responsible for the most prevalent of diseases known as brown bast. The frequent draining of the latex tubes causes the formation of a wound gum which blocks the vessels, and the trees run dry. This gives rise to various secondary changes, of which the most noticeable is the development of warty growths in the cortex that render the bark surface useless, however vigorous the growth of the tree. In some fields three-fourths of the trees is affected, and if the "physiological" explanation be correct, there can be no better course than a rest cure if the majority of the trees is to be retained. On the other hand, yields from plantations in the future may be enormously increased by suitable seed selection, as the yield of latex varies considerably with individual trees. It has been stated that three-quarters of the latex of a field may be obtained from a quarter of the trees. Consequently, if a selection could be made of the good yielders by choice of seed, by grafting, or other means, the output of rubber per acre should be increased very considerably. At present, however, planters are not anxiously considering these matters. They would rather welcome some convenient disease, which, while reducing the planted area, could be brought to a standstill when the market had sufficiently recovered. As practical business men they are promoting a rubber-control scheme to be affiliated with a similar scheme organised by the Dutch planting-interests, with a view to the efficient control of production and the attainment of a stable price for the commodity.

INDUSTRIAL TRUCKS AND TRACTORS.*

W. P. KENNEDY.

One of the most urgent problems in industrial management to-day is the economical application of labour or man-power to manufacturing operations. The development of machinery for definite processes of manufacturing or fabricating was relatively simple, but the application of machines to such indefinite operations as the transport of material through plant or works has been much more difficult, although from the standpoint of reducing costs it is often more important.

At the present time the machines in use are mostly of the electric type, the application of the internal combustion engine for this purpose having been comparatively limited. Electric machines may be divided into two general classes: load-carrying machines which carry the load on their own structure, and tractors which do not carry the load but haul a train of trailers. Either of these forms may be equipped with auxiliary apparatus such as cranes, elevating platforms and hopper-dumping-bodies for handling loose material, but these are more usually applied to the load-carrying type than the tractors. Tractors may be of the 4- or 3-wheeled type, the latter being especially suitable where crooked passage-ways exist, as is often the case in the older works. One load-carrying machine which is coming into general use on account of its labour-saving value is the electric elevating and depressing platform type of truck. The machine with its platform depressed is run under a separate platform or "skid" on which the load has been previously stacked. The platform is then elevated by the electric gear and the loaded "skid" lifted off the floor and carried to its desti-

nation where the machine platform is again depressed and withdrawn, leaving the "skid" resting on the floor.

Most modern machines are driven by a single reduction and worm-gear mechanism, with direct but flexible connexion between the worm and motor and the truck driving wheels, the connexion with the steering and driving shaft being entirely enclosed and provided with continuous lubrication. Nearly all vehicles, whether tractors or load-carriers, are equipped for steering with their four wheels, thereby providing for short turning-radius.

The storage batteries with which these vehicles are equipped are either of the lead-plate or "Edison" nickel-iron type, and are generally assembled in trays for convenience of removal and replacement, so as to allow of practically continuous service, although the usual practice is to provide battery-power sufficient for the day's work and to recharge the cells at night. The batteries are commonly operated in series with a controller-arrangement providing for three speeds forward and three reverse, so that the machine can be run with equal facility in either direction.

The motors used are of the 4-pole series type, wound for suitable voltages and having very high overload capacity for short periods; the service in which the machines are employed being intermittent, the frequent stops prevent overheating of the motors and give the batteries opportunity to recuperate. The ampère-rating of these motors is usually between 60 and 70, and the normal speeds vary between 1600 and 1700 rev. per min., the gear-reduction required being 17 to 1 with driving wheels of 20 in. diameter. The speed is normally four miles per hour loaded, and six without loads.

The appended table gives some particulars of these machines:—

Type of machine.	Load carry-trucks.	3-wheel tractors.	4-wheel tractors.
Battery voltage ..	24	32	48
Kilowatt-hour capacity ..	5 to 8	7 to 10	11 to 16
Weight of machine, lb. . .	2500 to 3000	3000	4000
Starting draw-bar pull, lb.	500	1500	—
Do. 4-wheel drive, lb.	—	—	3000
Do. 2-wheel drive, lb.	—	—	1500
Pull when running under normal load, continuous, lb. . .	250	300	400
Do. Intermittent service of 30 minutes' duration, lb. . .	—	600	800
Capacity of machine, carrying, lb. . .	4000	—	—
Capacity of machine, hauling, tons . . .	4	6-10	10-20

When these machines are applied to rail-service, their tractive effort is decreased by two-thirds, and it must be remembered that to obtain the best and most economical results the work of the machines should be so scheduled and co-ordinated with the general factory operations that they are practically in continuous service.

So many factors have to be taken into account in determining the cost of operation that it is not possible to give exact figures, although, broadly speaking, it may be assumed that the daily cost will range from \$2.00 to \$4.00 where a fair amount of work is performed, although in some instances it may be as low as \$1.00 or as high as \$5.00. These figures include interest, depreciation, upkeep and power for charging the battery, but not labour for operating.

Trucks vary in price from \$2000 to \$3000, and tractors from \$2200 to \$4200.

To arrive at the total annual cost of operating the machines themselves, without trailers or other auxiliary apparatus, and without taking into consideration insurance, overhead and other general

* Abstracted from a paper read before the American Section at New York, on April 22, 1921.

charges, the following factors may be fairly used:—Interest at 6 per cent., depreciation 10 per cent., battery upkeep one-third of the original cost, tyre upkeep one-half of the original cost, mechanical upkeep 5 per cent. of the total value of the machine, and power cost at the prevailing rate per kw.-hr., assuming that the battery will require charging up each day to 150 per cent. of its rated capacity.

SOCIETY OF CHEMICAL INDUSTRY.

JULY MEETING OF COUNCIL.

At the meeting of Council held on July 15, Sir William Pope presiding, a letter was read from Dr. R. F. Ruttan accepting nomination as President of the Society for the year 1921–22, and expressing his appreciation of the honour which the Council had conferred upon him. A grant of £150 was made to the Committee of the Montreal Section towards the expenses of the Annual Meeting. An invitation was received from the Committee of the Glasgow Section to hold the Annual Meeting of the Society in that city in 1922; the invitation was accepted unanimously. A proposal from the Glasgow Section to admit "Associates" to meetings of that Section at the nominal subscription of 5s. per annum was approved; such "Associates" of the Section will not be entitled to receive the Journal and they will have no voting power at meetings.

The Council decided that a "Messel" Memorial Lecture should be instituted to perpetuate the name of Dr. Rudolph Messel, and that a gold medal with an accompanying honorarium should be presented to the lecturer. It was further agreed that the remainder of the income from the bequest should be allowed to accumulate for the present.

It was reported that a meeting of Sectional officers had been held in Manchester to discuss questions of importance to the Society. A report on one of the questions was being submitted to the Publications Committee for its consideration, and other matters would be brought before the Council at the October meeting.

The President intimated that he had arranged for a question to be asked in Parliament as to whether plant and apparatus lying idle in certain Government Factories could be made available for use in the laboratories of Universities and Technical Colleges (*cf. J.*, 1921, 215 n).

Dr. S. Miall was elected the Society's representative on the council of the exhibition to be held in April, 1922, by the Coal Smoke Abatement Society. A vote of sympathy was passed with the relatives of the late Dr. H. R. Le Sueur, joint hon. secretary of the Chemical Society. Twenty-three members were elected.

Particulars concerning the Dinner of the Society to be held in October will be found under "Official Notices" in the issue of the *Journal* for July 15.

ANNUAL MEETING, 1921.

A communication has been received from Mr. F. B. Carpenter, Chairman of the Fertiliser Division of the American Chemical Society, inviting all members of the Society of Chemical Industry who are interested in fertiliser chemistry to attend and participate in the meetings of the Division to be held from September 6 to 14 by communicating papers and taking part in the discussions. Any member of the Society of Chemical Industry who desires to accept this invitation and who is prepared to submit a paper is requested to

communicate at once with Mr. Carpenter (c/o Virginia-Carolina Chemical Co., Richmond, Va.), furnishing him at the same time with the title of his paper in order that it may be included in the programme of the meetings.

MEETINGS OF OTHER SOCIETIES.

THE FARADAY SOCIETY.

At a meeting held on June 22, Prof. A. W. Porter presiding, a paper on "High Temperature Phenomena of Tungsten Filaments," from the Research Department of the General Electric Co., London, was presented by Mr. C. J. Smithells. Two types of tungsten wire are in general use for lamp filaments; one is composed of pure tungsten, and the other of tungsten containing up to 1 per cent. of a refractory oxide such as thorium. The crystal growth of such filaments during burning has been investigated. In pure tungsten filaments crystal growth is very rapid, and can be detected after a few seconds' burning, whilst a practically constant crystal size is reached after about 15 minutes' burning at the normal temperature of a lamp filament. The author suggests, however, that although the crystal size remains constant with longer periods of burning, the condition is not stable, and the boundaries are in constant movement. Deformation of the filament occurs during recrystallisation and is more rapid during the preliminary period of rapid growth than later in the life of the filament. The refractory particles in a "thoriated" filament restrain crystal growth, so that, after many hours' burning, the crystal size is quite small. Such filaments deform very little during burning. Traces of phosphorus or sodium in a gas-filled lamp will reduce the thorium in a filament and cause an increase in the grain size. These elements are without effect on pure tungsten filaments. Part II of the paper dealt with the chemical reactions which occur in gas-filled tungsten-filament lamps when traces of the common gases are present in the filling gas, and the types of failure produced in each case were described. The effects produced by oxygen, hydrogen, water vapour, carbon dioxide, carbon monoxide, and hydrocarbons were discussed.

A paper by Mr. E. Kilburn Scott described the work of A. McLean Nicholson on "The Piezo-electric Properties of Rochelle-salt Crystals." Certain crystals, when subjected to pressure at opposite ends, generate a potential difference at those ends which may be of considerable magnitude. This is said to be the case only when the crystals possess skew symmetry with regard to the line of pressure (*cf. J.*, 1919, 159 n). Rochelle-salt crystals have been found to show this effect to a remarkable degree, and potentials as high as 500 volts have been obtained. The author demonstrated this property by means of a phonograph record which was made to produce vibrations in an aluminium plate in contact with a crystal; the current generated in telephone-receivers attached to the ends of the crystal reproduced the tune on the record. The work promises to be especially valuable in developing a hearing apparatus for very deaf people, and is also being applied to ordinary telephones.

Mr. Emil Hatschek described a simple apparatus for determining the coagulation velocity of gold sols. A transparent rectangular cell is divided into two wedge-shaped halves by a transparent diagonal partition. One half is filled with the red sol to be examined, and the other with the completely coagulated blue sol. A similar cell is filled with the sol and electrolyte under examination. The