Ralph Wolfe, in a paper before the Car Foremen's Association on the care and maintenance of air brakes, said: "In order to get the proper operation of the brakes there are many factors to be taken into consideration: 1. The efficiency of the pump and what it costs to pump against leakage on big trains. 2. The brake pipe leakage and if the rate of reduction is sufficient to cause undesired quick action of the triples. 3. The length of piston travel in order to get the proper brake cylinder pressure on a given brakepipe reduction, which will have the proper retarding effects on each car. 4. The results obtained due to unequal distribution of braking power, throughout the train. While the question of leakage is the most important of all, with an 80-car train of 10 in. equipment we have a volume of 275,200 cu. in. If the conditions were such that we had a 12 lb. brake pipe leakage a minute, we would be losing 130 cu. ft. of free air a minute, which would be equivalent to the efficiency of the 8½ in. cross compound pump. If the leakage was 6 lb. a minute, we would be losing 65.5 cu. ft. of free air a minute, which would be equivalent to the efficiency of the 11 in. pump. It is estimated that the 11 in. pump consumes 200 lb. of coal an hour. This would require 4,800 lb. of coal to operate the pump 24 hours. Estimating the price of coal at $2 a ton, it would cost $9.60 to pump against a 6 lb. leakage on an 80-car train for 24 hours. If thirty trains were being handled under the same conditions for 24 hours, it would cost $288 for fuel alone. While working under the same conditions with the 8½ in. cross compound pump, the cost of fuel would be approximately $100 pumping against leakage."

Another report on leakage made up by a railway man is as follows: "Comparative cost of maintaining 70 lb. brake pressure and 100 lb. main reservoir on a 60-car freight train (engine boiler pressure 200 lb.), in one case against a brake pipe leakage of 12 lb. a minute, and in the other a brake pipe leakage of 5 lb. a minute. Twelve pounds a minute brake pipe leakage equals a loss of 18.20 cu. ft. of free air, which represents a loss of 1,092 cu. ft. an hour and 10,920 cu. ft. for 10 hours. Five pounds a minute brake pipe leakage equals a loss of 7.54 cu. ft. of free air a minute, 542 cu. ft. an hour and 4,520 cu. ft. for 10 hours. An engine fitted with an 11 in. compressor would consume about 47 tons of coal, while supplying a 12 lb. a minute brake pipe leakage continuously for 1,000 hours. The same engine and compressor supplying a 5 lb. a minute leakage continuously for 1,000 hours would consume approximately 19½ tons of coal; 47 minus 19.5 equals 27½ tons; 27½ ÷ 47 equals 0.58, or 58% savings obtained by simply reducing the brake pipe leakage from 12 lb. to 5 lb. a minute.

The difficulties encountered and time consumed in coupling and uncoupling hose in winter are considerable. Even at zero the hose becomes so hard as to lose all flexibility, and during coupling and uncoupling it is necessary to bend it, which usually cracks the rubber, making it porous. A hammer is commonly used for hitting hose couplings to make them lock. This tends to jar hose fittings out of place in the frozen bag at the nipple and coupling sleeve, causing them to leak when the train is in motion, especially when rounding curves. The hammering on hose couplings also damages them to such an extent that it is necessary to remove the hose on account of gaskets not fitting properly. The same trouble is experienced on the road on account of couplings being drawn up by frozen hose on curves, causing the brakes to creep on and making it necessary for trainmen to hammer couplings down in place. Another difficulty is that all angle cocks are not in a proper position to allow hose couplings to meet in line, consequently, the hose is twisted before they can be made to lock, and in case of their being pulled apart they very often do not unlock, breaking the hose or train pipe. The time ordinarily consumed in coupling and uncoupling hose of a 40-car freight train, under ordinary conditions at the different winter temperatures, is as follows:

			Min.		Min.
Zero . . .	1 man uncoupling		45	Coupling	50
5 to 10 below	"	"	50	"	55
15 to 20 "	"	"	55	"	60
25 to 30 "	"	"	65	"	70
35 to 40 "	"	"	70	"	75

The figures in the last column allow for coupling hose only. Any extra time required for changing hose, gaskets, etc., depends entirely on conditions. This ordinarily takes 15 to 20 minutes, sometimes it takes an hour.

The amount of both yard and road detention, chargeable to train line trouble, not to say anything of car and freight delays, is worthy of consideration. An hour and a half over each locomotive division is considered a good average of road detention to each freight train handled under northern winter conditions, caused mainly through hose troubles, creeping of brakes, and extra time taken for pumping up, in releasing. Along with this comes flat and shelled wheels from creeping brakes; also there is excessive strain on draft rigging. A broken train line means cutting out of car, and not unusually 24 hours delay to same in getting repairs made, which, where freight is concerned, is serious.

The opinion has been quite prevalent that air hose defects could be remedied by more careful attention and adherence to higher specifications in the purchase of hose. This is not altogether true, because the greater number of hose is scrapped because of mechanical injury and not through defective material. J. Sheafe, formerly Engineer of Tests of the Illinois Central, gave in an article in a railway periodical the results of an exhaustive inspection and recording of performance on thousands of air brake hose. This showed that the 30c hose showed up even better than the 65c hose, proving that the railways do not take proper care of hose, and that the majority of renewals are necessitated by mechanical injury. He further stated that there were only two things which would minimize the liability of accidents and increase the life of hose, viz., preventing mechanical injury and showing the date on which the hose should be removed, in legible figures, so that it would not be left on so long that it would be weakened.

The defects which develop because of the present hose connections between cars, as well as safety considerations and convenience, led inventors at an early date to the consideration of an automatic connector. Quite a few connectors have been developed to the point of trial, but until very recently none has had an extensive installation. We are using an automatic connector on the Canadian Northern in both freight and passenger service, and have 207 cars equipped. The first installation was made June 6, 1914, so that we have had three years experience with them. The connector which we are using is the Robinson, and this has also been installed on a large number of C.P.R. passenger cars. In the northern country, where the climate is sometimes very severe, we have greater need for a connector than railways operating in the south. It requires a good deal more steam to heat our cars, and the results of leakage are magnified. Our trains are harder to move, because the lubricating oils harden, and for this reason we have to cut down unncessary stops or delays to a minimum. The makers of this connector are so confident of the life of hose which the connector makes possible that they guarantee a life of three years for air hose used with it.

I am not going to give you a description of the mechanical features of this connector, but only some of the results which have been obtained with its use. W. L. Crocker, Chief Dispatcher, Canadian Northern Ry., Fort Rouge, Winnipeg, says that all trainmen have no hesitancy in affirming that, in their belief, both road and terminal detention would be materially reduced if all cars were equipped with these connectors. On the question of leakage I will quote from one of the reports which has been given on the connector: "During the intensely cold weather of December and January, when temperatures sometimes in excess of 40 degrees below zero were recorded in certain parts of Canada, where these cars were in operation, no trouble was experienced from leakage in connection with the device, although at the same time it was found impossible to prevent very serious leakage in ordinary hose." I quote further from the same report the following: "To one familiar with yard and train service, there appears to be no room for argument about the need of such a device. The greater life of hose, the absence of broken train pipes resulting from uncoupling cars without first disconnecting the hose, the saving of time and labor in making up trains, and the reduction in the cost of pumping air, all of which might be classed as direct or apparent economies, would undoubtedly justify the cost of application alone, but the writer is even more impressed with the benefits that would be secured indirectly. Numerous leaks are found in hose and gaskets at all seasons of the year, almost entirely the result of the practice referred to above, viz., pulling hose apart, thereby injuring the fabric and inner tube. In very cold weather, however, when the hose freezes, the difficulty in preventing air leakage becomes a controlling factor in the operation of long freight trains, and they have to be reduced in length to a point where the air pressure can be maintained irrespective of the tonnage ratings or the ability of the locomotives to haul them. Even at the best, this factor is responsible for a very great amount of terminal detention and labor on the port of car men trying to stop leaks." The connector increases the life of hose because it eliminates all mechanical wear thereon. The hose is never jerked or strained. Frozen hose does not interfere with its operation and leakage and breaks are cut down to such an extent that it is possible to run longer trains. We have found on the Canadian Northern that the Robinson connector saves us a lot of money. We estimate the comparative cost about as follows: Cost of present equipment, $23.90; cost of Robinson equipment, $36.95; difference, $13.05; cost of maintenance of present equipment for three years, $45.05; cost for Robinson equipment, $37.49; thus the saving in three years is $7.56. For six years the cost of maintenance of present equipment is $90.10, while for the Robinson connector it is $47.80, including the interest on the