

TECHNICAL MANUAL

MODEL WF-20 Ventilation Blower



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Foreword

Every effort has been to make this technical manual as complete as possible. As you read through this manual, you will note that some text is enclosed in boxes:

CAUTION: THIS TEXT HAS BEEN ENCLOSED IN A BOX BECAUSE IT IS EXCEPTIONALLY IMPORTANT.

This boxed text is meant to caution the mechanic and the operator of important maintenance and operational conditions which must be followed.

Take the time to follow the procedures in this manual and you will quickly find that the RAMFAN™ is simple to maintain and operate.

If you feel that any changes could be made to this manual to enhance its value please drop us a line.

Receipt/Uncrating

The following checks must be accomplished prior to operating the unit for the first time:

1. Visually inspect the fan and accessories for any damage incurred during shipment.
2. Check the enclosed shipping document to ensure order conformance, (ie. adapters, maintenance kits, spares, etc.)
3. Read this entire manual for specific setup/operation procedures.
4. Remove the four (4) machine screws retaining the fan guard to the fan housing. Spin the impeller with your hand. The impeller should rotate freely, with very minor resistance from the mechanical seal. Reinstall the fan guard with machine screws.
Notify the factory, or your RAMFAN™ distributor immediately of any discrepancy found.

The RAMFAN™ is now ready to put into operation.

General Information

Introduction

The RAMFAN™ Model WF-20 (hereafter referred to as RAMFAN™) is a high head, high volume, portable blower specifically designed for safe and efficient evacuation of smoke and volatile gasses. Pressurized water provides power to the unit through a small, highly efficient water turbine. An operational range of between 40 psig and 250 psig of water inlet pressure allows use in an unlimited variety conditions. The use of water for power eliminates the threat of electrical shock and minimizes the explosion potential associated with conventional electric and gas driven fans.

High head, high volume allows the attachment of substantial lengths of duct without sacrificing efficiency. The small physical size (18" dia.) and light weight (under 35 lbs.) ensure swift, efficient deployment.

RAMFAN™ is the beginning of a new generation of portable ventilation equipment capable of safe and efficient use under varied casualty situations; constructed of lightweight, corrosion resistant materials to ensure maximum service life with minimum maintenance.

Specification

Turbine Pressure (lb/in2)	Air Output (c.f.m.)	Air Output (c.f.m.) w/Multiplier
40	1000	1990
80	1420	2810
120	1750	3470
180	2150	4250
250	2530	5000

1. Weight: 35 lbs./48lbs. w/Multiplier.
2. Maximun operating Pressure: 250 p.s.i.g.
3. Flow: 29 gpm @ 40 p.s.i/74 g.p.m @ 250 p.s.i.

Technical Information

Component Description

RAMFAN™ is an axial flow centrifugal fan driven by a water turbine attached to a common shaft.

An eight (8) bladed axial flow compressor impeller, machined from aluminum casting is keyed to the shaft and secured by a stainless steel bearing type lockwasher and locknut.

A one piece turbine wheel is machined from an Acetal Polymer Thermoplastic (Delrin-100®), chosen for it is high tensile strength, toughness, and low friction coefficient. The turbine wheel is positioned against the backside of the seal seat and keyed to the shaft. It is secured by a stainless steel flat washer and self-locking nut.

The shaft is machined and precision ground from 300 series stainless steel for high tensile strength and corrosion resistance.

Prior to assembly in the fan, the rotating assembly is balanced to ensure vibration free operation throughout the entire operation range.

The rotating assembly rides on two (2) wide, single row, sealed ball bearings. The turbine end bearing is completely contained and handles radial as well as axial loads. The fan end bearing inner race is contained, while the outer race is preloaded by one (1) wave spring to insure proper ball tracking.

The fan end bearing and wave spring are contained in the bearing retainer. The bearing retainer is machined from aluminum. It attaches to the fan housing with four (4) 10-24 machine screws, and in conjunction with the nozzle contains and locates the rotor assembly.

The nozzle is machined from the same Acetal Polymer Thermoplastic (Delrin-100®) as the turbine wheel. Twelve precisely sized orifices machined in the nozzle direct water onto the turbine wheel. These orifices ensure the maximum amount of energy is extracted from the pressurized water source.

The nozzle contains and locates the turbines end bearing and mechanical seal head. It is held against the bearing retainer with four (4) 8-32 machine screws. A stainless steel shroud ring is press fit into the nozzle bore. The shroud ring maintains proper tip clearance to the turbine wheel.

The Rotor Module is located in the fan housing by the nozzle and bearing retainer and into four (4) stainless steel inserts in the fan housing. Two (2) O-rings, located on the O.D. of the nozzle, separate the high and low pressure sides of the turbine water chest.

An end face mechanical seal prevents water from entering the bearing cavity. The seal head is located in a counterbore in the nozzle. The seal seat fits against a shoulder on the shaft and held in place by the turbine wheel, washer, and locknut.

The fan housing is machined from an aluminum casting. Ten (10) vanes radiate out from the center section of the housing and connect with the wall of the outer section. These vanes act to straighten the flow of gasses through the housing, increasing the overall efficiency of the fan. Water entering and exiting the turbine section of the unit travels through two of these vanes. Symbols cast directly in the housing clearly identify the direction of flow of both water and gasses.

Water enters and exits the fan housing through specially designed swivels. The swivels are machined from aluminum castings. They rotate 360° on 32 individual Delrin-100® balls. These balls ride in a track between the swivel and the swivel coupling. The balls act to absorb the shocks to the swivels and prevent damage to the swivel and swivel coupling. The rotating feature ensures unhindered hose attachment regardless of fan position. The inlet swivel is fitted with an inlet strainer made of stainless steel wire cloth and having an integrally molded hose gasket. The strainer is positioned between the swivel and double female adapter.

The adapter allows attachment of 1- ½” male hose fitting. The discharge swivel is configured to accept a 1- ½” female hose fitting.

A stainless steel fan guard is attached to the inlet side of the fan housing to prevent foreign matter from entering the fan blades.

A recoil type static cord is provided for manual connection to ground.

Due to the many types of duct available and varied methods of attachment, design of a universal duct adapter is impossible. Several different duct adaptors are available.

Material Treatment

All aluminum parts are anodized to provide protection from abrasion, salt spray corrosion, and erosion. In addition the fan housing is coated on the outside with a thermoset polyester coating to further resist abrasion from handling.

Aluminum duct adapters are surface treated in a manner which preserves conductivity through the surface. Stainless steel duct adaptors are left uncoated to maintain continuity from the duct to the fan casing.

Functional Description

The RAMFAN™ is designed to effectively operate with 40 psig to 250 psig (MAXIMUM) inlet water pressure through 1-½” hose. The high tech yet simple design allows the blower to be operated in virtually any physical orientation without loss of performance.

Water supplied through a 1-½” hose is connected to the double female adapter on the inlet swivel. The water is routed through the turbine section and exits out the discharge swivel.

The discharge water can be dumped directly from the unit or can be routed to an alternate area through 1-½” hose. Position of the discharge hose in relation to the inlet can affect overall performance. Discharge water cannot be put back into the high pressure side of the source.

Once securely attached, the hoses can be used to physically lower the unit with attached duct into a space or void.

Performance

The advanced design of the RAMFAN™ allows efficient operation over a very wide range of conditions. The RAMFAN™ will convert 250 psig pressure delivered through a 1-½” hose to over eight shaft horsepower; in turn driving the 8½” diameter fan over 10,000 RPM, and moving over 2500 SCFM of air.

The specific end performance of the RAMFAN™ is dependent upon water pressure, inlet/outlet size, and size and configuration of attached duct. Figure 1 illustrated the operating characteristics of the unit. The duct used for testing was wire reinforced.

Performance data was taken over specific range inlet pressures; first with 60 ft. of 8” duct attached to the exhaust, and again with 200 ft. of 12” duct attached to the exhaust end. The flow and pressure reading taken from manometers positioned across a set of sized VDI orificies (standard sharp edge). Data was cross-checked using a flow anemometer.

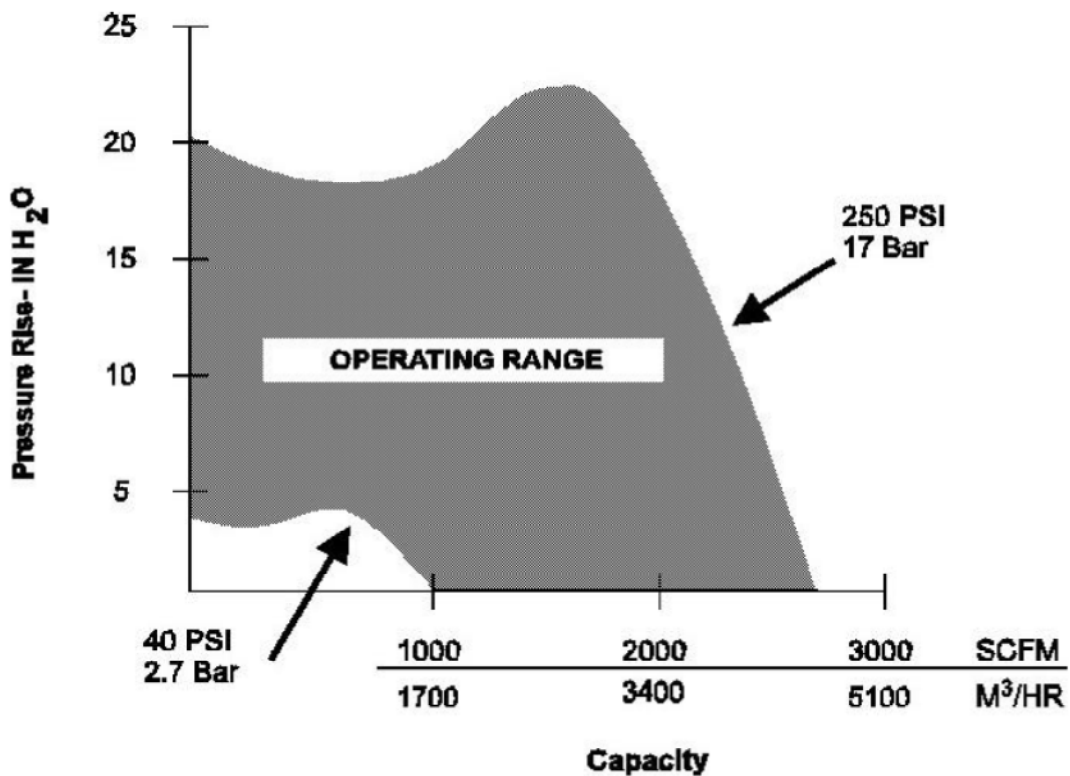


Figure 1

Operation

Deployment

No two casualty situations are ever identical; therefore deployment of the RAMFAN™ will involve different configurations.

CAUTION: DURING NORMAL OPERATION THE FAN SPEED WILL EXCEED 10,000 RPM. DO NOT OPERATE THE UNIT WITHOUT THE FAN GUARD SECURELY IN PLACE.

Prior to actual operation identify the following items.

1. Pressurized water supply including hose with 1-½" fittings. Either the firemain, or portable fire pump capable of 60 GPM at 150 psig may be used.
2. Location for dumping discharge water, and if required 1-½" hose for discharge water. The height of the discharge site above the blower will lower the pressure across the turbine reducing performance accordingly (10 ft. vertical = 5 psig).
3. Size, type and amount of duct required for specific application. Many types of duct currently in use are unidirectional by design. To ensure optimum service life, gasses must flow in the indicated direction. Check Manufacturers product tag prior to use.
4. For positive pressure ventilation use, secure the multiplier onto the discharge end of the blower. See the RAMFAN™ Deployment manual for different applications.

CAUTION: ENSURE DUCT ADAPTER MOUNTING SURFACES ARE FREE OF DIRT, GREASE, OR ANY FOREIGN MATTER. ROTATE ADAPTERS FIRMLY AGAINST THE MOUNTING STUDS AND TIGHTEN ALL FOUR (4) NUTS SECURELY. THESE STEPS WILL ENSURE ELECTRICAL CONTINUITY BETWEEN THE DUCT, ADAPTER AND FAN HOUSING.

5. Transport the fan and accessories to predetermined location.
6. Remove protective endcaps from inlet and discharge swivels. Connect the inlet and discharge water hoses to the fan. Run both hoses to provide as straight a path as possible. Attach and position duct as required.
7. Final positioning of the duct is dependent upon the method of ventilation to be used. If positive pressure ventilation, forcing air in to displace unwanted gasses, is used; the discharge end of the duct or fan can be placed directly at the opening. If negative pressure ventilation, exhausting of unwanted gasses through the blower, is used; the suction end of the duct or fan should be positioned as far into the space/void from the opening as possible. This will limit short circuiting, the possibility of fresh air mixing with the unwanted gasses.
8. If static electricity buildup is a potential problem, uncoil the static cord from the handle and connect to a suitable ground. It may be necessary to scrape away paint, grease and dirt to ensure contact.

CAUTION: EXHAUSTING GASSES THROUGH DUCT CAN CREATE A STATIC ELECTRICAL CHARGE, IT IS IMPORTANT TO ENSURE POSITIVE CONTACT TO GROUND TO AVOID UNWANTED DISCHARGE WHILE OPERATING AROUND EXPLOSIVE ATMOSPHERES.

9. Throttle the inlet water pressure slowly until the hose has filled and straightened. Visually check for leaks or excessive strain from the hose. Leakage should be controlled if the presence of water could be detrimental to the surrounding area.

CAUTION: IMMEDIATELY SECURE THE UNIT UPON HEARING EXCESSIVE MECHANICAL NOISE OR VIBRATION.

10. Check periodically during the operating cycle for abnormalities. Although the blower will not be adversely affected by a blocked suction other than a temperature rise, foreign material or other duct or blower blockage will detract from the optimum air flow rate. Any significant rise in the blower casing temperature is an indication of a problem. Most likely it is a blocked air inlet. Investigate immediately.

Securing from Operation

1. Upon completion of operation, secure supply water and disconnect from blower.
2. Disconnect discharge hose (if applicable) and allow blower to drain.
3. Disconnect duct from blower.
4. Disconnect static cord/clip and recoil around the handle.
5. Remove double female adapter and inlet strainer from swivel. Inspect and clean strainer. Reinstall strainer and adapter on inlet swivel. Tighten only enough to prevent leakage.

CAUTION: DO NOT OVERTIGHTEN HOSE CONNECTIONS; USE OF A WRENCH SHOULD BE LIMITED TO STOP ANY NOTICEABLE LEAKAGE. EXCESSIVE FORCE CAN RESULT IN DAMAGE TO THREADED CONNECTIONS.

6. Flush entire unit with fresh water. Blow dry with air and install endcaps on swivels.

Storage

The unit may be stored in any position. Care should be taken to prevent placing weight directly on the swivel assemblies, fan guard, or any attached duct adaptors. Check to ensure swivel endcaps are in place.

CAUTION: DO NOT STORE ANY FOREIGN OBJECT OR MATERIAL IN THE OPEN END OF THE FAN HOUSING.

Preventive Maintenance

When operated in accordance with the procedures contained in this manual, RAMFAN™ will require little preventive maintenance. The checks listed will help provide safe operation along with maximum service life.

1. To ensure dissipation of static electric charge, the static cord/clip and duct should be periodically checked for continuity. The teeth on the static clip should be wire brushed to remove any oxidation or foreign matter. The flange surfaces of all duct adaptors should be maintained free of debris and should be regularly inspected and cleaned. The grounding connection located on the side of the carrying handle should be kept tight and free of corrosion.
2. Fresh water flush after each use to avoid salt water corrosion.
3. Exercise care during deployment and storage to prevent physical damage.

Field Repair

The procedure outlined below is designed to provide sufficient information to successfully accomplish field repair of the RAMFAN™.

Refer to Figure 2 and 3 (exploded views) for visual guidance.

Disassembly

Remove any duct adapters attached to either end of WF20 Fan. Loosen (do not remove) the duct adapter retaining nuts (045) enough to allow movements. Turn the adapter CCW to align holes with nuts, and pull straight off.

Fan Housing / Rotor Module

1. Place the unit fan end up. Using a 1/8" Allen wrench remove the four (4) machine screws (008) and lift the fan guard (003) from the housing (007).
2. Use a small punch to bend the lockwasher tang (006) out of the locknut (005) slot. Hold the impeller (002) with your hand, rotate CCW to remove the impeller locknut (005).

CAUTION: DO NOT JAM ANY OBJECT BETWEEN THE FAN AND FAN HOUSING.

3. Using your fingers, pull the impeller (002) off the shaft (031) and out of the housing. Remove the key from the shaft. Two (2) 3/8"-16 threaded holes have been provided for jacking purposes in case the impeller will not pull off the shaft by hand. If uses, exercise to prevent cocking the impeller on the shaft.
4. Remove retaining ring (011) from groove in fan housing centerbody.
5. Use 1/8" Allen wrench to remove the four (4) machine screws (012) in the outer bolt circle. Remove only the screws in the outer (larger) bolt circle.
6. If necessary, use two (2) of the machine screw (012) just removed to install in the tapped screw holes provided. The holes are located in the same bolt circle. Use the screws as jacking bolts to break the O-ring seal. Apply even pressure the both side to prevent binding.
7. At this point it may be advantageous to reinstall impeller (002) and the impeller locknut (005) on the shaft (031). The impeller will provide a more secure pulling source during the removal and disassembly of the rotor module.
8. Remove the rotor module from the fan housing (007). Once completely out of the housing, set this assembly aside.
9. Move to the rotor module assembly. Using a 3/32" Allen wrench, remove the four (4) machine screws (025) holding the nozzle (017) to the bearing retainer (033).
10. Using 9/16" socket wrench, turn CCW to remove the turbine locknut (021). Lift the locknut (021) and washer (022) off the shaft.
11. Use two flat blade screwdrivers to pry the turbine wheel (029), from the shaft (031) and out of the nozzle (017). Remove the turbine key (034) from shaft (031). The turbine wheel should slide easily off the shaft. Do not use excessive force.

CAUTION: USE OF EXCESSIVE FORCE CAN RESULT IN DAMAGE TO THE TURBINE WHEEL HUB RELIEF.

12. Pull the nozzle (017) with the seal scat (030) and seal head (028) off the bearing retainer (033) and bearing (027). Use care not to damage the seal head (028) in the nozzle bore.
13. Set the nozzle (017) on a rag or some other soft surface with the seal head (028) face down. Push on the back of the seal head to remove it from the nozzle bore. Wrap the seal head (028) in some sort of protection to prevent damage to carbon face.
14. Remove the two (2) O-rings (016) from the nozzle (017) OD.
15. Bend the turbine end bearing lockwasher tang (024) out of the locknut (023) slot. Use spanner wrench, rotate CCW to remove bearing locknut (023).

CAUTION: DO NOT APPLY EXCESSIVE FORCE. IF THE SHAFT DOES NOT MOVE WITH ONLY A SMALL AMOUNT OF FORCE STOP AND INVESTIGATE. USE OF EXCESSIVE FORCE CAN RESULT IN DAMAGE TO BOTH THE SHAFT AND BEARING RETAINER.

16. Support the shaft assembly on the bearing retainer flange (033) and press the shaft (031) out of the turbine end bearing (027). Use extreme caution to prevent damage to the shaft (031).
17. Remove the shaft (031) with fan end bearing (027) from the bearing retainer (033).
18. Remove the wave spring (026) from the bearing retainer (033).
19. Press the shaft (031) out of the fan end bearing (027). Once again use caution to prevent damage to the shaft (031).

CAUTION: DO NOT PRESS DIRECTLY AGAINST THE THREADED ENDS OF THE SHAFT.

20. Clean and prepare parts for inspection and reassembly.

Swivel assemblies

1. Position the fan housing on its feet. Rotate the subject swivel (037) until the setscrew (043) is accessible. Remove the setscrew from the swivel.
2. Position the setscrew hole down (be sure to place something under the hole to catch the balls). Rotate the swivel back and forth slowly to allow the balls (041) to fall out. Each swivel (037) has thirty-two (32) individual balls. it may be necessary to tap lightly on the outside of the swivel to remove any balls that might have become lodged.
3. Pull directly outward on the swivel (037) to remove it from the swivel coupling on the fan housing. Remove the O-ring (040) from the swivel coupling.
4. To access the inlet strainer (038), unscrew the double female adapter (046) from the inlet swivel (037). The strainer may be in the backside of the adapter, use caution to prevent tearing the integral seal on the strainer.

Inspection

Table 1 lists the critical fits and clearances which must be adhered to for proper assembly and operation. This information should be used to determine the suitability for reuse of the component parts. See individual part inspection paragraph for specific information.

TABLE 1. CLEARANCE AND FIT TABLE	
Fan (002) to Shaft (031)	.0005/.0015 \emptyset Clear
Fan (002) to Fan Housing (007)	.035-.055 \emptyset Clear
Turbine Wheel (029) to Shaft (031)	.000/0.001 \emptyset Clear
Turbine Wheel (029) to Shroud Ring (030)	.008/.012 \emptyset Clear
Shaft (031) to Bearing (027)	-.0002/+0.0003 \emptyset Clear
Bearing Retainer (033) to Bearing (027)	.0006/.001 \emptyset Clear
Nozzle (017) to Bearing (027)	.000/.001 \emptyset Clear
Nozzle (017) to Bearing Retainer (033)	.000/.002 \emptyset Clear
Nozzle (017) to Seal Head (028)	-.003/-0.001 \emptyset Clear
Fan Housing (007) to Nozzle (017)	.006/.014 \emptyset Clear
Shaft (031) T.I.R.	.002 MAX
Axial Freeplay	.000/.006

FAN HOUSING (007) Visually inspect for damage to mating surfaces, fits and wearing areas. Check for damaged stationary vanes or evidence of contact with the impeller (003). Hand blend/straighten any minor irregularities.

BEARING RETAINER (033) Visually inspect for damage to bearing bore diameter and register fit to nozzle (006). Ensure mating surfaces are flat and true. Hand blend minor irregularities. Replace if fits are excessively loose or severely damaged.

IMPELLER (002) Visually inspect for evidence of contact with fan housing (001). Check fit to shaft (010). hand blend minor damage to blades or mating surfaces. Excessive metal removal will cause unbalance in the impeller. Unit should be dynamically balanced to a maximum of .25oz-in. residual unbalance.

NOZZLE (017) Visually inspect bore diameter for damage to fits for bearing (023) and seal head (012). Inspect water passages for blockage or damage. Make sure shroud ring is tight in bore. Hand work irregularities in bores and mating surfaces. Remove burrs from O-ring grooves. Replace if fits are excessively loose or shroud ring is loose.

TURBINE WHEEL (029) Inspect for missing or damaged blades. Check fit to shaft (010). Inspect mating surfaces for damage or irregularities. Hand blend minor irregularities. Replace if shaft fits are loose or blades are missing or severely damaged.

SHAFT W/KEYS (031) Inspect for damage to fits, keyways and thread form. Check for straightness by supporting the shaft on the bearing journals. Hand work/blend minor irregularities. Replace with new if bent or thread damage is beyond repair.

SEAL SEAT (030) Visually inspect sealing surface for scratches, pitting, signs of leakage. Lap minor surface irregularities. Any other damage is cause for replacement.

SEAL HEAD (028) Inspect carbon faces for any irregularity. Check bellows for deformity or tearing. Replace if discrepant.

FAN GUARD (003) Visually inspect for bent or damaged wire pieces or cracked welds. Hand straighten bent or deformed wire. Replace with new if any welds are found discrepant.

STATIC CORD (004) Check cord and lugs for electrical continuity. Inspect insulation for crackling or deterioration. Replace with new if discrepant.

ADAPTER, INLET, DOUBLE FEMALE (046) Check for thread damage or missing or torn gasket on outlet side. Major thread damage is cause for replacement.

INLET STRAINER (038) Inspect for blockage, ripped or torn wire mesh. Check gasket for tears or deformation. Replace with new if discrepant.

SWIVEL, INLET/DISCHARGE (037) Visually inspect for damage to ball track or O-ring groove. Inspect thread for damage or deterioration. Hand work minor irregularities. Damage to ball track or O-ring groove is cause for replacement.

BALLS (041) 64 ea. It is recommended that the balls be replaced as a set after any disassembly.

DUCT ADAPTERS Inspect for damage to mating surfaces and connecting devices. Hand work minor irregularities.

Reassembly

Prior to reassembly, ensure that all parts have been inspected and are suitable for reuse. RAMFAN™ is a simple unit but does operate at high speed and does generate substantial power. Proper assembly by qualified personnel will ensure successful overhaul.

Rotor Module

1. Heat the fan end bearing (027) to 200°-250° F and install on the fan end of the shaft. Position against the shaft shoulder. There are no bearing locknut threads on this end, hold in position until cool enough to touch with a bare hand.

CAUTION: USE ELECTRIC BEARING HEATER TO HEAT BEARINGS. DO NOT OVERHEAT OR OTHERWISE CAUSE LOSS OF BEARING LUBRICANT.

2. Install one (1) wave spring (026) into the bore of the bearing retainer (033).
3. Slide shaft (031) with bearing (027) into bearing retainer (033). Bearing should slide into bore of bearing retainer. It should not be necessary to use a press or excessive force to install the bearing. The shaft should spring against the wave spring.
4. Heat turbine end bearing (027) to 200°-250° F. Place heated turbine end bearing over the turbine end of the shaft (031) and up against shaft shoulder. Quickly install bearing lockwasher (024) and bearing locknut (023) on the turbine end of the shaft (031). **It is important that the bearings are firmly against their respective locating shoulders.** Position and bend lockwasher tang into slot in locknut.
5. Heat nozzle (017) in a water bath to 140° F. Place nozzle (017), bearing end down, on a flat surface. Carefully position seal head (028) in counterbore of nozzle (017) flange is flat against the nozzle surface. Failure to do will cause premature seal failure. Allow nozzle (017) to cool.
6. Slide nozzle (017) with seal head (028) over the shaft (031) and position against the bearing retainer (033) flange surface. The nozzle should fit snugly over the bearing (027) and over the register on the bearing retainer (033). Exercise care to prevent damage to the seal head (028) when sliding the nozzle (017) over the shaft (031).
7. Rotate nozzle (017) until threaded holes in the face align with through holes in the bearing retainer flange. Install four (4) machine screws (012) to secure nozzle (017) to bearing retainer (033).

CAUTION: DO NOT APPLY EXCESSIVE FORCE TO THE MACHINE SCREWS (012) SECURING THE NOZZLE (017) TO THE BEARING RETAINER (033). DAMAGE TO THE HEX DRIVE PORTION OF THE SCREW HEAD MAY RESULT.

8. Apply silicone lubricant to O-ring (35) and install over the shaft. O-ring shall fit into groove on shaft. Take care not to damage O-ring on shaft threads. Take care not to touch seal head with the fingers on grease from the O-ring. Any contamination on the seal head will reduce its effectiveness.
9. Install turbine wheel key in shaft keyway. Position turbine wheel (029) on shaft (031) with grooved side facing out firmly push into place. You should feel some resistance from compression of the seal head spring.
10. Install turbine washer (022) and turbine locknut (021) .
11. Torque locknut to 120-140 in/lbs.
12. The shaft (031) should turn easily in the bearing (020) contained by the nozzle (017) and the bearing retainer (033). Check for axial freeplay. If discrepant check fit of nozzle (017) to bearing retainer (033). They should be flush to each other.

Fan Housing

1. Lubricate and install two (2) O-ring (016) on the nozzle (017).
2. Position fan housing (007), impeller end up, on a flat surface. Position the Rotor Module (nozzle end down) over the bore in the fan housing (007). Push down evenly on the Rotor Module until the O-ring on the nozzle compresses sufficiently to allow the nozzle into the bore.
3. Once past the first O-ring the Rotor Module should easily move to the next O-ring. Align the bolt holes as close as possible and press firmly until the bearing retainer (033) seats against the mating surface of the fan housing (007).

CAUTION: USE HAND FORCE TO COMPRESS THE O-RING. EXERCISE CARE TO ALIGN THE ROTOR MODULE WITH THE FAN HOUSING BORE TO PREVENT DAMAGE TO THE O-RINGS. DO NOT USE HAMMER OR MALLET.

4. Rotate the bearing retainer (033) until the through holes align with the threaded holes in the fan housing (outer bolt circle). Install four (4) machine screws (012) through the bearing retainer (033) and into the fan housing (017). Torque evenly. There should be a moderate resistance to tightening due to the locking feature of the threaded insert.
5. Compress retaining (011) and slide into fan housing centerbody. Make sure it snaps into groove.
6. Install impeller key on shaft (key should fit securely in keyway). Position and install impeller (002) on shaft (031). Impeller should fit by hand, you do not need a press to install.
7. Install lockwasher (006) with the tangs facing out. Install locknut (005), tighten using hand tool or special tool. Bend lockwasher into locknut slot.
8. Rotate the impeller (002) to check for binding or rubbing. If any is detected, thoroughly review the prior assembly steps.
9. Position fan guard (003) and secure to fan housing (007) using four (4) machine screws (008).

Swivel Assemblies

1. Lubricate and install O-rings (040) in both swivels (037).
2. Position swivel over swivel coupling located on the fan housing (007). Apply even and firm pressure to push the swivel onto the swivel coupling so as not to damage the O-ring.

CAUTION: DO NOT USE ANY TYPE OF LUBRICANT EITHER ON THE BALLS OR IN THE BALL TRACK. DAMAGE TO THE BALLS AND DIFFICULTY IN REMOVAL MAY OCCUR.

3. Load the 32 Delrin-100® balls (041) into the swivel through the setscrew hole. Rotating the swivel to and fro as you load the balls will help them move into position.
4. Install the setscrew (043) to retain the balls in the groove.
5. Stake head of setscrew into elbow to prevent from coming loose.
6. Rotate the swivel to check for freedom of movement.
7. Install inlet strainer (038) and double female adapter (046) on the inlet swivel. Install protective endcaps.

CAUTION: DO NOT USE A WRENCH TO TIGHTEN THE DOUBLE FEMALE ADAPTER. DAMAGE TO THE STRAINER SEAL SURFACE MAY RESULTS.

List of Materials

RAMFAN™ Model WF20 - LIST OF MATERIAL

ITEM #	PART #	DESCRIPTION	QTY
001	WA1001	ROTOR MODULE ASSEMBLY, WF20	1
002	WA3000	WF20 IMPELLER	1
003	WA4001	WF20 FAN GUARD	1
004	WA2501	STATIC CORD ASSEMBLY	1
005	FP95805	N-02 BRG LOCKNUT, STEEL	1
006	FQ95805	W-02 BRG LOCKWASHER, STEEL	1
007	WA2101	WF20 HOUSING	1
008	FZ9103459-BH	Capscrew, 10-24 X 0.38, B/H	4
009	FZ91434	1/4" LOCKWASHER, EXT. TOOTH	1
010	FA9106474	Capscrew, 1/4-20 X 0.63, H/H, SS	1
011	FZVH-487S02	VH-487S02 SMALLEY RETAINING RING	1
012	FZ9103504-BH	10-24X1" C/S BUTTON HEAD	4
013	WF20-3CN0285	HELICOIL, FREE RUNNING 10-24x.285	4
014	WF20-3CN0475	HELICOIL, FREE RUNNING 10-24x.475	4
ROTOR MODULE			
015	WF20-2CN0328	HELICOIL, FREE RUNNING 8-32x2	4
016	NF2-238	2-238 BUNA-N O-RING	2
017	WA1500	WATERFAN NOZZLE, WF20	1
018	FZVH-231S02	VH-231S02 SMALLEY RETAINING RING	1
019	WA1510	WF20 SHROUD RING	1
020	DZW204KLL	W204KLL BEARING	1
021	FE91245NY	HEX NUT, 5/16-24, NYLOCK, SS	1
022	FF91445	5/16 FLAT WASHER SS	1
023	FP95827SS	NS04 BEARING LOCKNUT, SS	1
024	FQ95827SS	WS04 BEARING LOCKWASHER, SS	1
025	FZ9102485-BH	8-32 X 3/4" PHILLIPS HEAD C/S, SS	4
026	FZSSB-0185	SSB-0185 SMALLEY WAVE SPRING	1
027	DZ204SFFC	MRC 204SFFC BEARING	1
028	MA.50/6A	1/2" SEAL HEAD	1
029	WA1300	TURBINE WHEEL, WF20	1
030	WA1400	SEAL SEAT, WF20	1
031	WA1100	WF20 SHAFT	1
032	EA7020	KEY, 3/16" x .75"L IMP.	1
033	WA1200	WF20 BEARING RETAINER	1
034	WA1110	TURBINE KEY, WF20	1
035	NF2-010	O-RING, SIZE 010, EPDM	1
SWIVEL ASSEMBLY			
036	WA2804	SWIVEL, WF20 INLET (1.5-9 NH) 1 1	1
037	WA2204	SWIVEL, WF20 EXHAUST (1.5-9 NH) 2 1	1
038	WA2300	WF20 INLET STRAINER 3 1	1
039	WF20-0251	NH DBL FEMALE ADAPTR 1 1/2-9 4 1	1
040	NF2-224	2-224 BUNA-N O-RING 5 2	2
041	BZ03DELBAL	3/16" DIA. DELRIN BALL - 6 70	70
042	FJ99198	3/8 PIPE PLUG ALUMINUM 7 1	1
043	FC9108432	5/16-18X1/4 S/H S/S, STAINLESS 8 2	2
044	FZ9109536M	STUD, MILLED SS 3/8-16 x M8-1.25 9 8	8
045	FE91090	3/8-16 HEX NUT SS 10 8	8
046	WZ-CAP	WF20 ELBOW CAP, RED, 1.875 11 2	2

Fan Drawings

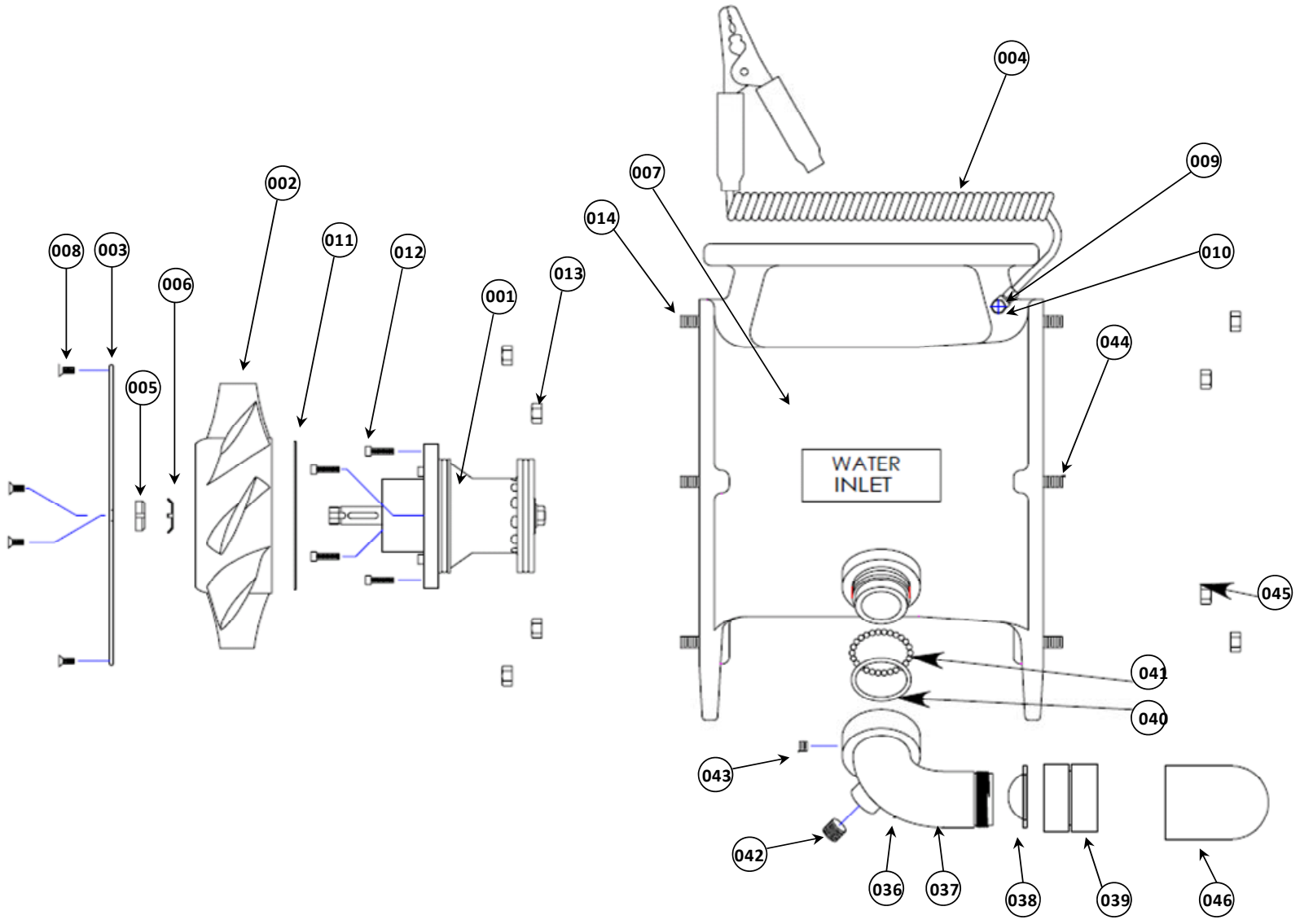


Figure 2

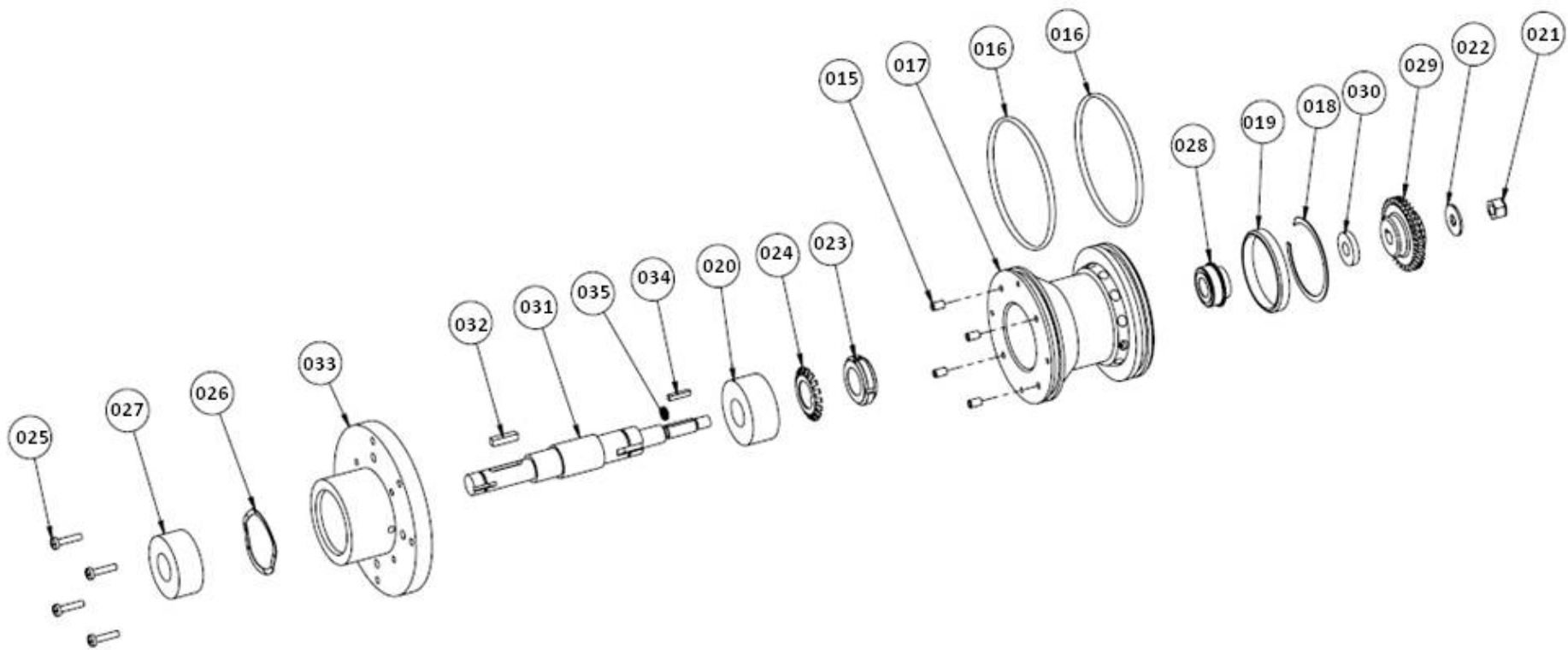


Figure 3