

served four years later, viz., in 1843 for the conduct of a traffic of greater volume, the diminution in the meantime being steadily progressive from year to year.

The application of expansive working by mechanism actuating the slide valve, coupled with the use of steam at higher pressures, was initiated as regards the locomotive by the late Mr. John Gray, in the year 1838, and first fitted by him to an engine called the "Cyclops."

This somewhat complicated and cumbrous apparatus was afterwards superseded by the "link motion," a simple and beautiful piece of mechanism, which, as is well known, has been brought into almost universal use. It was the invention of Mr. William Howe, an intelligent mechanic in the employ of Messrs. Robert Stephenson and Co., of Newcastle, and was adopted for the first time in their works in August, 1842.

The idea appears to have been suggested simply with the object of easier reversing, an improvement on the older arrangement of the "double gab," under which the forked or "gab" ends of the two eccentric rods, actuated by their respective eccentrics were connected by a short link, and thus lifted or lowered simultaneously the one into, the other out of, gear, according as it might be required to drive the engine forwards or backwards. This motion involved the stoppage and sudden starting again of the slide valve whenever the operation had to be performed, an operation attended with considerable shock and risk of derangement or fracture when performed whilst the engine was in rapid motion.

For the simple link, Howe substituted a slotted one, with a block sliding in it, carrying a pin to actuate the valve-rod, and adjustable within any given position within the link by the lever under control of the driver, so as to impart to the valve, without arresting its action, the special motions necessary for reversing and cutting off steam.

This invention, if it had been patented, would doubtless have proved a most lucrative one; but the inventor did not possess the means to secure the patent right, nor does it appear that its prospective value was, in the first instance, duly and fully appreciated by him.

Combined with the high pressures of steam now used, 140 to 180 lbs. per square inch, the link motion has contributed greatly to economising of fuel in the locomotive.

Certain substitutes for the control of valve motion by the link gear have been in some cases, and with advantage, adopted both in locomotive and marine engines. They possess the merit of