made between the cars and the conductor rails by means of a “ plough,” carried by a hard steel plate, which is channelled to receive the insulated wires leading up to the controller on the car. The plough carries two cast-iron rubbing-blocks, which are pressed outward into contact with the conductor rails by springs, the two being, of course, very carefully insulated from each other and from the other metal-work of the plough. It has been found expedient in practice to reverse the polarity of the current used on these conduit roads from time to time, since electrolytic deposits, formed by small leakage currents in the vicinity of insulators, &c., are thus dissolved before they become a source of trouble.

Great difficulty is experienced with all conduits in keeping them clean and free from water. On the London tramways a sump has been formed at intervals of about 60 yds. into which the conduit drains. These sumps are connected with the sewers. The principal objection to the conduit system is its heavy first cost. The tracks alone in London are estimated to cost about £13,000 per mile of single track against about £8000 per mile for a track to be worked on the overhead system.

This high cost of construction has caused considerable attention to be directed by inventors to devising surface contact systems.

Many of the designs which have been patented appear excellent in theory, but have been found untrustworthy under working conditions. Among those worked commercially in England are (1) the Lorain system in operation at Wolverhampton; (2) the Dolter system at Torquay, Hastings and Mexborough, and (3) the G.B. system at Lincoln. Of all these systems current is supplied from iron studs laid in the roadway be- tween the rails of the track to a skate carried on the car. The studs are placed 10 ft. to 15 ft. apart and contain a movable switch or contact, which is operated by the influence of a magnet carried under the car. In the Lorain system (fig. 9) connexion is made to the source of power through two carbon contact pieces. The lower carbon contact is carried on a soft iron strip which is connected to the supply cable by means of a flat copper ribbon spring. When the magnet passes from over a stud the iron armature and the lower carbon contact, which has been magnetically attracted, falls vertically, assisted by the copper ribbon spring. In the Dolter system the contact box (fig. 10) contains a bell crank lever with a carbon contact at its lower end. The upper arm of this lever is of soft iron, which is attracted by the magnet carried under the car. When the lever is moved the carbon block at the lower end is brought into contact with the fixed carbon contact in the side of the box which is perma­nently connected to the supply cable. In the G.B. contact box (fig. 11) contact is made direct to a bare feeder cable carried in a pipe under the boxes. The switch, consisting of a piece of galvanized iron, is suspended freely by means of an insulated phosphor bronze spring. At the lower end of this moving piece a carbon contact piece is attached. When the magnet carried by the car passes over a stud, the moving piece is magnetically attracted to the cable against the pull of the spring. In the Lorain and the Dolter systems the studs are raised slightly above the road surface—which is an objectionable feature—and the current is collected by a skate, suspended under the car, touching the projecting surface. In the G.B. system the stud heads are kept flush with the pavement, and the collector consists of iron links spring suspended. As the collector passes over the box the links are magnetically attracted, and move down, making contact with the stud.

In all surface contact systems, short circuiting devices are provided to detect any studs which may remain live after the skate has passed, either by blowing a fuse or by ringing a bell, but it is questionable how much reliance can be placed on their efficiency under all conditions. The collecting skate and magnets carried by the cars on a surface contact tramway are of considerable weight, and the skate requires renewal at frequent intervals.

An efficient system of street traction may be defined as one which, while giving a reasonable return on the capital invested, provides the public, without dis- figurement of the highway, with a quick and frequent service of comfortable cars.

When tramways were first introduced the surface of the streets was often exceedingly rough. The tramcar running on rails was there­fore a great advance in comfort of travelling on the old stage carriage. Horse traction, however, limited the weight of the car and the speed of travelling. The sub­stitution of steam traction for horse traction was a great advance. Higher speeds and quicker acceleration were obtained, and larger and more comfortable cars could be worked. The power, however, was limited, and the locomotives, built as light as possible, were expensive in first cost and maintenance. Cable traction, owing to the heavy first cost of the track, requires a great density of traffic to make it pay. The speed is limited both up and down hill to that of the cable. It has the advantage that it can be safely worked on severe gradients, and once installed the working costs are low.

Electric traction by accumulator cars was tried in Birmingham in 1890 and abandoned after some years of unsatisfactory working. The cars were costly to work and maintain. The storage batteries had to be re- charged at frequent intervals, and they rapidly dropped in capacity. There was little reserve of power, and the cells added considerably to the weight of the car.

Those forms of electric traction in which the power is supplied to the cars from an outside source have many advantages. Only the weight of the motors has to be carried. These are efficient over a wide range of speed, accelerate quickly, have a large reserve of power and are clean and silent. The electric conduit and surface contact tramways do not require any disfiguring over­head wires. They have, however, troubles of their own. The construction of the electric conduit is so expensive that its choice must necessarily be limited to large cities. The conductors are easily short-circuited. Gaps in the conductors must be left at the points and crossings. The cost of keeping the conduit clean is considerable. It has the advantage, however, of having both the posi­tive and negative conductors insulated. Surf ace contact systems require studs or contact boxes to be placed in the road. In most systems these project above the surface of the street. The switches, which they contain are hidden away from inspection. A failure of insulation or the sticking of a switch may allow a live stud to be unprotected in the roadway. The weight of the car and consequently the power required to move it is considerably increased by the skate, magnet and battery which have to be carried.

For simplicity of working the overhead system easily comes