Edinburgh, is doubtless familiar to some, but is too little known in this country. One of Moore's pumps has been in use at South Bulli Colliery, Illawarra, for some years.

Wire Rope.—For the general purposes of haulage, wire-rope transmission of power is unexcelled, and it has in many instances been used for other purposes, such as pumping in mines. For the latter purpose it has, however, received a limited application, a result due, it is to be feared, to defective installation, through a frequent ignorance of the properties of ropes and pulleys. When one remembers the admirable work done in the way of haulage pure and simple by modern ropes, it is inconceivable to think that this method could not be applied to pumping in mines, in many instances with favourable results. As an example, it may be mentioned incidentally that at the Metropolitan Colliery, in New South Wales, a band-rope of crucible steel $1\frac{1}{4}$ in. in diameter, taken down a shaft 1,100 ft. deep, and transmitting at least 100-horse power regularly for ten hours per day, worked without change for five years, and was then only taken off to insure perfect safety in an important service. The rope was far from being worn out when changed.

Electricity.—As a competitor with compressed air, electricity occupies the first place. Its use as a means of transmitting-power has of recent years been widely extended, and in mines we have it now applied to pumping, haulage per medium of locomotives, and fixed rope haulage engines actuated by electricity, winding below and above ground, to rotary and percussive drilling, and most successfully to coal-cutting machinery.

Compressed Air.—For the transmission of power this agent has therefore in certain directions serious competitors, in favour of which there has frequently been urged greater economy in first cost, in working-cost, in efficiency, and in applicability. These claims have, however, been keenly contested by the advocates of compressed air, who, on the other hand, contend that it supplies a means of power-transmission at once safe, economical, and efficient for general mining-work. The force of this contention has been much increased by the improvements effected during the last twenty-five years in the methods of generating compressed air and of using it, as will be shown later on. There is little need to dwell on the importance of compressed air as a factor in the economy of many mines, an enumeration of its uses making this sufficiently apparent. It is used to actuate rock-drills, underground haulage- and hoisting-engines, pumps, underground ventilating-fans, Korting's air-injectors, and coal-cutting machines. It is necessary to an intelligent appreciation of the subject to consider the laws relating to air as a gas, and the mechanical causes which render its economical use more difficult than would at first sight appear.

It is proposed, therefore, to consider the subject in the following order: (1.) The laws affecting the compression of air. (2.) The various styles of compressors. (3.) The causes of low efficiency in air-compressors. (4.) Air-conduits. (5.) Methods of using compressed air. (6.) Dangers attending its use.

(1.) Laws affecting the Compression of Air.

Air is an elastic fluid, which, when free from vapour, behaves as a perfect gas. 13·09 cubic feet at ordinary atmospheric pressure, and at 60° Fahr., weigh 1 lb. According to Boyle's law, the volume of a gas varies inversely as the pressure affecting it, so long as the temperature remains constant : consequently, in doubling or trebling the pressure the volume becomes one-half or one-third respectively. According to Charles's law, if the volume of a gas be kept constant, the pressure varies as the absolute temperature, and if the pressure be kept constant the volume varies as the absolute temperature. By the law of the transmutation of energy, work performed on a body, whether solid, liquid, or gaseous, is evidenced by a definite decrease of temperature in that body, and we are familiar with that fact as shown in the simple laboratory experiment of exploding a small charge of gun-cotton in a strong glass cylinder, through the rapid heating of the air contained in it by a sudden jerk of a tightly fitting piston. Consequently, when air is compressed it is heated ; when heated it expands, and the volume of air to be compressed is proportionately increased with a corresponding expenditure of the power required to compress it. Could the temperature of the air undergoing compression be kept constant (isothermal) during the process, and the heat taken up from it returned to the air during its expansion in the motor while doing work, all loss from this source would be avoided. This, however, is impossible, and the aim of modern compressors is to prevent an increase in the volume of the air by keeping down the temperature during the period of compression—that is, by approximating to what is termed the isothermal process. It is clear that the least efficient compressor is the one in which no provision is made for cooling the air during the actual period of compression—that is, one working on what is termed the adiabatic process.

(2.) Air-compressors.

Although compressed air had been used to a small extent previously, it was not till 1850, when the Mount Cenis tunnel was constructed, that its use became general.

Two forms of compressors are in use, in each of which a reduction of the temperature of the air is aimed at—in one case by the use of a liquid piston in the cylinder, and in the other way by a water-jacket round the cylinder, or by an internal spray of water. The former is termed a "wet" and the latter a "dry" compressor.

Wet Compressors.—Of these there are two types : (*a*) Where the water-piston owes its energy to the fall of water from a height ; (*b*) where the water is actuated by a steam-driven piston. At Mount Cenis, Mons. Sommeiller made use of water with a fall of 86 ft., and by utilising the momentum of the falling water he was able to obtain an air-pressure of 75 lb. per square inch. Though extremely low in efficiency (not more than 6 per cent.), and necessitating clumsy plant, the arrangement gave results sufficiently good. This principle has been applied in other cases, and one arranged by Hathorn, Davey, and Co., Leeds, was successfully used for many years in Mexico.