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Rotary Snow Plows, Their History, Construction, Etc.

By H. H. Vaughan, M. Can. Soc. C. E., Assistant to Vice President, Canadian Pacific Ry.

The development of the rotary snow plow has been chiefly due to Canadians and Canadian railways. This might be invidiously explained by the amount of snow which is supposed to fall in Canada, although as a matter of fact the difficulties experienced in dealing with snow are just as great on most of the roads crossing the Rocky and Cascade Mountains in the United States as they are on those in Canada.

In both countries the rotary snow plow has been extensively used during the past 20 years, and it has proved so far to be the only effective appliance for dealing with deep drifts and snow slides that were beyond the capacity of the wedge or ordinary snow plough. The latter is still used extensively, and for drifts of moderate depth through which a reasonable speed can be maintained, it can be operated much more quickly than the rotary. When cuts are too deep, snow cannot be thrown out of them with a wedge plow, and in the case of slides the drift may contain rocks or trees, which would make the use of it exceedingly dangerous. The rotary plow can then be used to save the labor of shovelling out by hand, which would be the only resource, on account of its ability to encounter snow of any depth and throw it to a considerable distance on either side of the track.

The rotary snow plow was originally invented by J. W. Elliott, a Toronto dentist, who in 1869 took out a patent on a "compound revolving snow shovel." This invention employed a wheel having a number of flat arms supported on a shaft rotating in line with the track. The wheel was enclosed in a casing shaped at the forward end to collect the snow, and flaring backward to a cylindrical portion surrounding the wheel. This casing was open at the top to permit the snow being thrown out by the centrifugal force. The wheel was driven by a rotary engine, and while the design was obviously crude, it evidently included the principle elements of the modern plow. No practical use was, however, made of this invention, but the idea was later taken up by Jull, who improved the Elliott wheel by placing a knife or cutting wheel in front of it. This knife wheel was intended to cut the snow from the bank and pass it into the fan wheel behind it, by which it could be discharged through the top of the casing.

The Jull invention was taken up by Leslie Bros., of Orangeville, Ont., who proceeded to construct a full size working model. The fan wheel was mounted on a hollow shaft, the knife wheel being carried on a solid shaft which passed through it. Both shafts were reolved in opposite directions through a system of bevel gears driven by a two cylinder engine. This model was erected on the end of a flat car during the winter of 1883-84 at the C.P.R. shops at Parkdale, Toronto, but before its construction was completed the winter was practically over. In order to test the invention, a bank of snow and ice was shovelled into a cut through which the C.P.R. tracks ran between Queens Wharf and Parkdale. The quantity available was limited, but it was clearly demonstrated that the Elliott principle of a revolving wheel could throw the snow clear of the tracks as both snow and ice were thrown over 200 ft. This preliminary trial also showed that it was necessary for the plow to be so constructed that snow could be thrown on either side of the track, and that a flanger was required to prevent the plow being derailed in hard snow or ice and leave a satisfactory rail after it has passed through. With the Jull knife the direction in which the snow was thrown could not be changed, as the wheel could only operate in one direction, and the opening in the top of the casing was fixed in position. Leslie Bros. then developed a wheel with reversible knife or cutters, which could be changed in position to enable them to cut in either direction, and a movable hood on the cylindrical portion of the casing through which the snow could be discharged on either side of the track. They also devised a suitable flanger or ice cutter, which was attached to the front truck of the plow. A full sized complete plow of this design was constructed for them by the Cook Locomotive Works, of Patterson, N.J., and was operated on the Chicago and North Western Ry. in Northern Iowa in 1885-86. It was then found that the principle of employing two wheels revolving in opposite directions was impracticable, as the friction caused by the snow passing between the two wheels absorbed more power than that actually required to cut away and throw the snow. It consequently had to be abandoned, but Leslie Bros. then devised a single wheel having knives or cutters directly attached to it, which automatically reversed in position according to the direction in which the wheel revolved. The plow with this wheel applied (shown in fig. 1) was tested during the same winter, before the snow had entirely disappeared, and proved that the loss of power was overcome. It was then shipped back to Patterson and rebuilt with the improvements that had been suggested by the season's experience. During the winter 1886-87, the improved plow, then known as the rotary, was given its first trial on the Oregon Short Line Division of the Union Pacific, where it proved such a complete success that the railway company not only purchased it after its first trip, but placed orders for three more of the same pattern to be furnished in time for the following winter. The introduction of the rotary progressed rapidly from that date. It was adopted by the Northern Pacific; Chicago and North Western; Chicago, Milwaukee and St. Paul, and many other roads in the United States, while in Canada eight were constructed by the C.P.R. in 1888 at its Montreal shops through the Polson Iron Works Co. of Toronto. The first of these plows, no. 101, had a wheel 9 ft. 10½ ins. in diameter, a boiler having 1,259 sq. ft. of heating surface carrying 180 lbs. pressure, and a two cylinder engine 17 ins. diameter by 24 in. stroke. The cab was of wood, and the plow without tender weighed 125,000 lbs. in working order. The main shaft was 8½ ins. diameter and the bearing 34 ins. long. The bevel gear on the main shaft was driven by a bevel pinion keyed to the cross shaft of the engine. The joint between the casting and the one supporting the engine shaft bearings proved to be a point of weakness on account of the heavy bending strain to which it was subjected when the lower portion of the casing was forced into hard snow. The side frame was a heavy 12 in. channel running from end to end. It was tied together by the main bearing casting and engine shaft casting at the front end and from the latter two inner frames extended to the back end. These supported the cylinder saddle and the boiler carriers, and were connected to the side frames by gusset plates. The structure was fairly strong longitudinally, but as later experience proved it did not possess the necessary vertical strength for the work it was subjected to.

The wheel with which these plows were fitted was known as the square fan type, and is illustrated in figure 2. The back was a sheet of steel plate to which longitudinal gusset plates or partitions were attached, which in their turn supported the front rings and the trunnions for the knives or cutters. The action of these knives can be clearly seen from the illustration. In whichever direction the plow was turning the resistance of the snow would tend to force the knives into a position in which they would cut the snow and deliver it into the compartments. Then, on account of the centrifugal force due to the revolving wheel, it would be forced against the casing until the opening was reached, when it would fly out in a straight line. This wheel proved satisfactory when handling the dry snow found east of the Rockies, but in heavy work the partitions were not sufficiently strong to drive the knives. As the men on the plows put it—"The back ran away from the front." To overcome this and handle the damp snow found on the western slopes, Leslie Bros. introduced the scoop wheel shown in fig. 3. In this wheel the pockets or compartments are conical shaped scoops strongly secured to a cast iron or cast steel centre. The knives are carried on the edges of the scoops, and the knives on the adjacent edges of each pair of scoops are connected together by links so that as one knife is cutting the snow, the other is pressed down to afford the necessary clearances. This style of wheel entirely superseded the older square fan type and has since been used.

The construction of the plow as a whole has not changed radically, with the exception of the special plows which will be described later. The wheel has been increased in diameter, 11 ft. being now the usual size. The engine and boiler capacity have been increased, the engine to 18 ins. diameter by 26 ins. stroke, the boiler to 200 lbs. pressure, with 1,852 sq. ft. heating surface. The bevel gear drive was changed to employ two bevel pinions with independent engine shafts, the bevel gears and pinions being made of steel with cut teeth in place of the cast iron gears originally used. The knives, which were originally made of steel plates, were greatly