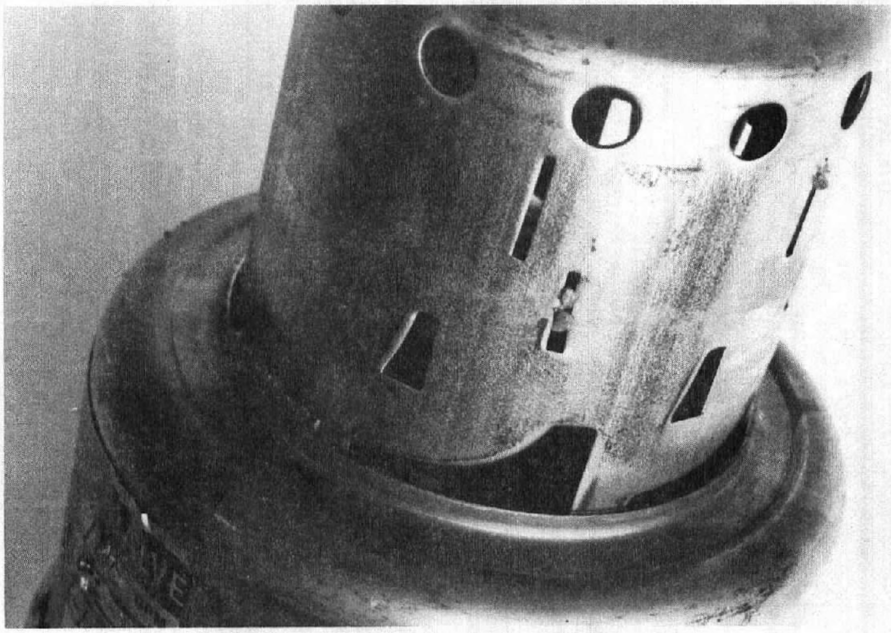
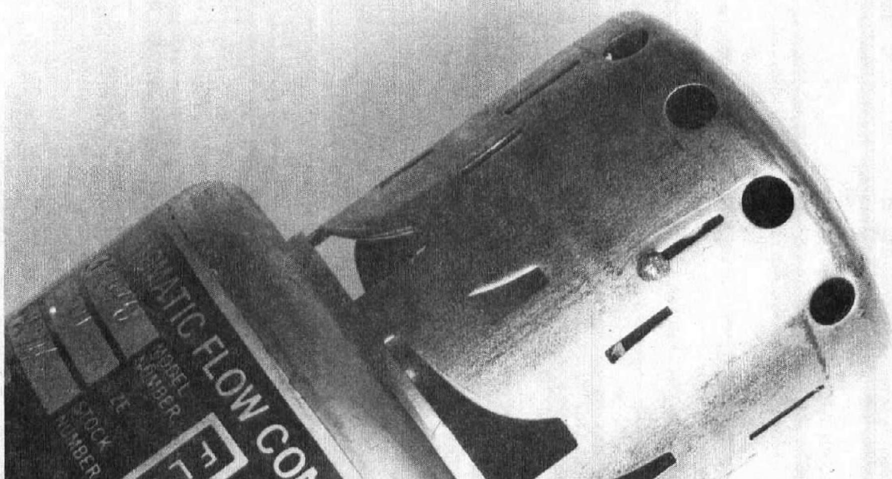


Figure 14.—Debris test results of Griswold 3-inch threaded cluster valve—design discharge 100 gal/min.

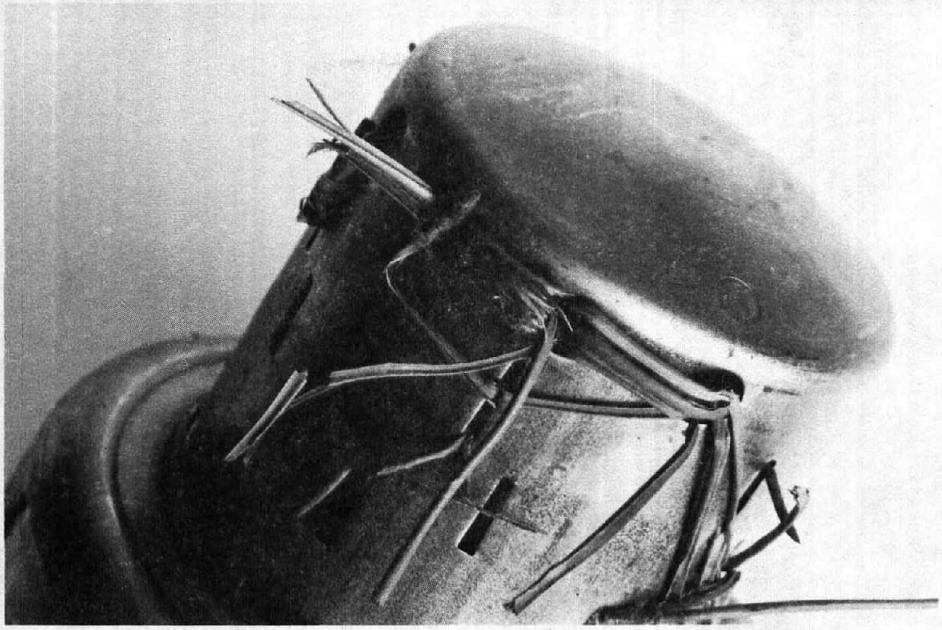


a. Flow cartridge after No. 6 sieve screened sand run

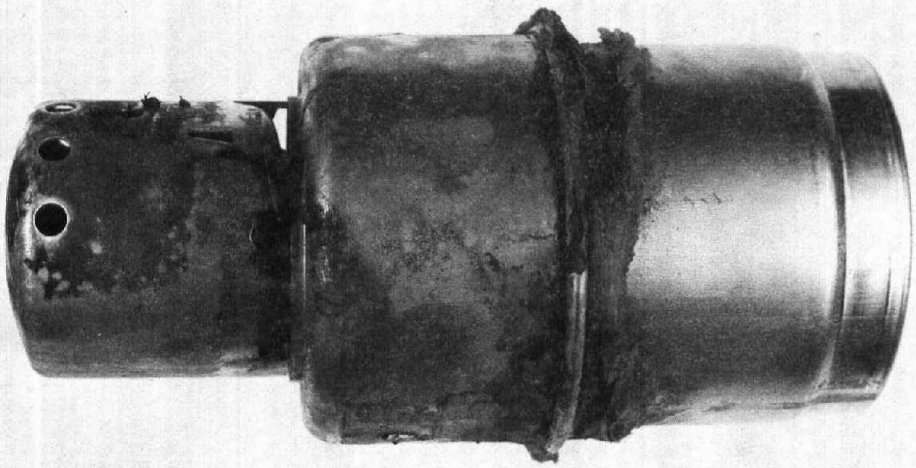


b. Flow cartridge after No. 10 sieve screened sand run

Figure 15.—Flow cartridges, after U.S.A. standard Nos. 6 and 10 sieve screened sand runs in 3-inch threaded cluster valve, design discharge 100 gal/min.



a. Flow cartridge after run with 1-inch pieces of dry pine needles.



b. Flow cartridge after run with field screened aquatic weeds.

Figure 16.—Flow cartridges after pine needles and aquatic weed runs in 3-inch threaded cluster valve, design discharge 100 gal/min.

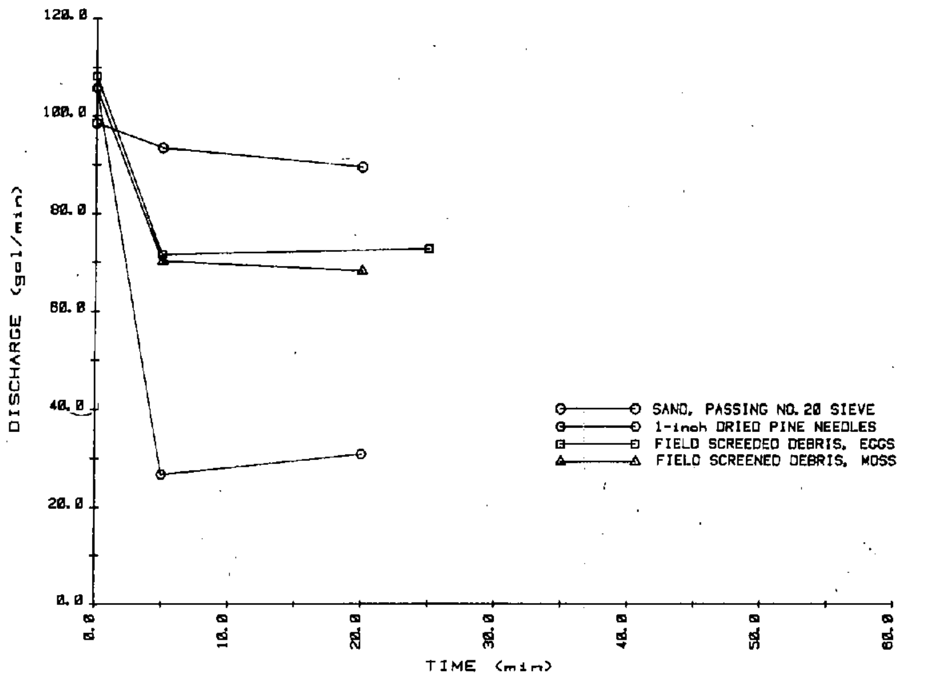


Figure 17.—Debris test results, 3-inch threaded inline valve, design discharge 100 gal/min.

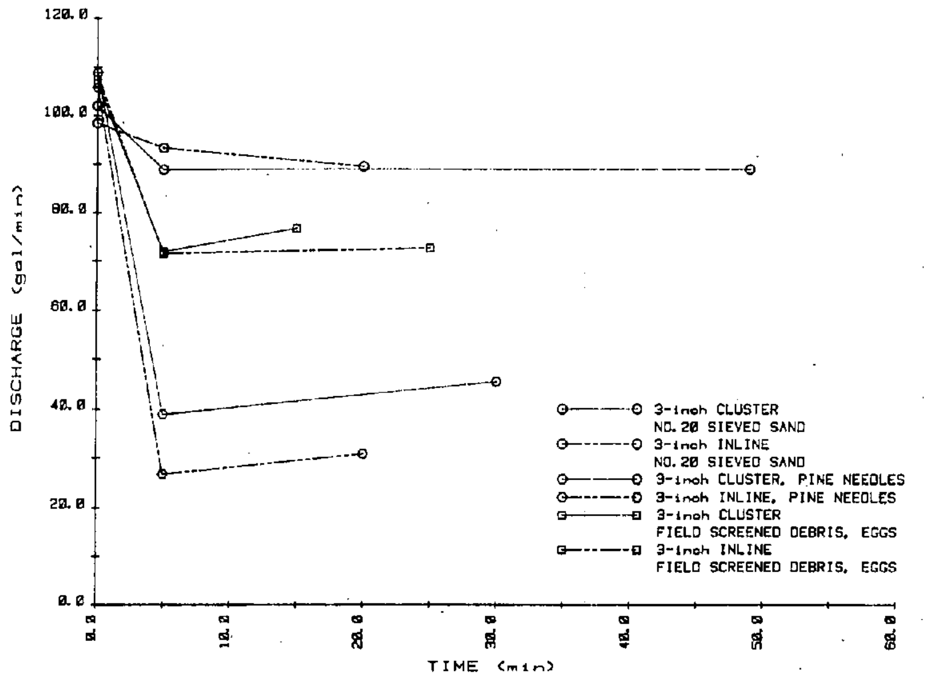


Figure 18.—Debris test results, comparison of 3-inch threaded cluster valve and 3-inch threaded inline valve — same debris types.

GPO 841-549

Mission of the Bureau of Reclamation

The Bureau of Reclamation of the U.S. Department of the Interior is responsible for the development and conservation of the Nation's water resources in the Western United States.

The Bureau's original purpose "to provide for the reclamation of arid and semiarid lands in the West" today covers a wide range of interrelated functions. These include providing municipal and industrial water supplies; hydroelectric power generation; irrigation water for agriculture; water quality improvement; flood control; river navigation; river regulation and control; fish and wildlife enhancement; outdoor recreation; and research on water-related design, construction, materials, atmospheric management, and wind and solar power.

Bureau programs most frequently are the result of close cooperation with the U.S. Congress, other Federal agencies, States, local governments, academic institutions, water-user organizations, and other concerned groups.

A free pamphlet is available from the Bureau entitled "Publications for Sale." It describes some of the technical publications currently available, their cost, and how to order them. The pamphlet can be obtained upon request from the Bureau of Reclamation, Attn D-922, P O Box 25007, Denver Federal Center, Denver CO 80225-0007.