FUEL OIL Journal

The Big Fault in One-Pipe Heating

DEALERS WHO CORRECT IT GAIN OPERATING ECONOMIES

By
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HEATING SYSTEMS that are not well adapted to intermittent firing prevent many oilburner owners from enjoying the full benefits of oilheating. Most existing systems were designed for coal firing. Many of them need changes before they operate well with an oilburner. Hence oilburner dealers can insure better customer satisfaction by making a careful check of each heating system in which they install an oilburner.

More oilburners are installed in one-pipe steam systems than in any other type of heating plant. The weak point of one-pipe steam jobs is that the radiators tend to heat unequally unless the system is carefully balanced; when small amounts of steam are generated, a few radiators generally get most of the steam. The oilburner dealer who thoroughly understands heating systems usually finds it possible to eliminate this after an oilburner has been installed. Sometimes steam mains must be changed. More often the operation of the system can be greatly improved, if not made perfect, through the intelligent application of radiator and steam main vent valves. A study of distribution difficulties that are often encountered with one-pipe steam systems may help dealers to improve the operation of such heating plants. In addition it will show why it is often necessary to correct the distribution faults of such heating systems before rapid-acting thermostats can be used successfully with them.

HOPED FOR EVEN HEATING

IN THE INSTALLATION DESCRIBED below, common troubles were encountered with an ordinary heating system. Soon after the burner was installed the owner realized that while 70° was maintained uniformly in the room where the thermostat was located, the temperature of the other rooms, especially those on the third floor, was lower. Since this had also been the case with coal, the owner didn't blame the unequal heating on the oilburner. He had hoped, however, that his house would be evenly heated with oil. He told all this to the oilburner dealer who sent a service man to investigate. The service man raised the thermostat setting 10 degrees, found that all the radiators heated, and reported that there was certainly nothing wrong with either the oilburner or the heating plant. To make sure that the service man was right, the owner called in a heating contractor, who did exactly what the service man had done and came to the same conclusion.

The owner was still dissatisfied. The dealer explained to him that an individual room thermostat control system, either electric or pneumatic, would undoubtedly solve the problem, but that the cost of such a system was prohibitively high for the average homeowner. Since the dealer implied that it wasn't wise to make a mountain out of a mole hill and that the trouble was not easily corrected, the owner resolved to stop bothering him about it and continue to endure the cold upstairs rooms.

When improved thermostats were introduced a year or so ago, the dealer sold one to this homeowner. The dealer had a hazy suspicion that the new thermostat would solve the problem by turning the burner on more frequently, for shorter intervals. The owner hoped the new control was the answer to his problem.

To the dealer's surprise and chagrin, after the new thermostat was installed the condition that the owner had complained about was worse. The dealer felt pretty sheepish about the whole affair. The more he saw of the job the more he realized that the owner was seriously inconvenienced by his cold upstairs rooms. The dealer was humiliated by having to admit that he had first ignored a well-founded complaint, then prescribed the wrong remedy for it.

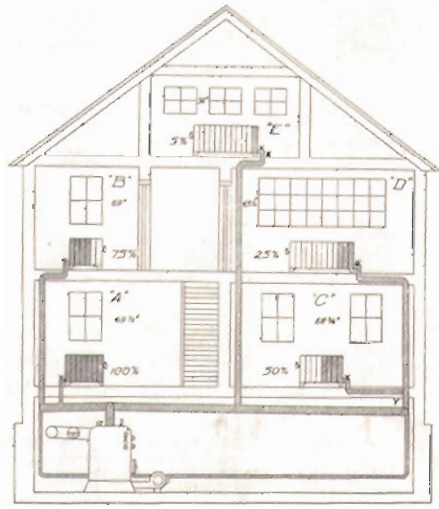

Diagram 1. *Shaded sections show steam distribution in radiators when the burner's running time is 15 minutes in each complete cycle.*

STUDIES SYSTEM

AFTER THE DEALER had consulted a heating engineer about the difficulty, he went back to the job to study the heating system. The five rooms in the back of the house are shown in diagram 1. The radiators in these rooms heated in the same manner as other radiators on the same floors. The diagram shows, by shaded areas, the radiator sections and steam mains which were filled with steam after the thermostat turned the burner off when the outside temperature was 32°F. The window area shown for each room indicates roughly the relative heat loss of the room. The percentage figure at each radiator gives, as accurately as the dealer could determine it, the percentage of heated sections of the radiator. Since the shading does not cover fractions of a section, it is less accurate than, and does not always agree with, the precentage figure. Room temperatures, in degrees Fahrenheit, are also given.

The dealer ascertained that the conditions shown by the diagram are typical of those that existed when the thermostat turned the burner off during 25°F. to 40°F. weather. The distribution of steam was slightly improved on very cold days. The only exception occurred each morning when the burner operated about an hour after the thermostat setting was raised from 60°F. to 70°F. At that time each radiator except radiator A, which is filled with steam in the diagram, had more heated area than diagram 1 shows. Heat distribution was improved, but the upper floors still received less heat than the first floor. The dealer noted that, after the morning warming-up period, the burner ran about 15 minutes each time the thermostat demanded heat. Its operating periods were slightly longer during very cold weather. Their tendency to be of almost equal length, during the varying weather in which these notes were made, was due partly to the boiler's steaming quicker after the burner started during colder weather when the system remained idle for shorter intervals.

The dealer could understand, after he

made diagram 1, why the rooms were unequally heated. Radiators near the boiler received steam before the others; small radiators, containing less air to be vented, filled with steam faster than larger ones. Comparing radiators made of the same type of section, a six-section radiator, for example, contains half as much air as a twelve-section radiator. Therefore, if both radiators fill with steam at the same rate, because of equal steam pressure on them and their air escaping at the same rate from identical vent valves, the twelve-section radiator will be half-heated when the six-section radiator is entirely heated. Of course, with radiators properly proportioned and intermittent firing, under these conditions the room with the six-section radiator would get about twice as much heat in proportion to its heat requirements as the room with the twelve-section radiator if the boiler stopped steaming when the six-section radiator was fully heated.

To complete his study of the behavior of the heating system, the dealer obtained data to make diagram 2. He felt each radiator at five-minute intervals after the burner started. Again, as in diagram 1, where the shaded area of the radiator does not agree with the percent of heated area noted in the diagram, the percentage is more accurate.

Diagram 2 shows that 15 minutes after the burner started *radiator* A is fully heated, but radiator E hasn't received any heat. The time that the steam loses in reaching radiators comparatively far from the boiler and the lag in the heating of the large radiators, due to their venting large amounts of air, are also evident.

A study of diagram 2 shows why upstairs rooms received less heat after the quick-acting thermostat was installed. When the burner ran for longer periods with the old thermostat, there was sufficient time, before steam generation stopped, for distant radiators to receive steam and for large radiators to be filled with considerable amounts of it. If, for example, the burner were to operate for ten-minute periods, radiator E would receive no steam while other radiators would receive sufficient steam, if the burner cycle were repeated frequently enough, to heat more or less comfortably the rooms in which they are located. Ten-minute firing periods are possible with some of the new quick-acting thermostats and may cause trouble if they are used on unbalanced steam jobs.

FIRING RATE INCREASED

SEVERAL OTHER interesting conclusions result from a study of diagrams 1 and 2. Because all the radiators were not full of steam after the burner operated 90 minutes, the dealer increased the firing rate of the oilburner. He wanted the burner to fire the boiler at the rate required to fill all the radiators with steam in less than one hour. The test firing in which this was done was started when the heating system had cooled 30 minutes after it had been completely full of steam.

The diagrams also show that the relative amount of heat given off by the steam mains and the boiler increases as the burner's firing periods decrease. This means that with shorter firing periods less of the heat in each gallon of oil is given off by the radiators, more by the boiler and the steam mains upstairs and in the cellar. If the boiler and the steam mains in the cellar are not well insulated, fuel costs may increase noticeably with short firing periods. Increased fuel bills may also result from short firing periods because the burner operates a greater percentage of its running time with a cool firebox. On many installations after the burner has been inoperative about 30 minutes and then starts, 5 to 10 minutes elapse before the firebox is sufficiently hot for the flame to burn cleanly and economically. Obviously good boiler and steam main insulation and quick-heating fireboxes should be used on new jobs where quick-acting thermostats are used. On old jobs where these features are not found dealers may find it difficult to get good results with thermostats adjusted to give firing periods as short as ten to fifteen minutes.

While shorter firing periods increased the unequal heating of the radiators on this installation, the basic trouble was with improper venting of air from the heating system. With this trouble corrected, the owner could enjoy the advantages of the quick-acting thermostat, and also have equal temperatures in each room. The oilburner dealer's application of suitable air vent valves to the steam mains and radiators proved this, settled the owner's troubles about unequal heating.

EQUIPMENT ADDED

THE OILBURNER DEALER found available several heating specialties which could easily be installed on this heating plant to improve its operation. A large quick vent valve installed on the steam main at X permitted radiator E to receive steam much more quickly. Another, installed at Y, speeded up the heating of radiators C and D. He used steam main quick vent valves with venting orifices about ten times the size of those in the radiator valves. Adjustable quick vent valves are made by some manufacturers, while others offer valves with different size venting ports. Using such valves permits the dealer to balance the system so that steam reaches the points where the valves are located as quickly, or as slowly, as desired.

The dealer found that by installing two radiator valves on each of the three largest radiators they filled with steam more quickly and tended to be full of steam when the smaller radiators were filled. The radiator was drilled and tapped so that the second vent valve could be installed next to the first one. Another way to insure each radiator's becoming filled with steam at the same time is to install special vent valves designed to permit equalization. Such valves are available in two types. The first is adjustable, the area of its venting port, hence the rate that steam flows into the radiator which it vents,

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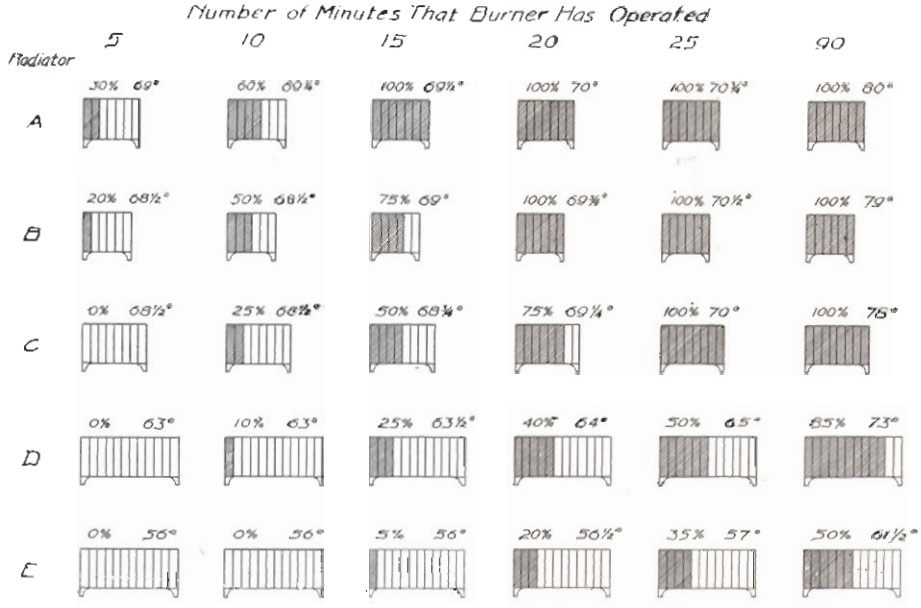

Diagram 2. *Steam distribution in each radiator shown in Diagram 1 after burner has run for various periods of time. Distribution is less satisfactory with shorter than with longer firing periods. Shaded areas show heated radiator sections.*

[*The Big Fault,* *begins on page 11*

can be varied on the job. If the radiator heats too fast the adjustment is closed a little; if the radiator heats too slowly the adjustment is opened. These valves are made in vacuum and non-vacuum types.

Another make of air vent valve designed to permit equalization comes in several sizes for radiators and in other sizes for steam mains. With these valves, speeding up or slowing down the heating of a steam main or a radiator is simply accomplished by installing vent valves with larger or smaller ports. The manufacturer of these valves recommends that as many as 4 steam main valves be installed at one point on a steam main which it is desired to fill with steam rapidly.

A highly developed form of radiator vent valve for one-pipe steam jobs is a combination room thermostat and radiator vent valve. It automatically maintains the desired temperature in each room by retarding the venting, hence the heating, of radiators when the room temperature exceeds the temperature for which the valve is set. Its manufacturers claim that it permits owners to enjoy individual room temperature control with a minimum expense for equipment.

Many oilburner dealers report excellent results from the sale of vacuum valves for radiators and steam mains of one-pipe steam jobs. The troubles of the heating plant described in this article were due mainly to improper venting, hence the replacement of the old radiator valves with new vacuum valves would probably not have cured them. Installing vacuum valves and making other changes necessary to permit the system to pull vacuums might have reduced the distribution troubles, however, because a system that pulls a vacuum vents less air during frequently repeated short burner operations. Hence, especially after the first long burner operation which heats the house to 70° mornings, there will be less air in the system. A more systematic plan to give the owner satisfactory results, together with the advantages of a vacuum system, would be to eliminate the venting troubles, by installing vents which will permit all radiators to deliver the proper proportions of heat with short burner operations, and at the same time convert the system to a vacuum system by using vacuum vents. Vacuum valves prevent radiators from cooling rapidly, help to deliver a more uniform heat, and reduce boiler and steam main losses by causing the boiler to deliver steam at lower temperatures after the burner stops.

Oilburner dealers who install vacuum type valves should be careful to complete the job of converting one-pipe steam jobs into vacuum systems. Not only should they install a vacuum type valve on every radiator and every long steam main, but they should also install on the boiler a steam gauge which shows vacuum and pressure and seal any air leaks in the heating system so that it can pull, and hold, high vacuums. Air leaks are best detected by putting ten or twelve pounds of steam on the boiler and searching for small leaks which show escaping steam or water. One-pipe steam vacuum systems are often reported to pull vacuums as high as 18″ to 20″. The dealer should continue to look for and close up leaks until the system can attain a vacuum at least as high as 10″ to 12″.

TROUBLE IS PREVALENT

THE VENTING TROUBLE discussed in this article is very prevalent on domestic installations. It serves the owner a good purpose, sometimes, by reducing his fuel expenses through underheating parts of the house. More often the owner is glad to buy the heating specialties necessary to correct the heating system's defect. Large buildings frequently use excessive amounts of oil because of venting troubles of one-pipe steam jobs. As an example of this: A large building has two sections, one which receives steam easily

because its radiators are connected to the heating boiler by short steam mains; the other section is hard to heat because the steam, before reaching it, travels through exceedingly long mains. Attempts to regulate the heat in this building by means of a thermostat located in the easily heated section prove unsuccessful because the thermostat turns the burner off before many radiators in the other section have received any steam. Therefore the thermostat is moved to the section of the building which is hard to heat. With it in this location, the radiators in the other section receive a wasteful overabundance of steam. It is not possible to reduce the heat given off by radiators of a one-pipe steam system without turning the radiators off entirely, hence the radiators remain turned on full blast while the building's occupants open windows to avoid uncomfortably high room temperatures. By the use of large air vents at the end of the long steam mains, and special air vent valves on the radiators, this heating defect may be corrected so that the radiators in both sections receive heat simultaneously. When these corrections are made it will be possible to locate the thermostat, with equally good results, in either section of the building. The overheated radiators and the resultant waste of fuel will be prevented. Several oilburner dealers have come to the wrong conclusion when they faced problems of this kind. They interpreted the difficulty incorrectly, calling it control trouble instead of heating system trouble, and tried to correct it by finding a more suitable thermostat location, or more suitable controls. Greater familiarity with heating systems and with heating specialties designed for oil-fired heating systems eliminates this wasted effort and enables well-informed dealers to make profits when they encounter sick heating plants.

IMPROPER PIPING

THE VENTING DIFFICULTIES described in this article are often increased by improper steam piping, a subject not covered in this article. Balancing the venting of a system includes, however, the use of vent valves which tend to correct piping defects and pressure drops in the system which are caused by long or undersize steam mains. Obviously, when a steam main is so small that the use of unusually large or duplicate air vents on it and on the radiators supplied by it fail to produce satisfactory results, the only remedy that remains is the installation of a larger main. This also holds true for other heating system defects, such as undersize radiators, which may be partly overcome by venting devices. Although proper venting can be stretched a point so that heating plant defects cause less dissatisfaction, it cannot entirely overcome basic faults of the heating system.

Only the simplest procedure for studying heating systems was outlined in this article. Many oilburner men now use special equipment, such as burner operation recorders and room temperature recorders to run down heating system trouble.

There is considerable room for improvement in the operation of heating systems fired by oilburners. Oilburner dealers who ignore this kind of work are inviting their customers to go to other dealers or to heating men to have the work done. The job of progressive oilburner dealers includes campaigns to educate users to the need of revamping heating systems so that they are fully adapted to oil firing.

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Rose Elected Arco Vice-President

MAX D. ROSE, eastern sales manager of the American Radiator Co., NewYork, was recently elected a vice-president. He joined the company in 1906, immediately after graduating from the University of Chicago, and was appointed eastern sales manager a year ago.