traffic. With the motor traffic which Massachusetts already has it has been found necessary, both for economy and for efficiency, where a road has heavy team traffic as well, to adopt in construction or resurfacing some form of bituminous mixture for the upper two or three inches of the road surface, at least, or some stronger road, like concrete. In many places, the Commission believes, such construction or reconstruction, has been, and will be, economical.

Conclusions Summarized.—A table has been included in the report showing as nearly as may be the results which have been observed after four years of experience with bituminous materials, comparing these results with the traffic going over the road in 1909 and again in 1912. The Commission realizes fully that more experience will undoubtedly cause it to change or modify some of its present opinions, but they are submitted for what they are worth as indicating the result of its experience in Massachusetts.

The standard road is 15 feet in width of macadam, with three-foot gravel shoulder on each side.

RESISTANCE OF THICK CYLINDERS TO RUPTURE.

According to M. Malaval, in "Rev. de Metallurgie," in a tube of the proportions of gun practice, the thickness about equal to the calibre, there are two distinct periods besides the elastic range. This is followed by the range of semi-elasticity or partial failure, which is of sensibly the same duration in stress. With increasing applied pressures the area of overstressed metal widens radially outwards. Thus if the pressure is released the outer elastic zone is prevented from returning completely to its original shape by the permanent deformation of the inner plastic zone. The mutual action causes the unloaded tube to be stressed in tension in the outer region and in compression in the inner, so that it is in the condition of an ideal shrunk composite tube—i.e., one with an infinite number of indefinitely thin components whose mutual pressures are such that under rising internal pressure all parts reach the elastic limit simultaneously and bear equal parts of the load. The semi-elastic period ceases when the outside layer reaches the limit of elastic deformation and is followed by the periods of general failure. During this period, covering an increase of resistance much greater than those of the first two periods, all parts show an increase of resistance, the inner region being in compression and the outer in tension. It follows that the metal, whose capacity for deformation is greater in compression than in tension, can withstand very considerable internal strains. It is concluded that the ordinary shrinking process might be replaced advantageously by one involving initial overstraining of a solid tube. A gun so constructed would withstand a pressure of over 1,500 kilogrammes per square centimetre (213,300 pounds per square inch).

The statistics of the report of Mr. J. McLeish on Economic Minerals and Mining Industries of Canada, contains the following record of production of pig iron:—In Ontario, in 1911, 526,635 tons valued at $7,606,939, in 1912, 589,593 tons valued at $8,176,089; in New Brunswick in 1911, 31,120 tons valued at $69,464, in 1912, 71,520 tons valued at $127,716; in Nova Scotia, in 1911, 390,242 tons valued at $4,682,904, in 1912, 424,994 tons valued at $6,374,910; in Canada, in 1911, 917,535 tons at a value of $12,307,125, while in 1912 an increase is shown in the production of 1,014,587 tons at a value of $14,550,999.

LIQUID, SOLID, AND GASEOUS FUELS FOR POWER PRODUCTION.

In a paper presented a month ago to the Engineering Section of the British Association, by Prof. F. W. Burstall, of the University of Birmingham, the means by which carbonaceous substances might be treated to render them suitable for the production of power were touched upon. The address has just appeared in extracted form in *The Iron and Coal Trades Review*, and is reproduced herewith:—

The fuel of the world, he said, consisted of two forms—liquid and solid, both of which were closely related inasmuch as they consisted of compounds of carbon and hydrogen, together with small percentages of other substances, such as nitrogen. Most engineers looked upon coal purely from the point of view of fuel to be used in a furnace for the production of heat. It was, however, a complicated substance from which could be extracted a wide range of valuable products.

There were points in the use of gaseous fuel which led to serious difficulties. In order to secure efficiency the main mass of the air must be heated by compression before the principal heat supply was added. The combustible gas might be added before compression began, as in the well-known Otto cycle, but this introduced the possibility of the charge igniting before the correct time. It also required that the gas should be free from any liquid or solid substances, a state of affairs not easy to obtain on a large scale. If the gas were compressed in a separate pump there was a certain loss of heat due to necessary cooling of the pump. With a liquid fuel there was no difficulty in forcing the small amount of oil required into the pre-heated air, and the oil was readily freed from foreign matter; also, there did not appear to be any inherent reason why the oil engine should not be made in the largest sizes, beyond those of weight and cost, where it must always be inferior to the rotary machine.

Passing on to deal with the gas turbine, Prof. Burstall said it could readily be shown that the velocities which had to be dealt with were no greater than those encountered in the steam engine, but there were difficulties which, in spite of innumerable efforts, had so far proved insurmountable. The greatest defect was that, so far, it had not been found feasible to compress the air and gas in the turbine itself. Separate compression considerably increased the losses, so that in place of the negative work being one-third of the gross work it would probably be at least one-half. and perhaps more. The cooling of the rotating disc and blades offered difficulties, and further, no material had been found so far that would withstand the erosive effect of the burning gases. It seemed very doubtful if the gas turbine could be constructed to compete with the reciprocator in the present state of knowledge.

It was important to consider the amount of various fuels raised in various parts of the world. At present about 1,200,000,000 tons of coal of various kinds were brought to the surface every year; crude oil amounted to about 50,000,000 tons per year, and it was doubtful if there were any large oil fields yet to be discovered. It, therefore, followed that the supply of oil was totally inadequate in amount to replace coal for power production on a scale equal to the present steam-power production. The artificial production of oil was at present being considered seriously by engineers, and much yet remained to be discovered in this field. Every engineer was familiar with the fact that when coal was heated in a closed retort gas and tar were given off, and also that the higher the