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JULY 1985

IMPROVED SPRAYFAN SYSTEM INSTALLATION GUIDE

Contract J0113010

Foster-Miller, Inc.
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16. Abstract (Limit: 200 words)

This guide contains information on the (1) description and capabilities, (2) design, (3) installation, (4) operation, and (5) maintenance of the improved sprayfan auxiliary ventilation system. The improved sprayfan system is a modified water spray system that directs intake air to and across the front of a continuous miner to prevent buildup of methane gas and dust concentrations. Although the improved sprayfan system operates on the same principles as the original sprayfan system, the layout and number of spray nozzles differ, providing additional water for improved dust suppression. Underground tests, independent laboratory tests, tests by the Mine Safety and Health Administration, and independent installations by coal producers have confirmed the performance of the sprayfan system. More than 300 sprayfan systems are currently in operation in underground coal mines.

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Fanspray system
Improved sprayfan system
Water spray fan
Water spray induced ventilation
Mine ventilation
Face ventilation
Methane control
Auxiliary ventilation
Dust control
Methane dilution

b. Identifiers/Open-Ended Terms

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FOREWORD

This report was prepared by Foster-Miller, Inc. (FMI), Waltham, MA, under the United States Bureau of Mines Contract No. J0113010. It was administered under the technical direction of PMSRC. The Technical Project Officer was Mr. Jon C. Volkwein. Mr. Doyne W. Teets was the Contracting Officer for the Bureau.

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1. INTRODUCTION

The Sprayfan System is a modified water spray system which *directs intake air to and across the front of a continuous mining machine to prevent buildup of methane gas and dust concentrations*. It has been found to be more effective, more reliable, quieter, less costly, and less likely to be damaged than machine mounted diffuser fans. Underground tests, independent laboratory tests, tests by MSHA, and independent installations by coal producers have confirmed the performance of the Sprayfan System and also have provided practical insight as to its limitations.

The Sprayfan System was originally developed by Foster-Miller, Inc. (FMI) under United States Bureau of Mines Research Contract No. H0230023. That research resulted in an earlier publication entitled "Sprayfan System Installation and Operation Manual-Volume II" (October 1981). The manual was prepared to aid in the proper installation and operation of the original Sprayfan System.

As a result of the original Sprayfan's popularity and advances in mine safety, additional research was conducted to broaden the application of and to further improve the performance and practicality of the system. The additional research resulted in the development of an Improved Sprayfan System which is described in detail in this manual. Although the Improved Sprayfan System appears similar to and operates on the same principles as the original system, the placement and number of sprays differ.

> *This manual replaces the original Sprayfan manual (October 1981) and is not intended for use with or as a supplement to that manual.*

The objective of this manual is to furnish potential users with the information required for the successful application and installation of the Improved Sprayfan System, including:

- Description and applications
- Design
- Installation
- Operation
- Maintenance.

The flowchart presented in figure 1 highlights the major steps involved in planning and completing an Improved Sprayfan installation.

A companion volume to this manual is available, entitled "Improved Diffuser and Sprayfan Systems for Ventilation of Coal Mine Working Faces." The volume contains information on the development and testing of the Improved Sprayfan System both in the laboratory and field.

Several other previously published reports contain information on the prior development, applications, installation and operation of earlier Sprayfan Systems. A list and description of all previous reports are included for reference in appendix A. Much of the information contained in those reports is updated by the current volumes.

As of July, 1985, it was estimated that well over 300 continuous miners were operating with spray systems employing Sprayfan principles. In addition to this guide, valuable information on the installation and use of the Sprayfan can be obtained by contacting and/or visiting mines that are currently using the Sprayfan Systems. Also, assistance in planning, testing, and installation is available from firms thoroughly familiar with the Sprayfan System.

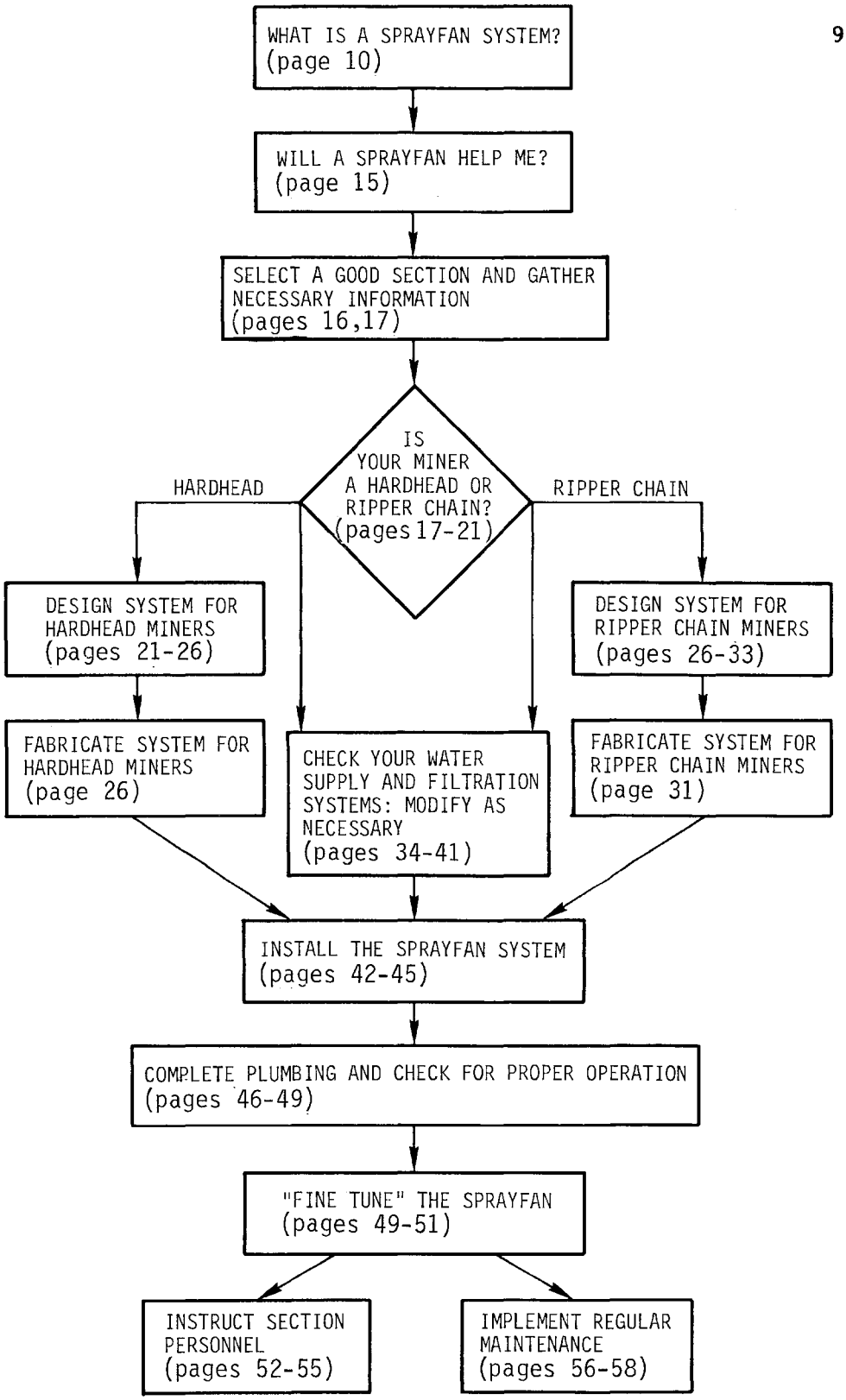


FIGURE 1. - Flowchart for planning installations of the Improved Sprayfan System.

2. SYSTEM DESCRIPTION

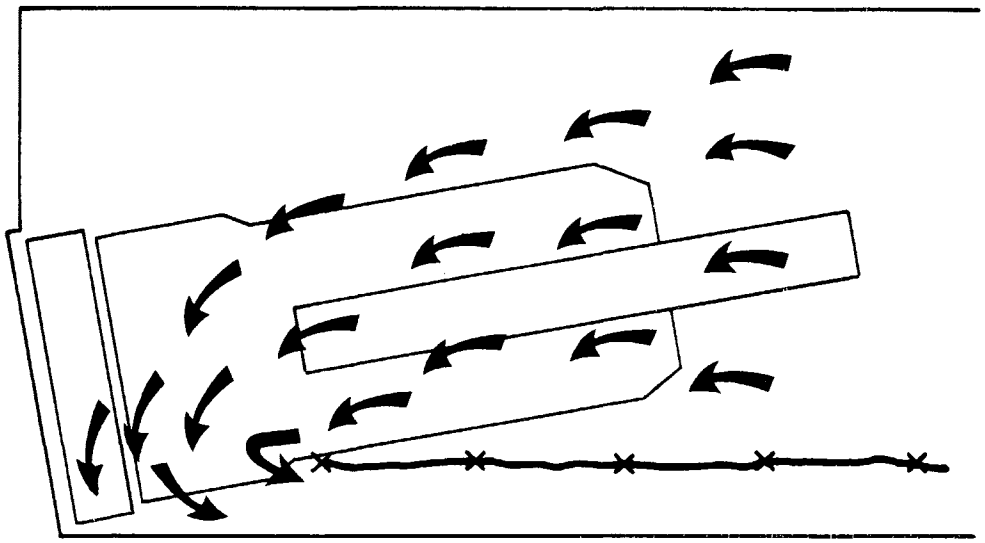
The Sprayfan System consists of water spray nozzles mounted along the side of a continuous miner (opposite the exhausting line curtain) and behind the cutterhead. Dust suppression sprays are replaced in a manner that redirects primary ventilation air toward and across the face while also suppressing dust and lubricating the cutting bits. Figure 2 shows the Sprayfan System's ability to eliminate "short circuiting" of ventilating air directly to the return.

Figure 3 shows a typical "conventional" water spray system (as supplied by the machine manufacturer), and compares it to both the Improved Sprayfan System and the original Sprayfan System. The conventional system contains sprays with a symmetrical and forward orientation. This arrangement provides some airflow mixing at the face but is often accompanied by recirculation and rollback of face dust and methane. Both Sprayfan Systems, however, use the airmoving capabilities of water sprays to push fresh air up the off-curtain side of the machine, across the face and into the return.

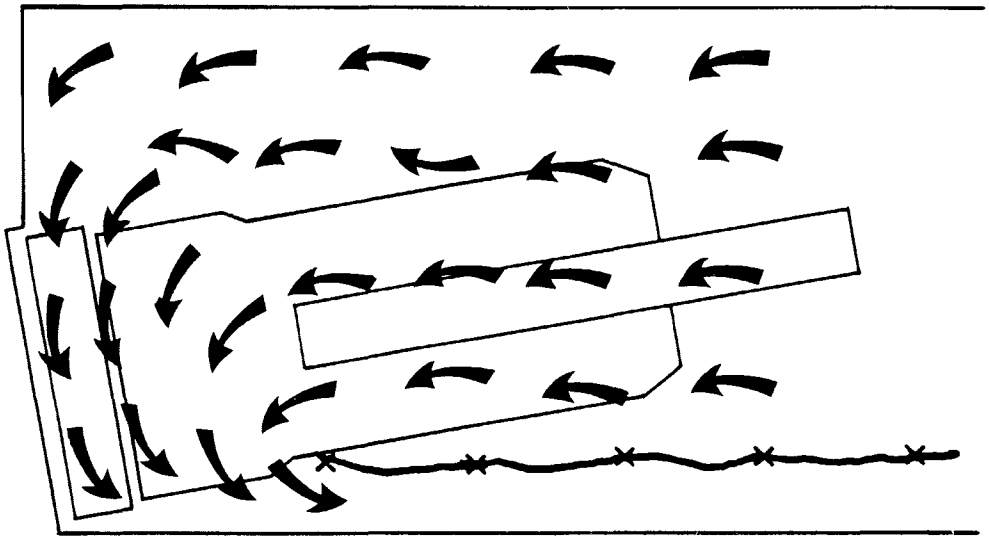
Differences between the original Sprayfan and the Improved Sprayfan, shown in figure 3, include:

- The number of front spray nozzles was increased
- The angle of the front spray nozzles was changed from a 15^{o} to 30^{o} angle toward the brattice side of the entry
- The side spray power was concentrated near the hinge point of the miner, and the number of nozzles was reduced
- Dust suppression sprays directed at the end of the cutterhead have been added
- The blocking spray on the original system (opposite the operator's cab) has been eliminated.

The Improved Sprayfan shown in figure 4 uses "side" and "on-board" sprays (manifolds ① and ②) to bring clean air along the side of the miner into the off-curtain corner. "Front spray manifolds ④ , ⑤ , ⑥ , and ⑦ contain angled sprays which move diluted methane and dust across the face toward the curtain side. The curtain then draws the contaminated air away from the face and into the return. The front spray manifolds also provide bit lubrication and dust suppression. Manifold ③ is mounted

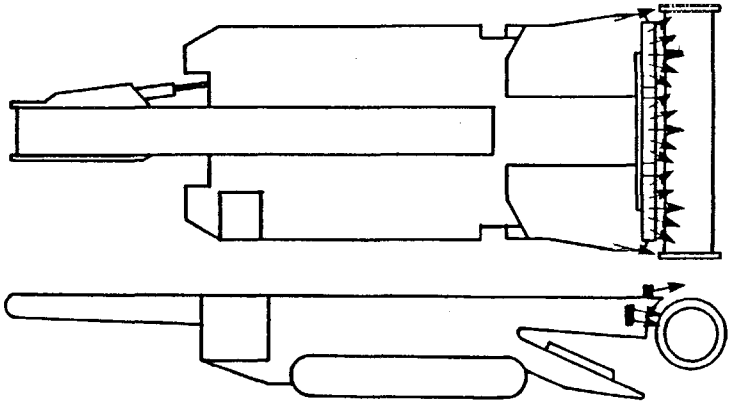


A. AIRFLOW WITHOUT SPRAYFAN

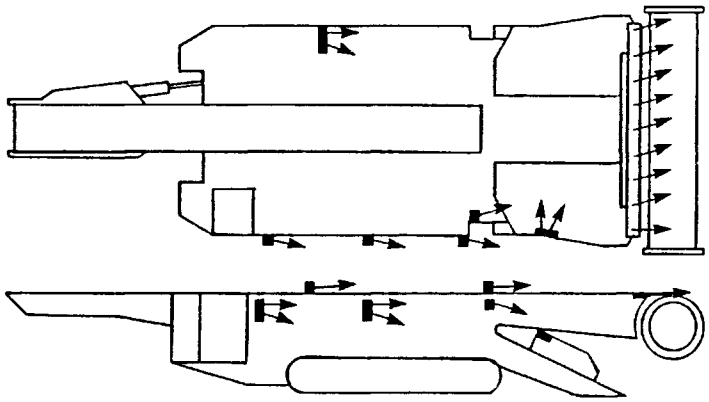


B. AIRFLOW WITH SPRAYFAN

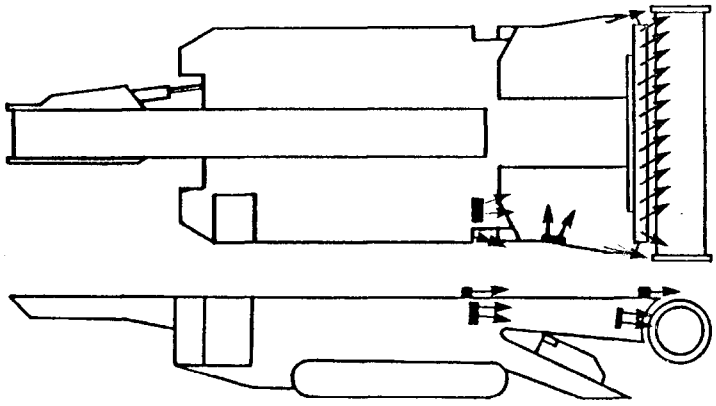
FIGURE 2. - Comparison of airflows (Sprayfan System details not shown).



CONVENTIONAL SPRAYS



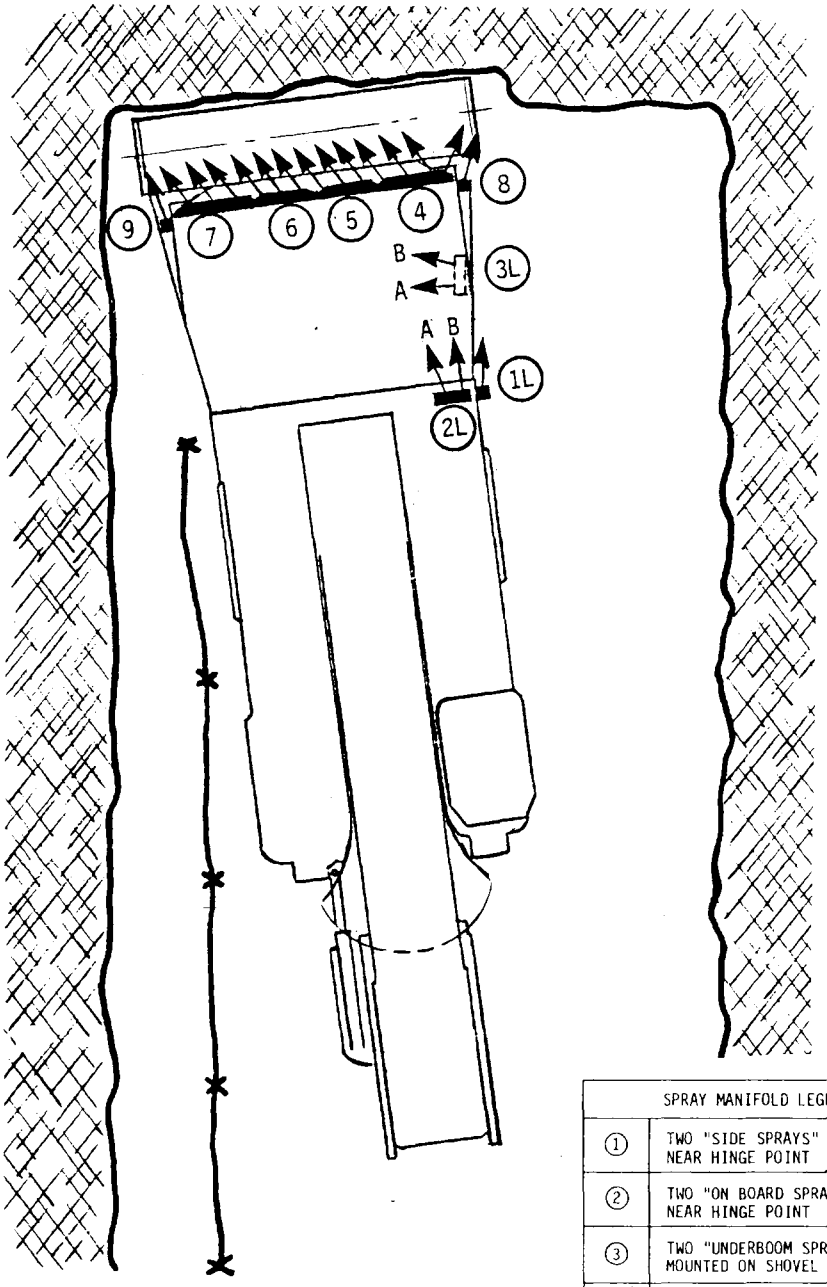
ORIGINAL SPRAYFAN*



IMPROVED SPRAYFAN*

FIGURE 3. - Comparison of spray system designs.

[1]Only left-hand return system is shown - mirror image is required for right-hand return.



SPRAY MANIFOLD LEGEND	
①	TWO "SIDE SPRAYS" NEAR HINGE POINT
②	TWO "ON BOARD SPRAYS" NEAR HINGE POINT
③	TWO "UNDERBOOM SPRAYS" MOUNTED ON SHOVEL (OR PAN)
④, ⑤, ⑥, ⑦	THIRTEEN "FRONT SPRAYS" BEHIND CUTTERHEAD
⑧, ⑨	FOUR "DUST SUPPRESSION SPRAYS" ON SIDE OF BOOM JUST BEHIND CUTTERHEAD

FIGURE 4. - Improved Sprayfan System layout (for left-hand return).

on the shovel (or pan) under the boom and is oriented to direct clean air under the head to sweep dust and methane from beneath the head into the return. Manifolds ⑧ and ⑨ are positioned to provide bit lubrication, bit cooling and dust suppression at the ends of the cutterhead. *Note: From this point the Improved Sprayfan System will be referred to simply as the Sprayfan System).*

Figure 4 shows a "single-sided" Sprayfan System for use with the brattice curtain only on the left side of the entry. For greater flexibility in mining, a "dual-sided" system is desirable so that both right and left side brattice returns can be ventilated. A dual-sided Sprayfan System contains all of the sprays illustrated in figure 4 as well as a set of "mirror image" counterpart sprays to be used only when the brattice curtain changes sides. This will be discussed in greater detail later in the manual.

Figure 4 illustrates a Sprayfan System for a hardhead miner. A slightly different design is used on ripper chain miners. For easy reference, the design and installation sections of this manual are divided into separate discussions for hardhead and ripper chain miners.

Normally the Sprayfan System uses about 25 to 30 gpm of water at 150 psi. Depending upon the conditions, nozzle pressure may range from 100 to 250 psi for effective Sprayfan operation. This may require upgrading the water supply system or the installation of a booster pump.

For clarity and brevity, this manual will reference only exhaust face ventilation by brattice curtain. The Sprayfan System is also applicable to exhaust face ventilation by fan and tubing although there is less operating history.

In all cases, the Sprayfan should not be installed on sections using blowing ventilation.

3. SYSTEM CAPABILITIES (APPLICATIONS)

A properly tuned Sprayfan System will:

- *Redirect* the available primary air and sweep it *up to and across the face*
- Control methane concentrations at the face, with the brattice at the operator's position, as well as or better than a conventional dust suppression spray system with the brattice 10 ft from the point of deepest penetration
- Reduce the incidence of face ignitions
- Control methane as well as or better than a diffuser fan
- Perform all of the functions of conventional dust suppression sprays
- Improve visibility by sweeping float dust to the return
- Control respirable dust at the operator's position as well as the conventional water spray system and better than the diffuser fans.

The Sprayfan System will not:

- Increase the total airflow in the working place
- Replace line brattice maintained within 10 ft of the point of deepest penetration when the mining machine is not at the face
- Operate with blowing ventilation systems
- Replace a dust scrubber
- Correct for insufficient primary ventilation.

MSHA has granted variances on a mine by mine basis to operate with a brattice setback in excess of 10 ft on continuous miner sections which use the Sprayfan System.

4. SYSTEM DESIGN

This section is based on actual installation and operation experience. It is intended for use only as a guide and must be tailored to each installation based on the machine configuration and mining conditions.

The *design* of the Sprayfan System involves the following steps:

a. Selection of mining machine section

b. Design assessment of the proposed installation

c. Manifold design and fabrication

d. Nozzle selection

e. Water supply system survey

f. Water filtration selection.

The following sections discuss each of the steps in detail.

4.1 SELECTION OF MINING MACHINE SECTION

Design assessment requires detailed information on the section and the specific machine proposed for the Sprayfan installation. Sections which are logical candidates for Sprayfan installations include those with a history of:

- Face ignitions
- Diffuser fan maintenance problems
- Excessive respirable dust concentrations at the miner operator's position
- High methane concentrations leading to machine downtime
- Difficulty in maintaining brattice or duct setback within 10 ft of the point of deepest penetration.

The intention to install a Sprayfan System should be presented to the appropriate enforcement agencies.

Installation of the Sprayfan System (particularly the first installation) is more easily accomplished on a new machine or on a miner being rebuilt.

4.2 DESIGN ASSESSMENT

After selecting a section where you intend to use a Sprayfan, the following information is required:

- Determine if the miner to be used is a hardhead or ripper chain machine. This is important because different front manifolds are used for each.

- Details of section ventilation including whether the section utilizes a single or double split and the range of airflows and velocities anticipated. This information will indicate whether a single or dual-sided Sprayfan installation is required.

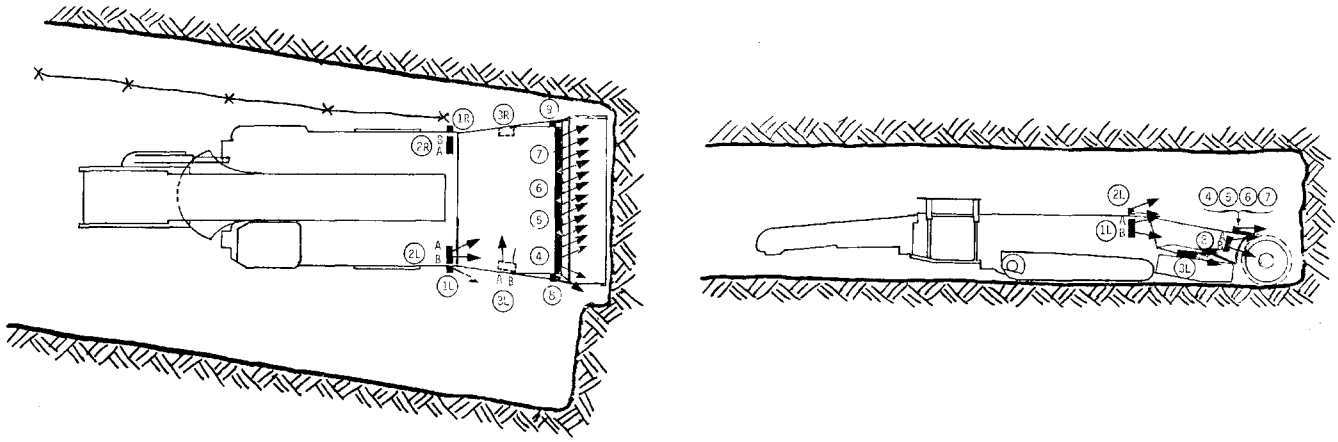
- Observation of machine operation through several complete cycles to identify safe mounting locations for spray manifolds under operating conditions. Dimensions of these locations as identified in table 1 (table 2 for ripper chain miners) should be taken. Tables 1 and 2 contain descriptions of manifold functions with information to aid in proper positioning and mounting.

- Detailed survey of the existing water supply system on the section including dynamic pressure (pressure at full flow conditions) and flow measurements. This is necessary to determine whether or not the water supply system is adequate. Detailed instructions on how to complete the survey will be presented in subsection 4.5.

- Plumbing diagram of the mining machine including cooling jackets, filtration, nozzle locations, and valving. Check manufacturers specifications for maximum cooling jacket pressure and minimum flow requirements. Also, check the plumbing diagram to be sure it matches the existing hardware on the machine. This information will be needed to complete plumbing of the manifolds.

- Typical cutting height in the proposed mining section. This will be needed to determine vertical manifold orientation and placement.

TABLE 1. - Sprayfan nozzle location guide for hardhead miners (left-hand return)



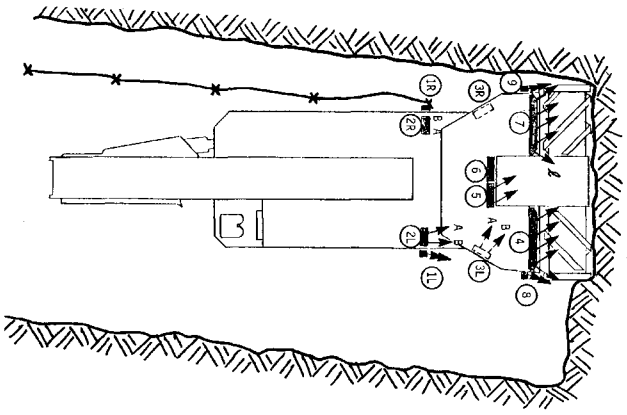
Note: The sketches above and the descriptions below illustrate the locations and objectives of each spray nozzle. The necessary discharge directions will vary on a mine-by-mine basis. Except where indicated, the typical discharge directions shown below are recommendations only, and may need to be modified for your mine.

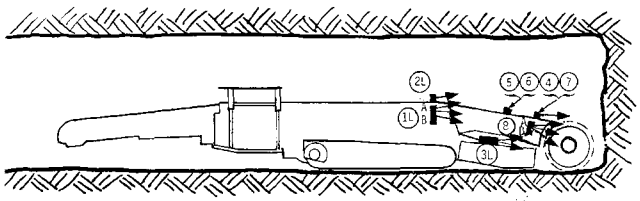
NOZZLE LOCATION	REQUIRED FOCUS OF NOZZLE SPRAY CONE	NOZZLE CENTERLINE DISCHARGE DIRECTION HORIZONTAL	VERTICAL	NOZZLE IDENTIFICATION*
(1L) A (1L) B	Left side of spray cones should just clear the outside edge of miner frame. Spray "B" is horizontal; spray "A" should tip upward. Sprays should not impinge on floor or roof.	15 deg right 15 deg right	5 deg up 0 deg up	BD20-2 BD20-2
(2L) A (2L) B	Use horizontal angles as specified at right, vertical angles will depend on roof height. Bottom of spray cone should just clear boom, when boom is level.	15 deg left 0 deg	15 deg up 15 deg up	BD20-2 BD20-2
(3L) A (3L) B	Objective is to provide full coverage beneath head, when head is raised. Avoid impinging onto gathering arms or underside of head.	As shown for full coverage under head		BD20-2 BD20-2
(1R) A (1R) B	Right side of spray cones should just clear the outside of miner frame. Spray "B" is horizontal; spray "A" should tip upward. Sprays should not impinge on floor or roof.	15 deg left 15 deg left	5 deg up 0 deg up	BD20-2 BD20-2
(2R) A (2R) B	Use horizontal angles as specified at right, vertical angles will depend on roof height. Bottom of spray cone should just clear boom, when boom is level.	15 deg right 0 deg	15 deg up 15 deg up	BD20-2 BD20-2
(3R) A (3R) B	Objective is to provide full coverage beneath head, when head is raised. Avoid impingling onto gathering arms or underside of head.	As shown for full coverage under head		BD20-2 BD20-2
(8) A (8) B	Left side of spray cones should just clear outside edge of boom. Top of spray cone "A" should hit top of bits, bottom of spray cone "B" should hit bottom of bits.	30 deg right 30 deg right	0 deg 0 deg	BD3 or BD20-2** BD3 or BD20-2
(9) A (9) B	Right side of spray cones should just clear outside edge of boom. Top of spray cone "A" should hit top of bits, bottom of spray cone "B" should hit bottom of bits.	30 deg left 30 deg left	0 deg 0 deg	BD3 or BD20-2 BD3 or BD20-2
All nozzles in manifolds (4)(5)(6)(7)	Figure 8 contains the engineering drawings used to fabricate manifolds (4)(5)(6) and (7). The correct spray nozzle discharge directions (shown at right) are already specified in Figure 8 and should not be changed. Orient manifolds onto miner so that bottom half of spray cones impact cutting bits; top half of spray cones should spray above bits.	10 deg up 30 deg to face as specified in Figure 8		BD3 or BD20-2

Notes: A BD20-2 discharges 2.0 gpm at 200 psi with a cone angle of 30 deg.
a BD3 discharges 1.3 gpm at 200 psi with a cone angle of 70 deg.
System totals: 23 nozzles, 34.1 gpm at 200 psi

*SPRAYING SYSTEMS INC. WHIRLJET™ NOZZLES or equivalent
**BD20-2's may be substituted for BD3's for practicality

TABLE 2. - Sprayfan nozzle location guide for ripper chain miners (left-hand return)





Note: The sketches above and the descriptions below illustrate the locations and objectives of each spray nozzle. The necessary discharge directions will vary on a mine-by-mine basis. Except where indicated, the typical discharge directions shown below are recommendations only, and may need to be modified for your mine.

NOZZLE LOCATION	REQUIRED FOCUS OF NOZZLE SPRAY CONE	NOZZLE CENTERLINE DISCHARGE DIRECTION HORIZONTAL	VERTICAL	NOZZLE IDENTIFICATION*
(1L) A (1L) B	Left side of spray cones should just clear the outside edge of miner frame. Spray "B" is horizontal; spray "A" should tip upward. Sprays should not impinge on floor or roof.	15 deg right 15 deg right	5 deg up 0 deg up	BD20-2 BD20-2
(2L) A (2L) B	Use horizontal angles as specified at right, vertical angles will depend on roof height. Bottom of spray cone should just clear boom, when boom is level.	15 deg left 0 deg	15 deg up 15 deg up	BD20-2 BD20-2
(3L) A (3L) B	Objective is to provide full coverage beneath head, when head is raised. Avoid impinging onto gathering arms or underside of head.	As shown for full coverage under head		BD20-2 BD20-2
(1R) A (1R) B	Right side of spray cones should just clear the outside of miner frame. Spray "B" is horizontal; spray "A" should tip upward. Sprays should not impinge on floor or roof.	15 deg left 15 deg left	5 deg up 0 deg up	BD20-2 BD20-2
(2R) A (2R) B	Use horizontal angles as specified at right, vertical angles will depend on roof height. Bottom of spray cone should just clear boom, when boom is level.	15 deg right 0 deg	15 deg up 15 deg up	BD20-2 BD20-2
(3R) A (3R) B	Objective is to provide full coverage beneath head, when head is raised. Avoid impinging onto gathering arms or underside of head.	As shown for full coverage under head		BD20-2 BD20-2
(8) A (8) B	Left side of spray cones should just clear outside edge of boom. Top of spray cone "A" should hit top of bits, bottom of spray cone "B" should hit bottom of bits.	30 deg right 30 deg right	0 deg 0 deg	BD3 or BD20-2** BD3 or BD20-2
(9) A (9) B	Right side of spray cones should just clear outside edge of boom. Top of spray cone "A" should hit top of bits, bottom of spray cone "B" should hit bottom of bits.	30 deg left 30 deg left	0 deg 0 deg	BD3 or BD20-2 BD3 or BD20-2
All nozzles in manifolds (4)(5)(6)(7)	Figures 11 and 12 contain the engineering drawings used to fabricate manifolds (4)(5)(6) and (7). The correct spray nozzle discharge directions (shown at right) are already specified in Figures 11 and 12 and should not be changed. Orient manifolds onto miner so that bottom half of spray cones impact cutting bits; top half of spray cones should spray above bits.	10 deg up 30 deg to face as specified in Figures 11 and 12		BD3 or BD20-2

Notes: A BD20-2 discharges 2.0 gpm at 200 psi with a cone angle of 30 deg.
a BD3 discharges 1.3 gpm at 200 psi with a spray angle of 70 deg.
System totals: 20 nozzles, 30.2 gpm at 200 psi

*SPRAYING SYSTEMS INC. WHIRLJET™ NOZZLES or equivalent
**BD20-2s may be substituted for BD3's for practicality

4.3 MANIFOLD DESIGN AND ORIENTATION

After completing the design assessment, the information gathered will be used to design and fabricate the Sprayfan System and install it onto the miner. However, before proceeding with the actual design and fabrication, review the information and suggestions discussed below.

Ventilation Direction

The ventilation survey may reveal that a dual-sided system is not necessary. However, *it is strongly recommended that a dual-sided system be installed regardless of the current ventilation because:*

- Mining sections sometimes convert to double-split ventilation or change ventilation direction
- The miner may be relocated to a section with the return brattice on the opposite side of the machine
- Initial installation costs are nearly the same for dual or single-sided systems.

All discussions throughout the remainder of this manual will reference only a dual-sided Sprayfan System.

Manifold Fabrication

> *This manual contains prints which can be used for the fabrication of all manifolds needed for a complete Sprayfan System. Prints are provided for both hardhead and ripper chain miners. These prints can be photocopied and submitted to a machine shop. However, specific information from the design assessment must accompany the prints. Refer to the prints and tables 1 or 2 for details.*

Permanent manifolds fabricated from stainless steel will require the least maintenance. Pipe threads for nozzle and adapter insertion will not corrode and there will be no interior flaking of water passages which may plug nozzles. Carbon steel is cheaper, easier to machine and weld and the internal water passages may be cadmium plated for corrosion resistance. Either stainless or carbon manifolds can be bolted into position. This is discussed in greater detail in the section on system installation.

All permanent manifolds should be designed to accommodate adapters (such as Spraying Systems Co. type 14988 or 13429 - see appendix B) which house the nozzles on most conventional spray blocks. If a nozzle ever had to be chiseled out, only the adapter must be replaced, not the entire manifold.

Hardhead versus Ripper Chain Miners

This manual contains Sprayfan designs for both ripper chain and hardhead miners. Major differences exist in the designs for front spray manifolds; consequently, separate discussions for each miner type have been furnished. A complete discussion for hardhead miners follows. For the ripper chain discussion, go to page 26.

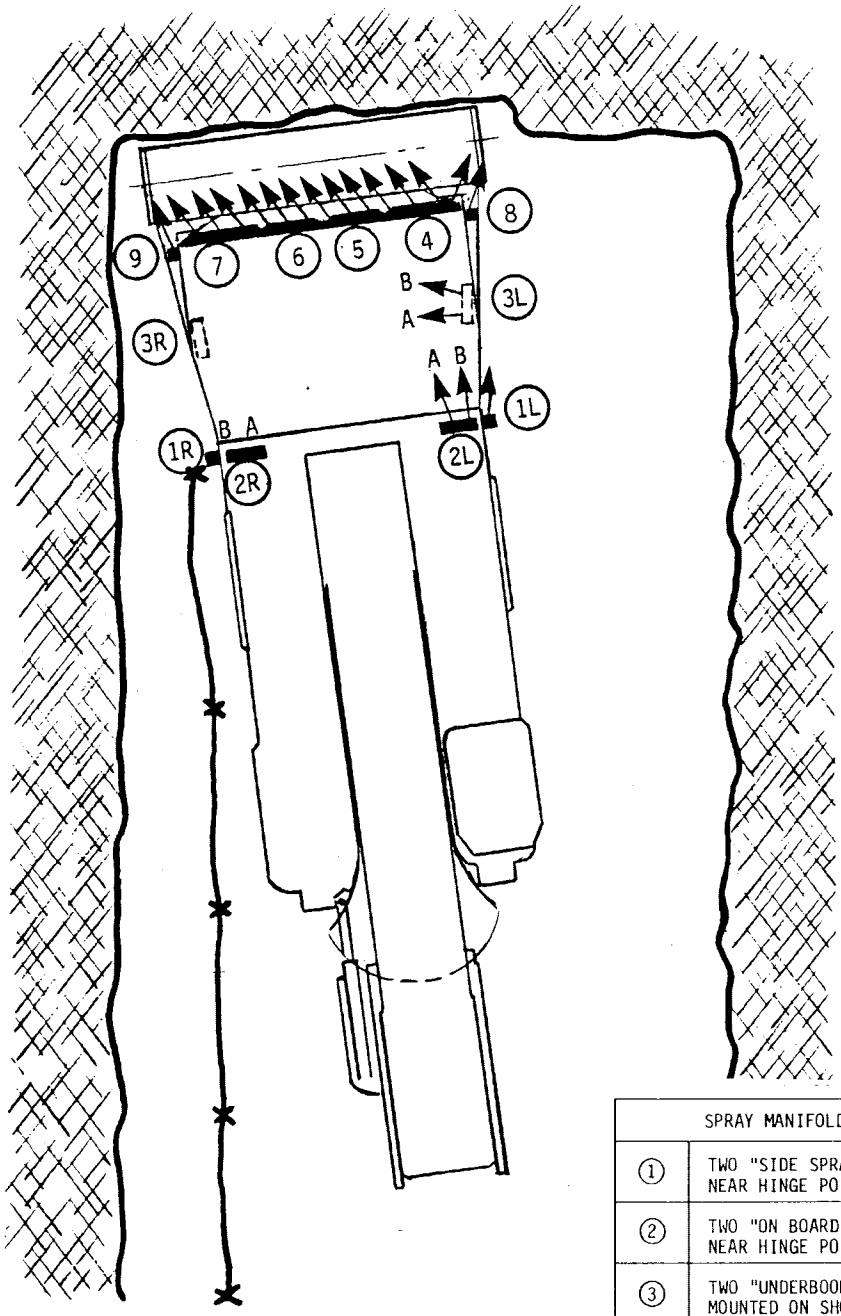
4.3.1 Design for Hardhead Miners

A typical dual-sided Sprayfan System for hardhead miners is shown in figure 5. A side view from the curtain side of the miner is illustrated in figure 6. Table 1 describes the detailed locations, spray angles and orientations of the twelve Sprayfan manifolds.

Figure 5 depicts a left-hand return to spray manifolds (1L), (2L) and (3L) are operated (as indicated by the arrows); manifolds (1R), (2R), and (3R) are intended for right-hand returns and are shown not operating. In manifolds (4), (5), (6) and (7), only the sprays angled across the head to the left are operating for a left return. *The single exception is the right-most spray nozzle in manifold (4): it is angled against the direction of the others toward the right side of the head to provide dust suppression and bit lubrication in that location.*

When the head is wider than the boom, manifolds (8) and (9) are used solely for dust suppression and bit lubrication on the extreme ends of the head and operate at all times.

Valving is used to direct water to the appropriate sets of sprays in manifolds (1) through (9). A single two-way diversion valve is required for simple operation (see plumbing diagram details). Manifolds (4), (5), (6) and (7) each contain two separate water supply legs for right and left returns. Use of the diversion valve automatically selects the proper supply leg. All manifolds have several possible supply ports for convenient hook-up.



SPRAY MANIFOLD LEGEND	
①	TWO "SIDE SPRAYS" NEAR HINGE POINT
②	TWO "ON BOARD SPRAYS" NEAR HINGE POINT
③	TWO "UNDERBOOM SPRAYS" MOUNTED ON SHOVEL (OR PAN)
④, ⑤, ⑥, ⑦	THIRTEEN "FRONT SPRAYS" BEHIND CUTTERHEAD
⑧, ⑨	FOUR "DUST SUPPRESSION SPRAYS" ON SIDE OF BOOM JUST BEHIND CUTTERHEAD

FIGURE 5. - Sprayfan System layout - hardhead miner (left-hand return).

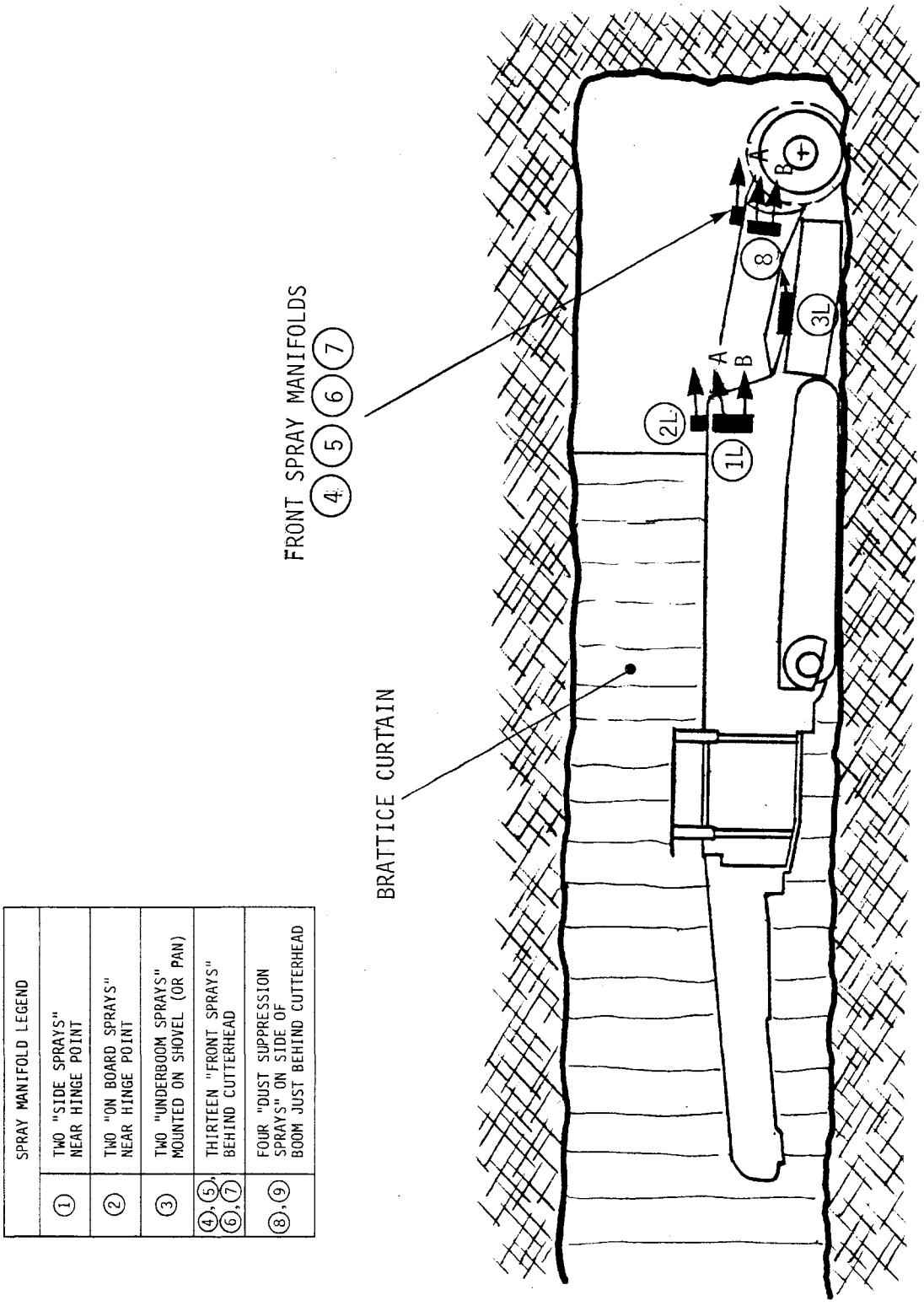


FIGURE 6. - Sprayfan System layout, side view - hardhead miner (left-hand return).

For fabrication by a machine shop, the 12 manifolds are separated into two distinct groups:

- Double nozzle manifolds, containing two nozzle ports and one supply leg
- Front manifolds, containing a number of nozzle ports and two supply legs.

The design specifications for these two types of manifolds are different and are therefore discussed separately below.

Double Nozzle Manifolds

Figure 7 provides the necessary engineering drawing to fabricate manifolds (1R), (1L), (2R), (2L), (3R), (3L), (8) and (9). The drawing, however, is a general double spray manifold drawing specifying only "angles as required." The spray discharge angles to be machined into each of the specific manifolds are given in table 1.

> *Be careful when specifying the double nozzle manifolds. They are not interchangeable between the right and left sides of the mining machine.*

To minimize interference of spray cones, spray nozzles should be located as far apart as practical. Hence, the overall manifold length shown in figure 7 (dimension A) has been left open. Generally a dimension A of 9 to 12 in is suitable to avoid spray interference, as well as provide a practical mounting length. Safe mounting locations should be selected where manifold length can be maximized.

Manifolds (8) and (9) are intended for use only on miners equipped with heads wider than the miner's frame. When the head width is not greater than the frame width, additional dust suppression and bit lubrication in this location is not required and manifolds (8) and (9) should not be installed.

When manifolds (8) and (9) are used, they should be located on the sides of the boom as far forward toward the head as possible. If located more than a foot or so behind the rear of the cutterhead, these sprays can interfere with airflow patterns established by the Sprayfan.

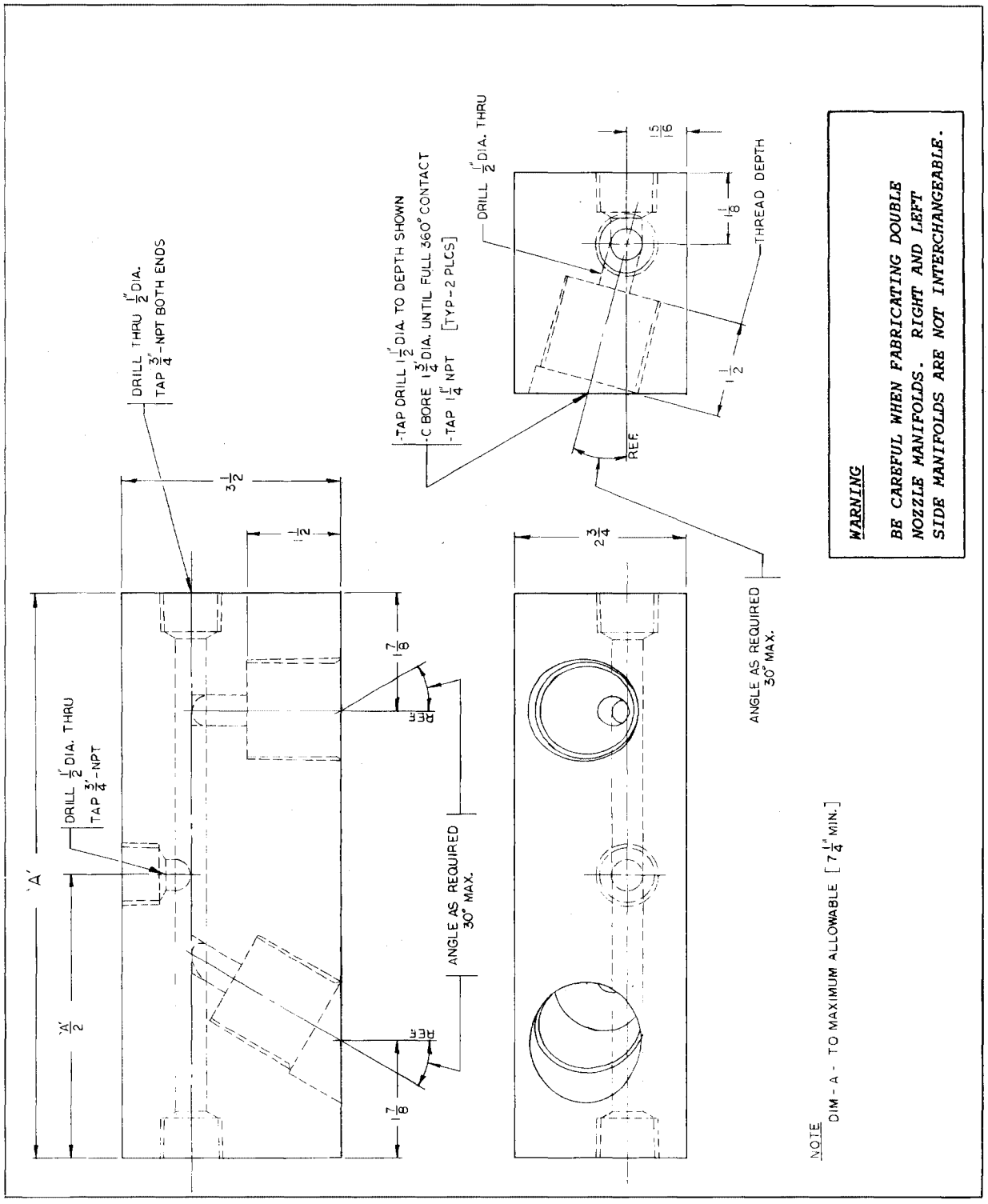


FIGURE 7. - Double spray manifold.

Front Manifolds

Figure 8 shows the drawings to fabricate each of the front manifolds for a hardhead miner. Notice that these four manifolds are not all the same: (5) and (6) are identical but are different from both (4) and (7).

Pay particular attention to the use of "DETAILS 1 and 2" in figure 8 when preparing to fabricate manifolds (4) and (7). Manifolds (4) and (7) have additional nozzles at their extreme outboard edges to wet the ends of the cutterhead. Spray discharge angles are specified in figure 8 and do not need to be determined for your miner.

As shown in the sketch "Spray Manifold Placement" in the lower left-hand corner of figure 8, manifolds (4) through (7) are intended to fill the entire boom width. Because boom widths vary for different models of hardhead miners, the lengths of manifolds (4) through (7) will vary accordingly. Length dimensions A and B in figure 8 have been left open and can be determined, for four different ranges of boom width, by using the table provided. Check the boom of your miner for suitable mounting positions and overall mounting width available before determining appropriate dimensions A and B.

This completes the design discussion for hardhead miners. After the manifold prints have been double checked, have the manifolds fabricated. Proceed to page 34 for the discussion of nozzle selection.

4.3.2 Design for Ripper Chain Miners

A typical dual-sided Sprayfan System for ripper chain miners is illustrated in figure 9. A side view from the off-curtain side of the miner is shown in figure 10. Table 2 describes the detailed locations, spray angles and orientations of the twelve Sprayfan spray manifolds.

Figure 9 depicts a left-hand return so spray manifolds (1L), (2L) and (3L) are operated (as indicated by the arrows); manifolds (1R), (2R) and (3R) are intended for right-hand returns and are shown not operating. Manifolds (4) and (7) (behind the head) each contain two sets of spray nozzles angled in both directions for use when the ventilation returns on either side. Sprays angled across the head to the left are operated for a left

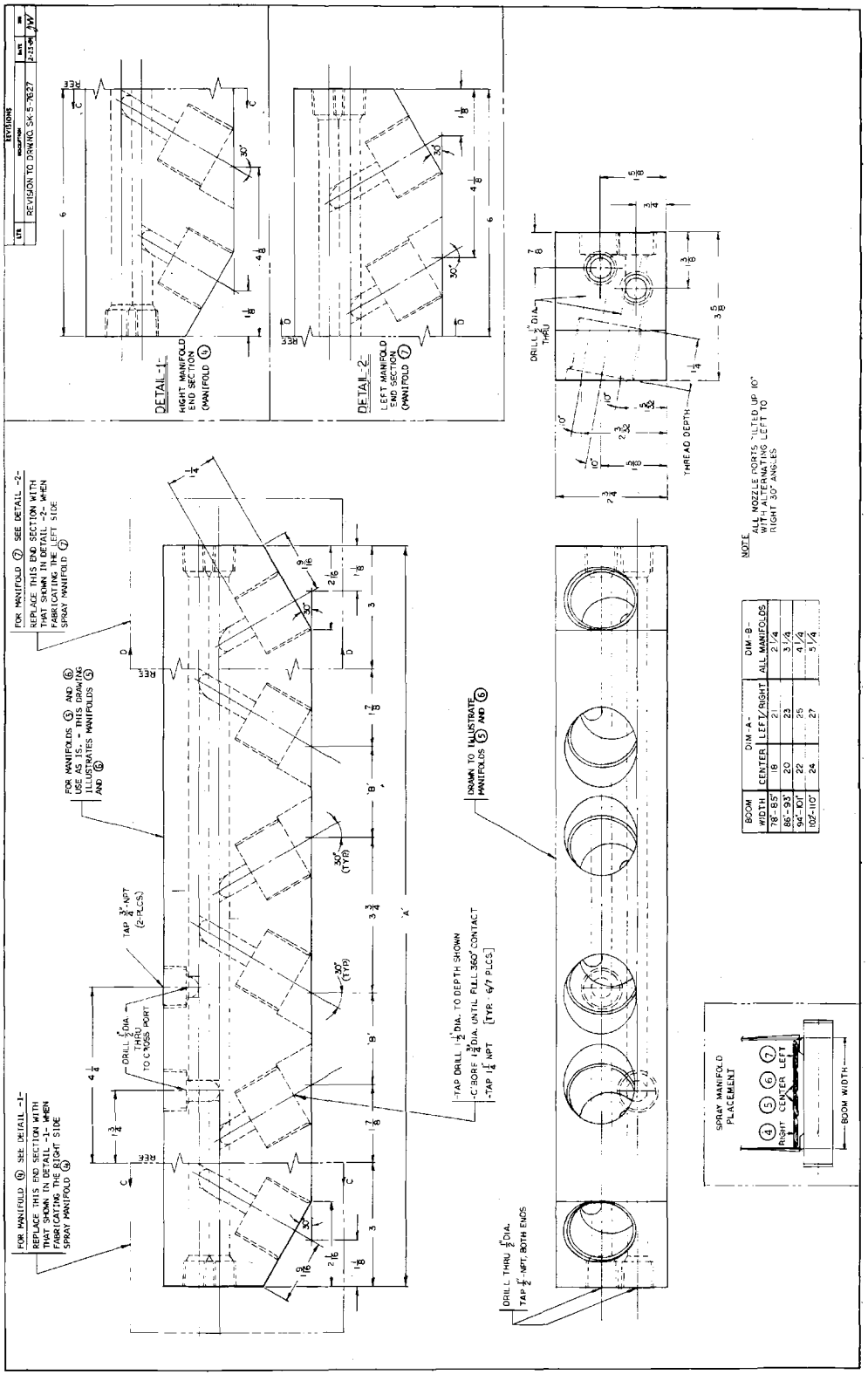
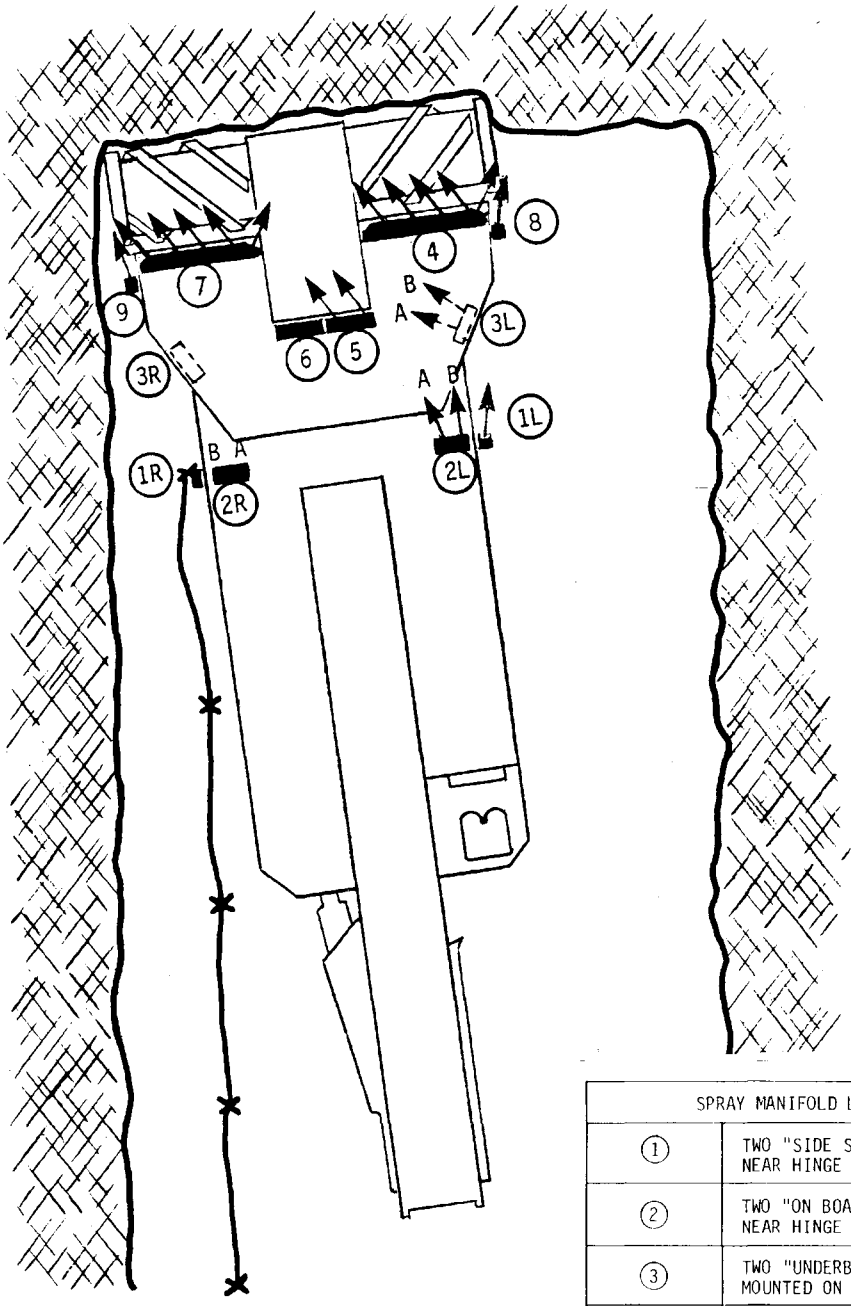


FIGURE 8. - Front spray manifolds - hardhead miner.



SPRAY MANIFOLD LEGEND	
①	TWO "SIDE SPRAYS" NEAR HINGE POINT
②	TWO "ON BOARD SPRAYS" NEAR HINGE POINT
③	TWO "UNDERBOOM SPRAYS" MOUNTED ON SHOVEL (OR PAN)
④ AND ⑦	TEN "FRONT SPRAYS" BEHIND CUTTERHEAD
⑤ OR ⑥	TWO "FRONT SPRAYS" BEHIND CENTER RIPPER CHAIN
⑧, ⑨	FOUR "DUST SUPPRESSION SPRAYS" ON SIDE OF BOOM JUST BEHIND CUTTERHEAD

FIGURE 9. - Sprayfan System layout - ripper chain miner (left-hand return).

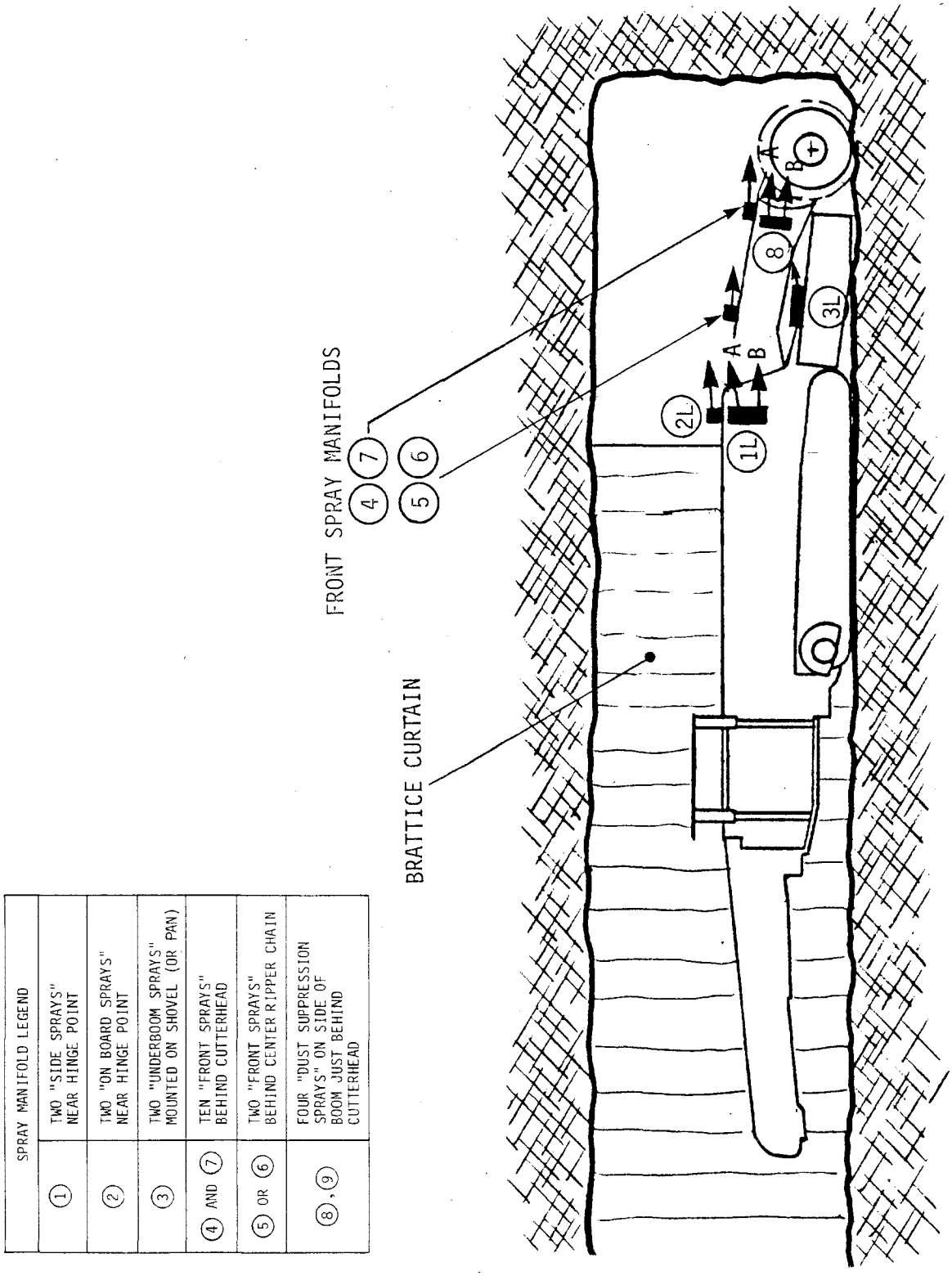


FIGURE 10. - Sprayfan System layout, side-view - ripper chain miner (left-hand return).

return. *An exception is the right-most spray nozzle in manifolds ④ and ⑦ which are angled to the right to provide dust suppression and bit lubrication into the corner of the head and ripper chain.*

Manifolds ⑤ and ⑥ each contain two spray nozzles angled in a single direction. Only manifold ⑤, with its sprays angled to the left, should operate with left ventilation returns; manifold ⑥ should be off. The reverse is true for right returns.

When the head is wider than the boom, manifolds ⑧ and ⑨ are used for dust suppression and bit lubrication on the extreme ends of the head and operate at all times.

Valving is used to direct water to the appropriate sets of sprays in manifolds ① through ⑨. A single two-way diversion valve is required for simple operation (see plumbing diagram details). Manifolds ④ and ⑦ each contain two separate water supply legs for right and left returns. Manifolds ⑤ and ⑥ each contain a single supply leg. Use of the diversion valve automatically selects the proper supply leg and manifold. All manifolds have several possible supply ports for convenient hook-up.

For machine shop fabrication, the 12 manifolds are separated into two distinct groups:

- Double nozzle manifolds, containing two nozzle ports and one supply leg
- Front manifolds, containing a number of nozzle ports and two supply legs.

The design specifications for these two types of manifolds are different and are therefore discussed separately below.

Double Nozzle Manifolds

Figure 7 provides the necessary engineering drawing to fabricate manifolds ①R, ①L, ②R, ②L, ③R, ③L, ⑧ and ⑨. The drawing, however, is a general double spray manifold drawing specifying only "angles as required." The spray discharge angles to be machined into each of the specific manifolds are given in table 2.

> *Be careful when specifying the double nozzle manifolds. They are not interchangeable between the right and left sides of the mining machine.*

To minimize interference of spray cones, spray nozzles should be located as far apart as practical. Hence, the overall manifold length shown in figure 7 (dimension A) has been left open. Generally, a dimension A of 9 to 12 in is suitable to avoid spray interference, as well as provide a practical mounting length. Safe mounting locations should be selected where manifold length can be maximized.

Manifolds ⑧ and ⑨ are intended for use only on miners equipped with heads wider than the miner's frame. When the head width is not greater than the frame width, additional dust suppression and bit lubrication in this location is not required and manifolds ⑧ and ⑨ should not be installed.

When manifolds ⑧ and ⑨ are used, they should be located on the sides of the boom as far forward toward the head as possible. If located more than a foot or so outby the head, these sprays will interfere with air flow patterns established by the Sprayfan.

Front Manifolds

Figure 11 provides the drawing required to fabricate front manifolds ⑤ and ⑥ located behind the ripper chain. Manifold ⑤ is shown in the drawing: manifold ⑥ is simply fabricated to the mirror image of manifold ⑤. Proper spray discharge angles are already specified in figure 11 and do not have to be determined. Manifolds ⑤ and ⑥ together should fill the entire width of the ripper chain as shown in the schematic sketch "Spray Manifold Placement" in the lower left-hand corner of figure 11. Measure dimension C on your miner and have manifolds ⑤ and ⑥ fabricated to lengths 1/2 x C as indicated in the figure.

Figure 12 contains the drawing necessary to fabricate front manifolds ④ and ⑦ located directly behind the head adjacent to the ripper chain. Both manifolds are identical and proper spray discharge angles are already specified in the figure. Simply determine dimension A behind the head of your miner and fabricate two manifolds to the appropriate length dimensions A and B as detailed in figure 12.

This completes the design discussion for ripper chain miners. After the manifold prints have been double-checked, have the manifolds fabricated. Proceed to the next section on nozzle selection.

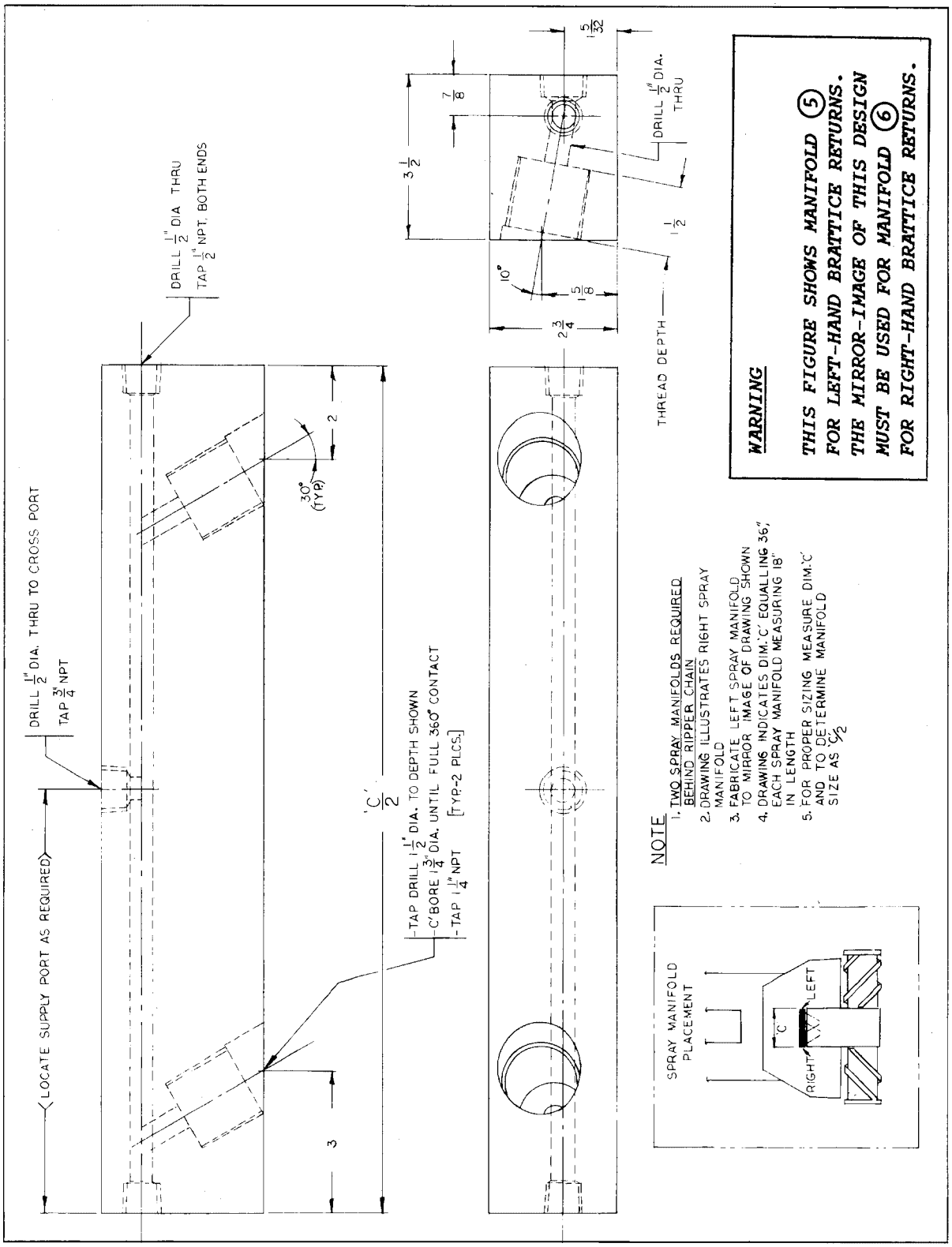


FIGURE 11. - Front spray manifolds - ripper chain miner (behind center ripper chain).

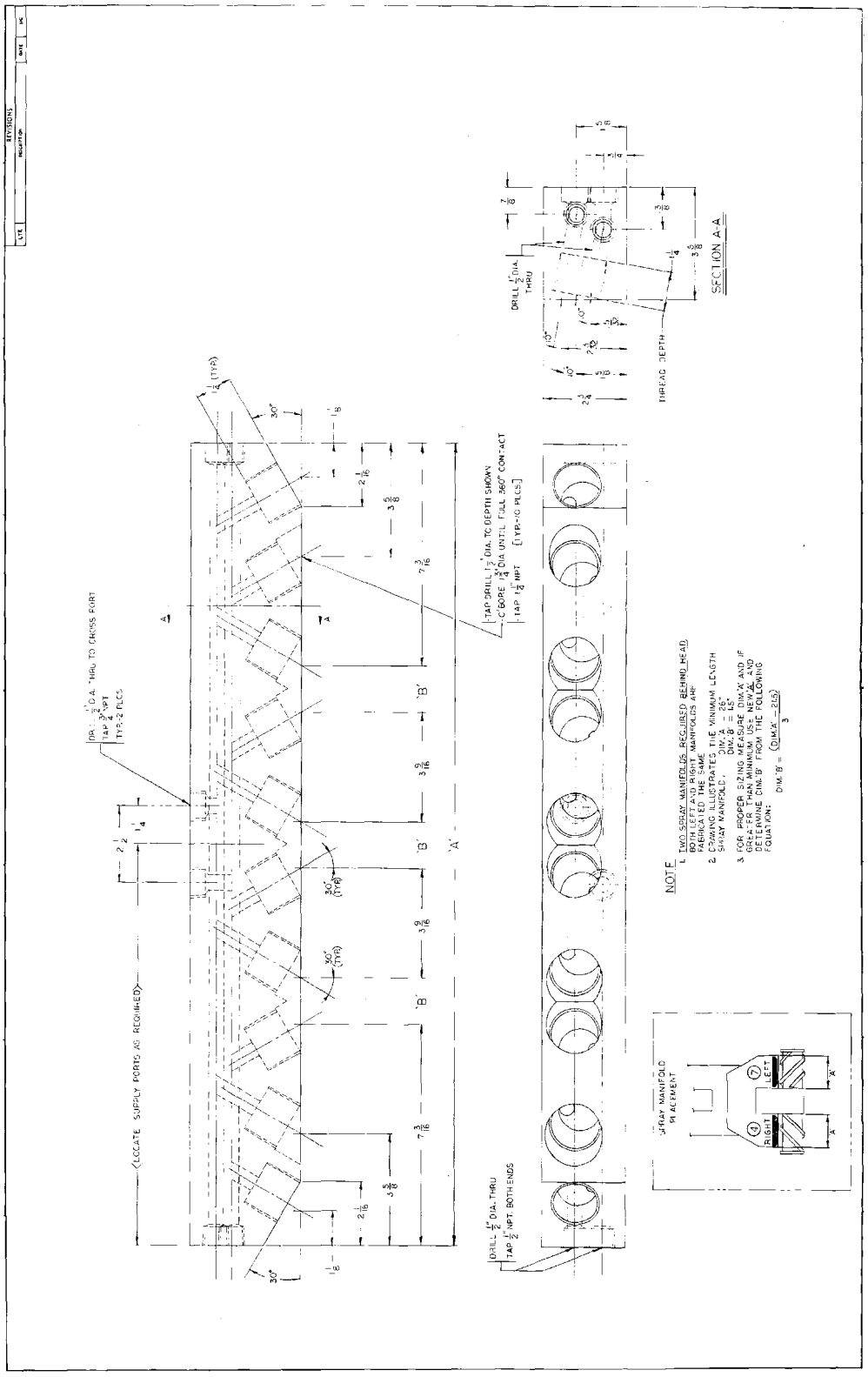


FIGURE 12. - Front spray manifolds - ripper chain miner (behind head).

4.4 NOZZLE SELECTION

The different nozzle positions described in tables 1 and 2 require different spray patterns for best system performance. *The nozzles along the side of the miner should have a narrow spray angle to avoid impingement on the miner and ribs. The nozzles behind the head should have a wide spray pattern for better coverage of the face.*

A recommended nozzle type is the hollow cone series, which offers a spray pattern and coverage that minimizes water consumption yet moves air effectively. The Whirljet nozzle (manufactured by Spraying Systems Co.), or other similar nozzles suitable for mine use, have no internal obstructions so that plugging and required maintenance are minimized (see appendix B). The Whirljet is comprised of two components, body and tip. The first number of the nozzle identification number refers to the body orifice size, while the second number specifies the tip orifice size. Although nozzles are usually supplied preassembled with the same body and tip number, other combinations of bodies and tips can be made up. For a given water pressure and tip, increasing the body orifice size results in a decrease in cone angle and an increase in flow rate. Nozzles from other manufacturers may be used as long as the performance characteristics listed in tables 1 and 2 are met.

The Sprayfan System as designed with the nozzles listed in tables 1 and 2 has enough airmoving power for <u>most</u> gassy mines. An <u>increase</u> or <u>decrease</u> in nozzle capacity may be in order for very gassy or moderately gassy conditions, respectively. <u>In any case</u>, <u>the total number and type of nozzles suggested should not be changed without adequate experimentation and testing</u>. <u>Indiscriminate</u> reduction of power (elimination of nozzles, etc.) without testing may result in a system which is incapable of properly ventilating the face.

4.5 WATER SUPPLY SYSTEM MODIFICATIONS

The effectiveness of the Sprayfan will be reduced if the water supply to the miner is inadequate. The two most common deficiencies in a water supply system are:

- Low water pressure and flow volumes at the continuous miner spray nozzles
- Poor filtration, resulting in frequent clogging of sprays.

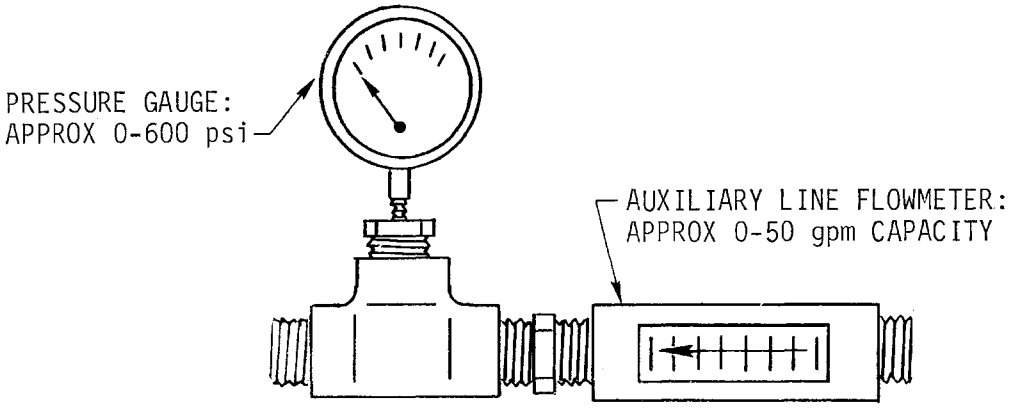
For average mining conditions, a Sprayfan will require a water flow of about 25 to 30/gpm at 150 psi. Actual operating pressures and flows, however, will depend on the mean entry air velocity and the gas conditions in the face area. Higher air flows and gas levels will require higher pressures and flows and lower airflows (and gas levels) will require lower pressures and flows.

> *In no case, however, should the Sprayfan water pressure be below 100 psi. This dynamic pressure reading must be obtained with the system operating at full flow.*

To determine if your existing water supply system is capable of properly supplying the Sprayfan, a few simple measurements are required:

- First you will need 2 pressure gauges, a flow meter, tape measure, and ball valve; figure 13 illustrates a typical measuring setup
- Next go to table 3 and complete the data table in the lower right portion of the page
- If the dynamic pressure (pressure at the nozzle tips during full flow conditions) at the front manifold is adequate, then no improvements to the supply system are required
- If dynamic pressure and flow requirements cannot be reached, then proceed to tables 4 and 5 to check the restriction of the existing water supply hose. You will need the data obtained in table 3. Simply increasing the diameter of the miner supply hose can dramatically improve the pressure and flow at the miner nozzles
- Finally, if the water supply is still inadequate, then installation of a booster pump may be necessary. (see Appendix B, for list of pump manufacturers).

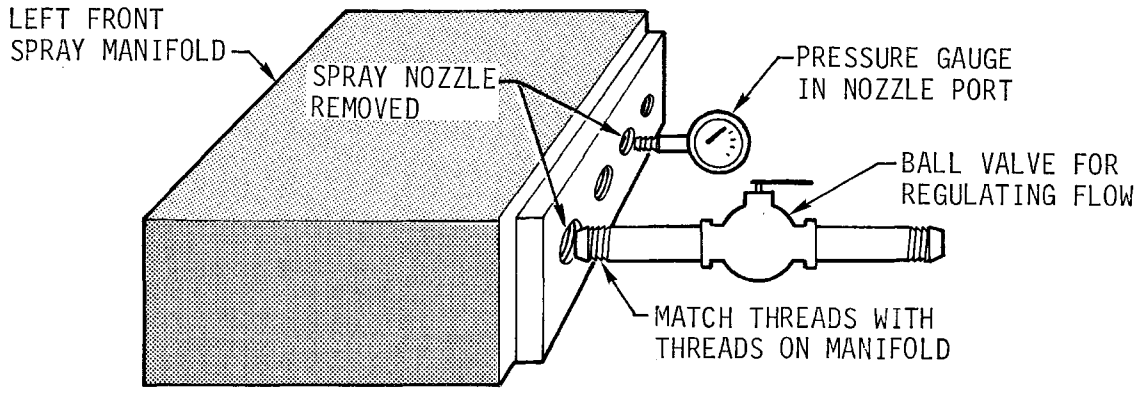
If a booster pump is required, the pump capacity should be on the order of 35 to 40 gpm at 400 to 600 psi in a typical installation. This is necessary to overcome pressure losses and still maintain pressures of 150 to 200 psi at the Sprayfan nozzles. In order to minimize required pumping capacity, the pump should be located at the end of the section water supply pipe and advanced with the section pipe. In this way, the distance between the miner and the pump does not increase. This also places



1. THE EXISTING CONVENTIONAL SPRAY NOZZLES AND WATER FILTER ELEMENT MUST BE CLEANED OR REPLACED TO ENSURE FULL SYSTEM FLOW BEFORE THE SURVEY BEGINS.
2. DISCONNECT MINER WATER SUPPLY HOSE AT ENTRY INTO MINER (LOCATION ② IN TABLE 3) AND INSTALL PRESSURE AND FLOW APPARATUS SHOWN ABOVE.
3. REMOVE A SPRAY NOZZLE FROM THE LEFT FRONT MANIFOLD AND INSTALL A SECOND PRESSURE GAUGE AS SHOWN BELOW.
4. INSTALL A BALL VALVE IN ANOTHER NOZZLE PORT AS SHOWN BELOW OR AT A CONVENIENT HOSE CONNECTION.

> This valve is used for increasing the total water flow used by your existing system to 25 to 30 GPM. This will simulate the flow required by the sprayfan system and let you determine the pressure that you have available. If your existing system uses more than 25 to 30 GPM then you will have to decrease the total flow by plugging nozzle ports.

5. PROCEED TO TABLE 3 FOR THE WATER SUPPLY SURVEY.



> Note: Information regarding water flow and pressure testing devices appears in the Appendix.

FIGURE 13. - Pressure and flow testing apparatus.

TABLE 3. - Water supply system survey

Materials required - Pressure gauge, tape measure, pressure gauge and flow meter apparatus, and ball valve (shown in figure 13)

Measurements

1. At location ① (left front manifold) measure the dynamic pressure at a nozzle port with 25 to 30 gpm of total water flow (measured with flowmeter at location ②). You may have to use the ball valve to increase the system flow rate to 25 to 30 gpm. If you have more than 25 to 30 gpm through your existing system then decrease the flow rate by plugging front nozzles.

2. Record the dynamic pressure in the table below. If the pressure is 150 psi or more, then your water supply system will probably be adequate for the Sprayfan System. (Remember: very gassy mines with high airflows may require operating pressures above 150 psi; mines with low airflows and little or no gas require 100 to 150 psi).

> If the dynamic pressure is less than 150 psi your water supply system needs to be upgraded. Proceed to next step to determine the pressure drop in your miner supply hose.

3. At location ② (hose entry into miner) measure and record the dynamic pressure with a 25 to 30 gpm flow rate.

4. Measure and record the maximum hose length used before the section supply pipe is advanced.

5. Measure and record the inside hose diameter.

6. At location ③ (the end of the section supply pipe) measure the dynamic pressure with a 25 to 30 gpm flow rate.

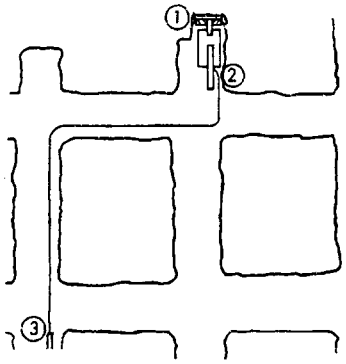
7. Proceed to table 4 with this information to determine the pressure lost through your existing hose.

Precautions

1. The existing conventional spray nozzles and water filter element must be cleaned or replaced to ensure full system flow before the survey begins.

2. Fully open all supply valves when dynamic measurements are being taken and set the flow rate at 25 to 30 gpm using the apparatus shown in figure 13.

3. When taking all measurements, be sure that other sections in the mine using the same water supply line are operating normally



Data Table		
Location	Dynamic pressure, psi	Flow, gpm
① Left front manifold		25 to 30
② Inlet to miner		25 to 30
③ End of section supply pipe		25 to 30
Hose diameter (inside) Total maximum hose length		

TABLE 4. - Worksheet for water supply data

Step 1:

- Using the information in table 3 determine the actual pressure loss in the miner supply hose.
- Subtract dynamic pressure at ② from dynamic pressure at ③

[dyn at ③ _____ psi] - [dyn at ② _____ psi] = _____ psi

Step 2:

- Determine the expected gain in pressure by selecting a larger hose diameter: compare the pressure loss through the larger hose to that of your existing hose (obtained in Step 1).
- For example: suppose you are using 800 ft of 1-in. diam hose, and in Step 1 you measured a pressure loss of 248 psi. Using the pressure drop information in table 5, you find that the expected pressure drop would be only 36 psi if you converted to 800 ft of 1-1/2-in. diam hose. Hence a pressure gain of 212 psi can be obtained by simply changing to the larger hose diameter:

248 psi - 36 psi = 212 psi gain

TABLE 5. - Total pressure drop ΔP (in psi) for given hose lengths

Hose length ft	Hose ID in.	Flow, gpm				
		10	20	30	40	50
400	1	20	64	124	204	300
	1-1/4	7	22	44	72	104
	1-1/2	-	9	18	29	40
600	1	30	96	186	306	450
	1-1/4	11	33	66	108	156
	1-1/2	-	14	27	43	60
800	1	40	128	248	408	600
	1-1/4	14	44	88	144	208
	1-1/2	-	18	36	58	80
1,000	1	50	160	310	510	750
	1-1/4	18	55	110	180	260
	1-1/2	<10	23	45	72	100
1,500	1	75	240	465	765	1,125
	1-1/4	27	83	165	270	390
	1-1/2	<15	35	68	108	150

the pump conveniently close to the load center. For ease of movement, the entire pump assembly should be skid-mounted.

Most high pressure pumps are available with specially hardened internal components which are resistant to abrasive mine water. However, a Y-strainer capable of removing large particles from the water supply should be installed upstream of the pump for protection. Smaller particles (capable of plugging nozzles) will easily pass through the pump on to the filtration system.

Ease of maintenance and reliability are prime considerations in selecting the type of pump. For underground application, the pump should be of a simple design with a minimum number of seals and bushings. Although reciprocating piston pumps are capable of very high pressure operation, they can be complex, containing many moving parts. A simpler pump, such as the Roto-Jet pump series (Kobe) or Worthington multistage centrifugal pump, should be considered. They are seize-proof and cannot overpressurize the system. Whichever type of pump is selected, it must accommodate the on/off operation of the system during mining. This can be accomplished by means of an automatic flow switch, which will start and stop the pump at predetermined flows. With some pumps, it is advantageous to accommodate the on/off operation of the system with a pressure relief valve and a bypass loop. See appendix B for a listing of suggested pumps.

Some continuous miners are equipped with machine-mounted booster pumps which can be used in lieu of a separate boost pump. The pumps generally supplied by the manufacturers for this purpose do not wear well in corrosive mine water and often do not provide enough pressure and flow to properly power a Sprayfan System. Water pumps can be fit onto the miner however, and powered off the existing hydraulic circuit. This arrangement allows the power supply for the pump to be controlled, through the use of pilot control valves, by the water spray valve in the operator's cab. The ease with which this installation can be made will depend on many factors, including existing miner layout, personnel qualifications and availability of hydraulic power on your miner. If mounting an on-board pump proves too time-consuming and costly then a section pump as described above is highly recommended.

4.6 WATER FILTRATION

The Sprayfan System is more than a water spray system. It is an auxiliary face ventilation system, which may be employed to alleviate potentially hazardous conditions. Good filtration is a must. Most factory-supplied miner filters and nozzle strainers are ineffective and impractical. They cannot handle the quantity and size of particles found in mine water and have high servicing requirements. Plugged nozzles result in an ineffective system (reduced ventilation of the face) and a restricted flow of cooling water through the miner.

An "improved" filtration system has been developed by the Bureau which is both practical and effective. The heart of the system is a commercially available hydrocyclone (Krebs or Conflow) which will remove minus 1/8 to 60 mesh particulate. The particulate is collected in the lower portion and is flushed out periodically simply by opening a valve. The plus 1/8-in material is removed by a flushable Y-strainer which is upstream of the hydrocyclone. The most practical location for the Bureau system is at the end of the hard pipe water supply line (see figure 14). Skid-mounted (with the booster pump), the system is accessible, easily maintained, and out of the way.

A second hydrocyclone, mounted on the miner, serves to remove particulate which may have entered the supply hose when disconnected for section advancement. The hydrocyclone is easily flushed clean by opening the valve on the flush outlet. The flush outlet can discharge through the machine wash-down hose making maintenance automatic each time the wash-down hose is used. The last stage of filtration necessary on the miner is flushable Y-strainers downstream of the cooling circuits on each side of the miner. These will trap particles which have corroded from the interior surfaces of cooling jackets and water passages on the miner. Refer to appendix B for detailed information on the filtration system components.

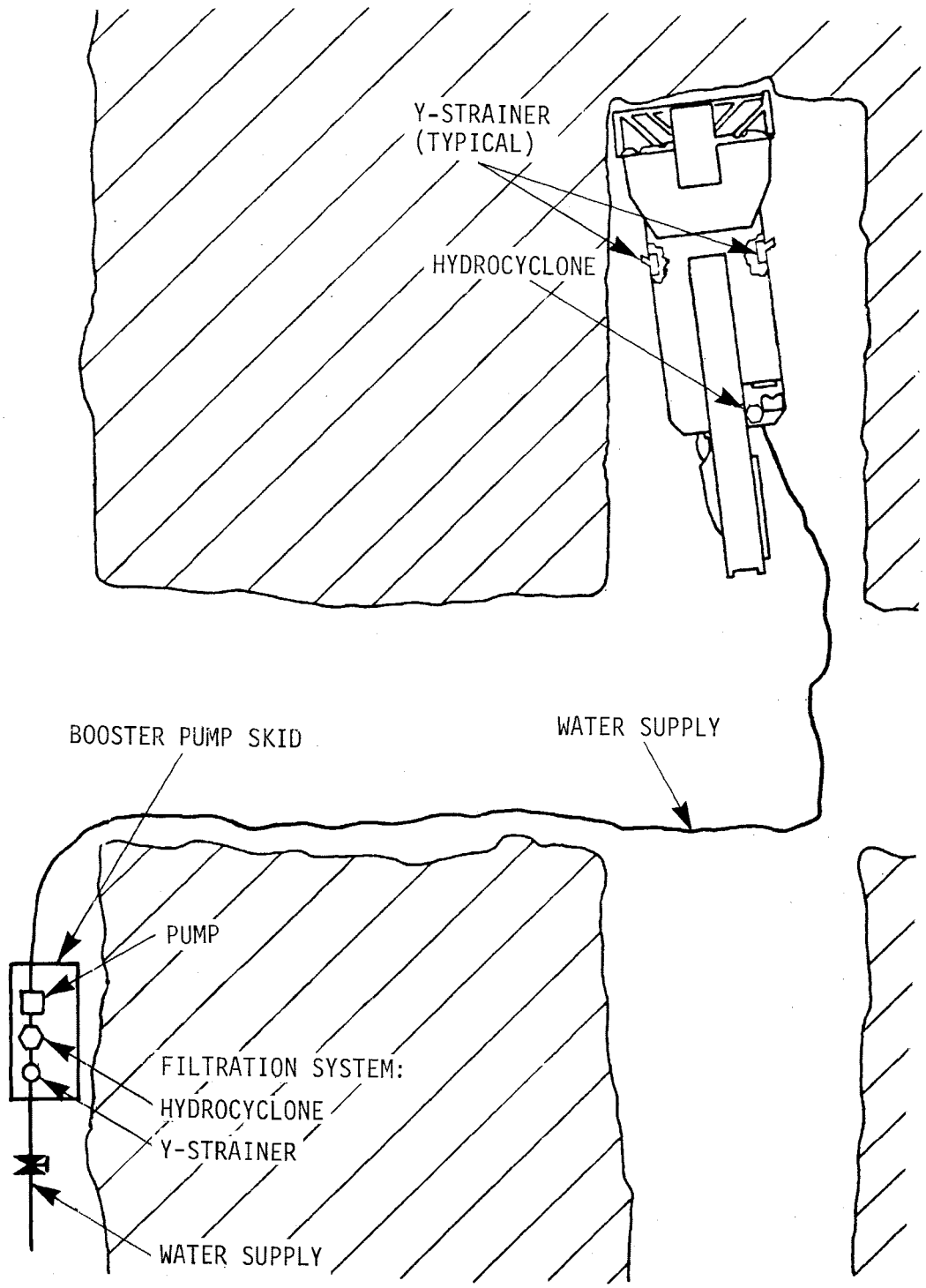


FIGURE 14. - Possible filtration component locations.

5. SYSTEM INSTALLATION

Ideally, the first installation should take place on a miner in for rebuild. In this way the time and facilities to develop installation techniques and system layout will be available. Different installation methods which have been used are presented in this section. The choice of one or another will be directed by the user's needs. Installation of the Sprayfan System is subdivided into manifold/nozzle installation on hardhead or ripper chain miners, plumbing, and fine tuning.

5.1 MANIFOLD/NOZZLE INSTALLATION

Spray manifolds will be located on the miner in the approximate positions shown in figures 5 and 6 (for hardhead miners) or figures 9 and 10 (for ripper chain miners). Exact mounting locations cannot be given since the physical interferences and dimensions on each miner differ. Manifold mounting locations should not vary more than $\pm$12 in from the positions shown in table 1 (hardhead) and table 2 (ripper chain). Large variations from the mounting locations shown may result in degradation of system performance. Small alterations must often be made to fit the system onto a miner while avoiding lights, hinge points, and control boxes which cannot support welding, etc. Small adjustments in placement are acceptable.

Keep the following principles in mind when adapting tables 1 or 2 to a specific installation:

- Side nozzles move the air up to the face; front nozzles sweep it across the face (see fig. 2)

- The front sprays must still suppress dust and cool bits. Since the conventional sprays have been removed, their functions must be assumed by the Sprayfan

- Anytime a spray impinges on the miner, the rib, the roof, or other sprays, air-moving capability is reduced. Impingement can also occur when debris obstructs the spray nozzle. Mount manifolds away from these areas

- Remember that all stages of the mining cycle must be well-ventilated.

Manifolds can be either bolted or welded into position depending upon location, manifold material, and feasibility. It is suggested that the front manifolds be welded because of their vulnerability and damage potential at the face. The other mounting locations may be welded or bolted depending upon:

- Required access into cover plates
- Frequency of manifold damage
- Weldability of manifold material
- User preference.

Stainless steel manifolds may be bolted to a steel bracket (angle iron) which has been welded to the miner. One advantage of the bolt-on style is that manifold replacement will not require tramming from the face which can be time-consuming. Both styles may require shims for final nozzle positioning and aiming.

Although installation of the Improved Sprayfan on hardhead and ripper-chain miners is similar, several key differences do exist. Therefore, discussions of each are separated below.

5.1.1 Installation on Hardhead Miners

Placement of manifolds requires reference to the positioning information provided in table 1. The manifolds must be carefully installed in relationship to the centerline of the miner in order for the final nozzle orientation to be correct.

Manifolds (1L) and (1R) should be located just behind (outby) the hinge point on the side of the miner. Sprays should be placed to avoid impingement on the miner or rib as indicated in table 1.

Manifolds (2R) and (2L) should be located on top of the miner body just behind (outby) the boom hinge point and as close to the edges of the miner as practical. Sprays should be oriented as specified in table 1 to direct airflow diagonally across the head of the miner. For high coal applications (greater than 7 ft), these manifolds should be mounted on 4- to 6-in high pedestals and tipped backward by approximately 10^{o} to help avoid spray impingement onto the boom when the boom is raised. This is illustrated in figure 15.

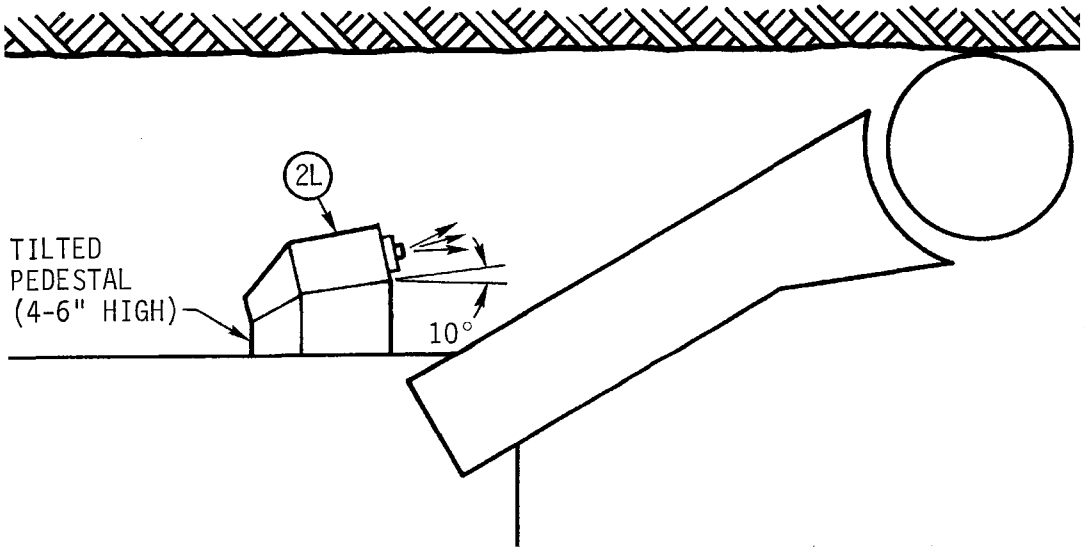


FIGURE 15. - Installation of manifold (2L) (or (2R)) in high coal.

Manifolds (3R) and (3L) are mounted on the shovel (or pan) and should be oriented such that the sprays do not impinge on the gathering heads. They should be mounted high enough that debris will not pile up in front of them and block the spray cones. These sprays are directed to sweep air under the boom.

When used, manifolds (8) and (9) should be located on the sides of the boom as far forward toward the head as possible. If located more than a foot or so outby the head, these sprays will interfere with airflow patterns established by the Sprayfan. Aim the sprays to hit directly on the rear of the cutter drum.

Use figures 5 and 6 to place manifolds (4), (5), (6) and (7) on a hardhead miner. The correct spray discharge angles are already specified in figure 8 and should not be changed. Orient these manifolds onto the miner so that the bottom *half* of the spray cones impact the cutting bits. The top half of the sprays should be in free air above the cutting bits for efficient airmoving across the face.

5.1.2 Installation on Ripper-Chain Miners

> *Placement of spray manifolds requires reference to the nozzle position information provided in table 2. The manifolds must be carefully installed in relationship to the centerline of the miner in order for the final nozzle orientation to be correct.*

The installation of manifolds (1R), (1L), (2R), (2L), (3R), (3L) and (8) and (9) on ripper chain miners is identical to that of hardhead miners. Please refer to subsection 5.1.1 and table 2 for the discussion regarding the installation of these manifolds.

Use figures 9 and 10 to place front manifolds (4), (5), (6) and (7), on a ripper chain miner. The correct spray discharge angles are already specified in figures 11 and 12 and should not be changed. Orient manifolds (4) and (7) onto the miner on either side of the ripper chain so that the bottom *half* of the spray cones impact the cutting bits. Manifolds (5) and (6) should be placed directly behind the ripper chain and oriented so that the bottom half of the spray cones impact the bits on the ripper chain. The upper half of the spray cones in manifolds (4), (5), (6) and (7) should be in free air above the cutting bits for efficient airmoving across the face.

5.2 PLUMBING

Once the spray manifolds have been mounted, the installation is ready for plumbing. A schematic diagram of a typical continuous miner water distribution system is shown in figure 16.

> *The recommended procedure is to use all the water from the cooling jackets. However, be sure that the expected Sprayfan System water pressure and flow will be consistent with the miner manufacturers specifications for maximum cooling jacket pressure and minimum flow requirements.*

Plumbing the Sprayfan System is straightforward:

- Water is routed to either the right-hand return or the left-hand return half of the Sprayfan System through the use of a two-way diversion valve in the operator's cab
- A distribution manifold is used to supply all spray manifolds on a given split (right or left-hand) with water
- Spray manifolds (8), (9) and throat sprays (if used) are plumbed into the circuit on the upstream side of the diversion valve because these sprays are used for either right- or left-hand returns.

The plumbing layout shown in figure 16 can be used for all miner types and all mining cycles. The hose diameters shown should be used. Larger sizes are acceptable but smaller sizes should be avoided.

The distribution manifold discussed above and noted in figure 16 greatly simplifies the valving and hosing required to plumb a dual-sided Sprayfan System. Figure 17 provides a simple distribution manifold design to eliminate plumbing complexity. Two of the manifolds shown in figure 17 are required - one for each side of a dual-sided system. The main water inlet line for each system (recommended at a 1-in diam) is fed into a distribution manifold, and individual hoses are simply routed from the distribution manifold to the various spray manifolds. Typically, the distribution manifolds are located inside the boom of the miner beneath the protective cover plates generally provided.

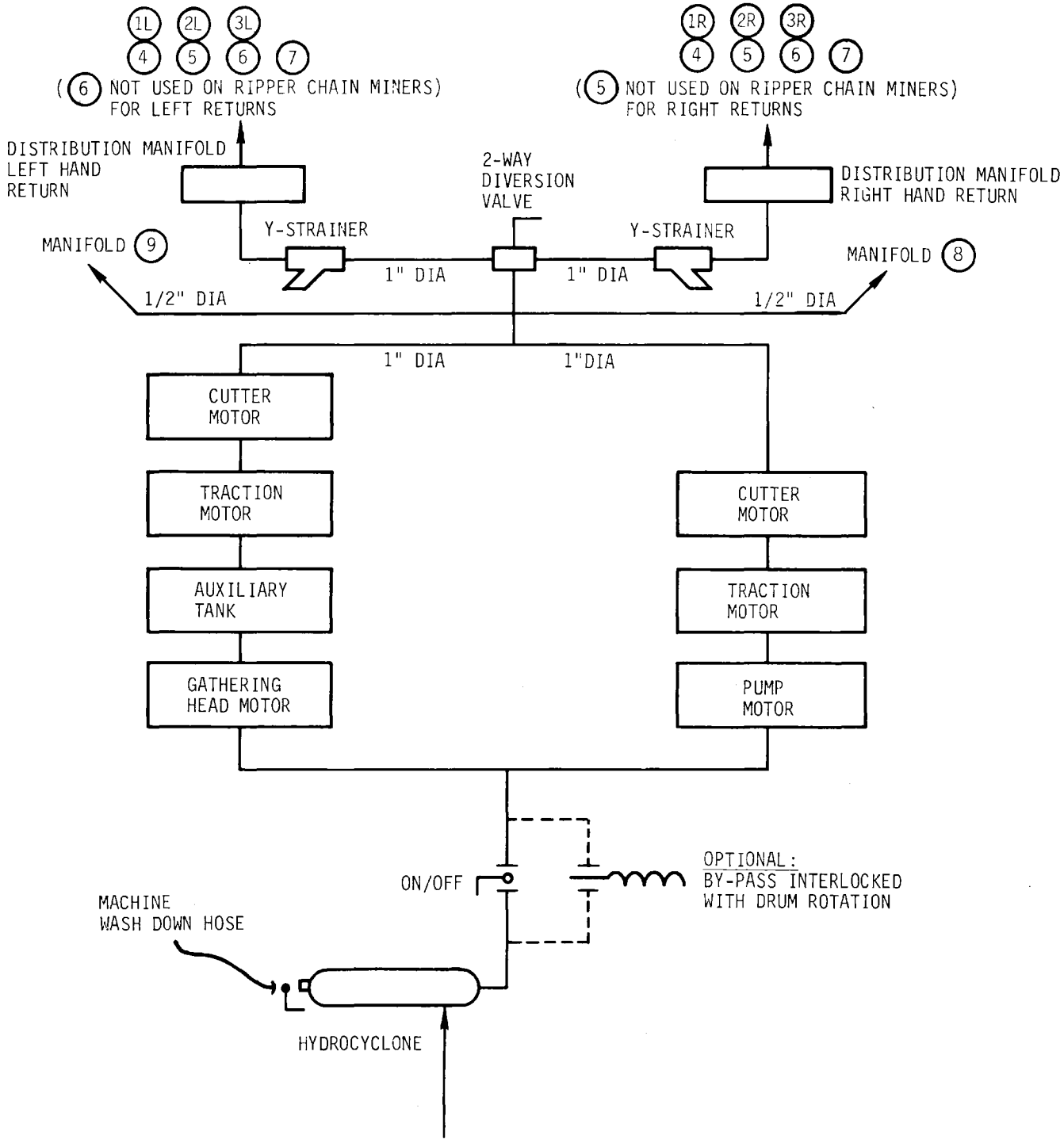


FIGURE 16. - Sprayfan System plumbing diagram.

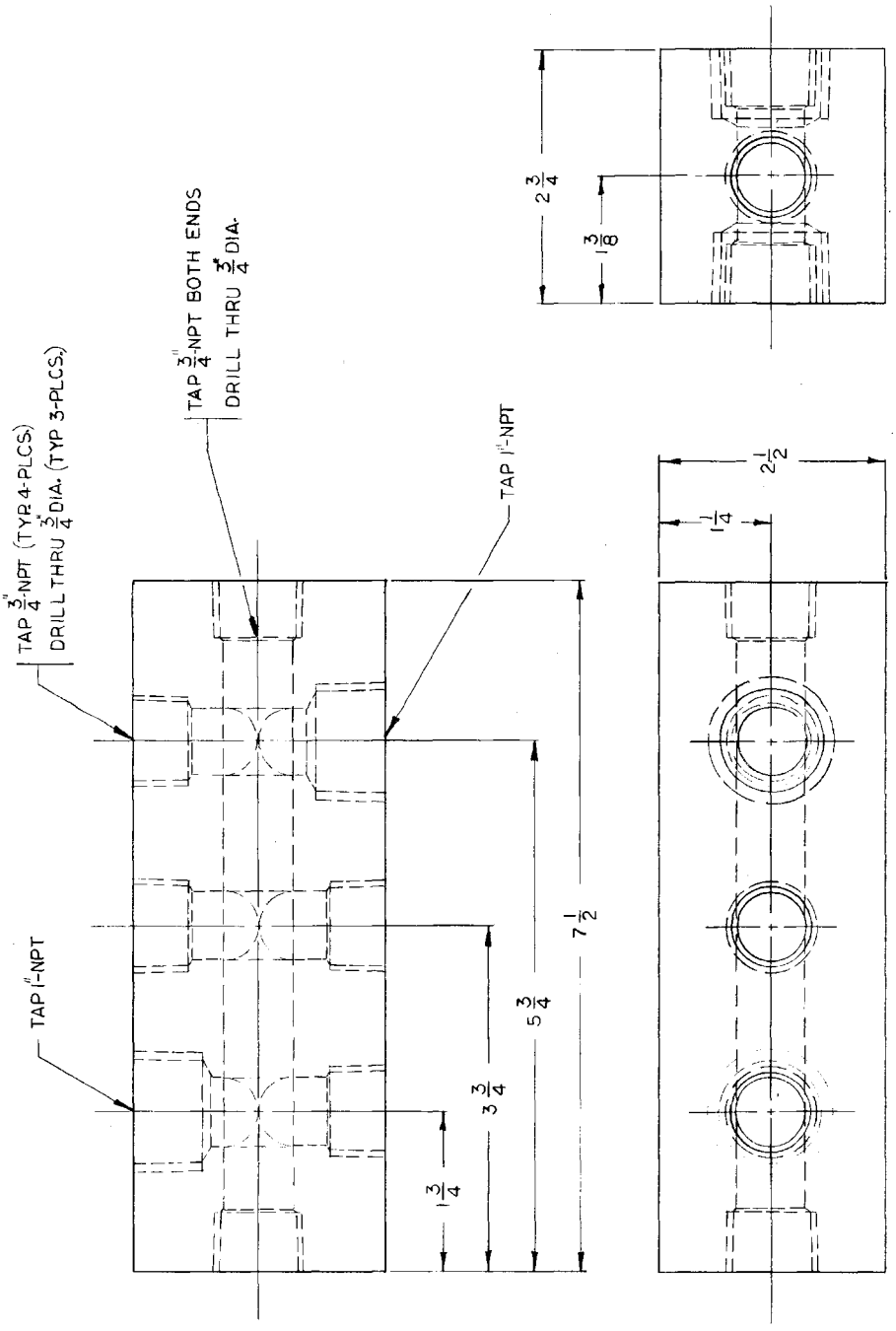


FIGURE 17. - Distribution manifold for internal plumbing.

An effective filtration system is the single most important component for a properly functioning Sprayfan System. The filtration must be plumbed into the system on the miner wherever room is available and mounting locations should be easily accessible for maintenance. Figure 18 shows a possible mounting arrangement for the filtration systems discussed earlier.

A safety bypass around the operator's valve may be installed. This bypass will include a pilot operated valve which is interlocked to cutterhead operation. This will ensure that the water sprays are "on" while the drum is rotating even if the operator has failed to open his valve.

5.3 FINE TUNING

It is helpful to fine tune the system following the installation and prior to mining. Keep the following precaution in mind during all steps of the fine tuning procedure:

The Sprayfan System as designed with the nozzles listed in tables 1 and 2 has enough airmoving power for most gassy mines. An increase or decrease in nozzle capacity may be in order for very gassy or moderately gassy conditions respectively. In any case, the total number and type of nozzles suggested should not be changed without adequate experimentation and testing. Indiscriminate reduction of power (elimination of nozzles, etc.) without testing may result in a system which is incapable of properly ventilating the face.

To fine tune the Sprayfan, tram the miner up to the face and establish normal ventilation. Turn the sprays on and use a dry chemical fire extinguisher (type A, B) as a sample "dust" cloud. Whether through smoke testing or actual mining, fine tuning can be accomplished by following the applicable steps outlined below:

a. If rollback of dust or "smoke" is occurring at the operator's position, the system may be too powerful for the quantity of primary ventilation (that is, the system is trying to move more air to the mouth of the brattice than it can accept), resulting in recirculation

b. First, double check face airflow to be sure that the section ventilation is properly established

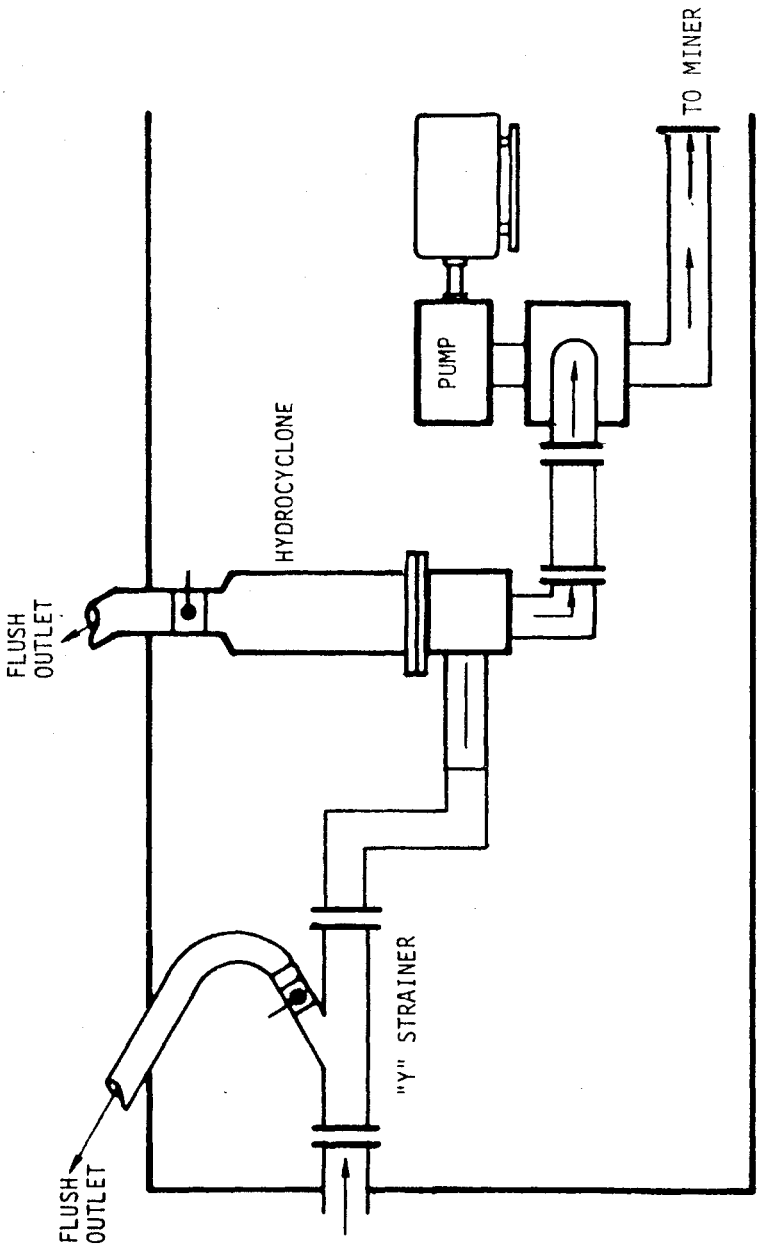


FIGURE 18. - Filtration system - skid mounted components.

c. If ventilation adjustments do not solve the problem, then reduce the system nozzle pressure to 100 psi if it was operating at higher levels. If this does not cure the rollback then eliminate nozzles in manifolds ① and ② along the side of the miner using the following procedure; recheck for rollback after each step:

1. Step 1 - Plug lower nozzle in manifold ①

2. Step 2 - Plug nozzle nearest rib in manifold ②

If rollback still occurs, then the problem is probably not being caused by the Sprayfan System.

d. When a properly balanced system has been attained, the methane levels behind the cutter-head on the off-curtain side of the miner should be monitored for one shift with a continuously recording methanometer. This ensures that the ventilating capacity of the system is adequate. If methane concentrations at this point are too high then the quantity of primary air to the entry is inadequate. The air quantity should then be increased along with a corresponding increase in Sprayfan power by systematic addition of the nozzles and pressures previously reduced to eliminate rollback

e. To increase water for dust suppression at the head with minimum effect on ventilation, add nozzles at underboom manifold ③

f. If the system as designed and installed is inadequate for a very gassy mine with high ventilation flows, then the operating nozzle pressure should be increased. If this is not adequate then additional nozzles should be installed at manifold locations ①, ②, and ③ as required for more air at the face.

6. SPRAYFAN OPERATION

Operation of the Sprayfan System is simple. For single return systems it requires only that the sprays be activated prior to cutting. This is done using a valve in the operator's cab as is current practice with conventional spray systems. For dual systems (those operating on sections with left and right-hand splits), the appropriate set of manifolds must be activated, depending upon which side of the entry the ventilation is returning.

Once the system is installed, the section boss should thoroughly explain system operation to section personnel (especially the miner operator and helper). *Training sheets* with operating instructions (figures 19 and 20) have been included in this section for reproduction and distribution to miners (sheets for both hardhead and ripper chain miners are provided). These can serve as pocket guides for the first few shifts of Sprayfan operation until personnel become familiar with its use and operation.

Basic rules for effective Sprayfan operation are:

- *Always operate the spray manifolds which are on the side of the miner opposite the line curtain.* When the return is on the left hand side of the entry, the spray manifolds along the right hand side of the miner will be operating and vice versa.

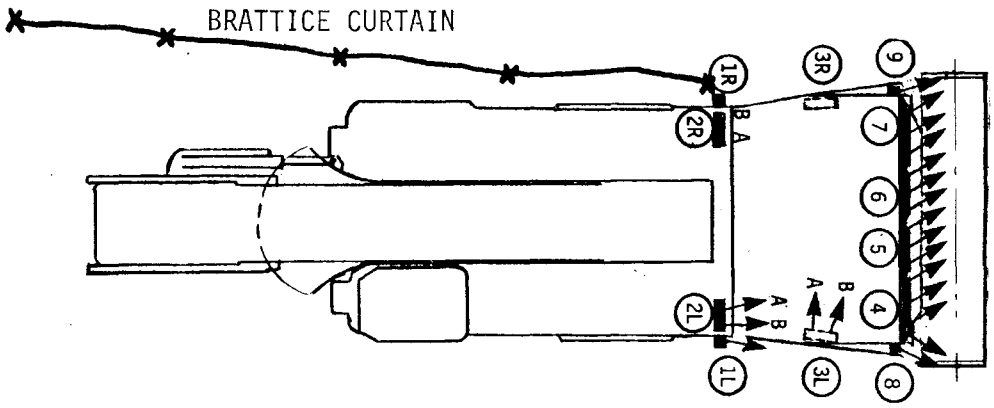
- Always start the sprays *before* drum rotation begins. This will serve the following purposes:

  1. The system requires a short period of time to react and redirect the airstream to the face.

  2. It will be obvious whether or not the *correct* spray manifolds are on.

> *If the wrong set of sprays are operating, the miner and sprays should be shut down immediately and the correct sprays turned on.*

  3. The sprays will act as an *early warning system* for anyone standing near the head that operation will begin shortly.



1. WHEN WORKING LEFT HAND SPLIT, SPRAYS 1L, 2L, 3L AND THE SPRAYS ANGLED TO THE LEFT, IN MANIFOLDS 4, 5, 6 AND 7 OPERATE.*

2. WHEN WORKING RIGHT HAND SPLIT, SPRAYS 1R, 2R, 3R AND THE SPRAYS ANGLED TO THE RIGHT, IN MANIFOLDS 4, 5, 6 AND 7 OPERATE.*

3. MANIFOLDS 8 AND 9 (IF USED) ARE FOR BOTH RIGHT AND LEFT HAND RETURN SYSTEMS.

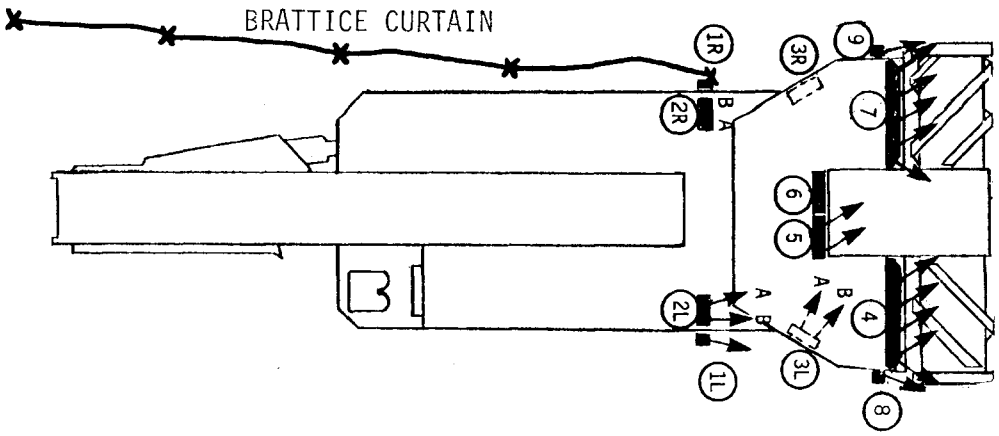
4. FLUSH HYDROCYCLONES EACH SHIFT.

5. CHECK NOZZLE OPERATION VISUALLY DURING EACH PLACE CHANGE - CLEAN OR REPLACE PLUGGED NOZZLES.

*NOTE: TWO SPRAYS WILL OPERATE AGAINST THE DIRECTION OF THE OTHERS - THESE ARE FOR DUST CONTROL AND BIT LUBRICATION.

SPRAY MANIFOLDS	NOZZLE TYPE
(1L), (2L), (3L), (1R), (2R), (3R) SIDE, ON-BOARD AND UNDERBOOM	BD20-2 (OR EQUIVALENT) NARROW HOLLOW CONE (30° SPRAY ANGLE)
(4), (5), (6), (7), (8), (9) FRONT AND DUST SUPPRESSION SIDE SPRAYS	BD3-3 OR BD20-2 WIDE HOLLOW CONE (70° SPRAY ANGLE)

FIGURE 19. - Sprayfan training sheet - hardhead miner.



1. WHEN WORKING LEFT HAND SPLIT, SPRAYS 1L, 2L, 3L, 5 AND THE SPRAYS ANGLED TO LEFT, IN MANIFOLDS 4 AND 7 OPERATE.*

2. WHEN WORKING RIGHT HAND SPLIT, SPRAYS 1R, 2R, 3R, 6 AND THE SPRAYS ANGLED TO RIGHT IN MANIFOLDS 4 AND 7 OPERATE.*

3. MANIFOLDS 8 AND 9 (IF USED) ARE FOR BOTH RIGHT AND LEFT HAND RETURN SYSTEMS.

4. FLUSH HYDROCYCLONES EACH SHIFT.

5. CHECK NOZZLE OPERATION VISUALLY DURING EACH PLACE CHANGE - CLEAN OR REPLACE PLUGGED NOZZLES.

*NOTE: TWO SPRAYS WILL OPERATE AGAINST THE DIRECTION OF THE OTHERS-THESE ARE FOR DUST CONTROL AND BIT LUBRICATION.

SPRAY MANIFOLDS	NOZZLE TYPE
(1L), (2L), (3L), (1R), (2R), (3R) SIDE, ON-BOARD AND UNDERBOOM	BD20-2 (OR EQUIVALENT) NARROW HOLLOW CONE (30° SPRAY ANGLE)
(4), (5), (6), (7), (8), (9) FRONT AND DUST SUPPRESSION SIDE SPRAYS	BD3-3 OR BD20-2 WIDE HOLLOW CONE (70° SPRAY ANGLE)

FIGURE 20. - Sprayfan training sheet - ripper chain miner.

- *Never* cut without the system operating. The sprays are necessary for proper face ventilation, dust suppression, bit lubrication, and motor cooling

- In addition to operation during actual cutting, the system may be used (if needed) to clear gas (and dust) from the face more quickly after buggy loading is completed. *In some cases* when methane liberation from the freshly cut face is very high, it may be necessary to operate the system periodically while waiting for the next buggy to prevent the miner from shutting down ("gassing out") due to high methane concentrations.

7. SYSTEM MAINTENANCE

The Sprayfan System requires no more attention or maintenance than a *properly* maintained conventional dust suppression system and much less than a diffuser fan. A simple program of preventive maintenance is essential, however, for continued, effective system operation.

Maintenance on the Sprayfan System can be divided into the following categories:

- Filtration system flushing
- Nozzle cleaning/replacement
- Pump maintenance.

A maintenance checklist and a list of recommended spares which should be kept on the section are given in tables 6 and 7. A commercially available tool to remove the nozzle adapters is listed in appendix B.

Nozzle cleaning will require less time if the non-clogging filtration system is installed *in the system and maintained*. The Y-strainers on the pump and miner and the hydrocyclone or (backflushing filter) should be flushed *daily* by simply opening the flush valve for a few seconds. Filter elements should be replaced as operating experience dictates.

Nozzle operation should be *visually* checked each time the miner changes places. Nozzle cleaning will be necessary if the nozzle is *plugged* or if the orifice is partially *blocked* resulting in a disturbed spray pattern. Plugging will usually be internal to the nozzle, requiring removal, flushing of the manifold, and nozzle cleaning. It is recommended that a few spare nozzles of each capacity and a wrench be stored in the operator's cab for quick nozzle replacement. A set of tip cleaners (like those normally used for acetylene torch tips) will facilitate nozzle cleaning. In many cases, particulate matter may plug the nozzle tip from the inside. This type of plugging requires removal of the tip. All spray nozzles in the system should be removed and replaced with new ones at least four times a year if it does not occur through replacement due to damage, etc. This is necessary since *orifice wear* gradually changes the spray pattern and spray characteristics.

TABLE 6. - Sprayfan maintenance checklist

Task	Frequency
Check nozzle operation	A visual check during each place change
Flush filtration system	Daily
Nozzle cleaning	As required
Nozzle replacement	Once every 3 months
Grease pump bearings	As required

TABLE 7. - Recommended Sprayfan spares

Quantity	Item	
Assorted	High pressure hose	
Assorted	Pipe to hose fittings	
10	Nozzle adapters	on section
18	Spray-nozzles (proper types)	
1 can	Antiseize lubrication	

Note: Spares in the shop should include all of the above items in greater quantity, plus:

- One of each type of spray manifold used in the system
- Pump seals and other spares recommended by the manufacturer
- Flow switches (used for pump control).

Pump maintenance is entirely dependent on pump type and operating experience and is best left to the judgement of each mine. The candidate pumps listed in appendix B have been chosen for underground application with consideration for maintenance. Models are available with options such as tungsten carbide seals which will perform better under harsh operating environments. Pump bearings should be kept well lubricated in accordance with the manufacturer's recommendations. The Y-strainer on the pump inlet should be flushed regularly. The flow switch controlling pump on/off operation is the most likely component to fail, and a supply of spares should be maintained.

A shop man must understand Sprayfan System operation well enough to restore its original function. The training sheet located in the system operation section should be distributed to *all* section personnel including mechanics. This will facilitate a proper understanding of system operating principles. Specific examples of actual practice that will rapidly reduce Sprayfan effectiveness include:

a. Punching out nozzle orifices with nails

b. Operating with plugged nozzles

c. Aiming nozzles directly at the rib (or the miner body)

d. Adding nozzles aimed against the direction of the Sprayfan's nozzles

e. Replacement of spray manifolds in positions other than those intended

f. Use of nozzle types other than those listed in tables 1 and 2 (or equivalent).

APPENDIX A--BIBLIOGRAPHY OF SPRAYFAN REPORTS

Wallhagen, R.E., "Development of Optimized Diffuser and Sprayfan Systems for Coal Mine Face Ventilation," November, 1977. This report describes the results of a four year investigation into improved face ventilation systems, including the original prototype Sprayfan System.

Ruggieri, S.K., "Sprayfan System - Installation and Operation Manual - Volume II," October, 1981. This report describes the design, installation and operation of the Original Sprayfan System.

Schroeder, W.E., "Sprayfan System - Results of Mine Testing - Volume III," October, 1981. This report describes the results of two underground installations and evaluations of the Original Sprayfan System.

Ruggieri, S.K. and Babbitt, C.A., Addendum to "Sprayfan System - Installation and Operation Manual - Volume II," May, 1984. This report details the changes which were made to the Original Sprayfan System and describes the design, installation and operation of the Improved Sprayfan System.

Ruggieri, S.K., Muldoon, T.L., Babbitt, C.A. and Lee, E., "Improved Diffuser and Sprayfan Systems for Ventilation of Coal Mine Working Faces," July, 1985. This report describes additional research conducted to further improve the Original Sprayfan System's performance and practicality (Improved Sprayfan) and to evaluate its effectiveness under a wider variety of mining conditions, particularly very gassy mines. The report serves as a companion document to the "Improved Sprayfan System Installation Guide."

APPENDIX B--MANUFACTURERS OF SPRAYFAN COMPONENTS

Reference to specific brands or trade names in this report is made to facilitate understanding and does not imply endorsement by the Bureau of Mines.

Spray Nozzle Manufacturers

Spraying Systems Company
North Avenue and Schmale Road
Wheaton, IL 60187
(312) 665-5000

SPRACO
Spray Engineering Company
East Spit Brook Road
Nashua, NH 03060
(603) 888-1050

Bete Fog Nozzle, Inc.
305 Wells Street
Greenfield, MA 01301
(413) 772-0846

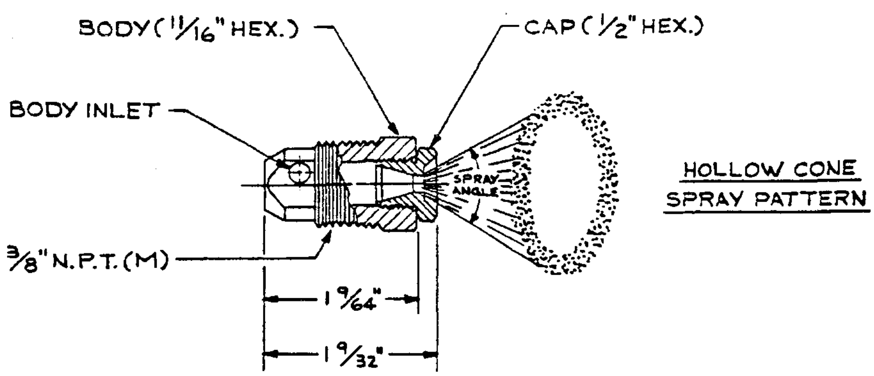
Delevan Corporation
811 Fourth Street
West Des Moines, IA 50265
(515) 274-1561

Senior Conflow
P.O. Box 265
Clinton, PA 15206
(412) 262-5631

W.M. Steinen Manufacturing Company
29 East Halsey Road
Parsipanny, NJ 07054

Hahn Industries
P.O. Box 388
Bogota, NJ 07603
(201) 343-0200

3/8 BDM MINER WHIRLJET NOZZLE



FEATURES:

- TOUGH, DURABLE REINFORCED NYLON BODY WITH BRASS CAP.
- FINE MIST SPRAY IDEAL FOR WETTING DUST.
- LARGE ORIFICE.
- NO INTERNAL OBSTRUCTIONS.
- RECESSED ORIFICE HELPS PREVENT DAMAGE.

NOZZLE NO.	ORIFICE DIA.	CAPACITY G.P.M. (Gallons Per Minute) AT P.S.I. (LBS. PER SQ. IN.)								SPRAY ANGLE		
		10 P.S.I.	20 P.S.I.	40 P.S.I.	100 P.S.I.	200 P.S.I.	300 P.S.I.	400 P.S.I.	500 P.S.I.	20 P.S.I.	100 P.S.I.	500 P.S.I.
3/8 BDM-2	5/64"	.20	.28	.40	.63	.89	1.1	1.3	1.4	60°	69°	62°
3/8 BDM-3	3/32"	.30	.42	.59	.94	1.3	1.6	1.9	2.1	64°	75°	64°
3/8 BDM-5	1/8"	.50	.71	1.0	1.6	2.2	2.7	3.2	3.5	73°	78°	72°
3/8 BDM-10-2	5/64"	.35	.49	.70	1.1	1.6	1.9	2.2	2.5	30°	46°	32°
3/8 BDM-20-10	11/64"	1.4	1.9	2.7	4.3	6.0	7.4	8.5	9.5	56°	64°	54°

DESCRIPTION
3/8 BDM MINER
WHIRLJET NOZZLE

SPRAYING SYSTEMS CO.
Spray Nozzles and Accessories
North Avenue and Schmale Road, Wheaton, Illinois 60187

Ref :
Revision No.
Data Sheet No. 18891

NOTE: As discussed in the text, a 3/8 BDM-3 or a BDM-20-2 spray nozzle is recommended for use in manifolds ④, ⑤, ⑥, ⑦, ⑧ and ⑨ and a 3/8 BDM-20-2 spray nozzle (or equivalent) is recommended for use in manifolds ①, ② and ③ - see tables 1 and 2.

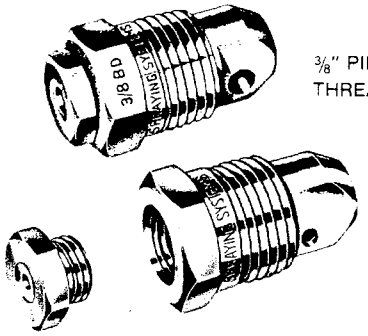
BULLETIN 189

MINER NOZZLES

3/8 BD *WhirlJet.*
FOR DUST SUPPRESSION

SPRAYING SYSTEMS CO.
North Ave. at Schmale Rd.
Wheaton, Ill. 60187

FINE MIST SPRAY IDEAL FOR WETTING DUST
LARGE ORIFICE
NO INTERNAL OBSTRUCTIONS
MOST CLOG-FREE MINER NOZZLE AVAILABLE
ALL BRASS CONSTRUCTION
HOLLOW CONE SPRAY PATTERN
INTERCHANGEABLE AND REPLACEABLE PARTS

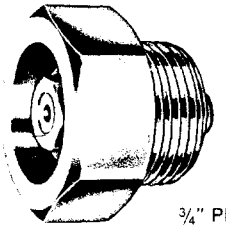


3/8" PIPE THREAD

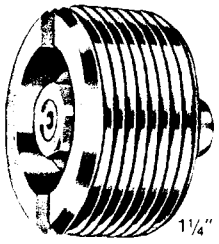
NOZZLE NO.	ORIFICE DIA.	CAPACITY G.P.M. (Gallons Per Min.) AT P.S.I. (Lbs. Per Sq. In.)								SPRAY ANGLE		
		10 PSI	20 PSI	40 PSI	100 PSI	200 PSI	300 PSI	400 PSI	500 PSI	20 PSI	100 PSI	500 PSI
3/8 BD 2	5/64"	.20	.28	.40	.63	.89	1.1	1.3	1.4	60°	69°	62°
3/8 BD 3	3/32"	.30	.42	.59	.94	1.3	1.6	1.9	2.1	64°	75°	64°
3/8 BD 5	1/8"	.50	.71	1.0	1.6	2.2	2.7	3.2	3.5	73°	78°	72°

Wide choice of other capacities and spray angles available —
Ask for Data Sheet No. 14889

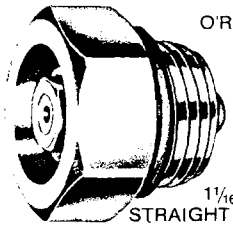
3/8 BD *WhirlJet.* ADAPTERS TO FIT ALL MINING EQUIPMENT



3/4" PIPE THREAD
ADAPTER No. 14988



1 1/4" PIPE THREAD
ADAPTER No. 13429



O'RING
1 1/16-12 STRAIGHT THREAD
ADAPTER ASSY. No. 15097

Hex socket wrench clearance provision in all adapters.
Nozzle may be removed from adapter without removing adapter from machine.

Ordering Instructions: Order nozzle by nozzle no., for instance: No. 3/8 BD3
Order adapter by adapter no., for instance: No. 14988

SPRAY NOZZLE REMOVAL TOOL

QUALITY SERVICE

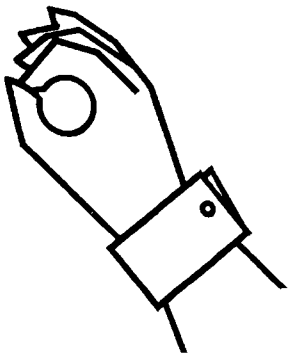
HAHN INDUSTRIES

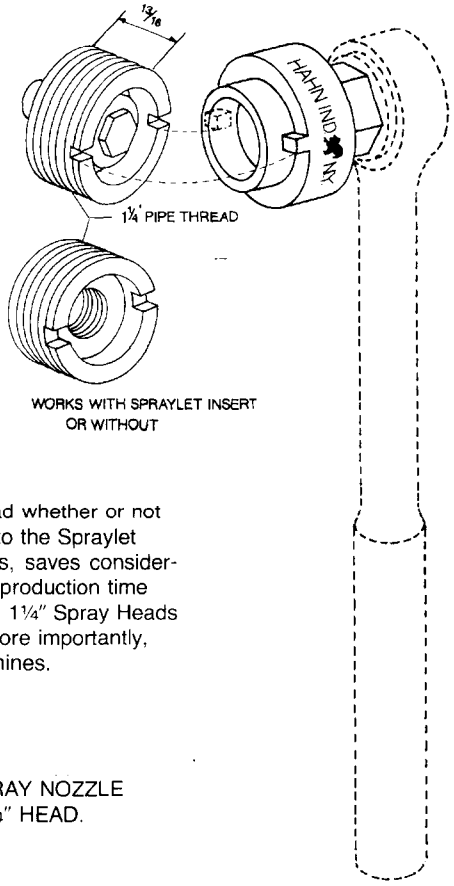
MINE AND MILL SPECIALTIES

WE SERVE THE MINING INDUSTRY

Equipment News — **SPRAY NOZZLE TOOL FOR 1¼" HEAD**

A UNIQUE NEW TOOL





New 1¼" Spray Nozzle Tool

Not long ago, Hahn Industries made life a lot easier by developing a new Spray Nozzle Tool to fit any Standard ½" Socket Wrench which, in turn, "twirls" Spray Nozzles in and out of Continuous Miners with minimum effort. Now, this has been followed up with another Tool which works on the increasingly popular 1¼" Head Assembly . . . see Sketch.

The Tool is designed to grip the 1¼" Spray Head whether or not it is asembled to the Spraylet Insert and, thus, saves considerable labor and production time in "twirling" the 1¼" Spray Heads in and, even more importantly, out of the machines.

SPECIFY: SPRAY NOZZLE TOOL FOR 1¼" HEAD.

Please phone or write:

HAHN INDUSTRIES
MINE & MILL SPECIALTIES, INC.
259 QUEEN ANNE ROAD
P.O. BOX 388
BOGOTA, NJ 07603-0388
TEL: (201) 343-0200

Our safety products are, in addition to **SPRAY NOZZLE TOOLS** and **SPRAY NOZZLES** for Continuous Miners and Belt Spray, **BRATTICE CLOTH** with a Flame Spread Index of "close to absolute zero"; and also Color-Coded **SILICONE DIODES,** all quality products in a medium price range.

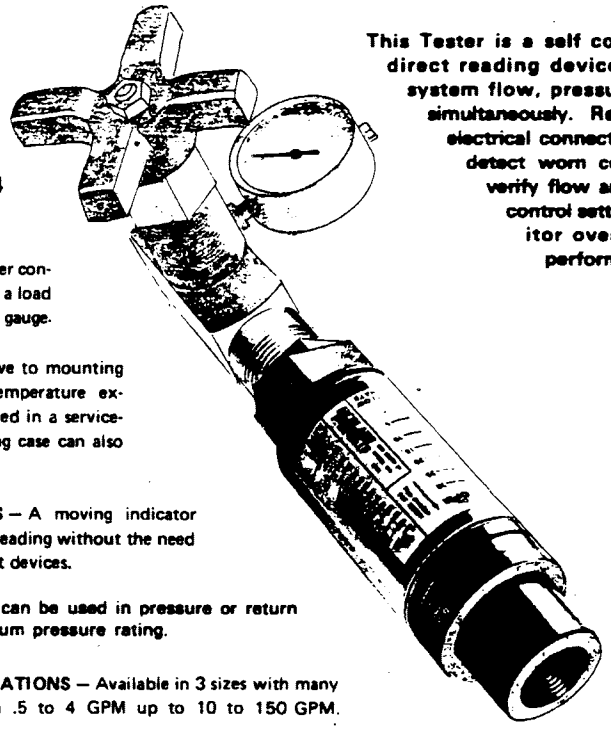
GUARANTEE: RETURN OF ANY OF OUR PRODUCTS ACCEPTED, REGARDLESS OF CONDITION, IF NOT COMPLETELY SATISFIED AND CONVINCED.

WATER PRESSURE AND FLOW TEST KIT

NOW get either a COMPACT

HEDLAND TEST KIT

HEDLAND PRODUCTS
220 South Street
Rancine, Wisconsin 53404
414-639-6770



This Tester is a self contained, a direct reading device to check system flow, pressure or both simultaneously. Requiring no electrical connections, it can detect worn components, verify flow and pressure control settings or monitor overall system performance.

EASY TO USE – The compact tester consists of a high pressure flow meter, a load valve, a 3000 PSI standard pressure gauge.

RUGGED – The tester is insensitive to mounting position, shock, vibration and temperature extremes. It can be shipped or carried in a serviceman's tool kit. A standard carrying case can also be furnished.

NO ELECTRICAL CONNECTIONS – A moving indicator on the flow meter provides direct reading without the need for electrical connections or readout devices.

HIGH PRESSURE — **The tester can be used in pressure or return lines. See table below for maximum pressure rating.**

FURNISHED TO YOUR SPECIFICATIONS – Available in 3 sizes with many different flow scales ranging from .5 to 4 GPM up to 10 to 150 GPM.

LOW COST – The combination of low cost and rugged durability means every service person could have one or they can often be shipped in place of sending a service person.

SIZES AVAILABLE			
Ports	1/2" NPT	3/4" NPT	1-1/4" NPT
Flow Meter Range	.5 to 4 GPM .5 to 5 GPM 1 to 10 GPM 1.5 to 15 GPM	1 to 10 GPM 1 to 15 GPM 1 to 20 GPM 2 to 30 GPM	5 to 50 GPM 7.5 to 75 GPM 10 to 100 GPM 10 to 150 GPM
Max. Pressure Rating	3000 PSI	3000 PSI	3000 PSI

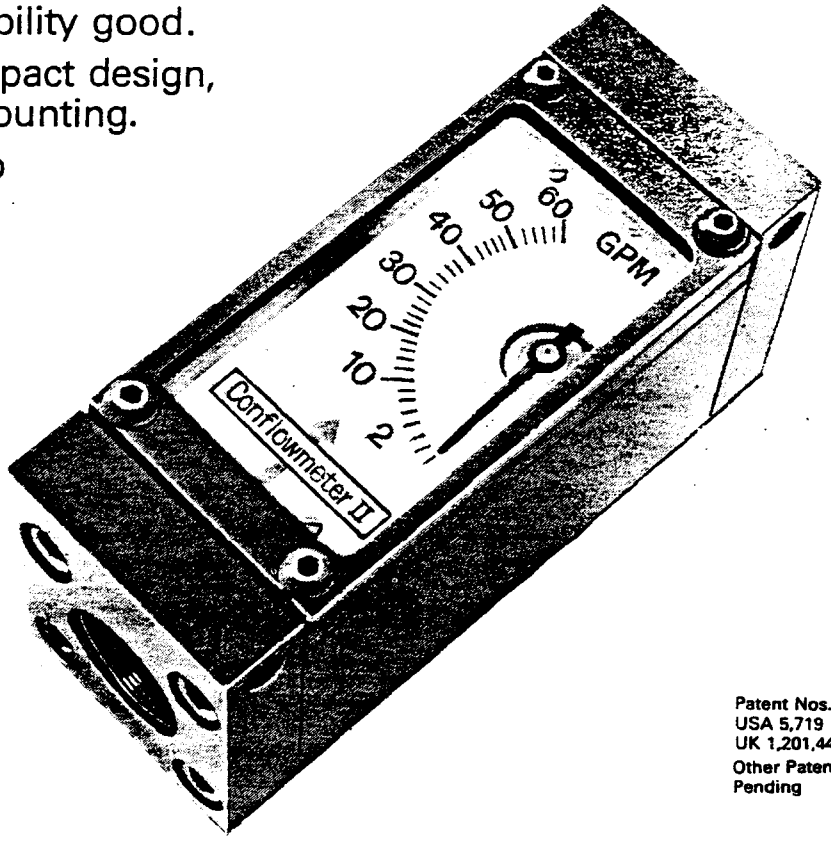
or

FLOW AND PRESSURE MEASUREMENT
Flowmeters

CODE 452

Conflowmeter II

High Pressure Shock Resistant Unit.
Versatile mounting facilities.
Viscosity stability good.
Rugged compact design, for in-line mounting.
Insensitive to attitude.



Patent Nos.
USA 5,719
UK 1,201,441
Other Patents Pending

Conflowmeter II	
Code 452	Bronze
Code 453	Aluminium
Code 454	Stainless Steel

The Conflowmeter II is a versatile flow rate meter which will provide essential details of flow characteristics required by engineers to determine the efficiency of a hydraulic system. It is a useful unit for isolating system faults as it is extremely portable.

SENIOR CONFLOW
Dust Suppression, Sprays, Valves, Gauges and Specialized Mine Equipment
DIVISION OF SENIOR INDUSTRIES INC.

P.O. BOX 265
CLINTON, PA 15026
PHONE: (412) 262 5631
TELEX: 866733

Pump manufacturer	Model number	Maximum performance	Price*	Includes	Type	rpm	Horse power	Notes
CAT Pumps Corporation 1600 Freeway Blvd., N. Minneapolis, MN 55430	CAT 6020	60 gal/min at 1000 lb/in.^{2}	4,718	belts, pulleys, p-gauge, guard, inlet pressure reducer, base	triplex piston/ plunger	2225 belt drive	15	Ease of repair, subassemblies readily available in kits, easy to replace Recommended on hand parts; packing, seals Pump capacity/pressure can be modified by replacing top end. Maximum inlet pressure 40 lb/in.^{2} recommended 20 to 30 lb/in.^{2}, therefore requires a pressure reducer Cast aluminum case, steel and alloy crank rods, cylinders
Kobe Inc. 3040 E. Saluson Ave. Hunington Park, CA 90225	ROTA-JET RG 30	40 gal/min at 950 lb/in.^{2} or 10 gal/min at 1100 lb/in.^{2}	6,130	motor, base, belts, guard	single stage centrifugal	3275 belt drive	30	Ductile iron construction must use specified lubricant Pickup tube vulnerable to wear Standard tube costs* $540 with trade-in $1080 without trade Optional wear resistant tungsten carbide tube costs twice as much Spare pickup tube would be recommended, as they can be difficult to obtain (16 to 18 weeks) Normal on-hand parts; seals and bushings
Sundstrand Fluid Handling 14845 West 64th Ave. P.O. Box FH Arvada, CO 80004	P-28DE	22 gal/min at 405 lb/in.^{2} or 39 gal/min at 380 lb/in.^{2}	2,989	custom skid base, coupling motor	single stage centrifugal	11000 direct coupled gear drive	25	Seals are tungsten carbide all stainless construction Normal on-hand parts; seals and bearings Gearbox uses automatic transmission fluid Maximum inlet pressure 250 lb/in.^{2} Maximum working pressure 1500 lb/in.^{2}

Note

The pumps listed above can be categorized into two types: centrifugal and positive displacement. Centrifugal pumps are less efficient than positive displacement. However, they have the ability to vary their flow rate with only small changes in pressure. The variable delivery of centrifugal pumps makes them attractive where flow rates are changing or where some flexibility is required. To benefit from the higher efficiency of the positive displacement pump, the pump has to be matched to the requirements of the system. A positive displacement pump delivers a fixed output at a predetermined pressure. If the demand is less than the pump's output then the pump has to dump excess flow and the system overall becomes inefficient.

Pump manufacturer	Model number	Maximum performance	Price*	Includes	Type	rpm	Horse power	Notes
Ingersoll-Rand Standard Pump Aldrich Division Allentown, PA 18105	GTB Series	160 gal/min at 350 lb/in.^{2}	5,772	motor base coupling	Two-stage centrifugal	3600 direct coupled	50	Particularly heavy-duty construction cast iron case, bronze rotors, stainless shaft Operating at top of pressure range and bottom of flow range, therefore inefficient Capable of larger flows Recommended on-hand parts: bushings, seals, perhaps bearings, maximum inlet pressure: 150 lb/in.
FMC Agricultural Division Jonesville, AR (501) 935-1970	John Bean W1122B1CD	37 gal/min at 800 lb/in.^{2}	3,108	base, motor, belts, guard	triplex piston	520 belt drive	15	Cast iron crank case forged alloy shaft, crank Steel rods, pistons, ceramic cylinders, needs no inlet, pressure reducer Recommended on-hand parts: packings, cups, durable, good for entrained solids
Gardner-Denver Industrial Machinery Division 1860 Gardner Expressway Quincy, IL (217) 222-5400 Gardner-Denver District Office 4499 Cambell Run Rd. Pittsburgh, PA 15205 (412) 935-1511	Gardner-Denver PQ2 2 in. or 2-1/4 in. cylinder	2 in.: 41 gal/min at 755 lb/in.^{2} 2-1/4 in.: 51.5 gal/min at 600 lb/in.^{2}	5,828	motor skid-base mechanical lube relief valve drive, guard	triplex piston	350 belt drive	15	Cast iron case Cast aluminum and bronze fluid end and valves Corrosion resistant

*1980 manufacturer supplied prices.

Note

The pumps listed above can be categorized into two types: centrifugal and positive displacement. Centrifugal pumps are less efficient than positive displacement. However, they have the ability to vary their flow rate with only small changes in pressure. The variable delivery of centrifugal pumps makes them attractive where flow rates are changing or where some flexibility is required. To benefit from the higher efficiency of the positive displacement pump, the pump has to be matched to the requirements of the system. A positive displacement pump delivers a fixed output at a predetermined pressure. If the demand is less than the pump's output then the pump has to dump excess flow and the system overall becomes inefficient.

FILTRATION

Hydrocyclone Manufacturers

Senior Conflow
P.O. Box 265
Clinton, PA 15206
(412) 262-5631

Krebs Engineers
1205 Chrysler Drive
Menlo Park, CA 94025
(415) 325-0751

Y-Strainer Manufacturers

Self-Cleaning Strainer Company, Inc.
4545 Southwest Highway
Oak Lawn, IL 60453
(312) 779-3040

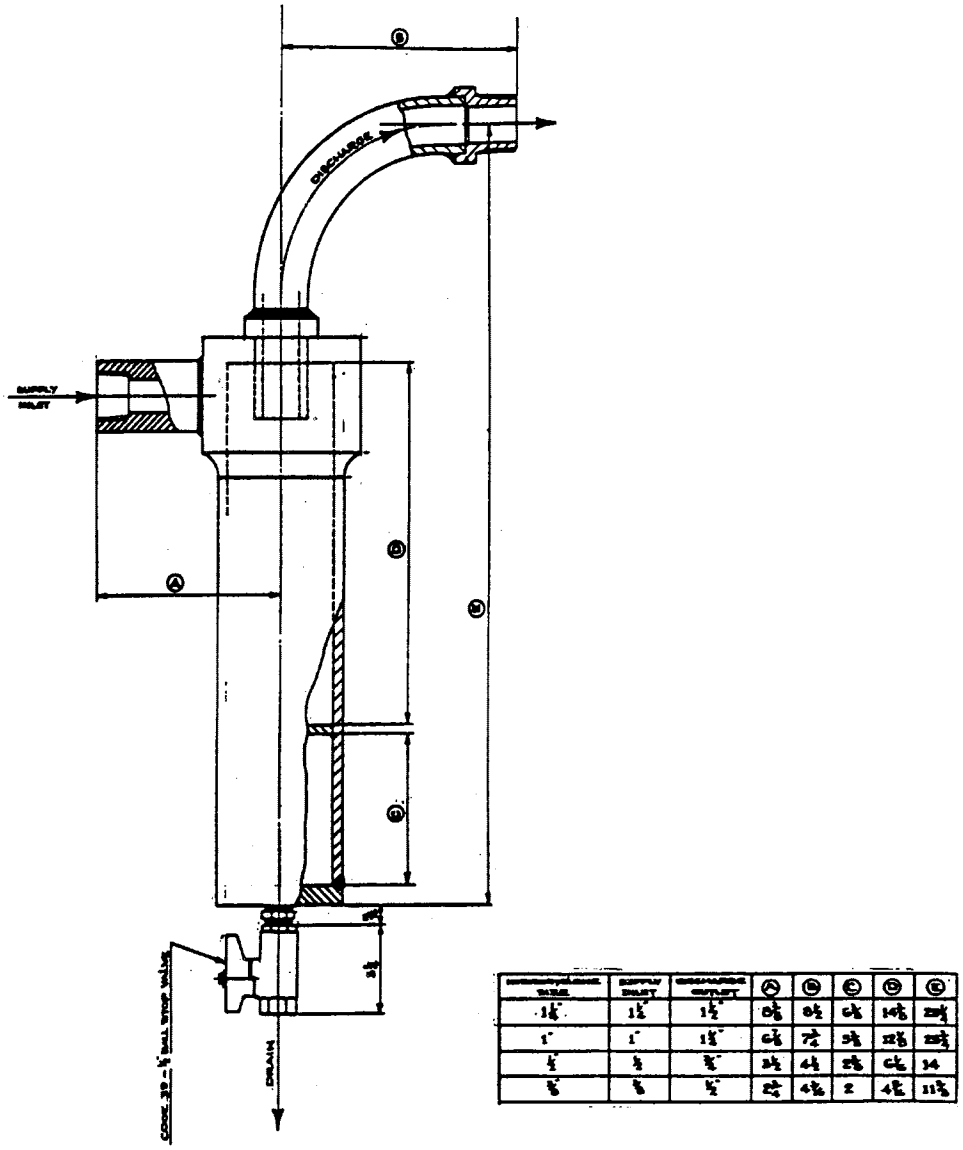
Mueller Steam Specialty
P.O. Box 1569
901 Carolina Avenue
Lumberton, NC 28358
(919) 738-8241

Fabrotech Industries, Inc.
P.O. Box 130
Old Bethpage, NY 11804
(516) 752-1770

Armstrong
New Braunfels, TX 78130
(512) 625-2394
Three Rivers, MI 49093
(616) 273-1415

Senior Conflow
P.O. Box 265
Clinton, PA 15206
(412) 262-5631

HYDROCYCLONE

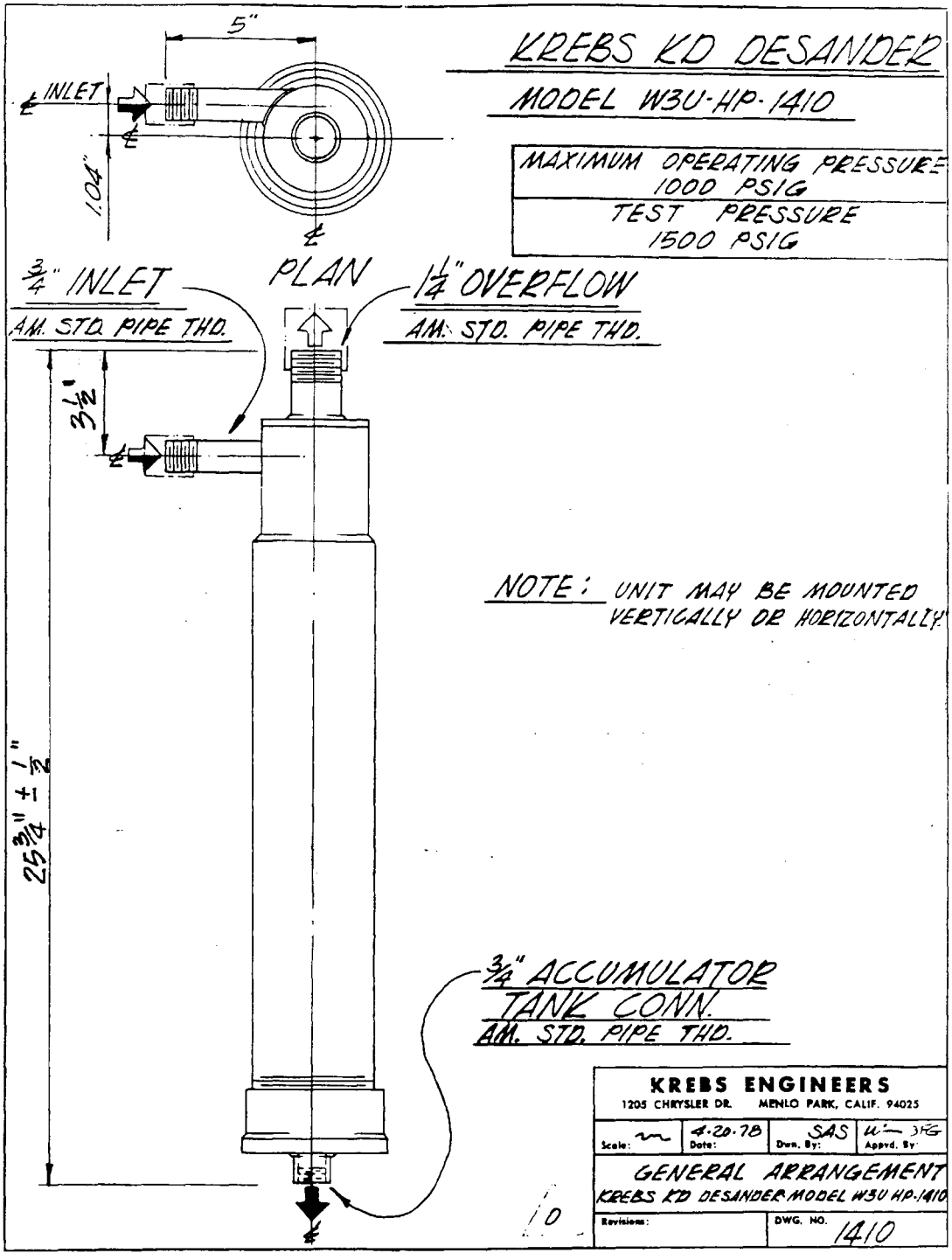


1½"	1½"	1½"	6⅜	8½	6¼	14⅝	23¾
1"	1"	1¼"	6⅛	7¾	5⅜	12⅝	23¾
½"	½"	¾"	3½	4¼	2⅝	6¼	14
⅜"	⅜	½"	2⅝	4⅛	2	4⅝	11⅝

HYDROCYCLONE

SENIOR CONFLOW
P.O. BOX 265
CLINTON, PA 15206
PHONE: (412) 262-5631 TELEX: 86-6733

KREBS KD DESANDER



CAST IRON Y-TYPE STRAINERS

STYLE S, SCREWED CONNECTION
STYLE T, SCREWED CONNECTION

SIZES: 1/4" thru 3"

SPECIFICATIONS:

BODY MATERIAL: CAST IRON ASTM A-126 CLASS B

NOTE: The **STYLE S** has been redesigned and will now be identified as **STYLE T.** Interchangeability of screens will be effected on Sizes 1", 1¼", 1½" **&** 2". During the transition period, starting January 1981, shipments may consist of both Style S and Style T Strainers.

CONSTRUCTION:

Constructed of high-tensile ASTM A126 Class B Cast Iron with blow-off connections and easily removable cylindrical screens. A tapered seat allows the screen to be self aligning and assures a perfect fit. 2½" and 3" sizes have a flanged blow-off cover.

MILITARY SPECIFICATIONS:

Strainers can be supplied to conform to MIL-S-16293F, Type 1, Style Y, Class 250. **CAUTION:** A **COMMERCIAL** Strainer will not comply with a Military Specification. Consult factory for pricing.

BLOW-OFF OUTLETS:

N.P.T. tapped in sizes specified on dimension table. Not normally furnished plugged.

OPERATING PRESSURES AND TEMPERATURES:

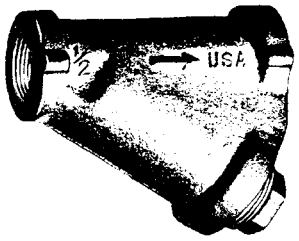
Steam ..... 250 psi at 406° F.
Water, Oil, Gas ..... 400 psi at 150° F.

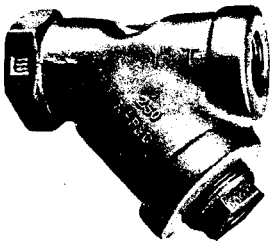
STANDARD SCREENS:

Service	Connections & Sizes	Screen Openings	Screen Material
Liquid	Screwed ¼" thru 2" 2½" thru 3"	20 mesh .045 perf.	Stainless Steel 18-8
Steam	Screwed ¼" thru 2" 2½" thru 3"	20 mesh .045 perf.	Stainless Steel 18-8

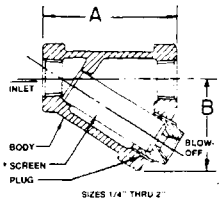
Other Screen Perforations & Materials Available on Request.

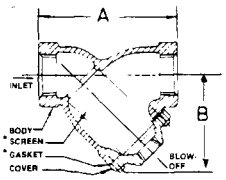
STYLE S





STYLE T





*** DENOTES RECOMMENDED SPARE PARTS**

DIMENSIONAL DATA: **NOTE:** Dimensions shown are subject to change. Contact factory for certified prints (exact dimensions) when required.

Size	STYLE S					STYLE T				
	A	B	Size Blowoff NPT	Ship Weight Lbs.	Screen Area In²	A	B	Size Blowoff NPT	Ship Weight Lbs.	Screen Area In²
1/4	2-23/32	1-3/4	1/4	1-1/4	3.0	2-23/32	1-3/4	1/4	1-1/4	3.0
3/8	2-23/32	1-3/4	1/4	1-1/4	3.0	2-23/32	1-3/4	1/4	1-1/4	3.0
1/2	3-7/16	2-3/8	3/8	1-3/4	5.4	3-7/16	2-11/16	3/8	1-1/2	5.4
3/4	4	2-3/4	3/8	2-1/2	8.7	4-3/8	3-3/8	3/8	2-1/2	8.7
1	4-5/8	3-1/4	1/2	4-1/2	12.7	4-7/8	3-1/2	1/2	4-1/2	11.9
1-1/4	5-3/8	3-1/2	3/4	6-1/2	18.1	5-3/8	4-1/8	3/4	6-1/2	16.2
1-1/2	6-1/16	4	3/4	8-1/4	25.3	6-3/8	4-11/16	3/4	8-3/4	23.2
2	7-1/2	5	1	14-1/2	39.2	7-1/2	5-7/16	1	12-1/2	35
2-1/2	9	6-3/4	1-1/4	22-1/2	47.9	9	6-3/4	1-1/4	22-1/2	47.9
3	10	7-7/8	1-1/4	35-1/4	64.8	10	7-7/8	1-1/4	35-1/4	64.8

PAGET
SELF CLEANING STRAINER CO.
4545 SOUTHWEST HIGHWAY
OAK LAWN, ILLINOIS

12/80