The Problem Solver
HYDRONIC HEATING HANDBOOK

AUGUST, 1984 SYSTEM NOISES PART 6

WE REMEMBER . . .

. . . going out to listen to a complaint about a "noisy" pump not too long ago. It was in one of those post-World War II homes where the boiler is installed right in the kitchen as one of the appliances.

An elderly women met us at the door, offered us a seat at the kitchen table and a cup of coffee and told us all about how she'd lived alone since the kids had grown and her husband had passed on.

"He used to take care of all these problems," she said. "What do I know about boilers? I hear these noises and I'm afraid it's going to explode."

So we sat and waited. And even though it was a cold day we could hear nothing but a well-tuned system humming along.

"There!" she said, "Hear it?"

And we listened. But we heard nothing out of the ordinary.

"There!"

We shrugged and moved closer.

Frustrated, she jumped up and pulled the plug on the refrigerator. "No one can ever hear any of **my** noises when all these other noises are on!"

OH! YOU HAVE TO BE A PHILOSOPHER

Most people expect their refrigerators to make noise. The noise means it's working. Oil and gas burners are O.K. too. They make "O.K." noises. It's the electric motors that seem to get to most folks. Maybe because it's a quiet noise? Who knows?

Anyway, we explained to our new friend that anything that turns is going to make a noise and the slight noise meant only that it was on. It was perfectly normal. Nothing was going to explode.

So she thanked us and we left inspired. Inspired to write this article about system noises because, as you well know and just between us experts, **all** those noises out there ain't normal. Not by a long shot.

Take, for instance . . .

VELOCITY NOISE

It is the nature of circulators to be blamed for things they don't cause. If a heating system were a classroom and the components the kids, the circulator would be the red-haired freckled kid in the last row with the slingshot in the back pocket of his overalls and the grin on his face. True, he's no angel, but he can't possibly be making **all** the noise. He's just the first one singled out.

Pumps get blamed for velocity noises because they only happen when the pump is running. Maybe they're responsible, but then again maybe they're not.

If water moves too fast through a pipe it will make a whistling noise. It's the same noise you get when you open the kitchen faucet. But that's an "O.K." noise; nobody complains about that. Nobody complains that half-inch pipe is used to carry a flow that by all rights belongs in a pipe twice that size. It's domestic water, for Pete's sake! Domestic water has always been noisy. Just like refrigerators. It's O.K.

But whistling heating systems are bad business so let's see what we can do about them.

There are actually three kinds of velocity noises and they're made worse if a lot of air is present in the system. You can tell there's a lot of air if the whistle varies in pitch and loudness as the pump runs.

The first kind of velocity noise is caused by an oversized pump. This noise will be heard everywhere in the system. The pump is

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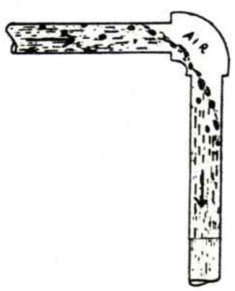
pushing more water than the system can handle and it's a very common problem because pumps are notorious for being oversized.

To solve the problem you can try throttling the pump on its discharge side if you have a globe, ball, butterfly valve or a plug cock. Never try to throttle with a gate valve; they can't take that kind of service. And never throttle a pump on its suction side even if that's the only valve you have. The pump will be starved for water and burn itself out in no time.

By partially closing a valve on the discharge side of a pump you're increasing the system head pressure and giving the pump more to push against. With this higher pressure to overcome, the pump is forced to move less water. If the pump isn't too oversized you'll be able to move it back to a point where the whistling stops, but there's a fine line here because in throttling you may set up a whistle in the throttling valve itself. If that happens you have only one choice and that's to trim the impeller. This involves cutting off a portion of the impeller's diameter with a lathe and a bit of engineering know-how is needed to figure out how much to cut. Here we suggest you call us for advice. If it's a B & G pump we'll be able to tell you exactly what needs to be done.

The second kind of velocity noise is a local noise in only one or two circuits and this is caused by a balancing problem. The pump supplies water to the entire system and depends on the piping system to direct the flow to the right areas. If the system is out of balance too much water will flow through a circuit designed for a lesser flow and that circuit will be noisy. (See Part 5: "Piping Systems" for ways to balance noisy circuits.)

The third kind of velocity noise is also caused by balancing, but it involves circuits where water moves too slowly. Here the noise is caused by air and instead of a whistle you get a "waterfall" sound where the pipe turns downward. It looks like this.



Low velocity through this pipe prevents the air from being carried down with the flow of water. The air piles up at the top of the elbow when the pump is on and you get a "waterfall" sound as the water cascades past the air.

When the pump is off, the air spreads out at the top of the pipe. Installing an air vent, even an automatic air vent, may not help with this problem because if water is moving slower than six inches per second air will just keep coming out of solution. It goes on and on. The answer is to balance the system because chances are you're also not getting enough heat in that zone and the waterfall noise is the least of your problems.

NOISY PUMP BEARINGS

Here's where you can blame the pump, right? Bearing noises are loud and obviously coming out of the pump so it has to be the culprit.

Well, hang on there while we call a few witnesses for the defense. "Your Honor, we call to the stand all those thousands of mechanics who oil and grease pumps and motors."

And up to the stand walk all these guys with oil cans and grease guns and we'd be willing to bet more than half of them have the wrong stuff in those cans and guns.

Evidence: An examination of the oil in those cans shows a large percentage to be the wrong viscosity. These people don't read directions and the bearings fail.

Evidence: A further examination shows the oil to be detergent oil which is great for a car engine but disastrous for a pump. Pumps must be oiled with non-detergent oil. Oil evaporates over time; detergent doesn't. As you oil and re-oil a pump the ratio of detergent to oil builds up in the favor of detergent. Detergent cleans, but it doesn't lubricate and as a result — the bearings fail.

Evidence: Some of these people are using 10W-40 motor oil; some are using cooking oil; some are using STP!

No foolin'

Evidence: Some of these folks with the grease guns are not removing the botton plug to flush out the old grease! In effect, they're wasting their time — and the bearings.

Evidence: All those people who just plain forgot to oil or grease the pumps when they were on the job doing routine service. And all of those people with constant circulation who didn't oil the constantly running pumps at the proper intervals.

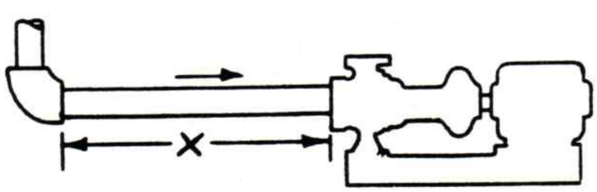
Those bearings depended on you and you let them down. For shame!

And what about the rest? Well, let's look at some of those installations, especially those base-mounted pumps.

Notice how the suction piping drops directly down into an elbow at the pump suction? Notice how that suction piping has been reduced to save a few bucks? Why it's smaller than the suction opening! Notice all those valves and strainers so close to the pump suction?

These are the things that kill base-mounted pump bearings and it happens every day. Think about it. Water is heavy and when it makes a turn it's also very turbulent. If you spin it off an elbow right into a rapidly spinning pump impeller that water's weight is going to be way out of balance. It hits one part of the impeller harder than it hits the other part. It's like white-water rapids inside that pump and it's not going to be long before the bearings feel the tremendous strain and give up.

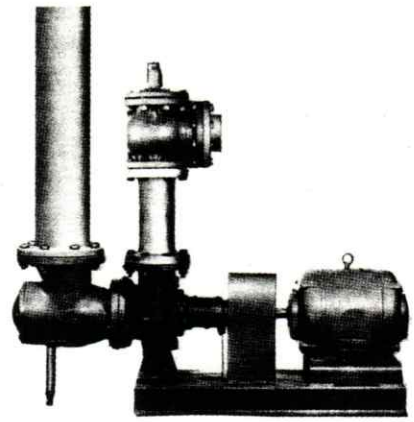
The approach piping to a pump suction must be at least five times as long as the pump suction diameter. So if your pump has a six-inch suction the approach piping has to be at least 30 inches. Just like this.



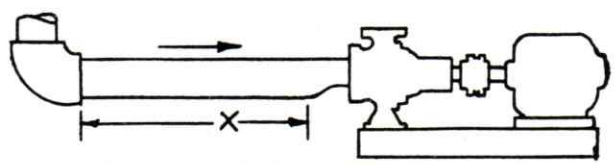
The length of "X" is at least five times the pipe diameter.

But who takes the time, expense, or the space to do this? Only those who aren't looking for bearing problems.

The only way around this if you have a tight space is to use a Suction Diffuser which straightens the water out with special vanes right at the pump suction. Here's one installed on a pump.



Whether it's straight piping of the proper length or a Suction Diffuser another thing to keep in mind is this. The suction piping can't be smaller than the suction size of the pump. Undersized piping increases the pressure drop and the pump will be trying to push out more water than it's pulling in. That's also the reason you don't place valves and strainers right at the pump suction. The result is cavitation which can shake a pump to pieces. We'll get to that in a minute. Here's how the piping should look with a larger-than-system-pipe-size pump suction.



The lenght of "X" is at least five times the pipe diameter.

Notice that eccentric reducer at the pump suction? The flat part of the reducer must be on top so air won't get trapped at that point.

These are things that, if ignored, cause bearings to fail and make systems noisy. Watch out for them.

We rest our case.

PIPE EXPANSION NOISES

Tick. . . tick. . . tick, tick, tick. . . BANG!

Oh, those expansion noises in copper baseboard can drive your customers crazy! Every time the pump comes on line the copper starts to grow and those growing pains are noisy. Let's take a look at this common problem.

Here's how it all starts. Let's say you install a piping system on a beautiful day when the temperature is inching up toward 80 degrees. That's also going to be the temperature of your copper piping, give or take a degree. You put it all in and start it up. You have your high-limit aquastat set at 190 degrees to give you an average temperature of 180 degrees in your baseboard which means your copper is going to go through a 100-degree temperature rise from what it was installed at. Tick, Tick!

Know this: For every 100 feet of copper tubing you're going to get a growth of over one inch when you put it through a 100-degree rise in temperature. If you made your installation on a colder day you're going to be in worse shape as far as the newly found copper goes. The same goes for water temperatures that are higher than 180 degrees.

And the copper's not only getting longer; it's getting wider too so the ¾-inch hole you drilled to accommodate that ¾-inch pipe is going to have the ¾-inch pipe lifting the floor up. Thump, thump!

These things may seem like common sense, but you'd be amazed at how many people forget to take them into consideration. For example, consider a gravity conversion job. When the system had no pump the piping got hot gradually and the expansion noises were almost nonexistant. Add a pump and you're going to have a system that dances the mambo. Happens all the time.

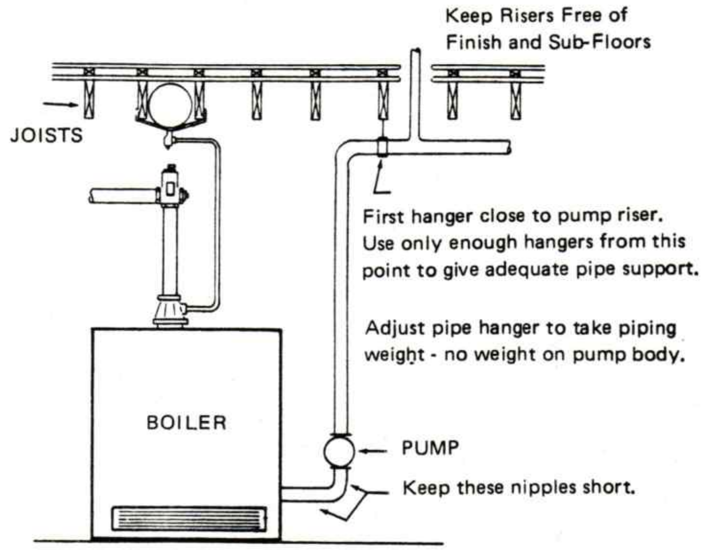
There are two ways around the problem of pipe-expansion noise. The first is to use expansion compensators. They look like this.

You use them where you have a straight run of any length that may cause a problem. If you give us a call, we can tell you where they belong on your problem job.

The second way to avoid expansion noise is to run the system on constant circulation and vary the temperature of the water. This gets you away from the sudden change in temperature and also gives you many many other advantages. (See Part 1: "Gravity Systems")

And while you're looking at your noisy pipes be sure to check those pipe hangers. Any hanger that places strain on the piping will turn the entire building into one gigantic tuning fork. Hummmmmmmm. Many times a piping noise problem has been solved by just loosening up a hanger in one spot. Also keep an eye on the risers to make sure they don't come in contact with the building at any point.

The pump should be mounted as close to the boiler as possible, whether it's on the supply or return. You're shooting for something like this.



And as long as we're back on pumps, let's take a look at another potential noise maker.

MISALIGNMENT

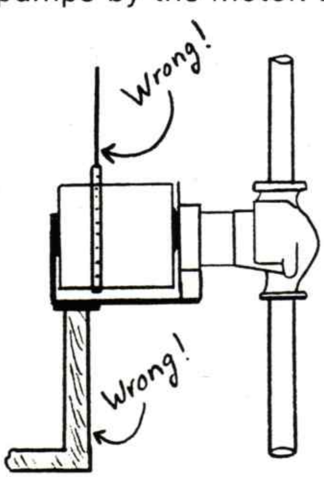
Pumps with couplers tend to be quieter than pumps without couplers. Couplers have another function few people ever think about; they're the "fuses" between pumps and motors. If a coupled pump should sieze up for whatever reason on the pump end, the coupler will break before the motor has a chance to go into "locked-rotor" and possibly burn out. In other words, an inexpensive coupler can and will save the life of an expensive motor in the event of an emergency.

But having a coupler means having a space between the pump shaft and the motor shaft and since both shafts are spinning at a high rate of speed we have to make darn sure those shafts are aligned with each other. If they're not you'll have a pump that goes "wawawawawawa" for awhile before something gives. And "wawawawawawa" is hard to live with. Like no other sound a system can make, "wawawawawawa" has a way of getting to you. There's something evil about it. After awhile you find your head bobbing up and down. Wawawawawawa!

But you don't have to put up with it. Just make sure the pump is in alignment. By this we don't mean stuffing a sliver of wood between the motor and the motor bracket either; we mean making sure the motor mounts on your inline pumps are round and not soaked with oil.

There's no doubt that oil is the best lubricant for rotating equipment, but some people like it so much they're overenthusiastic in its application, to say the least. They squirt and squirt until it runs out of the oiling hole and down onto the rubber motor mounts which are oil "resistant" but not oil-proof. And as you probably know, oil and rubber don't mix very well. The mounts sag and the shafts go out of alignment. The pump goes WAWA and the coupler breaks. Somebody shows up to change the coupler but doesn't change the motor mounts. More WAWA. And before long, the coupler breaks again.

Another thing that can throw inline pumps out of alignment is the silly practice of supporting pumps by the motor. Like this.



Most inline pumps don't need external support unless they're hefty and connected to small copper lines. In that case you're supposed to support the piping around the pump or the pump itself — but from the bearing assembly. B & G's larger inline pumps come with eyebolts in the bearing assemblies just for hanging. But some of the elaborate supports we've seen in the field are capable of supporting a Volkswagen! You don't need them. Besides, if you nail the motor to the ceiling or the wall or the floor you're going to have a big problem when the piping heats and expands. The pump is supposed to be able to move with the piping. WAWA!

Base-mounted pumps are another story. They're aligned at the factory, but the alignment will shift when the pump is trucked across the country and bounced down the steps at the job site. If it's a Bell & Gossett pump we will come out and align it again once it's installed. All you have to do is call us.

The types of base support for base-mounted pumps are a subject in themselves. To avoid noise we recommend bolting and grouting base-mounted pumps to concrete pads weighing at least one and one-half times as much as the pump. If you're using flexible isolators under the pump base make sure they're properly sized and also use flexible pipe connectors of the proper length, anchored on the system side to the floor or wall.

But now we're going beyond the scope of The Problem Solver. Those bigger jobs usually come with engineers. If you get involved with big base-mounted pumps, give us a call and we'll talk it out in depth with you. You should also know we stock those big pumps in Plainview and Franklin Lakes.

REVERSE PUMP ROTATION

This one is easy to solve. Let's take a look at a pump impeller to see which way it's supposed to spin.

Surprised? Most people are. Impellers "slap" the water; they don't dig in. It's possible to run a three-phase motor in either direction by switching any two of the three leads. If the pump is running backwards it **will** pump water, not very well, but it will. It'll also make a "churning" noise that's not very pleasant.

Single-phase pumps are "set" to run in only the proper rotation, but over the years we have seen a few defective pumps which will run backwards. It's rare, but it has happened so don't turn your back on the possibility. Remember the first rule of troubleshooting: Assume Nothing!

Here's a general rule for you on pump rotation: Imagine yourself sitting on the motor and facing the pump. From that position, small boosters should spin counter-clockwise and big pumps should spin clockwise. And if you look at the pump you'll see a rotation arrow stuck to the pump body (unless some idiot has taken it off.) If you hear churning, check rotation.

TRAPPED AIR IN A PUMP BODY

That churning sound isn't limited to reverse rotation; you'll also get it if air is moving through or trapped inside the pump body. If the air is "just passin' through" you'll have noise everywhere in the system. Air in a system sounds like marbles are rolling around inside the pipes. You can hear the air pinging and clinking its way around the piping. For solutions to air-related problems see Parts 3 and 4 on "Air Problems."

Air trapped in a pump body is another problem and it varies with the type of pump — inline or base-mounted. Here we can speak of some definite solutions B & G has come up over the years. It's a good example of that innovative thinking we've been telling you about.

Some years ago, B & G developed and patented a special impeller for their inline pumps. It's designed to catch air, mix it up with the water, and throw it out of the pump. This not only avoids the noise problem, it also increases the life of the pump seal. You see, air that's trapped inside a pump when the system is first started up will stay there unless some way is provided to get it out.

When the pump is off, the air will sit at the top of the pump body. As soon as the pump is started, the air will move down and gather at the inlet of the pump and in back of the impeller where the mechanical seal is. It goes there because that's the area of lowest pressure. Once it's there it can't be moved out and it will stop flow as well as make that churning noise. Not only that, the air in the back of the impeller will make the seal run dry and burn it out.

As we said, B & G pumps have these patented impellers designed to get the air out so the pumps run quieter and the seals last longer. No one else has anything like it.

The big base-mounted pumps use a different method. They have vent tappings at the high point of the pump body. Any time the system is first started after being drained you have to open this tapping **while the pump is off** and rotate the impeller shaft by hand to get any air trapped in the impeller vanes out. If the pump is running and you try to vent it you'll be wasting your time because, at that point, all the air will have moved into the inlet of the impeller. The air at the seal face is moved out by metal turbulators cast into the pump body (another B & G idea). If you try to vent a base-mounted pump while it's running all you'll get is wet.

This venting procedure applies to every base-mounted pump on every system every time it's first started. It's almost never done and it's always a problem so watch out for it.

CAVITATION

This is something that happens more in "open" systems. It's a bigger problem on cooling tower and boiler-feed pumps, but it's not unknown in closed hot-water systems. Cavitation is what happens when a pump is starved for water. It tries to push out more than it's getting in. The pressure drop within the pump is so extreme that the water flashes into steam and expands right at the pump inlet. When that steam moves into the higher-pressure area at the edge of the impeller it collapses and you get tremendous water hammer that literally chips away the metal of the impeller. The pump makes a horrible churning noise and if there are gauges installed on the pump you can watch the needles shake themselves loose.

Cavitation can destroy a pump in a matter of days so watch that approach piping and all those valves and strainers you install there.

The solution to cavitation requires some engineering analysis so if you think you have this problem, give us a call.

NOT ENOUGH PRESSURE AT THE TOP FLOOR

This was more a problem in the days of the open system before closed compression tanks and pressure-reducing valves came to be widely used, but we still see it from time to time. It goes like this.

The purpose of a pressure-reducing valve in a hot-water system is to lift water from the point of entry into the system to the top floor **and then to pressurize it at the top floor.** Which is a point sometimes missed.

You look at the building and measure the distance from the reducing valve to the highest pipe in the system. Then you divide the distance in feet by 2.31. That tells you how many pounds of pressure the reducing valve has to be set for to get water to the top. But we're not done yet. Whatever pressure you arrive at is just for lifting. You have to add 4 psi to that pressure to make sure you will always have enough pressure at the top floor.

Here's why it's so important. Let's say you set your valve just to lift the water and let's say your water temperature is 220 degrees. By the time that hot water gets to the top there may not be enough pressure to keep it in a water state at that high temperature. The water can flash to steam and expand tremendously. You'll get a banging you won't believe.

The solution is simple — raise the fill pressure.

CHATTERING FLOW VALVES

Another common problem. Flow valves that go "clink, clink, clink." This problem is caused by air in the system. Water passes the valve and lifts the weight. Then comes a slug of air and the weight drops. Clink! Another slug of water. Up! Another slug of air. Down!

The answer is to install a system for removing the air — either Airtrol or Air Elimination. The answer is not to wrap solder around the weight. That will only make it worse. And the answer is not to take out the flow valve and put in a zone valve because that doesn't solve the air problem.

AND CHATTERING PRESSURE-REDUCING VALVES

By their very name, pressure-reducing valves reduce pressure from a high point to a lower point. But if the initial city pressure is very high you may have a problem with chattering when the valve feeds. There are two ways around this.

You can raise the setting of the PRV, if the system allows it. This will bring the high and low pressures closer together and the chattering should stop. If it doesn't, the only other solution is to add a second reducing valve and step down the high pressure in two stages before it enters the system.

A PARTING THOUGHT

And then there was the mechanic we met a few years back who topped off every job he did with a quart bottle of "Mr. Clean" detergent.

"It makes the water more slippery," he said quite seriously. "This way it can slip around corners without making noise. It's like putting slippers on the water. Here, put some on your fingers and rub them together. See! No noise!"

True story.

Guess it takes all kinds to make an industry.

SEE YOU NEXT MONTH