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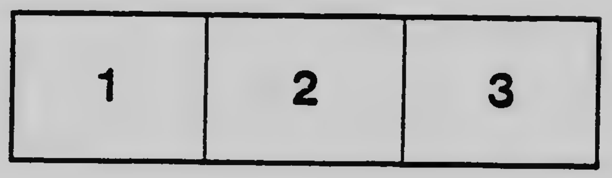

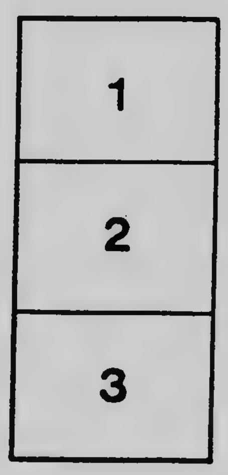

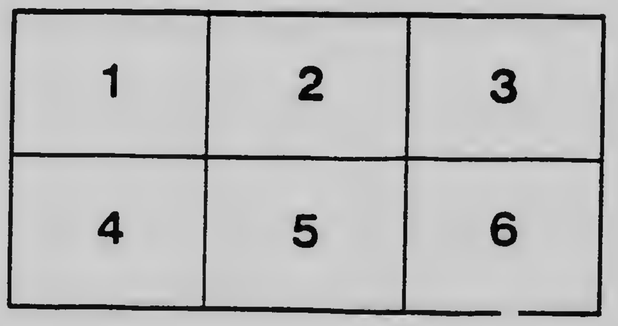

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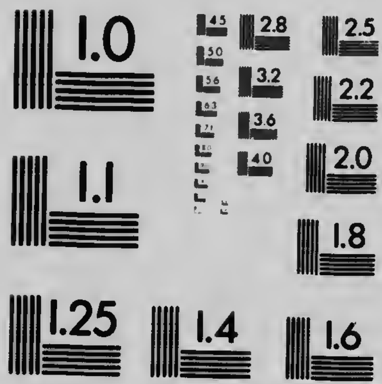

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CANADIAN RAILWAY CLUB

SOME RECENT DEVELOPMENTS IN CAR HEATING AND VENTILATION.

By Mr. Lewis C. Ord, General Car Inspector, Angus Shops, Canadian Pacific Railway Company, Montreal.

Passenger coaches, and, in particular, sleeping cars, are apt to be regarded as badly ventilated when compared with hotels, offices, dwellings, etc. This quite general feeling has resulted in the trial and adoption of a number of different devices for improving the air circulation and the more rapid change of the air in the car. These devices can not of themselves alone overcome the trouble, unless both the air supply and the heating of the car can be suitably regulated to suit the varying conditions of service. In the following extract from a paper presented by Dr. T. R. Crowder, at the meeting of the American Public Health Association at Milwaukee, September, 1911, the importance of this is clearly explained:

"It was suggested, long ago, by Hermans, a German in-"vestigator, that the discomfort was not so much the chemical "changes in the air as it was the thermal. Heat and aqueous "vapor increase rapidly in the ill-ventilated places with many "occupants, and thus prevent the usual dissipation of body "heat to the surrounding air. In experiments performed at "the Institute of Hygiene in Breslin, Germany, it was shown "that a healthy person placed in a closed cabinet could stand, "with no symptoms of illness or discomfort, carbon dioxide as "breathed out by himself, up to the amount of 100 or 150 "parts in 10,000, provided that the temperature and moisture "were kept low. However, when the temperature and mois- "ture were allowed to increase, depression, headache, dizzi- "ness, and a tendency to nausea were experienced. Under "these conditions the normal dissipation of body heat was in- "terfered with. The investigations presented by investigators "is such as to be convincing. It seems to be established be- "yond any reasonable doubt that discomfort is not due to any "change in the chemical composition of the air, but to "physical changes only; and that to maintain a normal heat "interchange between the body and the air is to avoid the "development of those symptoms which are commonly attri- "buted to poor ventilation. A certain amount of fresh air "must be supplied, of course; but *the most vital element of "the ventilation problem becomes that of regulating the tem- "perature of the air.*

"It seems probable that one main cause of the complaint of "poor ventilation in the sleeping car berth is purely psychic. "We are used to sleeping rooms with walls and ceilings very "far from us. In the berth they are very close. Their "very nearness is oppressive. It seems as if there can not be "air enough in this small space to supply our wants. The "sensation is often quite independent of the amount of air "supplied, and even of the temperature. The average carbon "dioxide in the air of running cars rarely shows more than 10 "parts in 10,000. No danger to health is to be apprehended "under the conditions ordinarily obtained, even in steel cars. "*Overheating is the paramount evil; it is the thing chiefly to "be guarded against in the effort to maintain comfort and "hygiene.*"

Too often the report of an investigator or expert fails in its results, due to some lack of consideration or allowance for some outside circumstance or condition, which may have some bearing upon the subject. This is particularly true in railroad work. But Dr. Crowder's report is one which railroad men generally should study and remember. He points out clearly the trouble arising from overheated cars; and while he does not say so, we know it is a trouble which is too common. He asserts and gives figures to prove it, that passenger cars are better ventilated under ordinary conditions than hotels, restaurants, offices, etc. He explains the greatest reason for the too common criticism of the ventilation of sleeping cars.

These are points which probably most railroad men have studied, and have come to similar conclusions. But it is urgent that these points should become more generally known, both by the trainmen and the travelling public, and the figures and comparisons given by Dr. Crowder are valuable, as they make definite comparisons in a manner that can be appreciated by all.

The best method of ventilation was studied and reported upon by the Master Car Builder's Association. Their report practically endorsed the system used by the Pennsylvania Railroad. This system is based on the following conditions: To keep the carbon dioxide in the air down to 6 parts in 10,000, every person would require 3,000 cubic feet of fresh air per hour. Calculating on the maximum seating capacity of the car, this would require all the air in the car to be completely changed every four minutes, which it is claimed the system accomplishes.

The car is arranged with two intake cowls at each end of the car, one on each side of the roof, so located that the two to the rear serve as intakes, and the air is taken in and carried down to the floor of the car in air ducts or passages, and is passed around the radiator or heater pipes which are covered, and out into the body of the car by air ducts situated under the seats. The report very strongly stated that this principle of forcing fresh air into the car, heated, was the best method of ventilation. On the contrary it strongly criticized the principle of exhaust ventilation or ventilation from the deck sash, and heating by exposed radiator pipes along the side of the car. But the general opinion of both the railroad men and the travelling public seems to favor the latter method.

However much the Pennsylvania Railroad method may be admired it could not possibly be adopted for use on transcontinental trains in this country. Zero weather is probably no more frequent in the district in which these cars are operated than 50° below zero is north of Lake Superior or in the mountains. To bring in a large amount of air from outside and raise it some 60 degrees or more, as in zero weather, while it is travelling some fifteen feet or more, is some task. On the rear of some long trains, I understand, it has proven difficult, if not impossible, to maintain the maximum air supply and the temperature of the car from 65° to 70°. At the same time the heating surface in these cars is almost double the amount usually required, even in this country, and due to the rapid air circulation along the radiator, the radiation of heat is much more rapid for the same amount of heating surface than it is with the systems used here. But to try to raise the temperature of the air 120° from the time it entered at the top of the car until it entered on the floor line, would require again double the radiating surface, and a steam consumption that it would not be possible to supply. It is difficult to get sufficient steam to the rear of our long trains to keep the rear cars comfortably warm, but we have always the Baker heaters to fall back upon should the car get too cold. With the steam consumption many times as great and no heater to fall back upon, the Pennsylvania arrangement would be altogether inadequate to our needs.

Exhaust ventilation has been strongly criticized, because it causes air leaks into the car. Reports have stated this to be wrong principle, and that the air pressure in the car should, by means of intake ventilators, be above that of the outside air, and cause all the leakage to be outwards. It has been asked what is the use of trying to make the sash air tight, and then use exhaust ventilators to pull more air in?

There is method in this madness. The strong growing sentiment in favor of exhaust ventilation shown by trainmen, porters, and the travelling public is proof that there is something in it, even if they can not tell you why. Passengers want to see the deck sash open, they are increasingly observant of the ventilation, but they do not want draughts. Now, it is not possible to have the deck sash open without draughts in severe weather, particularly if there is a side wind blowing unless there is exhaust ventilation. Intakes on the floor level must have the air heated before entering the car, but even then the passengers are not satisfied, and they would like to see the deck sash open as well. You may call it sentiment, but to the man the feeling is real and is easiest catered to by having the deck sash open.

Ventilation is, as a rule, most difficult in severe winter weather, as cold draughts are then hardest to avoid. Consider then the ventilation of a sleeping car with the berths made up, first by the ordinary deck sash, by heated air inlets under the seats, and lastly by exhaust ventilation.

Under normal conditions the porter opens alternate deck sash along each side of the car. The heater pipes under the berth heats the air under and in the lower berth too much, and usually a man who objects to a warm room has to open the window slightly to keep the air sufficiently cool. If the car has three sash, as is customary in the north, the small opening in the outer sash may not give as much ventilation as is desired. In the upper berth the outside air blows freely in from the ventilators, and at times the draughts caused are very annoying and severe. If too many of the ventilators are closed to accommodate those in the upper berths, those in the lower berths will frequently suffer from being too warm and the ventilation poor.

With the air inlets on the floor line, the draughts in the upper berths are avoided, but the conditions in the lower berth is only slightly better, as the air comes out to the aisle. The overheating that is apt to occur under the lower berth is apt to be less, but the objection to the closed deck sash can not be avoided.

With exhaust ventilators the porter opens a considerable number of deck sash. No draughts are noticeable anywhere, but there is a steady air circulation from around the sash, etc., from the lower berth and through the curtains, and through the upper berths to the ventilators. There is also an air movement in the aisles, etc. But nowhere should these air inlets be sufficiently large in a well-built car to constitute a draught. The deck sash are open and there are no draughts, but the ventilation is good. Under such circumstances there will be little complaint. Also these are conditions that are not hard to obtain with but slight alteration to cars now in service.

In summer weather entirely different conditions exist. The draughts that were so objectionable in winter weather are essential. Electric fans are put in to stir up the air and to stimulate these draughts. Powerful intake ventilators at the desk sash are even more valuable than electric fans for this purpose, so long as all cinders are kept out. If exhaust ventilators at the deck sash are used at the same time there is too strong a tendency for the air to whip in at the intake and out at the exhaust. Under such conditions it is better to use intake ventilators only, and keep the exhaust ventilators closed. This will cause the air to strike down more into the body of the car, and will assist in preventing a heavy inflow of air with perhaps the accompanying dust and cinders at any window which may be open. The arguments in favor of intake ventilation for summer weather are strong and based on similar reasons as for exhaust ventilation in the winter.

When standing at stations and in train sheds intakes at the floor line with fixed deck sash are deficient. This is important, particularly on sleeping cars, which make only three or four hours run at night and then stand until passengers awake. Any system which depends upon the velocity of the train alone is inadequate to meet such conditions. It is essential at such times, particularly in summer weather that all the deck sash will open to properly ventilate the

This is a point which usually does not receive sufficient attention, as many a headache and a miserable trip on a train is caused by the very badly ventilated and overheated condition of the car before leaving the terminal.

Proper ventilation must be variable to meet conditions. Three chief conditions are: those of summer and hot weather conditions, standing and in train sheds, and lastly, of winter weather conditions. In cold or winter weather the most important point in proper ventilation is the regulation of the heat. Overheating has been responsible for far more discomfort than insufficient air supply. It has been very common, because the means for controlling the heat in the cars was inefficient. This fact Mr. Vaughan brought out very clearly in the discussion following a paper on Car Heating, read by Mr. G. E. Smart, before this club in April, 1908. Mr. Vaughan said in part as follows:

"There is one thing I would like to say to-night to our friends who represent the steam systems. I do not think they have said the last word as to the regulation of steam heat. Steam heat is a peculiar thing; you have very little more heat with twenty pounds of steam than with one pound. It is almost a question of having steam or no steam, and a slight variation makes very little difference in the circulation. It is possible, by throttling the steam, to regulate the circulation in the coil, but there is every chance of freezing it if it is turned off, and left off too long."

To make clear the improvements, which have resulted in a large measure from the attention which was drawn to the regulation of the heat at that time, it will be necessary to briefly review the earlier developments. Passenger car heating may, for convenience, be considered in two classes, those using hot water in the radiator pipes in the car, and those using steam. Hot water heating is principally used on lines in the north, some lines using it almost exclusively on their equipment. Elsewhere it is used on sleeping, dining, parlor, and official cars, and on any equipment where it may be necessary to keep the car warm if cut off from a steam supply. The earliest development was the Baker heater, in which the fire was the only means of heating the water in the pipes and making it move or circulate. This was early supplemented by using a steam jacket in addition to the stove, so that steam could be used to heat the water, or fire, as desired. One system was introduced by which the steam actually entered the water to heat it, but due to various causes the system lost favor and is gradually dropping out of service. But in by far the greater number of hot water heated cars the steam does not enter the water at all, but heats it by means of a steam jacket or sleeve of various construction.

Steam jackets have to be made with sufficient heating surface to keep a car comfortably warm in the coldest weather with not more than 15 lbs. steam pressure, as this is as much steam as could be expected to be obtained on the rear of a ten or twelve car train in weather 20° and 30° below zero. Such weather, as you know, is not extreme, and lower temperatures are not unusual. Steam pressure lower than from two to five pounds pressure are not, with systems using steam jackets, sufficient to cause the water in the radiator pipes to move or circulate. The importance of this latter point is not generally clearly understood, so much so that one company manufacturing hot water heating equipment actually supplied a system in which it was proposed to heat and make the water circulate by vapor. An explanation of the causes of circulation will make clearer the chief difficulty in the heat regulation.

Hot water heating, as applied to passenger cars, is usually arranged with the pipes along the sides of the car, just above the floor, with the stove and the heating point above the level of the radiator pipes. The hot water has therefore to go down to the radiating pipes and the cool water must rise to be heated, which is the opposite of what we would expect. Let us consider the conditions as they actually exist. Assuming that the lowest heating point is two feet from the floor and that above the heater coil or steam jacket, there is a return bend with a back outlet, the pipe to the expansion drum on the roof connected to the back of the bend and the downflow pipe to heater pipes in the car on the opposite side. The situation in service might be considered as this: 2 feet of water at 80°, 6 feet of water at 212°, balancing 8 feet of water at 210°; the 2 feet of water at 80° being the water returning to the heater to be reheated; the water at 212° the water in and above the steam jacket, and the water at 210° the water which is going out to heat the car. From these figures it will be seen that the average temperature of the water in the riser pipe is less than that of the water in the downflow pipe and the circulation would tend to reverse, which, as a matter of fact, under such conditions it does. But the difference in the weight of the two columns is so small, about 23 grains or one-twentieth of an ounce, that the backward movement is very small. The water in the coil, however, gets hotter and hotter and finally boils. When boiling commences steam will form very rapidly, due to the comparatively large heating surface of the steam jacket or coil and the relatively small volume of water. The steam bubbles which form exert an equal force in each direction, but the inertia of the column of water from the coil or steam jacket to the expansion drum, approximately 8 feet long, is much less than that of the column downward from the coil and through the pipes in the car and downflow pipe to the expansion drum, 250 feet or more in length. The water in the riser pipe is therefore easiest to move, and the steam bubbles which form displace an amount of water equal to their volume from the riser pipe into the expansion drum. The water in the riser pipe, now a mixture of steam and water, is lighter than the column of water in the downflow pipe; the difference in the weight of the two columns might be estimated at 1½ pounds, although this will vary considerably. It is this force which sets the water in the radiator pipes in motion, and the motion will continue with lessening force until the steam bubbles have all escaped into the expansion drum, the water from the drum falling back into the circulation as required to replace the steam bubbles escaping. This movement of the water in the circulating pipes frequently becomes continuous when the return water comes back warm enough and the heat applied is great enough to cause a continuous formation of steam bubbles in the riser pipe.

It is evident that if steam must form in the riser pipe, the steam supplied must be slightly higher in temperature. But if there is any pressure upon the system due to the expansion of the water after the heater was filled or air pressure on the water, the boiling point of the water will be raised and the steam supplied will have to be hotter to cause circulation. The minimum steam pressure that will cause the water to circulate is usually from two to five pounds. The maximum steam pressure required at any time should not exceed fifteen pounds. Notwithstanding this, many absurd claims have been put forward by the various companies supplying the equipment for Pressure Reducing Valves or "Temperature Regulators," the following being a very good example: "This immensely valuable addition xxx completely solves the problem of temperature regulation. It is an automatic attachment which will positively maintain the required heat in every car, neither too much nor too little, but the exact amount necessary to warrant the greatest comfort." How unreliable such claims have proven we all are aware. These pressure regulators are practically useless for the purpose for which they were installed. Their normal position has been wide open and the regulation done by the angle valve. They are not worth spending money upon in repairs, and when defective or leaking might better be removed and a piece of pipe put in instead.

Realizing at last that the necessary control could not be obtained in this manner, the multiple or split system was introduced, as outlined in Mr. Smart's paper. This arrangement consisted of two separate heating systems in the one car, each system having two pipes on each side of the car, and so arranged that one system could be shut off entirely and the heating surface in the car reduced one half. This was a very considerable advance in the control of the heating systems. This arrangement, however, had two steam inlet valves and two steam traps. To further simplify the arrangement this arrangement has been altered to one steam inlet valve and one steam trap. When it is desired to reduce the heat in the car a valve at the outlet of one of the steam jackets is closed, and the condensation collecting fills the steam portion of the jacket, preventing the entry of the steam. Reopening the valve, the water will escape by gravity and pass out at the steam trap. This arrangement prevents the possibility of one of the traps freezing if the steam valve leaked slightly when shut off, as occasionally occurred with the former arrangement.

This idea of heat regulation was carried even further by the use of two systems, each with two steam jackets, by which the two systems could be operated with all jackets working, or any desired number less. This arrangement accomplished a very considerable advance, but it required the location usually of two of the steam jackets under the car and two inside with a corresponding increase in the number of steam traps, steam inlet and blow-off valves, and the additional trouble necessary to maintain the equipment and increased difficulty of operation.

The regulation of the heat by altering the steam pressure supplied had proven a failure. The use of separate systems in the car operated independently, was a considerable gain; the further increase in the control, of being able to shut off one of the steam jackets on each system without shutting them entirely off, was even better. But for many reasons the application of either of these arrangements to old equipment meant the remodelling of the piping, and in some cases the change of the heater equipment in the cars.

However, a much more simple and effective arrangement was designed. It was recognized that the best means of controlling the temperature of the car was by varying the heating surface exposed to the steam. This can be easily done by allowing the water of condensation to collect in steam jackets to different predetermined levels. In cars already equipped this can be accomplished by connecting the stand pipe or controller in the pipe carrying off the condensation from the steam jackets, and by connecting the top of the steam jacket or jackets to the top of the controller, so that the steam pressure in each will be the same. If the water is allowed to accumulate in the stand pipe to any of certain overflow levels, it will assume approximately the same levels in the steam jackets or steam coils, proportionately varying the surface exposed to the steam. In the case of new cars the arrangement is the best, on account of its simplicity and its wide and positive range of control. Should any failure of the controller occur, and it fail to adequately hold the condensation, the conditions would be no worse than formerly, if the car was too hot and required regulation the angle valve would have to be used in the old way.

Freezing of the drip has always been a bugbear with the hot water systems, but as it is possible to shut off the heat from the steam jacket by allowing the condensation to collect, which it does very rapidly, this system has been arranged so that the heat can be shut entirely off in the car without shutting off the steam from the drip, which means practically the entire prevention of frozen drips.

The "Controller," as the valve operating the water levels has been called, has usually four adjustments marked, "Full On," "¾," "½," and "¼." When it is desired to shut the heater off entirely it is done by the angle valve in the old way, but this does not shut off steam from the drip. The efficiency of the regulation has been most satisfactory. It has made it possible on a mild night in the winter, that even a lower berth at the heater end can be kept comfortable without overheating, no matter what steam pressure supplied, and also no worry of a frozen drip or water pipes in the morning.

While very considerable improvement has been made in the control of the heat, several other improvements have been made in the hot water systems worthy of consideration.

In one heating system a so-called "Accelerator" fitting has been used, presumably to accelerate the circulation. This device was evidently designed on a misconception of the cause of circulation, the argument used is equivalent to a man lifting himself by his boot straps. The fitting consists of a casting into which the riser pipe is screwed, and a jet or nozzle forming practically a contracted continuation of the riser pipe, is turned over and pointed down the downflow pipe. The connection to the expansion drum is made from around and behind this nozzle. Water we know is practically incompressible; steam under pressure exerts an equal force in all directions. When steam forms in the riser pipe, water must be displaced out of the heater pipes as rapidly as the steam forms. The only place the water can go is into the expansion drum, but the more contracted the opening from the riser pipe to the expansion drum the more apt is the steam to force back on the water in the pipes in the car and up the downflow pipe to the expansion drum. A return bend with a back outlet because of its freer connections is much to be preferred as an accelerator fitting.

Extra heavy lap welded pipe and grey cast iron bends, ells and tees, with malleable or wrought iron couplings are best for the heater pipes. Extra heavy butt welded pipe is too apt to open on the seam in bending, and the use of the lap welded pipe will always save a considerable percentage of new work having to be stripped down after testing with the usual annoying delays. When a car happens to freeze up with the water in the pipes, the butt welded pipes will open at the seams, but with the lap welded pipes the bends and tees will fail and comparatively little of the pipe will be damaged. Grey iron fittings also provide means for getting the water out of the pipes in the car if the crossover pipes are frozen, or if for any other reason the car cannot be drained in the usual way. A hammer will break the cast iron fittings easily and the water can be got out in this way.

Lagging the expansion drums is also unnecessary. Steam is formed in the process of moving or circulating the water. If that steam does not condense, pressure will build up in the expansion drum, raising thereby the boiling point of the water and slowing the circulation by increasing the time required to bring the water up to the boiling point. The increased pressure also adds to the liability of loss of water through leakage. The tin jacket or cover, to prevent cinders lodged around the drum or entering the car through the holes around the pipes, is all that is required.

In piping a car it is always wise to have the warm water pass directly to the top and circulate downward through the coil, particularly if it is a high coil, as in baggage or mail cars, etc., as it affords some small aid to circulation. But in sleeping cars and coaches the advantage to be gained is so small that it need not be considered. If the water passes upward through a coil twelve inches high and then straight down, the water in the downflow pipe must in every case be colder than that in the riser pipe, and an aid to circulation. In some recently built cars the piping arrangement has been spoiled for just such foolish reasons. The piping of all double circulation systems should have the hot water of the one system run direct to the crossover pipe, and the other go to the opposite corner of the car to balance the heat of the two systems as far as possible.

The proper washing out, filling or draining of hot water systems has always been a trouble; various devices have been gotten up to overcome the troubles experienced. To afford an easier and simpler means Mr. Dunn, Foreman Steamfitter at Winnipeg Car Shops, devised a very simple and efficient fitting for overcoming all trouble experienced in this connection. It consisted of a "cross" fitting used as an elbow on the crossover pipe. In service the two extra connections were plugged. To wash out, fill or blow out, a brass brush was inserted in one opening in such a manner as to divide the cross into practically two ells, thus overcoming all the trouble of the steam or water going both ways at once. A somewhat similar arrangement has been designed for use in cars with crossovers above the floor accomplishing the same results.

Filling heaters on cars in trains has always been a slow job, and at a time when minutes count. Filling valves with plug cocks or rotary metal faces to make a joint are too unreliable, cut and leak too readily, and require to go to a shop for repairs. A new funnel cock, threaded 1¼ pipe size, has been designed, using a 1" globe valve composition seat. The funnel serves also as the handle. When the funnel stands in position for filling the valve is open. Just before the funnel reaches a vertically downward position the valve is closed, with the pressure in the expansion drum and the weight of the funnel both helping to keep the valve closed. This prevents the chance of the water hose dragged along the roof of the car pulling the handle of the funnel cock open, and affords an easy means of knowing whether the valve is open or closed. It is simple, the seat can be renewed in a few minutes, and it is showing considerable improvement over the older valves.

Safety valves are also important. There are all kinds of them. It is not necessary that a safety valve for a car heater should be delicate and pop closely to a given figure; but it is essential that it should be rugged and seat tight, and it is better if the adjustment can not easily be altered. Rubber ball safety valves are too uncertain and too liable to failure. Diaphragm valves are more expensive than is necessary, and also they are more apt to leak. A very simple valve is one with a cap covering the spring and valve, with the adjustment made by a pointed set screw bearing on the centre of the cap inside, the pressure transferred to the spring by a nut on the adjusting screw. The valve is giving very much better results than the other valves used formerly.

Steam hose failures are an expensive item of maintenance. Not long ago some of the companies supplying steam hose couplings flattened the angle of the hose nipple, making it more in line with the body of the coupling itself. This made the coupling less apt to open, as the slack of the train pulled out and the sharp bend of the hose beyond the coupling helped to keep the coupling locked, but resulted, as investigation showed, in destroying a number of hose from a bad kink just above the upper end of the nipple. If the angle of the nipple only is changed, the couplings drop closer to the track; it is necessary to shorten the length of the coupler head, as well to make them hang the same height as formerly.

Some companies operating in the North West have asked for heaters with very considerably increased capacity of coils and larger bodies, to improve the heating efficiency of the heater when using fire. This will, undoubtedly, meet more readily the needs of very severe weather, but it will make overheating more difficult to avoid in mild weather. Complaints of cold cars are too frequently blamed to the heaters without sufficient investigation. If the heater pipes are hot and the car has sufficient piping, storm sash, some repairs to the car or similar remedy is required. If the heater pipes are not warm it is the heater all right. But many cars have been sent in to shops because they could not be kept warm, have been overhauled and sent back with the report that there was nothing wrong. After perhaps a week or ten days the trouble commences again. The reason is simple. Good dry ash is a splendid insulator. Ashes lodged between the coils of the pipe and between the pipe and the heater shell reduce the effective heating surface 50° or more. Al[illegible] if the fire is allowed to build up from the grate on ashes, [illegible] of the heating surface of the coil is lost. It is imperative [illegible] mixed trains, or where heaters are used regularly, that the fires are dumped occasionally and the heater thoroughly cleaned out. With poor coal it is even more important. Every heater man in a coach yard is well aware of this, as trainmen are not always sufficiently particular to keep heater properly shaken down and ashes cleaned out. Larger heaters and heater coils should be avoided, if possible, but where they are really needed there should be no hesitation in having them applied.

The gravity check applied to the steam hose coupling has proven a considerable advantage in getting steam through a train by assisting to get rid of the condensation without having to blow it all out at the rear. It is a safety device to enable the car or yardman to know whether there is pressure on, or to get rid of the hot water in the hose before uncoupling, and prevent the danger of being scalded. It is an assistance against the danger of freezing up if water lodges in the hose when steam is cut off.

Valuable as the gravity trap is on steam hose, as an auxiliary to an automatic steam trap, it is unnecessary and another chance for leakage under the car. It is better removed and the hole plugged, using the gravity trap for replacement in steam hose as required.

Having considered the causes contributing to overheating in hot water heating systems, the same arguments apply as strongly to regulation of steam systems by the pressure of the steam. It is not possible to get sufficient regulation by varying the pressure of steam in the radiating pipes. It, therefore, becomes necessary to supply so little steam that the steam will not get as far as the outlet. To do this a thermostatic valve has been used at the vent to shut off the steam entering the pipe, as soon as the temperature at the outlet reaches nearly the boiling point. This allows practically two adjustments only—pressure and vapor.

Realizing the difficulty of adjusting the heat, dry or direct steam systems are usually arranged with an independent system on each side of the car, allowing one side to be shut off at a time, reducing the heat in the car by one-half; but an uneven and bad distribution of the heat results. Another trouble has been that the trap of the system closed off has frozen from either water working out of the trap, due to the poor drainage after steam was shut off or due to the leakage of the steam inlet valve. Going a step further some of the companies have introduced two, three, four, and even more separate systems on each car, effecting a great improvement in the control of the heat, but very much increasing the cost of the installation and maintenance, and increasing the difficulties of operation and steam consumption. Electric control is also being tried, as it has been before, perhaps this time with better success, but such arrangement should be avoided if it is possible to accomplish the necessary results without.

The trouble with the proper regulation of a steam heated coil is this. The maximum heat required should be obtained with not more than 10 pounds pressure, or an average temperature of the pipes from 220° to 230°. If steam only is blown into the pipes and the steam reaches the outlet, even at atmospheric pressure, the temperature of the steam must be at least 212°. If the steam supply is further reduced until it is all condensed before reaching the outlet, a peculiar condition results. At atmospheric pressure, one cubic foot of steam may be said roughly to condense into a cubic inch of water. Therefore, while the velocity of the steam entering the pipes might be considerable, the steam in the other end of the pipe will exist only as water with a dead column of air above it, which would enter from a drip as soon as the rate of condensation exceeded that of the steam supply. The condensation lying in the pipe and accumulating so slowly would cool off completely, and were the outer end exposed outside in severe weather, as under a car, it would be possible to freeze the drip with the steam turned on. As far as the steam travels in the pipe the temperature of the pipe will be high, but may drop very rapidly beyond that point. This practically makes it necessary to bring the steam almost to the drip sufficiently to maintain the drip at a temperature which will prevent any danger of it freezing. This is practically as much as any vapor system has yet been able to accomplish, and it is evident that under such conditions the range of the heat regulation can not be sufficient to properly meet service conditions.

To overcome this trouble an entirely new arrangement was designed and put into service. A jet of air and steam was blown into the pipe, the air acting as a medium or vehicle to carry the steam, or condensed steam in suspension, and to prevent the water of condensation lodging in the pipe and cooling off. The proportions of air and steam were made variable from a small jet of steam and a considerable volume of air, to a heavy volume of steam and no air. To get the full value from the steam before reaching the outlet all the piping was made continuous, requiring the steam, or steam and air, to travel upwards of four times the distance usually necessary in vapor systems. By this method it is possible to carry a heat in the pipes in the car so mild that it is possible to bear the hand on three of the four pipes, and even the fourth pipe is not up to the usual steam temperature. To look at the drip it would have all the appearance of damp steam escaping, but it would feel just slightly above the temperature of the car, scarcely blood heat of the hand were held in it. There is also better provision made for drainage of the pipes when the steam is shut off, and a provision against a frozen drip should the steam inlet valve leak when shut off. The system costs little more than the ordinary direct steam arrangement and the valves are located in the same positions as formerly.

The paper is long enough to require an apology. Perhaps an apology is due that the improvements or similar improvements were not introduced earlier. Railway cars have not been always as well heated as they should have been; the tendency to be too generous with the heat in mild weather, and with cold draughts of fresh air will always have to be watched against. It is necessary that all concerned should give this matter their attention while travelling on trains; it is due both the companies and the public. Discussion of the conditions and the improvements come now at an opportune time. In the North, where our range of temperature is greatest—particularly downward—we should lead in such matters. This is a subject which all those who travel on trains are able to criticize, and whose views are welcome. I hope the length of the paper will not prevent a free expression of opinion, and criticism of any points of difference.