SOME ASPECTS OF THE POWER PROBLEM FOR THE TEXTILE INDUSTRIES

By Charles J. Kavanagh

THE subject of motive power for the textile industries has, of late, occupied a good deal of attention, and it is the writer's object to review, without prejudice, the present situation and probable developments.

Power generation and power transmission for textile factories are undergoing a metamorphosis, and whatever particular specie of generator will finally be evolved it is difficult to say. Speaking generally, till a recent date the steam engineer was predominant: the driving of textile mills his monopoly. This is scarcely the case now, for some very energetic competitors have entered the lists; the issues are keen, and will be keenly fought. If steam triumph, with which will rest the laurels, the slow-speed or quick-revolution engine, or the steam turbine? If not, will the gas engineer with his producer plant be victor over the advocate of the oil engine? Will electric transmission and driving supplant that by rope and belt? And what are the answers to all these questions? The sanguine steam engineer will give his, the gas-engine zealot his, and the electrician his. But now that we have all these sources of power generation in the field, the efficiency of one or the inefficiency of the other will be made manifest by the trend of the times; the progress of those that are found wanting will be retarded, and each will ultimately work out its own salvation.

It cannot be due to any lack of appreciation of the electric motor on the part of the mill-owner that its more universal adoption has not come about, since he has seen it thrive under the most moderate as well as the most trying circumstances. Being a shrewd man, he has had a preference rather for trodden paths than for unbeaten ways, and it is this preference, or his inertia, that the electrical engineer has had to overcome, and he is most able to tell you of its amount.

It is easy to understand the position of the mill-owner. Reliability to him was the most important factor, and so long as he secured this, together with a degree of economy as high as that of his neighbours with whom he had to compete, he was satisfied. When approached on the subject, he wished to leave the electrical equipment to his more enterprising fellows and profit by their experience. An installation to him, although it was in vogue elsewhere, savoured of an experiment, and he was within his rights in drawing a distinction between experiment and finance. What he wanted was reliable figures as to the benefit that would accrue, and these the electricians had not to give him, for they had just entered the field and were gaining experience, whilst the steam engineer had had a century of it and knew all the requirements. There is little doubt the electrical engineer got in the thin end of the wedge during the recent unprecedented activity in making extensions to existing plant, and the satisfactory results recorded here secured a wider sphere for his services elsewhere.

THE ELECTRIC DRIVE

The requirements of the textile industry are characteristic. The materials worked with are neither coarse

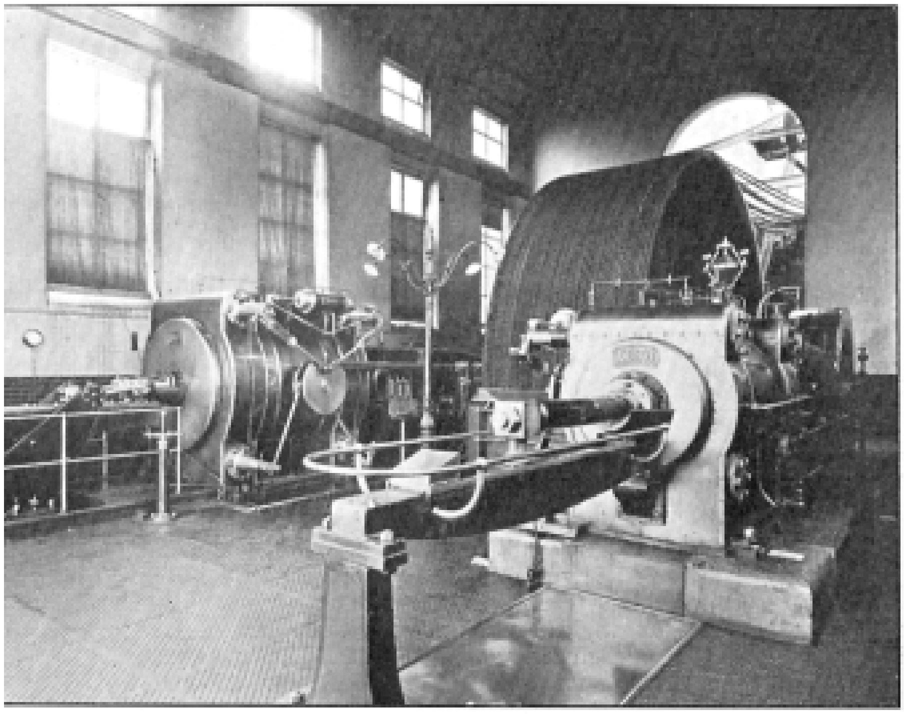

FIG. 1.—CROSS COMPOUND ENGINE OF 1400 HORSE POWER, BY MESSRS. HICK, HARGREAVES & CO., BOLTON, DRIVING A LANCASHIRE COTTON MILL. COAL CONSUMPTION FOR ALL PURPOSES 1¾ POUNDS PER I.H.P. HOUR

nor heavy, but extremely fragile, and consequently the machines required to work them must be sensitive and as free from cyclic variation as possible. And what is more adapted to these requirements than the electric motor? In the cotton industries the evenness of turning is of first importance, and this *sine qua non* is much more emphasized in the jute and flax industries, where the materials worked with have not the elasticity of cotton.

It is maintained that an electrical equipment is justified if only for the steadier drive and greater flexibility which result from its adoption, even if the cost per unit is within a reasonable margin in excess of the cost per unit by a purely mechanical drive. The interest on capital charges, it might be remarked, in electrical equipments form a prominent factor, and tend greatly to increase the cost per unit at which power is supplied.

The excellence of the drive in the case of a steam-driven mill equipped on the most modern lines is, in general, admitted, and the efficiency of transmission by ropes from the engine's pulley to the various lines of shafting being high, and the steadiness of the drive also good, as testified by the facility with which five counts are spun in certain Lancashire districts. If it be asked, then, wherein lies the advantage in the case of a modern mill working constantly at full load of an electric drive, the answer given is, in the increased rate of production possible by the more uniform turning moment and the greater flexibility obtained.

If the subject be treated in divisions, it will be easier to see where the merits or demerits of a particular application lie and to form an idea as to their economic value.

FLEXIBILITY

It is true that, with the electric motor, the maximum of flexibility is

FIG. 2.—VIEW SHOWING TRANSMISSION ROPE-RACE USED IN CONNECTION WITH ENGINE SHOWN IN FIG. I. MESSRS. HICK, HARGREAVES & CO., LTD., BOLTON

secured. Changes can be wrought easily and expansions effected with convenience, while there is no excuse for transmission losses to a machine which is not in commission. Individual driving permits the running of a machine out of complete disregard to its neighbour, and such sections of machinery whose working is not warranted by the requirements of trade may be shut down.

Then there is the case where, due to want of capital, a complete mill installation cannot be carried out. Here such machinery as could be bought would be laid down, due consideration being taken for future expansion, and the power taken from some public supply. Of course, a greater cost per unit would have to be paid, but this would prove more economical than running a power plant designed to cope with a maximum on a very light load.

A hot bearing is, unfortunately, not an unknown thing in a textile factory, and its occurrence is attended by appreciable loss when a series of machines is thrown unproductive; but where the electric drive is adopted the mishap is more or less localized, and merely affects individual machines or a lesser group.

STEADY RUNNING AND ELASTICITY OF REGULATION

To obtain the best quality of work with a maximum rate of production, extreme steadiness of drive, together with a degree of flexibility, is essential. A polyphase motor of the three-phase type is well adapted to these requirements; its uniformity of speed is only subject to changes by the cyclic variation of the prime mover, and with the turbine, with its comparatively continuous flow of steam, these are almost entirely eliminated, and with other forms of steam engine scarcely more in evidence. A feature, however, in which the polyphase motor is deficient is that, without the aid of very cumbersome devices, speed regulation is not possible, and even when attained, only amounts to a radical change. Provision is, consequently, sometimes made for altering the ratio of gear wheels. The direct-current motor, on the other hand, lends itself admirably to a close adjustment of speed regulation, and were it not for its sparking propensities, would be well adapted to the spinning mill, where the machines are run at the greatest speed short of breakages of yarn.

In the textile industries, as elsewhere, the raw material differs in quality from time to time. An inferior class of material demands a different rate of production to that of good quality, and unless the motor is adaptable to circumstances, a maximum output is not ensured.

RELIABILITY

The reliability of the electric motor is established. It has with success been applied to most classes of work, and under adverse circumstances, both climatic and otherwise.

The alternate-current motor has in electro-textile work proved quite reliable when due consideration has been given to the conditions under which it is required to run.

In shipyards and workshops the direct-current motor may be seen at one instant running light and in the next subjected to overload, and then, perhaps, with reversed rotation through a similar cycle. Is it likely to prove deficient in the textile industries where none of these extremes are brought into focus?

POWER ECONOMY

It is not disputed that the efficiency of the motor is high, the smaller ones being in some degree less efficient than their larger brethren; but it is questionable whether the efficiency of transmission electrically is better than that by the most modern mechanical means. With scientific lubrication and oils of the most suitable viscosities, etc., adapted to the various conditions, the work lost in friction can be reduced to a very small amount. In an electrical installation in which, say, the individual drives are in excess of the group, an inefficiency is introduced first between the engine and generator, then in the distribution mains, and finally in each individual motor. In direct driving a good deal of belting and gearing is done away with; but where the group system is resorted to, the dispensations do not form so large a factor. Whether the efficiencies of transmission balance each other or not is a controversial question, and both sides have their adherents; on the face of it, it would appear that the electric drive would not effect any further economy in the reduction of power.

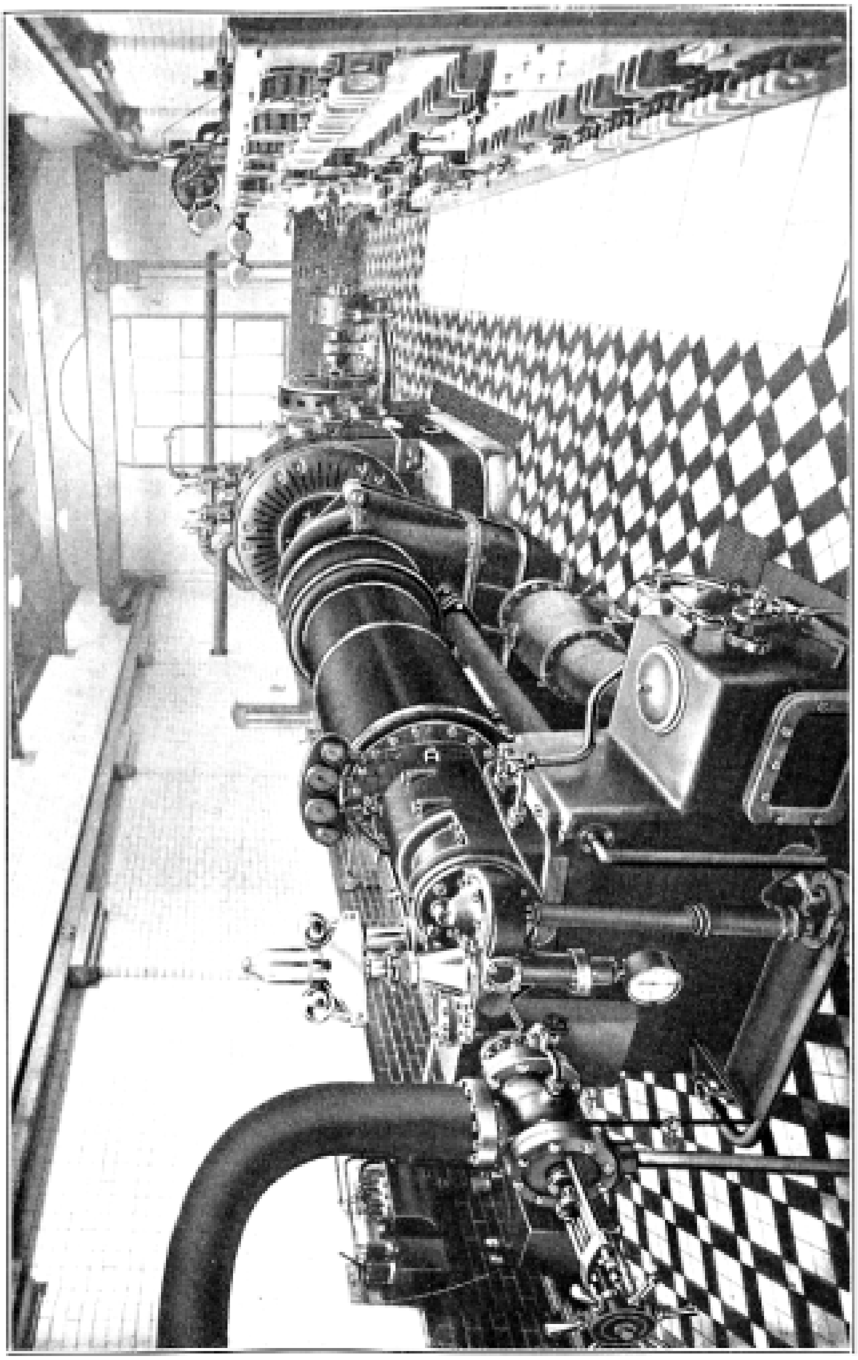

FIG. 3.—TURBO-GENERATOR SET FOR AN ELECTRICALLY OPERATED MILL AS INSTALLED BY MESSRS. DRAKE & GORHAM LTD., MANCHESTER

MAINTENANCE COSTS, WEAR AND TEAR AND DEPRECIATION

The maintenance costs, which include supervision and working costs, are, with the electric motor, extremely low. The machines are designed to be as fool-proof as possible, and beyond occasional replenishing with oil and dusting, little attention is needed.

Wear and tear do not form any considerable factor. With induction motors the bearings are the only parts subjected to wear, whilst with motors of the direct-current type, the commutator will be found to be durable and the wear of the brushes small.

ALTERNATING CURRENT OR DIRECT CURRENT

With either of these systems of generation and distribution excellent results can be obtained.

A three-phase system scores over the direct-current in point of simplicity and maintenance charges. It is true that, when subjected to heavy overloads, its effects on the prime generator, and consequently other motors, are pretty considerable; but with the class of work upon which it is employed in the textile industries overloads are more the exception than the rule. Provision is usually made for starting up these motors on no-load, and being put to their work when they have nearly arrived at their synchronous speed, which must be effected without shock, otherwise breakages of yarn, etc., would be the result.

The direct-current motor is well adapted to close adjustments of speed, and enable machines to be run up to the greatest possible speed short of breakages of thread: but on account of commutation, which is not always sparkless, the risk of fire in the fluff-laden atmosphere of a cotton mill is somewhat enhanced.

GROUP AND INDIVIDUAL DRIVING

In deciding on which of these systems be adopted in a particular case one is guided by certain definite prin-

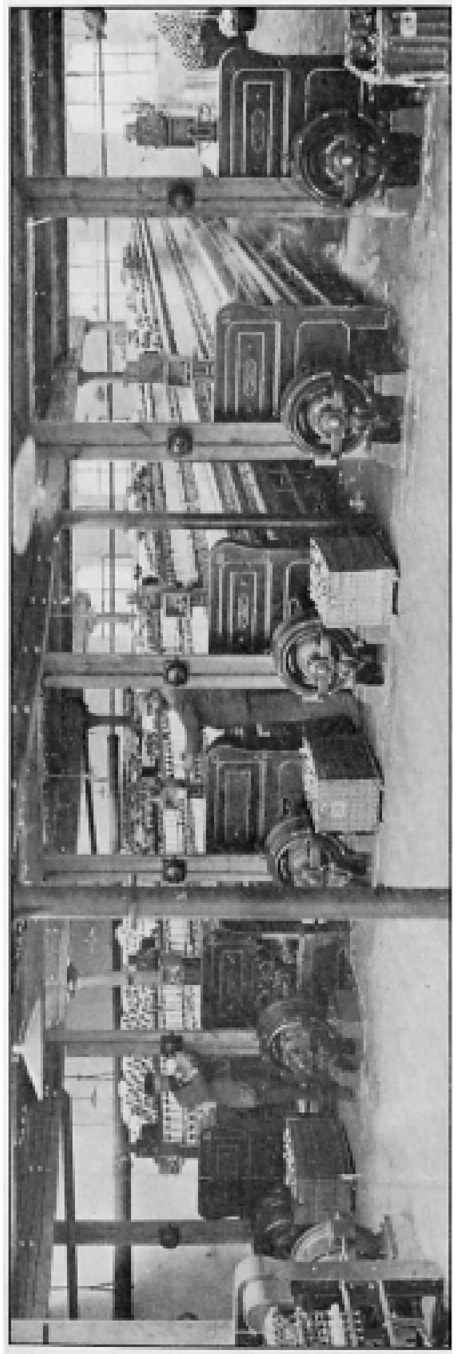

FIG. 4.—DIRECT DRIVEN RING SPINNING FRAMES, SINGLE-PHASE REPULSION MOTORS BY MESSRS. SIEMENS BROS., LTD.

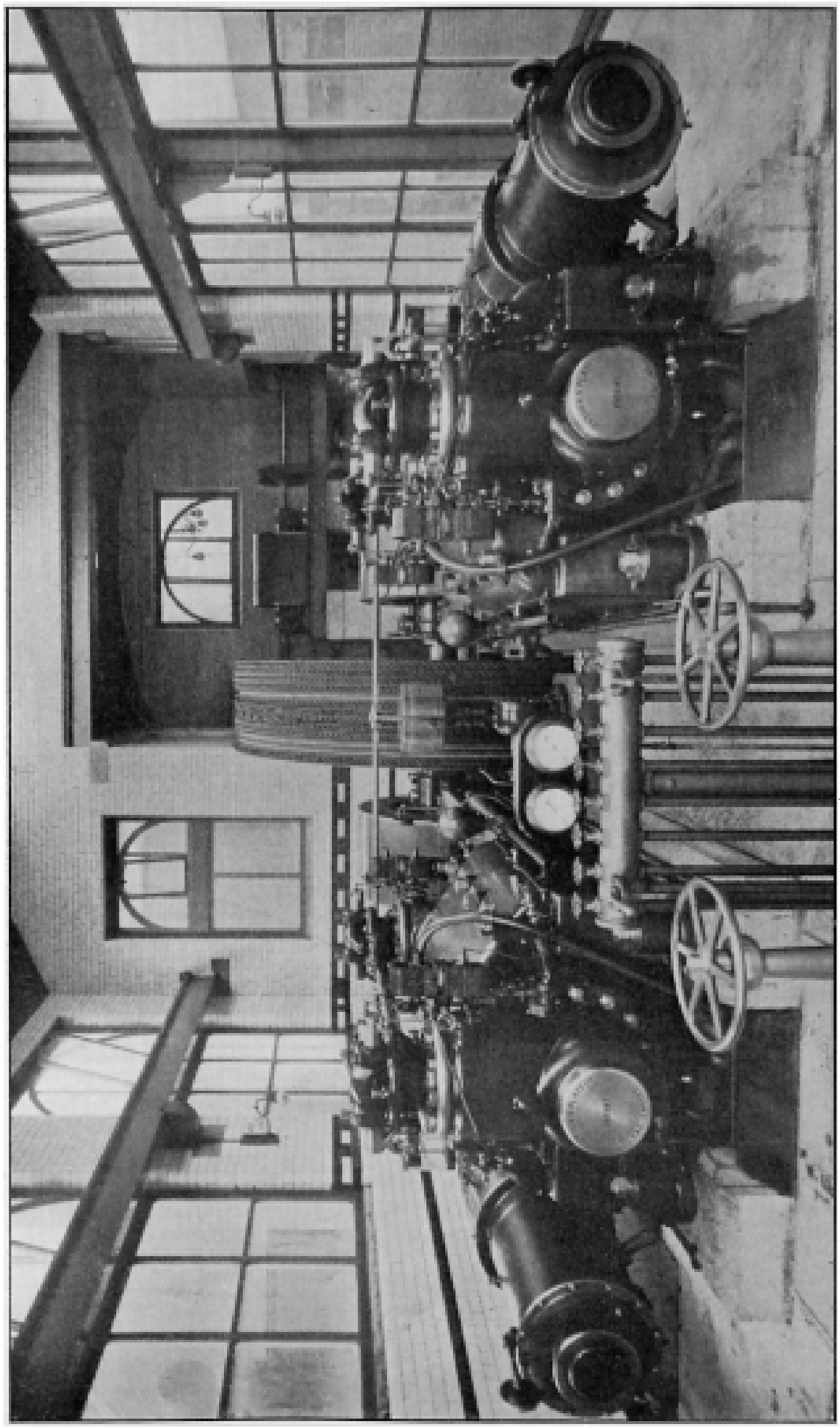

FIG. 5.—TWIN-CYLINDER GAS ENGINE OF 600 BRAKE HORSE POWER INSTALLED BY MESSRS. MATHER & PLATT, LTD., MANCHESTER, IN A SPINNING MILL

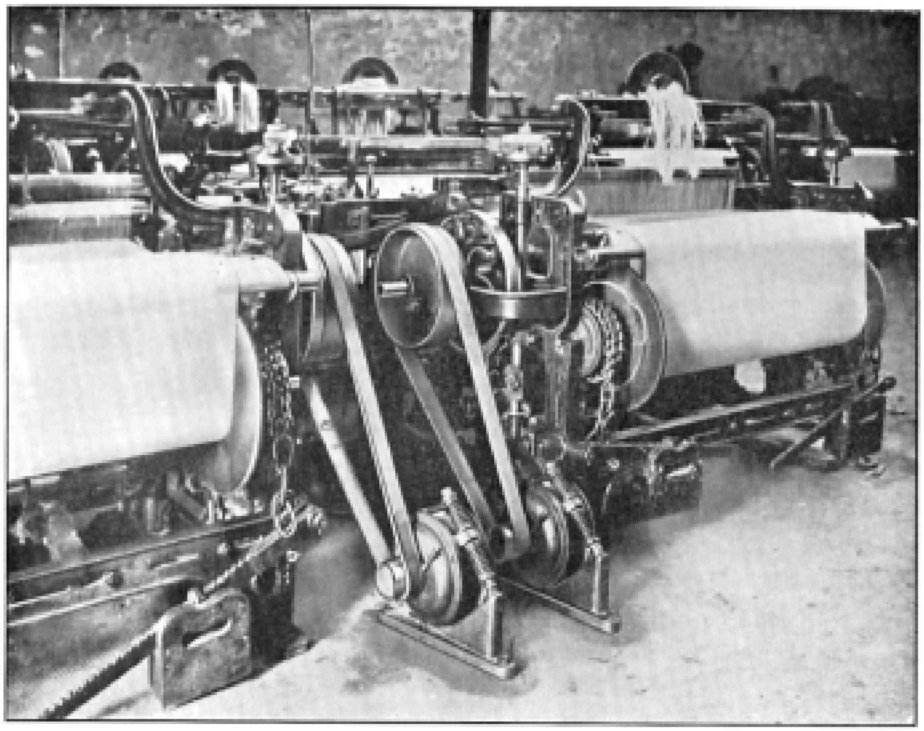

FIG. 6.—LOOMS DRIVEN BY INDIVIDUAL MOTORS, BY SIEMENS BROS., LTD. THE MOTORS ARE CARRIED IN SPRING SUSPENSION, INSURING UNIFORM BELT TENSION

ciples, but the commercial factor enters largely into the question. With some machines the power absorbed is so small that it is not to advantage to make use of an individual drive in each case, especially as these low-rated motors run at a speed which demands the introduction of some form of reducing gear, and are, to an extent, inefficient, to say nothing of the prohibitive cost of an equipment and an increased liability to breakdown. There are, of course, many machines which lend themselves admirably to individual driving, and in such cases the mechanical losses are reduced to a minimum, and belts and gear wheels are, to good extent, dispensed with. But whether the capital outlay on a number of motors for individual driving is warranted ought only to be decided on after deep reflection, for it is a serious matter to have capital sunk in power when it might be more productive elsewhere.

In group driving several machines are operated by one motor; the initial outlay is thus kept down, and a better electrical efficiency is the outcome.

The nature of the load on mule spinning frames renders a group drive imperative, because of the extreme variation throughout a cycle of operations. An individual motor would require to be large enough to cope with the maximum demand, and this would result in low efficiency and load factor; but by grouping the machines and running them as far as possible in definite sequence, the load peaks can be made to level themselves off.*

POWER GENERATION

The ideal for power generation in Great Britain lies in the centralization of power plants in close proximity to the coalfields, and in a highpressure distribution to mills erected in the vicinity. To the mills alone it would mean a great reduction in capital outlay, and would be attended with advantages of no minor importance. First and foremost their complete power installation would be dispensed with, and appreciable saving in building effected by the elimination of engine houses, foundations, boiler settings, flues, chimneys and rope races. Then with the concentration of power plants, where several thousands of horse-power were being developed, the most economical prime movers could be used, with a stand-by, set for emergency, and nothing spared, either in the main or auxiliary machinery or apparatus, to secure the utmost economy of generation.

It may follow that the gases at present escaping from coke-ovens and blast furnaces will be harnessed to good extent and made to perform useful work, instead of being allowed to be dissipated into space, to the detriment of life and Nature.

In consideration of the recent phenomenal building and equipment of mills, it is doubtful whether the question of centralized power supply will receive serious attention in this decade.

PRESENT SITUATION AND PROBABLE DEVELOPMENTS

Steam-power plants are to-day predominant, and are likely to maintain their prestige in the near future. But there is keen conflict even in its own ranks, the quick-revolution engine with the slow-speed Corliss and piston drop-valve engine, and the steam turbine with all. If steam is to survive the competition of the gas engine, high degrees of superheat will have to be employed, and greater economy will be required in the steam-generating plants. The slow-speed Corliss engine is scarcely adapted to the employment of very high-temperature steam, as the lubrication of the valves becomes a difficult matter, and unless the difficulty is overcome in the near future it is possible that,

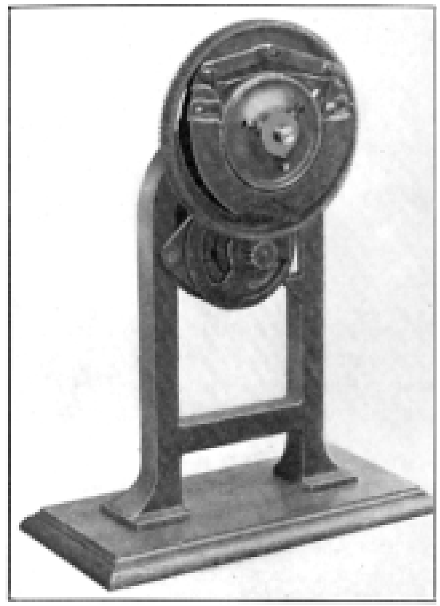

FIG. 7.—CENTRIFUGAL DEVICE TO PERMIT MOTORS RUNNING UP NEARLY TO FULL SPEED BEFORE THE LOOM IS STARTED. MESSRS. SIEMENS BROS., LTD.

for the electric generation of power, it will not receive the consideration that its competitors, the quick-resolution engine and steam turbine, will. On the other hand, the piston drop-valve engine is excellently adapted to superheated steam, and from it great economies may be expected. The writer favours the vertical type of these engines, and is of the opinion that if they could be run at a greater speed it would prove a stubborn opponent to its rivals. During the recent boom in electro-textile work many quick-revolution engines were installed, coupled to both direct-current and alternating-current generators, whilst the turbine was used to equal extent.

The turbo-generating plant has now arrived at a high state of excellence, and possesses many advantages over the reciprocating steam engine. Since the flow of steam through the turbine is practically continuous, there is an almost entire elimination of cycle variation, and the motors, in consequence, run steady. An appreciable saving is effected in space and foundations, and the use of oil, except for bearings and such like, is unnecessary. Present practice with turbine equipments is to install turbo-alternators in duplicate, each of such power to deal with half the load under normal conditions with a maximum of efficiency, and capable of 100 per cent., with an increase in steam consumption of from 10 to 12 per cent. With this arrangement, although the capital expenditure is somewhat heavier, a greater immunity from breakdown is secured.

It is recognized that the gas engine operating on producer gas is the most economical source of power from coal that we have; but until greater reliability and steadier running are secured, it is not likely seriously to challenge the predominance of the steam-power plant. The issues betwixt them resolve themselves into reliability and freeness of cyclic variation for the gas engine and efficient combustion and economy of steam generation for the steam plants.

Great advancements are being made with gas-engine units, and in the near future it is possible that producer plants, at present in a transitional stage, will be seen operating quite satisfactorily on low-grade bituminous fuels.

The efficiency of combustion and steam generation even with our modern boiler plants is not satisfactory, only some 60 per cent. of the total heat developed being transferred to the water in the boiler. A solution to the difficulty seems to be offered in the firing of boilers of the water-tube type by producer gas, the products of combustion being used for pre-heating the air used for combustion.

Much could be done in this direction if engineers would turn their energies to the subject and apply themselves with equal industry as they have done to the development of the turbine and electrical machinery.