kinds, makes this system effective in results and efficient in its operation.

In purchasing, the Engineer-Constructor should find some advantage over an occasional buyer. He is in the market constantly, is favorably known by the manufacturers of standard equipment, and buys apparatus delivered f.o.b. cars, doing all erection work as far as possible with his own experts, and calling on the factory for assistance only when necessary.

There should be the greatest unity between the engineering, the purchasing and the construction department. The plan of organization to secure the results is shown by the diagram, Fig. 2. It is always better to have the construction superintendent in the office while preliminary decisions are being made and bills of matetrial are being prepared.

Throughout the entire progress of the work, systems are in use to keep all concerned informed as to each move. The construction office is advised by the home office as to the material ordered and as to the probable delivery of this material. The home office is advised as to the receipt of material on the job as well as to the progress of the construction work, and any reports and advices as to the labor situation. To accomplish the former copies of contracts for apparatus and orders for material are sent to the superintendent in charge of construction. Such reports and orders contain exact information as to the material covered by them, as well as to the time at which this material is expected to arrive on the work. A card system in which are entered all orders and contracts is used in the home office, and is designed to follow up and secure prompt delivery of all material and apparatus. In case of any changes in time of delivery of material, the construction superintendent is advised in advance, and is thus in position to make any alterations necessary in his program. The importance of promptly delivering the material on the job cannot be over-estimated, and the value of a system that will provide for the delivery of the materials in accordance with an approximate schedule previously arranged for will appeal to all interested in construction work.

Practically all of the material is ordered by the home office. In case, however, it is more advantageous to order small quantities at the seat of the work, such orders are issued by the superintendent, a copy of all such orders being sent to the home office, after which they are recorded and handled in all respects similar to orders issued from the office.

Records of all material received on the job are kept by the superintendent in the form of a material report. These reports are written out in a duplicate book as each shipment is received, and one copy is sent without delay to the main office. This serves to keep the home office very closely in touch with the field work, so far as the receipt of material is concerned.

In construction work consisting of a great many items, such as will be found in railroad shops, it is very desirable to know with a fair degree of accuracy the exact progress of the work. Certain lines of the work, such as the delivery and installation of machinery, are dependent upon the progress of other work, such as the completion of the buildings and foundations. In order that this information may be always at hand, progress reports from the work are received at stated intervals, usually two weeks apart, giving in detail the progress of the work under each classification head. This information is kept in form for convenient reference, and is useful in a variety of ways. Not only do these reports keep the engineering force in touch with the progress of the work, making it possible to more efficiently insure the work coming in proper sequence, but they also provide the information necessary to make decisions as to changes in detail, in case such are found necessary after the work has been begun. These progress reports, together with a record of moneys expended for material and labor at any date, give timely information as to the actual cost of the work as compared to the estimated cost. As such reports are made on the work under each classification heading, any variation of the cost from the estimate is at once detected. This is of importance to the constructor who proposes to complete a certain improvement within a definite estimated cost, and to the client's official who may be charged with the responsibility of protecting a definite appropriation.

Wherever it is possible, curves or diagrams are used to represent the condition of affairs of which record is to be kept. A chart showing the progress of the work on building construction is easily made, and shows very clearly at a glance the exact condition of the work at any time. Such a chart is shown in Fig. 3, which indicates the progress of the work on one of the buildings at the time of completion of the fifth payroll. On this chart the base represents the total estimated cost, and is divided into the various classifications covering the cost of this particular building. In this case these classifications cover excavation and fill (about 2-3 per cent. of the total cost), concrete footings and piers (about 6 2-3 per cent. of the total cost), while the other divisions, such as engine pits, underground heating ducts, concrete superstructure, and so on make up the total cost of the building. At the end of each two-weeks' period, the total expense that has been incurred during the two weeks previous is plotted under each classification head, and this area on the chart indicated in such a way as to designate the progress made during the particular period in question. A glance at the chart will show the total amount completed under each classification represented on the chart at the time the last entry was made, as well as the amount of work done under the various classifications during each period considered.

Moreover, it is at once evident that, during the period of the fifth payroll about ten per cent. of the work on the engine pits, twenty per cent. of the concrete superstructure, thirty-six per cent. of the brick work, fifteen per cent. of the sills and coping, forty per cent. of the windows and small doors was completed, and no work was done on the smoke-jacks and ventilators, none on the roofing, and none on the sash operators and foundations. In other words, these progress reports become the graphical history of the job. After having made out the necessary reports covering both the material and the labor that have been used on the work, it is a very simple matter to embody these results in the chart A copy of this chart is then sent to the main office where it remains until the time for the next report, at which time it is sent back to the job for the additions that have occurred during the period.

In addition to these some other curves, showing the progress of the work may be of interest. These contain in graphical form a record of the number of workmen employed on the work at all times, together with information as to the number of carloads of material received, the weather conditions, and other matters of interest.

Progress photographs are taken of the work at intervals of about two weeks. These show at a glance not only the general progress of the work, but many construction details, as well, which are of interest and value. These photographs are of a standard size, and mounted on cloth, so as to be bound in convenient form for reference. All the reports just referred to, viz., the progress reports, charts and diagrams, while very easily obtained, and requiring but little work in their preparation, supply a great deal of valuable information, and are of worth far exceeding the trouble and expense contracted in securing them.

Although every facility is provided for keeping the main office and the construction office in close touch, it should not be understood that the engineering is done at arm's length, and that all plans and specifications are devised and completed by an engineering force in the office to be sent down to the construction superintendent on the job for his execution. A competent engineer is in charge of all construction work, and spends a certain amount of time in the field, thus putting him in close touch with the situation, and enabling him to more efficiently direct the detailed engineering work that is done in the main office.

It would be a big mistake to think that such an organization as we are outlining could be got together and perfected in its work in a short time. A winning team is not made in a week, a month, or even a year. It takes time to find the men, to break in raw material, to perfect the plays, to develop a system, and to create a loyalty both inside and outside the team. In the case of our Engineer-Constructor