come the extra resistance caused by the spark-arresting appliance. The railway companies I have mentioned prefer to take the risk—that risk being so infinitesimal with hard coal—and save the fuel rather than have this extra resistance. At one time on the New Zealand railways, a good many years ago, the same practice was followed with hard coal. We had no special spark-arrester when burning hard coal, Newcastle or Brunner; but it was ultimately decided that, as a matter of extra precaution, this diaphragm-plate should be adopted; and, after many modifications as to the size of holes in plates, we have now used this standard pattern for a number of years. This pattern, I may say, was in use before any of these fire-claims were made.

102. Are all your engines on the same principle?—Yes, all that burn hard coal. I might, for your information, Sir, show the difference in burning lignite coals. The firebox arrangement is the same in both, the firebrick arch and the deflector being identical. When burning lignite we use a special funnel with a deflector-plate in it instead of this diaphragm, which has been found by experience to be not adapted to burning lignite, as it gets choked. This deflector is placed near the top of the funnel, and all the sparks by virtue of their velocity have to strike there. There they are broken up by impact and fall back into a space prepared for them. They are again shot up and again broken up, and the result is that they are ground into an almost floury state, and escape in the form of dust in the current of smoke and gas. We contend that, with this arrangement in efficient working-order, all the larger particles are broken up and the danger from fire is reduced to the lowest possible minimum. This does not apply to the Canterbury fires at all, because there we were burning hard coal.

103. You consume only hard coal in Canterbury?—Yes; and therefore this lignite arrangement does not apply except in Southland and Otago.

104. Is lignite used in any other part of Otago?—It is used only in Southland and Otago. For the use of the lignites we have our engines specially fitted with the apparatus as described, this being the outcome of many years' experience, and it has been brought now to as fine a point as we are able to bring it in the meantime. We are satisfied it is the most efficient form of spark-arrester known up to the present time. In the smoke-box of the lignite-burning engines we have an arrangement of petticoat pipes which largely assists in the safe combustion of lignite coal.

105. Is that used in all the engines?—Yes, in all engines burning lignite. I might also point out that our smoke-boxes are made as I will show you on an engine. They are much longer than is the case in the English practice. We follow the American practice in that respect. The American practice is to give more space for the ashes and cinders that may come through the tubes, so that they lie, as it were, in a dead corner out of the eddy of the draught. These particles of unconsumed fuel shoot right against the inside of the door, and their tendency is to fall down out of the way of the eddy, and, as a matter of fact, we find ashes where the eddy of the draught has swept past and left them. I might say that the question of the most efficient method of spark-arresting has been investigated by scientists and railway men for many years, and up to the present time it is in a tentative state. The difficulty is this: that if you are to allow the smoke—the products of combustion—to pass out freely—and that they must pass out comparatively freely is essential in order that there may be sufficient draft for the fire—it presupposes that you must allow an exit, even if somewhat restricted, for some comparatively small dust with the products of combustion. The most effective spark-arrester of all is, of course, a solid piece of plate on the top of the funnel, but at the same time it is an absolute bar to the use of the engine. If you make one hole or a thousand holes in that plate on the top of the funnel to let out the gases you at the same time make a certain amount of opening for the small particles of dust and unconsumed fuel. The only thing I want to point out is that the most efficient methods have been adopted, so far as known, and the perforated plate I will put in will show that only very small particles can get out. I claim that the small particles that might get out, even although in an incandescent state when ejected, do not necessarily remain hot, because in passing through the air all the body is out of them, and in travelling a short distance the last vestige of heat disappears, usually long before they reach the ground. I might put in for your consideration, Sir, an extract from a recent number of the *Scientific American Supplement*, 2nd December, 1899. It bears on the subject, and is, I think, of interest. It is as follows:—

Investigations made at Purdue University, in Indiana, do not bear out the current belief that locomotive sparks are the cause of the greater number of the forest fires. In the Indiana experiments a series of large pans were placed at a distance of 15 ft., 25 ft., 50 ft., 75 ft., 125 ft., 175 ft., 275 ft., and 375 ft. from a railroad at a point where there was a heavy grade and where many freight-trains passed daily. Each pan was covered with soft cotton cloth, so that if live cinders reached them the fact would be known by scorched or burnt places in the cloth. When the experiments were concluded it was found that the greatest number of sparks or cinders had fallen in the pans 50 ft. and 75 ft. from the track. The largest cinder did not equal the size of a white bean, while in no instance was the cloth in the pans even scorched. The inference was that, if the cinders were hot when they left the smoke-stacks, they had lost their heat in travelling the 50 ft. or 75 ft. This would indicate that fires communicated from locomotives are rare.

I might say that this experiment was made at a point where there was a heavy grade, and, of course, that means that the engines would be belching forth their smoke and steam at the maximum rate. Of course, the cases of fire we have had under consideration were not at heavy grades, and therefore there was much less liability. I would also point out that a spark or unconsumed particle the size of a white bean would not go through the perforated plate we use. In the last number of an American technical paper there is a leading article on "Draft Appliances and Extended Smoke-boxes," as follows:—

The development of the different parts of the locomotive from the most primitive form to the shapes and dimensions that are the most simple, durable, efficient, and hence the proper forms of use, presents remarkably interesting subjects of study. None of these divisions of locomotive development presents more curious phases of study than that of locomotive draft appliances. In a paper by the well-known engineering expert, Mr. Snowden Bell, presented to the Western Railway Club, on "Locomotive Front Ends," an excellent history is given of the principal appliances used for draft-inducing and spark-arresting purposes. Unfortunately there is a natural conflict between