ACTION OF STEAM

In steam, as in other gases, there is a natural repulsion between the various particles, each particle trying to separate itself from the others so that it will fill the receptacle in which it is confined. Its natural tendency is to expand and thus push out whatever is resisting it. If the steam is enclosed and superheated, the natural tendency of its particles to separate is intensified and we thus obtain increased work from a given weight than is possible with saturated steam.

If we should take an open kettle filled with water setting on a fire, and allow all the water to be evaporated without creating any pressure, there would be little or no noise created during the time the steam was passing to the atmosphere. However, if a small opening was provided so that the steam would be generated faster than it could escape from the kettle a pressure of steam would be accumulated inside the kettle which would cause a considerable noise as it was passing out through the restricted opening. Increasing the pressure would increase the noise made by the flowing steam and decreasing the pressure would decrease the noise in proportion. Therefore the sound created by the exhausting of steam into the atmosphere is due more to the pressure of the steam than to its volume.

It can be seen from this that when the exhausts at the smoke stack of a locomotive are loud and heavy, that steam under a heavy pressure is being passed through the nozzle tip. We know that steam under a heavy pressure has power to do considerable work, and unless it is permitted to escape from the cylinder after it has done its work, it will resist the return movement of the piston by offering what might be termed back pressure, or a pressure in the cylinder on the exhaust side of the piston, which prevents the live steam on the opposite side from freely moving the piston throughout its stroke.

When the exhausts from the nozzle are sharp and there is an interval between the exhausts when no sound is produced, it is evident that the pressure in the exhaust side of the cylinder is very low. On the other hand, if the steam is being discharged at the nozzle tip so rapidly and in such quantities that the exhausts are very loud and there is no interval which will enable the exhausts to be readily distinguished, the steam which is being exhausted is still capable of doing considerably more work through its expansive power and also there remains in the cylinder a considerable pressure which is tending to obstruct the return movement of the piston. Such a condition is brought about by so working the engine that the steam from the boiler is allowed to follow the piston almost its entire stroke, until the speed has been increased to such an extent that the flow of steam through the exhaust channels in the saddles to the nozzle tip is practically continuous. Under these conditions the live steam from the boiler is retarded in its work of moving the piston by the pressure thus maintained on the exhaust side of the piston. This reduces the power that it is possible for the engine to develop and the speed that it might attain.

Shortening the cut-off, by moving the reverse lever toward the center allows the boiler pressure to follow the piston through only

a portion of its stroke and permits the steam to complete the piston's movement under its expansive power, at the same time causing its pressure to be reduced by the time the valve opens the exhaust port, when a further reduction in pressure takes place. The results then would be the same as carrying an increased boiler pressure, because the pressure on the exhaust side of the piston would be considerably reduced, giving more power to the live steam on the opposite side of the piston, permitting it to force the piston more freely throughout its stroke. It would be possible to distinguish each exhaust as it occurred, by providing an interval during which there was little or no pressure remaining in the cylinder, and it would be possible to obtain greater power and speed with the same amount of steam or maintain the same power and speed with a greatly reduced expenditure of coal and water.

The natural tendency is for steam under pressure to expand or push out in all directions. If, therefore, steam is admitted to a locomotive cylinder at 100 pounds pressure and is caused to follow the piston at this pressure for its full stroke, the average cylinder pressure would be 100 pounds.

If steam at 150 pounds pressure is admitted to the cylinder and allowed to follow the piston at this pressure for only a short distance, and is then cut off by the valve closing the steam port, the confined steam in the cylinder will continue to push on the piston after the supply from the boiler is cut off. In this case the withdrawal of steam from the boiler only lasts until the valve closes the admission port, after which the steam begins to expand.

If the steam, which was admitted at 150 pounds pressure for only a portion of the stroke, had reduced to 50 pounds pressure when the valve opened the exhaust port after the steam had completed the movement of the piston, then the average pressure would be 100 pounds as in the former case. A smaller volume of steam at a higher pressure would have therefore given the same average cylinder pressure, and the pressure being lower when the exhaust took place would insure a lower pressure on the exhaust side of the piston during its return stroke.