*Discussion on Paper No. 6662**

Rate fixing in civil engineering contracts

by

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The Author, in introducing his Paper,† remarked that the treatment of rate fixing and the settling of claims were aspects in civil engineering contracts which did not appear to have been adequately dealt with in recent times by the Institution.

62. The first question that came to his mind was why was this not a matter suitably covered in standard publications. An examination of the subject, showed that the answer to this question was relatively simple.

63. Until the beginning of the second world war, the power of the engineer appeared to have been substantially greater than it was at the present, particularly in the financial sphere. It was indeed a relatively simple matter for the engineer and the contractor to meet at the conclusion of any project and to settle first the outstanding rates and then to settle the claim all in a short discussion. This was a satisfactory way in which to deal with the matter, the assumption being that the two men as heads of their respective firms representing the engineer and the contractor, were men of substance. It also presupposes that the engineer was a man of integrity and vision: he would have to ensure in these negotiations that the employer and contractor each were fairly treated. In this way a quick and satisfactory form of justice appeared to have been effected.

64. In the last two decades, however, with the advent of large nationalized bodies employing their own engineering staffs, the old fashioned method has been found wanting for a variety of reasons. The employer, on his part was naturally conscious that he was dealing with public money and that everything had to be properly accounted for: just as important it must be seen to be properly accounted for. The contractor, on his part appeared to have a tendency with regard to any difficulty to try and evoke the letter rather than the spirit of the contract conditions in general, and the bill of quantities in particular. As to the engineer, it was perhaps more difficult to comment on him, apart from the remarks the Author had already made regarding his diminished power. The engineer seemed to have moved with the times, rather than try in any way to dictate the change in the state of affairs; this might be considered to be a little regrettable on his part. It should be remembered, however, that the advent of the General Conditions of Contract issued jointly by the Institution of Civil Engineers, the Federation of Civil Engineering Contractors, and the Association of Consulting Engineers, at the end of the second world war has had some influence in this context. For example, that document had covered the question of unforeseen physical conditions, a matter previously left entirely to the engineer's discretion.

65. Another matter which the Author thought needed a general comment was the fact that competition in the field of civil engineering construction had never been higher than it was at the present time: the inevitable result had been increasingly

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* *Proc. Instn civ. Engrs*, vol. 24, February 1963, pp. 223–234.

† In view of the special nature of the subject Mr Haswell's introductory remarks at the meeting are here printed before the ensuing discussion.

keen pricing, with consequent problems for contractors in clearing a reasonable profit when difficulties were encountered.

66. It was a logical development from this that there might be a tendency for a contractor to welcome variations subsequent to the letting of a contract as a possible means of securing payment at prices more advantageous than those included in his tender.

67. While the Paper suggested a possible means of dealing with the problem, derived from the commonsense guidance given in the I.C.E. Conditions, the Author had offered it in the hope that it would stimulate reflexion and invite discussion upon current practice in this important and controversial facet of the engineering profession. The Paper had been purposely kept brief for two main reasons: first, to highlight the principles involved; and secondly, to be of some assistance to the younger engineer.

68. The Author then referred to the mechanics, as it were, of rate fixing. First he wanted to make clear the provisions of the contract conditions. Standardization had helped simplify the matter, in that it was common practice to use the I.C.E. General Conditions of Contract. Quite clearly the engineer had the power to fix rates, in the same way as he directed the design and construction of the works for the period of the contract. However, in practice rates were—except in rare cases—agreed as between the contractor and the engineer. The machinery of agreement if conducted on a rational basis worked successfully providing a spirit of co-operation existed between the contractor and the engineer.

69. There were different ways, he continued, of arriving at the correct figure for a new rate in any particular circumstance. The suggested formula was given to illustrate the principle, rather than its use in any set manner, and in arriving at the formula the following points had been accepted:

(*a*) That the new rate should be the rate which would have been inserted in the tender, had that particular item been included in the original bill of quantities.

(*b*) That any increase in the volume of work to be executed should not be allowed for; this means that there would be no reduction in the static on-cost covered in the tender price. Thus it was accepted that, with all other things being equal, an increase in the total volume of work was to the advantage of the contractor. It might be added that where there had been any substantial reduction in the total volume of work, it was usual for the contractor to make a case out for consideration on completion of the works.

(*c*) That due allowance should be made for special circumstances: in this context anything in the nature of a contract risk was not a special circumstance.

It might not be inappropriate at this stage to set down one or two definitions, that seemed to require clarification. For instance in Clause 52 of the I.C.E. Conditions it was noted that extra and additional works were several times referred to without distinction: the same would also be applied to substituted work. These the Author thought, might be defined in the following terms:

70. Extra works were any works which were not contemplated by the employer at the time of letting the contract. Additional works were any items of work which should properly have been included in the original bill of quantities, and necessary for the proper completion of the works; they had therefore either been omitted or were the result of the finalization of design. Substituted works covered items—as suggested by the title—such as a change in the concrete mix. A contract risk was anything which should be allowed for in a tender. It embraced such matters as the provision of finance, plant, men, and materials; allowance for bad weather, accident, and so on.

71. On the effect of 'weighting' a tender, the Author felt that this was a practice

which was not so frequently adopted by contractors nowadays owing to the gamble element it brought with it. There were exceptions, however, such as for excavation in tunnels where the contractor wished to recover reasonably quickly large temporary works expenditure. The deliberate 'weighting' of an item where a mistake in the bill of quantities had been spotted was another thing altogether. These matters could easily be guarded against by the proper preparation and study of the *vidimus* when tenders were considered: this was, of course, a most important document. Once a tender had been accepted it was too late to do anything in this respect: a contract rate was a contract rate. In his conclusion, the Author spoke of the case of the contractor who saw that the engineer had one nought too few in the billed length of pipeline for a large water supply project. The related item was heavily weighted: the engineer should have, but did not, make and study the *vidimus* and the employer paid very substantially for the mistake. The contractor, of course, made his fortune and died a millionaire.

Mr M. W. Leonard (Director of Soil Mechanics Ltd) remarked that the excellent attendance that evening must convey to the Author, in a most practicable way, the appreciation felt for his Paper.

73. Mr Leonard spoke as a contractor and wished to contribute to the discussion on this Paper in respect of the principles giving rise to rate fixing in preference to the actual mechanism of arriving at a rate, as this was so usefully covered in the Author's Paper.

74. The Author had drawn attention to some of the reasons why rates had to be established during the currency of civil engineering contracts, and, in particular, due to the following: (*a*) The change in the nature of the ground; (*b*) Insufficient information available to the contractor to enable him to prepare satisfactory rates for inclusion in his tender for the main work; (*c*) Lack of information at the significant time during the period of the contract for those who had to plan and execute the work; (*d*) Alteration to the work by the employer.

75. Some of these were tenable and even unavoidable, but not always so.

76. It was Mr Leonard's view that the necessity for much of the rate fixing today was an imposition on one or more of the three main bodies concerned with contracting, namely, the employer, the engineer and the contractor.

77. This would seem to be particularly the case when the contractor entered into an agreement with the employer to undertake a specific work for a stated price, and it subsequently turned out that he was expected to do something quite different for much the same price; in such cases, substantial rate fixing was hardly a substitute for the original contract and it was a compromise solution in which one party might well feel aggrieved.

78. It was not always readily realized that a modification in the works could have an effect on the contract beyond that indicated in the rate for payment for that individual operation.

79. Only too often rate fixing during the work was relied on by the three parties he had mentioned, one or severally, to avoid the clear thinking that was essential for the planning and execution of modern civil engineering projects from the start. When this was absent, it was difficult to recover a great many of the standing charges which were incurred due to poor outputs that arose from *ad hoc* working conditions; it was even more difficult to allow for this in a rate adjustment.

80. Of course, in many cases the need for variations to the work and subsequent agreement of terms for payment were absolutely necessary and desirable; however, the Author offered others for challenging comment in this valuable Paper.

81. For example, he said there were many cases where new rates were required due to the nature of the ground. Surely, in these enlightened days of appreciation of soil mechanics it did seem to him that reasons for fixing new rates on this score should become minimal; it was difficult to see how any civil engineering work could

go ahead without the nature of the ground being properly explored before the work was commenced, and certainly before the contractor was invited to submit a price.

82. By this he did not mean that he was advocating a comprehensive site investigation in every case, but rather one that was appropriate to the needs of the engineer and contractor.

83. It was clearly necessary, even essential, that ground conditions should be known from the commencement of the development, and it was to be much regretted that employers were still reluctant to spend money on investigating sites before they started development proceedings.

84. The limitation of the extent of the preliminary investigation should not be immediate cost, but ultimate economy—once wide extrapolation was admitted as a substitute for sound interpretation of known facts, then a substantial element of speculation would enter into the concepts of the eventual contract, giving rise to much unnecessary labour in such matters as rate fixing and overcoming the delays in the completion of the work.

85. They must all by now be aware of the high cost of no site investigation; let them also be conscious of the cost of a limited one which would affect the smooth organization and execution of the work.

86. Turning to some of the other shortcomings which the Author had referred to which lead to rate fixing that could otherwise be avoided; today they still had drawings presented to the contractor's estimator which were insufficient to convey to him the extent of the work for which he had to prepare prices. Sometimes this was attributable to the employer not giving to the engineers sufficient time to prepare the contract papers, even though the contractor was still expected to give a binding tender in even less time—much less as a rule.

87. Consequently, the contractor had to make assumptions which accompanied his offer and so let occasion for price fixing arise during the job.

88. On the other hand, when there was sufficient time for the engineer to prepare his plans, but for some reason the information was not available for the contractor to proceed with the work at the time he wished to do so, in order to conform with the programme, he then had to seek rates to cover the dislocation for which the engineer might not be entirely blameless.

89. The contractor might well have doubts in his mind when negotiating such rates if he felt the engineer had to sit in judgment on a situation he might have created, but in order to maintain a satisfactory climate for the future, the contractor had to accept new rates, although he did not agree with them.

90. The engineer could be in an unenviable position in rate fixing, as the contractor envisaged him as being expected to be completely unbiased, but at the same time he knew that both had an employer, who might well not realize the function of the engineer in such matters.

91. The Author said that contract matters in relation to the contract as a whole should be dealt with on completion of the work. If this meant delaying full payment until rates were fixed, then it could only be equitable if the contractor received a contribution towards his having to finance the money due to him that remained outstanding, often for several years, through no direct fault of his own.

92. The essence of his contribution to this discussion was to suggest that the necessity for rate fixing should be kept to a minimum, because he felt for all parties concerned that a contract was better understood if it was carried out in accordance with the agreement reached by the two parties on the basis of the understanding they had of the obligations involved when they entered into it.

Mr W. A. Fitzherbert (Civil Engineer, Central Electricity Generating Board) thanked the Author for a Paper well calculated to promote discussion on a matter which, to judge from the large attendance, was very dear to the hearts of engineers, and congratulated him on the courage he had shown in lifting the lid of Pandora's

box and letting loose an unknown quantity of contentious material and no doubt an unlimited number of questions.

94. In the limited time available to him, Mr Fitzherbert proposed to comment on the Paper before referring to the complex nature of power station work. He had been associated with the design and construction of power stations since 1936, apart from the war years, and he would like to explain, if he had the time, why contracts for power stations differed from those for harbours, bridges and straightforward motorways.

95. The extent of the civil engineering work alone in power station construction over the last fifteen years since nationalization had been of the order of £30 m. per annum, and with the accelerated programme for the completion of power stations by 1967–68, the expenditure on civil engineering works would be over £40 m. annually.

96. Because of the nature of the work, the very tight programmes and the fact that forty different contracts were placed at one time and had to be phased to meet the commissioning of the boiler plant, the Board had several modifications, variations, additional works and other reasons why contractors invariably made claims, so that the Board had had a fair share of rate fixing and claims. He wished to outline how they attempted to get uniformity of treatment from the consulting engineers that they employed because the same contractors might be carrying out similar work in the North of England under one firm and in the South under another firm of consulting engineers.

97. He had known the Author since 1933 and had had the pleasure of attending on behalf of a client, on at least seven conventional stations and taking part in negotiations, rate-fixing meetings, claims and other matters which formed the background to the Paper. In some cases there had been no agreement and in others 100% agreement.

98. Turning to points in the Paper, the adverse physical conditions mentioned by the Author in his opening remarks appeared in rate fixing claims again and again and there seemed at times to be some confusion in the treatment of the subject. It was referred to in §§ 6 and 35 of this Paper. Clause 12 of the I.C.E. Conditions of Contract laid down a procedure for dealing with costs arising from adverse physical conditions. The agreement on new rates under Clause 52 should arise only if the works were varied to avoid the necessity for the doing of the additional work or using additional plant specified by the contractor when he asked for additional costs for adverse physical conditions. The examples of piling given in the Paper might be considered to be there merely to raise some contentious points.

99. In addition, the Paper highlighted a major difficulty in the I.C.E. Conditions, which was the conflict between Clause 52 (quoted in Appendix 1 of the Paper) and Clause 56. Clause 52 (1) referred to valuations of variations as amounts to be added to or deducted from the sum named in the tender. That was the treatment of variations so far as a building contract was concerned similar to the method used in the R.I.B.A. form on a lump sum basis, but Clause 56 referred to the remeasurement of the contract as a whole. He would illustrate that point in a later question.

100. He was interested also in §§ 32–36 on the boundary of rate fixing. The Generating Board were answerable just as much as many other employers in great detail not only as to how they spent the money, but why. When the electricity supply industry had been nationalized in 1948, 570 different undertakings had been taken into one, all with varying conditions of contract, and the first step taken by Mr Houghton Brown, then Civil Engineer to the Board, had been to standardize on the I.C.E. Conditions. Meanwhile, they had been dealing with a six-year backlog of claims. Having standardized on those Conditions, they had found that amendments to them were necessary so that they could be applied to power stations, and after another six years they had finally, in conjunction with the Federation of Civil Engineering Contractors and the Association of Consulting Engineers, produced their own conditions, which were virtually the I.C.E. Conditions but with additions to several

of the clauses to make them applicable to the building of power stations and the civil engineering work associated therewith.

101. In particular, they had defined more clearly the difference between variations (Clause 51) and modifications of the contract. The latter they regarded as works undertaken outside the scope of the original contract as tendered. Variations were clearly defined already, so that they had not had to define them. They had also clarified the matters to be dealt with as claims, which arose in a variety of ways—delays, lack of access, lack of information, lack of programme—and rate fixing, which they said should be left to cover measured works executed in accordance with the engineer's drawings. Many engineers would be relieved to hear that they had not altered Clause 12 in jot, tittle, comma or fullstop.

102. He would like the Author to indicate, in the context of the I.C.E. Conditions, what steps were taken in calculating starred rates to deal with the consequences of delay or lack of access, and, if the Author included them in his unit rates, how he avoided duplication of payment when he received the inevitable overall claim at the end of the contract.

103. Mr Fitzherbert's other question related to the clash between Clauses 52 and 56 to which he had already referred. In dealing with rate fixing, was not there a complete conflict between Clauses 52 and 56 of the I.C.E. Conditions? Was it practicable to measure variations as such, as distinct from the remeasurements? If so, what was the distinction, and did this lead to any difference in treatment between rates arising from variations and those arising from remeasurement?

104. He had another question which referred to the examples given in the Paper. In the block of on-costs no distinction was made between fixed or semi-fixed charges and variable charges. Did not that method lead to possible over-valuation of both additions and omissions?

105. He had one question in the lighter vein, because the examples given in §§ 42 and 43 did not seem to be altogether serious. The need for four lorries to be in attendance on a machine excavating 10 cu. yd/h was not understood. Presumably disposal was on site, since no tipping charges were shown, and on this basis the round trip took two hours. Had this any significance?

106. Everybody had heard over the last few months, and had seen on television, the reasons why the Generating Board had not been able to meet the load this winter, and there was no point in his going through them again, but out of this, two basic facts had emerged so far as the electricity industry was concerned. The first was that there was a constant investment of new capital in new plant. The Board had to meet the peak load and must therefore have the additional plant. The second was a basic characteristic of the industry. The possibility of the differential loading of plant, and therefore the maximum use of the most efficient plant, put an enormous premium on technical development.

107. To give a few examples of this technical development, in 1948, when the industry had been nationalized, it had been installing to 30-MW sets. Successively it had gone from 30 to 60, 120, 200, 300, 375 re-heat, and now to 500-MW sets. The thermal efficiency aimed at had risen from 27·6% in a 30-MW station in 1948 to a design thermal efficiency of 39·2% for the 500-MW sets which would be commissioned in 1965, an advance of nearly 12%. Turning to capital cost, in 1948 for a 30-MW station the capital cost for the whole station was £67/kW, while in 1965 for a 500-MW station the capital cost would be £35/kW.

108. It would be seen, therefore, that the development of plant was of vital importance to the supply industry, and as a consequence the 'messing about' with civil engineering contracts which sometimes occurred was necessary. They placed forty contracts and had everybody tied up to a four-year programme and they were now trying to find whether they could do it in three years instead. Any delay through lack of material, lack of information or lack of access affected not only the civil contractor but all the people who followed him. They expected to vary the works

and had to modify them because the latest plant was put in almost overnight. On some stations they started off with the idea of having four boilers of a certain type and ended up with three of one type and one of another. All these things had to be done to increase the thermal efficiency and reduce the overall costs. He hoped that these facts would help all those who paid electricity bills.

Mr A. Goldstein (Partner, R. Travers Morgan & Partners, Consulting Engineers) added his congratulations to the Author. He thought both the Paper and its introduction were models of their kind; brief, stimulating, thought-provoking, and doubtless leading to an excellent discussion. He found himself in sympathy with the Author's general aims, though he would take issue with several of the Author's stated methods of achieving these aims.

110. While the Author's attempt to reduce rate fixing to a formula was a brave attempt, it suffered (as would all formulae) from a basic weakness. In order to use any formula by itself for the establishment of a *new* rate, then, by the very terms of reference, it would have to be demonstrated that all rates in a bill of quantities had been derived consistently by the same formula using the same or similar constants. It needed only brief examination of any bill of quantities for civil engineering works to show that this was simply not so. There were various reasons for this. To mention only one or two, the 'loading' of rates was frequent, not necessarily related to any attempt by the contractor to benefit from any errors in the bill of quantities. Rate loading could and did occur quite reasonably when a contractor wished to obtain increased funds in the early part of the contract to assist in his financing of the job. Similarly, some parts of the work might be more profitable than others to a contractor experienced in certain aspects of the work; consequently, he might take different views on those parts of the work and price them differently. Further, there was the element of the contractor's appreciation of risks; certain parts of the work might involve much greater risks than others and, consequently, the contractor might take entirely different views and rate accordingly. On the lighter side, most engineers who had assisted in the building up of tenders had experienced the position where a tender was carefully worked out to the final detail; it then went up to the board room at the eleventh hour for a final blessing; the directors, exercising their judgement as to the state of the market and the necessity for getting the job, took a view and sent it down at half-past the eleventh-hour to the estimators to 'knock off £100 000'. In the final rush, therefore, the rates had to be adjusted, to comply with this policy decision and this made any attempt at formulae meaningless.

111. Referring now to some other parts of the Paper, Mr Goldstein thought that at first sight § 10 might seem unexceptional. However, on detailed analysis, it seemed that the position was by no means as clear as stated. In several cases the engineer might need a 'crystal ball' to proceed as was suggested in the Paper. The effect of genuine errors also vexed this issue. It seemed to him that each of these cases must be judged on its merits and that the statement could only be admissible as a generality.

112. Referring to § 2 of the Paper, Mr Goldstein thought that on civil engineering work (particularly where the civil engineering work was the main part of the work as distinct from perhaps power stations, factories and the like) *all* drawings, bar lists, etc., must be ready at the time of tender. It was for the engineer to insist that he be given sufficient time to ensure that this was so. The contractor was entitled to this when tendering and it only made, for lots of arguments if all this material was not available. In his opinion, the engineer would not be exercising his duties properly if only a few typical drawings were available. The situation was by no means the same in civil engineering work as it was in building; in the latter the often made, and, at tender, contemplated, changes of the work might make this procedure impracticable; but this was to the detriment of building work procedure and should not be followed in civil engineering work.

113. Referring to § 23, it seemed to him that while a site meeting during the tender period might be good practice, in his experience it was seldom of great advantage. By no means all the tenderers attended. In any event, anything said by the engineer or by the engineer's staff was completely without contractual basis and most instructions for tendering included an express clause stating that neither the employer or his representatives nor the engineer or his representatives had any power to say anything at such a meeting which was contractual. Consequently, much misunderstanding could arise through this type of 'off the record' discussion. It seemed to him that it was better procedure to have any queries sent in to the engineer in writing on the understanding that all queries and answers were circularized to all tenderers.

114. He found it difficult to follow § 26 of the Paper with regard to the recommended conservatism of the resident engineer in fixing 'on account' rates. Provided that the work could be properly priced, it seemed to him the better procedure for the engineer, having done his best to agree with the contractor, to make the decision as to what the rate should be and then stick to it. There had recently been much criticism of the time taken in settling final accounts and he felt sure that if all interim matters of this nature were dealt with in an energetic and forthright way, everyone would know where they stood and the time at the end would be much reduced.

115. He could not understand the example illustrated in § 35. Quite apart from whether Clause 12 applied in the case of simply harder-than-expected driving (the Clause dealt with unforeseen physical conditions and by no means all cases of hard driving fell within the scope of this Clause), even if an extra rate were granted, then it would surely only apply to the situation where Clause 12 applied, viz., where there were unforeseen physical conditions. The suggestion that it would apply to all piles, even if only part of them came under this clause seemed to him erroneous.

116. He would take issue with the Author's statements in §§ 33 and 36, namely, that contractual matters should be left to the end of the job. Similarly, he seriously doubted whether the Author was right in suggesting that the contractor could always claim at the end of the job. There was no doubt in his mind that Clause 52 (4) was one which, although ambiguous in many respects, 'bites' on this matter. There seemed no question but that unless the contract stated anything to the contrary in any particular clause (e.g., Clause 12), the contractor was obliged to submit his claims within a month. Quite apart from the purely contractual interpretation of the contract, the Federation of Civil Engineering Contractors, in their memorandum to Sub-Committee B of the Estimates Committee, Session 1961–62 (7th Report from the Estimates Committee), stated this in so many terms. This principle was subject only to the engineer's discretion to waive it. The engineer might exercise this discretion or might not. Certainly, in the event of some simple 'fine print afterthoughts' by the contractor at the end of a job, the engineer might be held to be exercising his discretion improperly if he did so at all. If he did not exercise his discretion, then it seemed clear that the claim was inadmissible for consideration quite apart from its validity or otherwise. It seemed unlikely in law that the arbitrator could change this principle. One must after all consider that on all these jobs the employer was entitled to be progressively advised as to expenditure. With the best will in the world misunderstandings might arise which if they were pointed out by way of a claim at the right time might result in consequential action reducing costs. Expenditure of public monies must be considered no less stringently than private monies and, in the case of a private job, the employer simply might not have the extra sums available. These two particular paragraphs could be misleading and perhaps the Author would care to qualify them in some respect.

117. Referring now to the General Conditions of Contract, comments on these had been made both in the introduction and by other speakers. There seemed no doubt that whatever one might think about the value of the particular current I.C.E. Conditions, they were ambiguous in many respects and to that extent could be held a bad form of contract. Much emphasis was often and rightly laid to the establish-

ment of good relations between contractor and engineer both on site and at head office. This was a proper emphasis, but if 'good relations' existed there was no need for a form of contract (in the sense that it could be put into the safe and 'forgotten'). Standard forms of contract must always be drafted on a basis that the parties might at some time or other be obliged to deal with each other at arm's length, and it was irrelevant and erroneous to justify shortcomings in the Conditions of Contract by emphasis on good relations (though, happily, these often existed).

118. The Author had referred to the situation before the second world war where the engineer was often required to act in a 'quasi-judicial' position. This was perfectly true and indeed had a long precedent dating back to the original establishment of the present type of contracting procedure by Telford. However, those forms of contract did not have an arbitration clause and there was little doubt that under the current form the engineer could not act in such a position. It seemed to him that the value of an arbitration clause in cases where principles were involved was extremely questionable. Certainly in those cases arbitration was neither cheaper nor shorter than legal procedure and generally had an unsatisfactory outcome; apart from anything else it could not form a precedent. Often it was simply a 'dummy run' leading to a stated case and authoritative treatment at law. He felt that a limited reversion to pre-war types of contract whereby for certain aspects the engineer was the final arbitrator under the contract would be greatly in the interests of both the contractor and the employer.

119. To summarize, he welcomed this Paper which was just the type of paper one ought to have. However, he would rebut the suggestion that the subject was a matter of 'science'. Certainly, the subject was one that always made for good discussion but like all really important issues seldom lent itself to a purely scientific approach. Most cases required a considerable amount of experience, and, above all, sound judgment. He was content to have it so, since judgement had often been referred to as the highest faculty of the human mind.

Mr R. L. Triggs (Director, Edmund Nuttall, Sons & Co. (London) Ltd) felt that when speaking on such a subject as that under discussion, speakers should declare their interest. He was a contractor; and he had some doubts about whether the Paper should ever have been published; it might have been better had it been circulated furtively from hand to hand amongst those engineers with sufficient experience not to be corrupted by what it contained, for what in fact it did contain was a set of rules, a code of practice, for rate fixing.

121. For those who wanted to know how to fix rates the method was set out in Clause 52 of the General Conditions of Contract. What it amounted to was this:

> 'If the Contract shall not contain any rates applicable to the extra or additional work, then reasonable prices shall be fixed by the Engineer'.

It would be a great pity if today's changing conditions, which the Author had described in his introduction that evening, in any way restricted the complete freedom of the engineer to do what he thought was reasonable without any pressure on the part of his contractor or his employer to conform to a set of rules.

122. In § 10 of the Paper it was stated that.

> 'A satisfactory interpretation of his responsibility is for the engineer to determine, for new or substituted items, the rate which the contractor would have inserted against that item had it been included at the time of tender.'

It was interesting to see how that could work out, and Mr Triggs quoted one simplified case. The facts in this case had been slightly different. He had to say that, or one member present would attack him afterwards. This was not a claim that he was putting forward.

123. Some time ago a contractor had been asked to tender for a quay wall. The line of the quay wall ran roughly parallel to the shore at low water, but was at a slight angle with the shore, so that one end was in comparatively shallow water and

the piling could best be done from equipment based on land, but at the other end, where the water was deeper, it could be carried out better with a pile frame on a pontoon. Only one equipment, however, was necessary for the whole job, and the overall advantage lay in employing the pontoon for the whole of the work. A tender and prices had accordingly been put in on that basis.

124. Before the work started, the employer decided that he could make do with a shorter quay wall and he chopped one-third off the end where the water was deeper. The result was that the balance of economy changed and it became more economic to drive the piles with equipment on land. The contractor therefore decided to use land-based equipment and started the work. Later, however, the employer had second, or rather third thoughts and decided to go back to his original scheme.

125. What should the contractor be paid in that hypothetical case? (The circumstances had in fact been more complicated than this.) According to § 10 of the Paper, the rate should be that which the contractor would have inserted against the item at the time of tendering. The contractor had in fact inserted a price for that precise work at the time of tendering, but he had supposed at that time that he would be doing all the work from a pile frame on a pontoon rather than using a Goliath on land. Was the engineer in such circumstances to stick to a written rule, or should he say 'No, I shall throw my rules out of the window and do what I think is reasonable'? It would be a sorry day for everybody if the engineer felt himself restricted in any way from doing exactly what he thought was reasonable, and for this reason he felt that any attempt to write a set of rules for rate fixing should be treated with great caution.

126. Mr Triggs felt that he had perhaps been a little critical, and he had omitted to congratulate the Author on having the courage to write a contentious Paper and particularly on his splendid introduction of it that evening, which was very interesting indeed. The fact was that whenever a contractor saw the words 'rate fixing', he felt that he had to start arguing; that was in his code of practice!

Mr V. H. Gritton (Senior Engineer, Sir Wm Halcrow & Partners) said that when he saw the announcement in the Institution's programme that a Paper was to be presented on rate fixing, he had been extremely pleased that the Institution had decided to include this among the subjects for discussion, and he was very grateful to the Author for setting down the basic principles which underlay this comparatively difficult subject. Young engineers in particular, when they went into consultants' or contractors' offices, had virtually no knowledge at all of the subject. They came from university after receiving a purely engineering training and, if they went into a contractor's office, were made to think about and feel the cost of the job, but in a consultant's office they probably did not often get that kind of training. Only when they became resident engineers and had to grapple with the contractor, did they really meet the problems and acquire a knowledge of costs which was going to be useful to them later as consulting engineers when they had to produce the estimates which were so important when submitting their schemes to their employers. The Institution, therefore, might well consider setting papers on this subject in Section B of the Institution Examination; it could have a paper on bills of quantities and costing, and, in due course the universities might follow suit and treat this subject in their final year.

128. On rate fixing, consulting engineers and contractors got together and tried to agree rates. They both worked them out completely independently and then came together to find that their rates were miles apart. Why? In many cases, probably, the profit motive in the contractor's office or in the mind of the contractor's engineer tended to make him feel that things were a little more expensive, and the consulting engineer, thinking of his client, tended to be on the low side; but there were other reasons, and Mr Gritton felt that the Paper, by over-simplifying the problem avoided the reasons. The examples given in the Paper were, he knew, supposed to be very

general, but for the benefit of young engineers who would read the Paper there were a few points which he wished to make.

129. Examples were given which included labour, materials, plant and on-costs, but in § 44, dealing with excavation, account might have been taken, as a further example, of the fact that the excavator had to be brought from wherever it had been working last to the site of the present work and the cost of that transport had to be included in the rate. In § 49 there was a concrete mixer but there was no item for transporting the concrete from the mixer to the work or for handling it by crane, skips or in any other way.

130. On § 11, while the number of men and the size of the plant could be arrived at fairly easily, the manner in which the particular operation under construction was tied in with the whole programme on the site was much more difficult to analyse. For example, where several operations were to be followed in sequence, it might happen that all the operations had to be carried out at the speed of the slowest, so that the cost of all of them would be higher than had been originally calculated when considering each of them separately.

131. On the question of plant, the Author gave some examples and used Federation rates. The engineer could look up the day-work schedules of the Federation of Civil Engineering Contractors or the lists of the Contractors' Plant Association for rates on many items of plant, but would sometimes be faced with having to agree rates with contractors for large and difficult items such as dredgers, cableways, crushing plants, tunnelling Jumbos, etc., and would find very little in writing to help him. The experienced engineer would have no difficulty in arriving at these rates, but the young resident engineer on site who had to agree a rate with the contractor might find it a problem, and it might be useful to give a formula to help him to arrive at the hourly cost of such plant. It was necessary for the formula to provide variables for the various conditions which arose and Mr Gritton suggested the following:

$$H = \frac{\left[\frac{r(1+r)^l}{(1+r)^l-1}\right] CK(1+M)+I+F}{2400}$$

132. H was the hourly rate which was required, based on 2400 hours a year. The figure of 2400 could be varied if much overtime was to be worked. r was the rate of interest on capital, chosen according to the figures existing during the period of the contract. l was the life of the machine in years and would vary according to site conditions, climate and other factors, such as the use of inexperienced drivers on sites abroad. C was the capital cost of the machine. K was a factor which was important for these big items of plant, as it depended on the ratio between the time spent in working and the time of enforced idleness in between contracts. This ratio was known as the occupational ratio and where idleness was $33\frac{1}{3}\%$, $K=1{\cdot}5$. M was the addition which had to be made for repairs and maintenance, and would vary up or down according to the problems of the particular site, the skill of the mechanics, the heavy stocks of spares that the contractor had to carry abroad and so on. I was the insurance cost and F covered the annual fuel and lubrication costs. A separate allowance had to be made for the transport of these big pieces of plant to the site, sometimes half way across the world.

133. He believed that l, the life of the plant, was probably one of the most controversial figures. The old rule of 20% depreciation a year was not a satisfactory answer for a dredger. It might be possible to arrive at the life by having two curves, one for depreciation and one for repair and maintenance costs, and where the two crossed would be the end of the economic life of the machine; but these curves must be based on facts, and the facts were usually not available when the calculation was being made. Perhaps there was no answer to the problem of the life of the machine, which might depend as much on the character of the contractor and of his plant engineers as on anything else.

134. Summarizing, he would emphasize again that rate fixing was a difficult subject and must not be over-simplified. Although the Paper set out some of the basic principles, young engineers using the Paper as a model must realize that the examples did not include all the various aspects which they must allow for when trying to arrive at a rate themselves. For plant the formula which he had suggested might be of some help and he would be interested to have the Author's views on it.

Mr D. P. Bertlin (Messrs Bertlin & Partners) said that when he told an American friend that the Institution was to discuss the question of rate fixing in civil engineering contracts, his friend remarked that the Institution must be a very progressive body, as a learned society, to discuss the question of fixing rates. It had been necessary to explain that fixing in this country meant something rather different from its meaning in America.

136. He had been a contractor as well as a consulting engineer and he had also been a client, so that he had looked at the business of rate fixing from many different angles. The formulas which had been proposed that evening seemed to him to be rather lacking in reality, and he did not see how it was really possible to apply a formula to this problem. All these rates had to be fixed according to the merits of the case and many different factors had to be taken into account, such as, for example, the problems posed by Mr Triggs's telescoping jetty. There was no point in trying to be too precise or in trying to restrict the engineer in any way in fixing rates. For one thing, each individual contractor had his own system of estimating, and unless one were going to price a contract right from the start and do more or less what the contractor had done (which would never be in agreement with the contractor's version), it was necessary to go about rate fixing in a much more arbitrary way. Mr Bertlin felt that an engineer would normally know the right sort of rate and would therefore be able to arrive at a fair figure.

137. This seemed to him to be a very personal matter indeed. It was the duty of the engineer to be completely impartial and to take into account the points of view of both the client and the contractor. He should not be influenced by the fact that the contractor might be losing money. Mr Bertlin recalled that on one contract, just before he had had to fix several rates, the contractor had sent him a letter enclosing a chartered accountant's statement to the effect that he, the contractor, was losing a lot of money, which seemed an odd way of starting such a discussion.

138. There were a few points which should be kept in mind, in order to avoid having to fix rates more than was necessary. One was that, as had already been mentioned, very adequate plans and drawings should be prepared before the contract was let. Another point was that rates ought to be arranged before any substantial work was carried out, if this was possible, because a contractor would always be more amenable if he realized that the work might not be given to him.

139. The fair fixing of rates must depend very much indeed on the individual consulting engineer and his skill and experience. It might not be a case of 'Your life in their hands', but it was certainly a case from the client's point of view of 'Your money in their hands'. The necessity of fixing rates and settling claims was one of the strongest arguments for the continued existence of consultants, and, as there would be a lot to fix in the future, consultants were likely to have a reasonable future ahead of them.

Mr T. M. Megaw (Partner, Mott, Hay & Anderson) suggested that the admirable Paper under discussion would be quoted, and probably misquoted, in arguments for many years to come. His own comments on it were on the narrower aspect of pricing as distinct from the wider discussion on claims which had been introduced. As Mr Goldstein had pointed out, the Author's formula for pricing seemed to contain a tacit assumption that contract prices had been built up on a consistent and uniform system which could be analysed and utilized for building up new prices as necessary.

Unfortunately, contract prices did not always conform to such a system, but must be accepted as an element of any pricing, whether or not a reasonable analysis of their make-up could be obtained. In those circumstances Mr Megaw wished to suggest some of the principles which applied, though a great deal must be empirical.

141. The standard Conditions of Contract provided that work should be valued at the rates in the contract if applicable, and, if not, that reasonable prices should be fixed by the engineer. Extra items fell normally, he suggested, into one of three categories. There were those items to which contract prices could be applied directly; there were those so different that contract prices could not be applied at all; and, thirdly, there were items in which there was a substantial element of work already priced in the contract but also an element of new work.

142. In the first category, the question to be considered by the engineer was whether or not the contract rate was applicable, which involved careful examination of the real content of the item and not merely its description in the bill. It should be noted that in Clause 12 of the Standard Method of Measurement it was made clear that the description of an item was to be as brief as was consistent with its identification and that reference to the drawings and specification was necessary to establish its content. By 'the real content of the item' he meant the various things necessary for its complete execution, whether they were explicitly defined or were implicit in the item. That did not necessarily involve any examination of the make-up of the price, which might be helpful but might be quite misleading. The real content was what should be covered; any charges or special loadings in the price were irrelevant. The total quantity involved might be relevant. Having examined this content and heard any arguments, the engineer formed his opinion whether or not the rate was applicable. If applicable, he would not further examine the reasonableness of the rate, whether it seemed to be too high or too low; it was a contract rate.

143. In the second category would come the completely new items. These could be priced only on a basis of cost, actual or estimated, with proper additions for overheads and other charges, as in the Author's formula.

144. It was in the third category that most items fell and that difficulties arose. Some variations from contract items were small and it was easy to apply a price from a contract item, with adjustments as shown in the Paper. If the variation from the nearest comparable contract item was substantial, or if two differently priced contract items were both relevant, it might be difficult to arrive at a fair and reasonable price on this basis, but he was strongly of opinion that variation of contract items should be to the greatest possible extent dealt with by adjustment on the contract items and not by re-pricing. There was a distinction to be made, however, between the pricing of variations and the pricing of additional works ordered against a provisional or contingency sum. In the latter case the principles still applied, but it was much more difficult to establish the extent to which any contract price was applicable.

145. Those concerned with fixing rates should keep their eyes on the real content of the work concerned and not merely juggle with the arithmetic of prices.

Mr A. J. Edney (Consulting Engineer) observed that the Author's carefully reasoned approach to the problem of rate fixing was undoubtedly directly applicable to problems which admitted a straight arithmetical calculation. By adopting the system suggested, it would be possible to arrive at reasonable prices for varied work when existing rates in the bills of quantities provided a suitable basis for such calculations. Difficulties began to arise when circumstances rendered contract rates, or rates analogous to contract rates, unreasonable.

147. It was then, as the contract said, the duty of the engineer to fix a rate or price which he considered to be reasonable and proper. He might be called on to do this in respect of variations or in assessing claims under Clause 12 on account of unforeseen physical conditions or artificial obstructions. This latter was not strictly rate fixing, but the same problems were involved.

148. Factors giving rise to special circumstances affecting rate fixing were well known to most engineers and might include delay to, and interference with, the execution of the works; disruption of project organization; uneconomic working of labour; disorganization of the plant programme; difficulties in obtaining additional materials; and late issue of drawings and instructions.

149. Any of those factors might cause considerable extra expense to a contractor in circumstances which entitled him by the terms of the contract to be reimbursed. They certainly frustrated any attempt to relate rates or prices to those which a contractor might have inserted at the time of tender.

150. It was because these problems were often not capable of solution by exact mathematical formulae that the engineer's representative and the contractor's agent, who usually had to deal with them in the first instance, sometimes allowed clumsy and unskilful attempts at negotiation to develop into personal quarrels. This could be disastrous to the successful and economical carrying out of the work, particularly on isolated sites or overseas contracts. Quarrels of this kind had a habit of spreading and affecting the attitude and morale of everyone on the job.

151. It was essential that the engineer's representative and the contractor's agent should leave their principals room for manoeuvre in later negotiations. The responsibility for arriving at a just solution in these matters was the engineer's and his alone. The contract said: 'The Engineer shall determine . . .', and 'The Engineer shall fix such rate . . .'. This work required patience and ability to argue with courtesy and good temper. The engineer was, as the Author said, charged with ensuring that the employer and the contractor were treated with justice.

152. In this somewhat difficult problem of fixing prices when there were special circumstances, Mr Edney suggested that it was sound practice to invite the contractor to put forward his own calculations of special rates or prices or of extra expense and at the same time to submit in writing the full facts on which he based his calculations and to set out exactly the words of the contract which he considered entitled him to payment. The engineer was then in a position to satisfy himself on the alleged facts or to disprove them, and also to consider the applicability of the contract clauses on which the contractor sought to rely. It was advisable for the engineer to record his notes in writing.

153. Both parties were then in a better position to negotiate a just price. This usually required a flexible approach and rigid attitudes should be avoided. If agreement could not be reached, the contractor's remedy under the contract was to give notice that there was a dispute and to invoke the arbitration clause. If he did this, the engineer had first to reconsider the matter in dispute and give a decision in writing to both the contractor and the employer. That was an added reason for the engineer to record the arguments in writing in the first instance.

154. In the Author's comments on the boundary of rate fixing it was mentioned in § 32 that it was wise for the employer and the engineer to reach agreement on certain matters. There should be no misconception of the duty of the engineer to remain independent of his employer when carrying out what were called quasi-judicial tasks which were imposed on him by the contract. The fixing of reasonable and proper rates was one of those tasks. The engineer's position in such circumstances had been defined by Lord Esher in the case of *McDonald* v. *Workington* (*Mayor, etc. of*) when he said:

> 'Where a surveyor is put into that position to give a certificate, I do not say he is an arbitrator but he is an independent person. His duty is to give the certificate according to his own conscience and according to what he conceives to be the right and truth as to the work done and for that purpose he has no right to obey any order or any suggestion by these people who are called his masters; for that purpose they are not his masters.'

155. Under the conditions of contract used in civil engineering, the employer

delegated completely the authority to the engineer both to order necessary variations and to fix the proper prices to be paid for them. The engineer in his capacity as agent must necessarily consult with the employer and report on the quality of work, on the contractor's expenditure and on the proper sum to be paid to the contractor. He must not submit to the employer's control and influence and render himself incapable of taking an independent view in giving his certificates, which of course involved fixing proper rates and prices.

Mr W. G. Mitchell (Mitchell Brothers Sons & Co. Ltd), speaking as a contractor, expressed his appreciation of being given the opportunity to comment on the Paper, which dealt with a matter of the greatest interest and importance to the contracting industry. He was of opinion that the satisfactory conclusion of any civil engineering project depended very largely on all those engaged in it working as a team and anything which might hinder this was, if possible, to be avoided. The more clearly it could be understood, especially by young engineers who might be holding their first appointment as resident engineers, how the rates in the contract had been arrived at, the less likely it was that friction would arise. That point had already been made by a previous speaker. Mr Mitchell's remarks would be directed more to younger, rather than more experienced, engineers, and therefore his comments on the fixing of rates were based on the more simple methods rather than the more complicated ones.

157. Before touching on the actual fixing of rates, he wished to comment on some of the general points to which the Author had referred. He had been delighted to find that the Author appreciated the necessity for an adequate tendering period. Even for the smallest job the contractor, apart from the work which had to be done in his office on preparing his tender, had to obtain quotations for materials, which often took a considerable time to get, and it was most frustrating for a contractor to be asked to prepare a tender in a very short space of time, often to suit a committee meeting of some local authority.

158. He was in general agreement with §§ 24–31 of the Paper, although he could not quite follow the reference in § 24 to the contractor applying for a new rate 'providing that the engineer issued a revised bill of quantities'. Surely the contractor could always ask for a new rate if he thought the existing one to be inapplicable? Similarly, he did not appreciate the comment of the Author in § 29 that at rate-fixing meetings 'all new rates are fixed by the engineer with the contractor's acceptance if not always his agreement'. Surely if the contractor did not agree with the rate, he did not accept it, unless as an on account payment?

159. In § 32 reference was made to general agreement between the employer and the engineer as to where the boundary of rate fixing lay. Mr Mitchell was concerned about this, as it might be taken as a watering down of the engineer's authority referred to in § 21. In Clause 52 of the I.C.E. Conditions of Contract it was clear that the engineer determined any variations in the sums paid to the contractor and should exercise this power without fear or favour. If either the employer or the contractor was dissatisfied, he could have recourse to arbitration.

160. He agreed with the point made earlier in the discussion with reference to the example given in §§ 35 and 36, that it could be very hard on the contractor if he made a legitimate claim and it was left for payment until the end of the job, which might keep him out of money to which he was entitled.

161. Coming to the mechanics of rate fixing, the first consideration was the case where an existing rate in the bill was considered applicable to an item of additional work. In that case the engineer must be assured that it was applicable. Contractors had had many fights with engineers on the applicability of existing rates.

162. The next point was the fixing of new rates. Here the Author said that to deal with the price of materials should be comparatively simple, and with that Mr Mitchell agreed. On the question of labour costs and the reference to extra men in a

gang, his thoughts turned to the case of half a man required for two hours at 3 a.m. If that was worked out as a rate, it was astronomical, but that situation arose and allowance had to be made for it.

163. On direct plant costs allowance had to be made for getting the plant to and from the site and for its erection. These items were not referred to in the example. The biggest difficulty arose with on-costs, because this was the most difficult matter to assess. In making up his tender the contractor had to prepare his programme and from this evaluate the site on-costs, generally built up from the erection of buildings, the provision of fencing, transport to and from the site and so on. These were in the main once-for-all charges for the work as set out in the drawings and contract documents. Secondly, there were the costs for supervision and so on, which were all functions of time. Thirdly, there were direct charges on wages such as third-party common law insurance, which were again largely functions of time. Fourthly, there were head office costs, and on top of the total for materials, labour and on-costs there was a small sum, he hoped, for profit.

164. From this it would be seen that if there were no variations at all, these items could be added as a lump sum or as a percentage. The method of adding them to direct costs differed with different contractors. Some spread them evenly; some put more on particular sections of the job, and justifiably because certain sections needed a higher proportion of temporary work. No general pattern could be assumed.

165. As soon as a variation of any size was introduced, there must be a complete reappraisal of the position and no fixed percentage could be added to deal with on-costs. The Author took the percentage on-cost on labour as 70% and on materials as 10%, but the percentages might be quite different for different variations in the same contract, though for practical purposes and small variations an overall percentage could usually be agreed. If major variations were made to the contract, there were many matters which were exceedingly difficult to evaluate. A large variation might involve complete replanning and reorganization of the contract and might cause delays due both to the variation itself and to the necessary time while the decision was being made and new designs prepared. As the Author said in § 12, time was a function of money and delays had to be paid for.

166. In conclusion, he thanked the Author for a Paper of great interest, which must have inspired thought in the minds of many people, as it had in Mr Mitchell's mind.

Mr C. D. Crosthwaite (Freeman, Fox & Partners) dealt with the statement in § 10, which he thought could be regarded as contentious, that the engineer should consider the rate which the contractor would have inserted against the item had it been included at the time of tender. What had to be borne in mind there was how circumstances had changed and what the contractor would have inserted with full knowledge of conditions as they were at the time that the rate was being fixed. For example, one reason for rate fixing might be that access which at one time had been available was no longer available, or the main items of plant might have gone, the batching plant might have disappeared, and more concrete might then be required; or the cranes might have disappeared and additional work might be wanted on the dam. In all these cases the engineer had to consider what the contractor would have done in pricing had he known of these factors at the time.

168. With regard to rate fixing, many speakers had said how much better it was that the engineer should not attempt to fix the rate unilaterally but that the rate should be a matter of agreement. He had better not say much more about that, except that if the engineer insisted on unilateral rate fixing, then if the contractor accepted the rate without question, the engineer could reasonably assume that his rate had been too high in the first place. On the whole, Mr Crosthwaite agreed with other speakers that the best plan was to attempt to find analogous rates and apply them, making allowance for differences.

169. The Author's calculation with regard to plant seemed to be related to Federation standard day-work rates. Mr Crosthwaite did not think that those rates were intended to be applied in that way. If there was a lot of new work and plant was charged at Federation rates, it would be found that the client had paid for the plant several times over. On the other hand, if the plant rates were realistic, he did not consider 5% was anything like sufficient as an on-cost addition.

170. Contractors differed very much in the way in which they charged their preliminaries. Some contractors put almost all their preliminary items into their rates. He spoke now to advise the young resident engineer who had to try to agree rates. Such an engineer would have to consider whether the preliminaries were in the items or outside, because it would make a substantial difference to the figure ultimately arrived at.

Mr G. Cole (Senior Engineer, Ministry of Agriculture), on the subject of on-costs, said that in § 10 it was suggested that a satisfactory interpretation of the engineer's responsibility was for him to determine, for new or substituted items, the rate which the contractor would have inserted if that item had been included at the time of tender. In § 19 the Author said that the assessment of direct costs was relatively straightforward but that this was not so with on-costs. No doubt that would be widely accepted. It was possible to agree relatively easily to figures for plant, materials and labour, but when the engineer allotted $x\%$ on labour and $y\%$ on materials, the contractor, perhaps not unreasonably, would reply that his figure was $z\%$ on labour. He could argue that this represented his actual costs, and what could be better than that?

172. In the same paragraph the Author said that the firm's on-cost was subject to the requirements of its policy at the time of tender. Mr Cole submitted that it was at least open to question whether the firm's policy should be an item in the engineer's price fixing. Moreover, although bills might be priced in the first instance by the firm's estimators nicely in accordance with the theory described, the board of directors—or some boards, as had already been said—would probably alter the prices before submitting the tender.

173. It was significant that the Author stated that using the contractor's build-up was '*a* satisfactory interpretation', because it had been forcibly suggested, though not in the present discussion, that this method was sacrosanct. If that were so, ought it not to be written into the conditions of contract? It would be most helpful to have the views of the Author and of further contributors to the discussion on other methods of fixing the on-cost.

Mr H. H. Miles (Peter Lind & Co. Ltd), who declared his interest on the contracting side, pointed out that in § 21 the Author stated that 'it is a fundamental principle that the engineer shall adjudicate in a manner fair to both contracting parties' and in § 32 said that 'it is not always easy for the engineer to decide where the boundary of rate fixing lies'. Was the Author prepared to say where this boundary lay? Mr Miles was worried to find that the engineer seemed to have had some of his powers taken away from him, but other speakers had said quite enough about that.

175. In § 28 the procedure to be adopted by a resident engineer was outlined. He hoped that the resident engineer in turn gave his views to the agent, so that when the representatives of the contracting firm and the engineer met, each side knew what the other was talking about and had all the facts clear. It was most useful if the facts could be agreed between the agent and the resident engineer at an early stage.

176. In § 35 the comment was made that in the circumstances given 'the contractor would have scored unfairly at the cost of the employer'. It sounded as though there had been a football match and a disputed penalty! He was sure that that was not the intention. There was no unfairness if Clause 12 had been carried

out correctly by both sides. The decision was advantageous to the contractor, and good luck to him!

177. In Appendix 2, dealing with excavation, had the Author considered making a supplementary item for the extra excavation? That might be in accord with the Standard Method of Measurement. The revised output rate was a direct combination of the output rates for the first 6 ft and the subsequent 2 ft on measured work. Had the Author given consideration to the increased overdig and subsequent backfill and the need for the increased area to accommodate larger batters, or the costs of any other method of retaining the excavation? A young engineer would need guidance on these points.

178. Generally, Mr Miles wished to emphasize that each rate in the bill of quantities was the optimum at which the contractor could do the work as specified in the conditions existing at the date of tendering. If those conditions were changed, this optimum disappeared. It should be realized that the rate for additional works might not cover all the extra costs involved, because the additional works might cause delays to the project as a whole, and these could involve considerable costs through the uneconomic use of labour and the upsetting of the arrangements for site organization, plant utilization and so on.

The following contributions were received in writing:

Mr F. G. Bridgman (Messrs C. Bryant & Son Ltd) wrote that in § 10 the Author stated that a satisfactory interpretation of his responsibility was for the engineer to determine, for new or substituted items, the rate which the contractor would have inserted against that item had it been included at the time of tender.

180. This was an incorrect interpretation. The rate determined for a new or substituted item was based on prices obtaining when the item was ordered to be executed.

Mr C. L. Clarke (Sir William Halcrow and Partners) wrote that this Paper was a welcome one, as it dealt with a problem occupying much time. Though the Author called attention (§ 22) to the need for an adequate tender period, he did not bring home the fact that so many of the difficulties in pricing variations arose from insufficient care being given by both parties in preparing the tender. As a result, it was, unfortunately, too often that the contract was awarded to the contractor who had made the largest inadvertent omission. Examples also occurred in most contracts of obviously erroneous rates; how far was it 'reasonable and proper' for the engineer to take such rates into account when pricing new and varied work?

182. These difficulties could be lessened by taking the following steps in the tendering stage:

(*a*) Allowing more time for preparation of tender documents by the engineer: this could often be achieved without affecting the completion date by letting separate contracts to cover preliminary works such as access, cofferdams or bulk excavation. These works could then be in progress while the main tender documents were being drawn up and, when the tenderers for the main contract came to site, they were more able to appreciate site conditions and hence to submit more realistic tenders. Disadvantages were obvious—the employer had to start the work, relying only on the engineer's estimate of the final cost—also the preparatory work might not have been carried out in the way best suited to the main contractor's methods, with consequent waste of money; these could usually be overcome with sufficient care and experience of the engineer.

(*b*) Allowing adequate time for the pricing of tenders: pressure by employers to cut the tender period might be reduced if the Federation and Association were to agree—and recommend with the General Conditions of Contract—minimum tendering periods for differing types and sizes of contracts.

(*c*) By tenderers stipulating more fully with their tenders the assumptions on which their prices were based where the conditions were not clear in the tender documents.

(*d*) By tenderers including with their tender a make-up of their rates: this suggestion was made with some hesitation due to obvious objections from contractors—mainly in their understandable desire for secrecy—though this secrecy often appeared misguided and frequently worked against the contractor's interests. The system was adopted when calling for tenders for a large contract (£3 m.) abroad with, perhaps surprisingly, little or no complaint by the tenderers. Not only did the fully-detailed tenders enable mistakes to be clarified, even if not changed, but also facilitated a fair assessment of suitable rates for altered work. (If tenders were inspected by the engineer before publication, mistakes could be rectified at that stage.)

183. The Author had advised (§ 26) resident engineers to be conservative in fixing the 'on-account' rates and then pointed out (§ 36) that it was 'often best' to leave some of the final rate fixing until the completion of the works. This was indeed often necessary, but was it then fair for the provisional rates to be fixed below realistic values? For example, it was not unusual for a contract to have a quarter of its work being measured under variation orders; if half these rates had to be left and were provisionally fixed, say, 20% below their final values, the tied-up capital, or outlay, of the contractor could be raised by a quarter or more. (Perhaps it was not surprising that the x% in contractors' tenders included such a variable amount to cover additional costs due to the engineer concerned.)

184. The Author's views would be welcome on the method of deriving the percentages X, l, p and m (§ 8). For example, was it fairer to arrive at these figures through the experience of the engineer by comparison with similar contracts—if there were such things, or by accepting figures proposed by the contractor and supported by necessarily nebulous figures?

185. Contractors might, perhaps, be interested to note the common-law attitude towards major variations (*per* Lord Kenyon in *Pepper* v. *Burland* (1792)): 'If a man contracts to work by a certain plan and that plan is so entirely abandoned that it is impossible to trace the contract . . ., the workman shall be permitted to charge for the whole work by measure and value as if no contract at all had ever been made.'

Mr C. V. C. Elliott (Director, Murray & Stewart (Border) (Pty) Ltd) wrote that as a contractor, he was most interested to read the Author's Paper. His formula, giving the basic method of arriving at a rate, was surely the method used by most contractors.

187. The estimate of the amount of labour and plant required for any particular operation was the basis of good contracting and many different techniques could be used for any one operation. This could give rise to differences of opinion when establishing labour and plant estimates for a new rate, but should not present much difficulty to an experienced resident engineer and an efficient contractor. Probably the main variable that had to be established when using the Author's formula was the percentage of on-cost, and here the writer would like to make the following suggestions.

188. If as many establishment costs as possible, some of which were listed in § 18 of the Author's Paper, could be allowed as lump sums in the preliminary and general items, then the remaining on-costs could be divided into on-site overheads, off-site overheads and profit. On-site overheads could be calculated by making allowance for all non-productive personnel on the site and the off-site overheads would vary, depending mainly on the amount of clerical and supervisory work not actually done by site staff and the amount of capital layout required to establish the contract.

189. As an indication of the variations possible in overhead percentages the writer could advise that the usual labour on-cost added in South Africa was often less than half of that which was indicated in the Author's examples. The indicated percentage added to material was common, but could be either double or half this amount, depending on circumstances, probabilities of waste, etc. Plant-hire rates were generally always expressed in terms of all-in rates, but included much higher overheads in arriving at these rates than those expressed in the examples.

190. The establishment of plant costs when arriving at new rates could be greatly assisted if a schedule of relevant plant-hire rates were called for with tenders. Any other plant rates required could easily be proportioned from those tendered.

Mr H. D. Manning (Messrs J. D. and D. M. Watson) wrote that he would appreciate the Author's comments on the following three points.

192. (*a*) Contractors were believed to base their tender rates on calculations of the type described in the Paper. They varied widely in their methods and in the percentage on-costs added, but there was a broad consistency in the resulting rates. Consulting engineers saw many rates tendered by many contractors for similar work on a wide variety of jobs. In fixing rates for variations, the engineer could use these inclusive rates, coupled with his knowledge of the particular case. Was not this method of price fixing not only legitimate but possibly preferable to an attempt to work out a hypothetical contractor's make-up?

193. (*b*) One was taught that, subject to certain safeguards, the engineer should specify what he wanted and leave it to the contractor to select his method of achieving that result. In some cases the contractor might use plant which the engineer thought uneconomical. If extra or varied work was required, the contractor would probably wish to use plant he had on site, although, again, the engineer might think the job could be done more cheaply with other plant. Should the engineer fix his rate on the assumption that the more economical plant were used, or must he accept the contractor's argument that he should be paid for use of the plant he had available on site?

194. (*c*) A tenderer might be successful in obtaining a contract because he had another contract in the immediate vicinity and was therefore able to cut his rates. In rate fixing for variations on the second contract should the engineer try to take into account the economics resulting from the proximity of the original contract, even though the latter might be nothing to do with him or his client?

Mr V. Navaratnarajah (Lecturer in Engineering, University of Malaya, Pantai Valley, Kuala Lumpur) wrote that the Author had presented an interesting Paper on an unusual topic, but a useful one to the practising engineer. Variation of rates was usually the factor which caused the most trouble between the engineer and the contractor, particularly if the engineer had to work for an employer whose funds were controlled by statutory bodies—as large variations had to be approved by the statutory body itself. It was fascinating to read a mathematical formula as a basis for computing scheduled rates. He believed that it would be ideal to agree on a linear simple function as presented by the Author, but experiences on contract works led him to think that in practice the problem was very complex.

196. Did the Author think that the following factors could be included under 'percentage on-costs on labour, plant and material' on a linear basis as explained in § 19, or as separate variables of a more complex formula?

197. (*a*) A good contractor usually planned the whole operation of the contract in detail, backed by records of plant and labour available to him. He had, if he was doing well, other contracts too, to which specialized labour and plant had to be shifted with a view to obtaining maximum use of his plant and labour. Hence an extra item of work, or even the same item of work, but of larger volume, might result in the whole operational plan of the contractor falling out of gear, thus resulting in, perhaps, financial strain on his other contracts. In such circumstances, the contractor

might have to resort to payment of overtime to his labour which resulted in a high extra rate. Under these circumstances, if the engineer was to be guided by the contract rates, it would seem unreasonable to the contractor. It would be unfair to reject it as falling within the category of contract risks.

198. (*b*) The pricing of a scheduled rate also depended indirectly on the magnitude of the extra work. It was sometimes of such a large magnitude that contractors preferred to claim it as a subsidiary contract. Occasionally these works could cause a lot of disruption in the programme of construction, particularly if the contractor had provided for certain items of works to be carried out under favourable climatic conditions. This was very important in the tropics where winters were very hard and rivers were sometimes not perennial. Work might have to be suspended because of continuous rain or flood conditions.

199. (*c*) The rating of a scheduled rate also depended on the progress of the works at the time of announcement of the variation. For example, if it was decided to increase the volume of work on a certain item of work which the contractor had already completed, it might become necessary for the contractor to bring back plant and equipment which he had already removed earlier from the work site. This type of contingency was not accounted for in the usual 'make-up' of extra rates.

200. (*d*) It was often the practice of contractors to let on sub-contract certain special items of work. In such cases, the contractor quoted a price inclusive of the price submitted by the sub-contractor, plus a small margin to cover his profit and overheads. When extra works were ordered, sometimes this special labour might not be available to him any more (which meant that he had to obtain fresh quotations) or he might have to pay a higher rate to retain their services for a longer period than earlier envisaged.

201. (*e*) Normally, when a contractor was ordered to carry out extra works, he expected that the necessary extension of time would be given to him by the engineer for carrying out such works, and generally no difficulty was encountered on this score. But in a big project, where a lot of services had to go in, thus necessitating more than one type of contractor to work at the site (e.g. in a building contract, the civil engineering contractor, the electrical contractor, the plumber, etc.), the pace of the contractor was set by the other contractors who were very anxious to finish their work in the scheduled time, thus setting a challenge to the standing and reputation of the contractor.

202. Rates in the contract documents served as a useful guide, but in arriving at any extra rate for an extra item of work, it was necessary for the engineer to appreciate the extra difficulties caused to the contractor by the variation, and make use of the discretionary powers available to him in Clause 52 (2) of the General Conditions of Contract.

Mr T. W. Weddell (Engineer, Rendel, Palmer and Tritton) wrote that the method of fixing rates for varied or additional work, given by the Author, was an ideal one, but in many cases factors arose which made its application difficult or even impossible. For instance, a contractor was under no contractual obligation to reveal his values of *l*, *m*, and *p*, and for various reasons might choose not to do so. The contractor might also have used different values of *l*, *m*, and *p* in fixing rates in different sections of the work.

204. Difficulties arose where an error had been made in making up a rate in the tender, but which rate was nevertheless contractual. The question arose: 'Should the engineer base a new rate on a contract rate which was obviously low?' On the other hand, where a rate was obviously high, it was not unusual for a contractor to press for new rates to be similarly high. In such cases, the interpretation given in § 10 would seem to apply, namely, that the new rate should be the rate which the contractor would have inserted at the time of tender, and assuming that no errors would have been made.

205. Where there were large numbers of rates for similar work in a contract, e.g., for varying depths of trench excavation for several diameters of pipe, it was usually possible to establish a general pattern in graphical form, from which new rates could be determined. In such cases, it was unnecessary to go back to the original tender make-up.

206. Difficulties also arose where actual quantities of work carried out varied significantly from those given in the Bill of Quantities. Provision was made in the Conditions of Contract for the engineer to review the rate in such circumstances. Could the Author give his opinion on the question: 'At what point did the amount of additional work of a particular kind become sufficient to justify a revised rate?'

207. Complications arose when the contractor applied 'weighting' to different sections of the Bill of Quantities. The commonest example was where a long list of general items provided an opportunity for a contractor to increase the amounts against those items, in order to obtain capital early in the contract period to finance the contract. As a result, the rates in the rest of the Bill were low and did not represent a true state of affairs. If, on the other hand, the number of general items was reduced to a minimum by including most works of a general nature in the appropriate items of the rest of the Bill (as in Clause 8 of the Standard Method of Measurement), that situation should not arise. What was the Author's opinion on providing advances early in a contract, which were deducted progressively from interim payments? The Bill rates should then be the true rates for work. Whether or not the contractor or the employer provided the initial capital at the start of a contract, the ultimate cost to the employer should be approximately the same.

208. Where rates had to be fixed for a completely different type of work, it would seem to be a useful safeguard to keep jointly all records of labour, plant and materials. Such records might well prove to be invaluable.

Mr F. J. Watkins (Director and Chief Engineer, Demolition and Construction Co. Ltd) wrote that he would like to refer to § 36 of the Author's Paper, where he advocated the principle of leaving all agreements to the end of the contract. From the contractor's point of view, this was most unsatisfactory, as he was heavily committed with retention money, plant, etc., and these undecided matters often added a very heavy financial burden on him.

210. The contractor had certain obligations placed on him by the terms of the contract requiring him to produce information in the early stages of the work. It should, therefore, be no more difficult for the engineer to judge and agree the facts at the time, rather than leaving them to the end of the contract and keeping the contractor in suspense for months and, if not, years.

211. The main difficulty that was experienced in agreeing rates with the engineer was that he did not give full consideration to the costs involved, in addition to the actual cost of the item of work, namely, disorganization, delay in completion, etc., causing summer work to be carried out in winter periods, when these facts were often more important than the actual face cost of the item.

212. The first object of the engineer should be to endeavour to negotiate prices with the contractor as soon as possible, to enable the financial position of the contract to be clear to both the contractor and the client. The arbitrary fixing of the rate by the engineer could never be satisfactory and this forced the contractor to go to arbitration which was both time-wasting and expensive.

Mr D. R. Culverwell (Assistant Engineer, Freeman, Fox & Partners) referred to certain difficulties which sometimes arose in rate fixing on a large complicated industrial job, such as a thermal power station.

214. On such work a civil contractor would be one of many other main contractors, all of whom were likely to be working close to one another on the site and to a tight programme. The civil contractor generally had to tender on outline drawings, for

at that stage detailed information on his work was unlikely to exist. It was almost inevitable that the work that he actually had to do would, in some respects, differ significantly from what he envisaged when he tendered. Further, detail information for the civil contractors might be slow in coming forward, with the result that work was started late and had to be done faster. Again, one contractor might be unable to achieve the progress required, possibly through no fault of his own, and so he delayed or impeded the work of those who followed. The net result could be that the work of the civil contractor, particularly of one who followed in the later stages of the construction, not only might be, in itself, different from that at tender, but might also have to be done under different conditions and to a different programme.

215. When a situation of this sort arose, the engineer had to determine to what extent the contractor should receive extra payment and had to assess how much this should be. Unless the situation was so bad that the contract was completely disrupted, this would usually involve revising existing rates or fixing new ones. Although the process might be lengthy and more complicated than the examples the Author gave for rating simple variations, the principle was still the same and no real problem need arise, *always provided adequate information had been recorded at the time the work was going on.*

216. It was there that, in practice, the difficulties seemed to arise, for, although the contractor might notify the engineer that his work was being upset in some way, and that he expected to be paid an appropriate extra, he often seemed reluctant to present to the engineer, when the work was going on, the necessary data and records to substantiate his claim. The engineer was still, nevertheless, expected to assess the extra expense the contractor had incurred and to fix reasonable and proper rates for the work. He was often expected also to take into account obscure but possibly valid secondary effects, concerning, for example, a re-disposition of plant. In some instances, the difficulties were made worse because the contractor did not notify the engineer of his claim until after the work had been finished.

217. If the contract was subject to the I.C.E. Conditions, then the engineer could decline to consider the claim on the grounds that it was not submitted properly. Generally, however, both he and the employer were reluctant to do this if they felt that the contractor had some sort of case.

218. A simple and typical example might be as follows: a civil contractor was impeded in his work by the presence of a large quantity of steelwork which was lying around the basement floor waiting to be erected. He pointed out to the engineer that this was in his way and was causing him extra expense. The engineer did what he could to improve the situation, but some effects still remained. Several years later, when the final account was being agreed, the contractor asked to be reimbursed various extra costs which he said arose because of this steelwork, e.g., extra walking time by labour, delays elsewhere, piece-meal working, restricted access, etc. The engineer knew the difficulty existed, but how, several years later, when it might be that all his staff who were concerned with the problem had left the site, could he possibly be expected to certify extra costs which would be fair both to employer and contractor?

219. Looked at like this, the matter might seem somewhat incredible; yet it had happened all too often. The procedure had broken down and with it the very valuable machinery of the I.C.E. Conditions whereby the engineer, with his power to fix rates and certify extra costs, could safeguard the proper interests of the employer and the contractor.

220. The difficulty would not have arisen had the contractor put forward data and evidence at the time, for then the engineer would have had opportunity to assess the circumstances himself. It should be noted that it was not necessary to settle the costs at the time; it might be in the interests of neither the employer nor the contractor to do so then and it might be much better left until the end of the job. There was no harm in this, provided adequate agreed records were kept. The engineer

must, of course, always be prepared to check records, even if, in some cases, this might appear to him to be tedious and unnecessary.

221. It was sometimes argued that, if detailed records were to be kept on large complicated jobs, then the contractor had to employ extra staff, who might be non-productive. This was hardly a valid objection, for, if the records were needed, then, to put it quite simply, they must be kept. Further, if this required extra staff, then surely they were a legitimate expense under the claim. It was also argued that often it was not possible to foresee the secondary effects of these situations at the time and that it was only when the contractor could look back on the job as a whole, that he could assess the real extent of his extra expense. While this might sometimes be true, it need not stop the contractor putting forward and recording what could be assessed at the time. He could qualify his statements by saying that certain further expense might arise through secondary effects and he could indicate what these were likely to be and how far they were likely to extend. The engineer then had opportunity to consider and examine them.

222. The importance of good rate fixing must not be under-estimated, for it was a fundamental process of the I.C.E. system of contract, but it could not be achieved, at least where complex work was concerned, without proper records. Where claims were submitted, the engineer, the employer and the contractor, but particularly the contractor who had the prime responsibility, should see that they were substantiated by records, checked and agreed at the time the work was going on, so that rates and costs could be properly assessed.

Mr W. R. Briggs (Sir William Halcrow & Partners) wrote that the Author had given a brief outline of the system followed by his firm in assessing new rates, but considerations of space had no doubt prevented him from describing the changes of approach that were required in different circumstances. Mr Briggs would like to enlarge on the Author's suggestion that the engineer's responsibility in rate-fixing involved the assessment of the value that would have been attached to an item if it had been included in the tender documents.

224. Rate fixing would involve fewer problems if all the rates tendered were always truly representative of the cost of doing the work. This was, unfortunately, not so: every contract seemed to contain some rates which were much above or below the cost of doing the work. Shrewd tendering accounts for some discrepancies: Mr Briggs recalled one contract in which the sum tendered against one item was at least ten times the cost of the associated work, and it was pretty obvious that the contractor had made up his tender in a way that would secure good early certificates. Discrepancies were sometimes attributable to errors of various kinds: it might merely be that a genuine estimate would either prove inadequate or rather high for some improved method devised after tender, but the writer knew of one case in which a contractor had made a serious error of transcription when entering rates in his tender.

225. Whatever their cause, irregularities of this kind always seemed to give rise to arguments on the method by which a new rate should be evaluated: either the engineer would think that a bill rate should be adjusted, while the contractor thought that the new rate should be built up from first principles, or vice versa. The views expressed depended partly on the degree of adjustment required (no one would think of abandoning a bill rate if the work concerned had been the subject of only a minor variation) and partly on the profit margin included in the particular rate (a contractor was naturally reluctant to abandon a 'good' rate).

226. It was the writer's submission that disagreements over the means of arriving at new rates would be diminished if it were accepted that in the case of varied or substituted work the end result required was rates which were consistent with the level of prices tendered, while in the case of extra or additional work the rates might stand on their own. This suggested distinction was based partly on general principles: payment was due in accordance with the original bargain for the original or equiva-

lent work, but the contractor should merely be paid a fair price for work that was not included in the bargain. The suggested distinction was also based partly on the difference between the 'reasonable' rates contemplated by I.C.E. Clause 52 (1) for extra work and the 'reasonable and proper' rates contemplated by I.C.E. Clause 52 (2) for work which was not in itself changed.

227. When some variation had been ordered in the work, and analysis of the bill rate in preparation for an adjustment revealed that the rate was above or below the cost of doing the original work, a new rate which was consistent with the original bargain would be obtained by working with estimates and scaling the adjusted figure up or down in the ratio borne by the tendered rate to the first estimate. With this approach, it would not be necessary to abandon a tendered rate as a basis of adjustments simply because it was substantially above or below the estimated cost. It would be necessary to start from first principles only when the substituted work required so many adjustments for operations or components different from those in the bill rate that the connexion with the original work became unrecognizable.

228. Any work which was extra or additional and not covered by the original bargain need not, it was submitted, be related to the level of rates included in the tender. Unless the basis of payment was settled before the extra work was carried out, there would merely be an implied agreement that the contractor should receive reasonable payment for it. The writer had searched works of authority in vain for firm guidance on what constituted a reasonable payment. Most text-books implied that reasonable payments would bear some relation to cost, but the basis of assessing this was rather vague.

229. The most likely pointer seemed to be a statement in 'Hudson' that the solution to this 'perennial problem . . . will be governed by questions of convenience from the evidentiary point of view'. Bearing in mind that despite the inevitable high or low rates the bulk of the rates tendered would bear some relation to the cost of doing the work, bill rates might be taken, until it was shown otherwise, to give good evidence of what would be a 'reasonable' price for work which had still to be carried out. If the work was done before the rate was fixed, the engineer might have the benefit of a factual record, agreed by the resident engineer. In the absence of glaring inefficiency, this would provide strong evidence of reasonable price. If the work had been done, but a factual record had not been agreed, the contractor might well offer the engineer his allocation sheets as evidence of cost. These might be regarded —perhaps unnecessarily—with a certain measure of suspicion, but if consistent with the resident engineer's recollection of what was done, might provide acceptable evidence. If allocation sheets were not offered or not accepted, it might be that bill rates, checked by estimates, would even at this stage be the only satisfactory evidence of what was reasonable.

230. The writer had not suggested that the mere segregation of items into those for which 'reasonable' rates and those for which 'reasonable and proper' rates were required would solve all problems, but merely that acceptance of the principle would remove one source of the arguments that were apparently inevitable whenever new rates became necessary.

Mr W. S. Forbes (Senior Engineer, Building Research Station) wrote that the Author rightly pointed out how difficult it was to negotiate rules for variations in civil engineering contracts. The basic difficulty was the incompatibility between the units of measurement used in a conventional bill of quantities and the way money was spent on site. This, of course, did not prevent in practice the settlement of rates between civil engineers and contractors in a pro-rata manner using the usual 'rules' of bargaining as between buyer and seller, rather than to attempt to reconcile bill rates with actual costs. Studies at the Building Research Station emphasized that it was unrealistic to attempt to feed back costs recorded on site in the terms of a formula such as was shown on p. 224 of the *Proceedings*.

232. The 'operational' bills,[1] prepared by the Building Research Station, were an attempt to provide a rational document, in terms of which it was possible to relate to costs collected on site.

233. The principal features of the bill were the separation of materials from labour and the breakdown into operations of work, when an operation was defined as the work done by a man or a gang without a break in the production pattern. These operations then became the 'units' for estimating the cost of labour. Plant costs were considered in the same sense as overheads and were not related to any particular operation.

234. An example taken from an operational bill prepared for a R.C. job was given below (Fig. 1). This illustrated the characteristic arrangement of the bill, showing the segregation of work in two areas of the building which was of different construction; the materials related to this work had been listed in units of measurement which were suitable for purchasing. This page from the bill had been priced to show the estimate

		Block A	Block B	TOTAL	Unit	Rate	BILL No. 4 LABOUR £ s. d.	MATERIALS £ s. d.
	NO. 19 GROUP OF OPERATIONS							
	REINFORCED CONCRETE FRAME, FLOORS, ROOF AND STAIRCASE							
	OPERATION NO.114							
A	*Fix rod reinforcement, including tying as necessary to reinforcement (in No.99 columns). Attend on plumber positioning prefabricated copper pipe units (in No. 4 columns)*							
B	*Erect formwork to ground floor columns in one lift, (1955 feet super of face to concrete columns), fixing ties and cramps to be cast in concrete.*							
C	*Place concrete to ground floor columns into formwork, around reinforcement and copper pipes, and vibrate.*						371 = =	
	MATERIALS							
D	1½" Diameter mild steel rods	4.5	-	4.5	Cwts.	49/6		11 2 9 ✓
E	1½" Ditto	2.9	-	2.9	"	49/6		7 3 6 ✓
F	1" Do.	9.8	-	9.8	"	49/6		24 5 1 ✓
G	⅞" Do.	2.9	-	2.9	"	51/3		7 8 8 ✓
H	¾" Do.	2.5	-	2.5	"	51/6		6 8 9 ✓
I	⅝" Do.	2.6	-	2.6	"	52/6		6 10 6 ✓
J	⅜" Do.	.3	-	.3	"	56/3		16 ✓
K	¼" Do.	1.1	-	1.1	"	60/6		3 6 7 ✓
L	2" "Denso" tape	13	-	13	Rolls	2/6		1 14 6 ✓
M	2½" x 22 gauge "Exmet" dipped one coat black asphaltum paint	225	-	225	F.R.	25/6 per 27		1 1 3 ✓
N	½" x 18 gauge galvanised mild steel hoop iron	.3	-	.3	Cwts.	134/6		2 1 10 ✓
O	Concrete (3000 lbs per square inch strength with ¾" aggregate)	12	-	12	Y.C.	56/-		33 12 0 ✓
	Sundry nails, Denso paste etc., necessary for fixing							5 -
	OPERATION NO. 115							
P	*Erect formwork to first floor soffits (3796 F.S. face of concrete beams and suspended floor) including fixing ties*							
Q	*Lay hollow clay pots in position*							
R	*Fix rod reinforcement to beams and floor*							
	Carried to Collection					£	371 = 1 5 ✓	106 3 0 ✓

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J. Chart. Surv. Instn

FIG. 1: PORTION OF OPERATIONAL BILL

of labour by the operation in terms of a lump sum and the detailed pricing of materials.

235. Although the operational bills so far prepared had been for application to building construction, the principles involved were equally suitable for other work, including civil engineering. Acceptance of these principles would require a radical change in contract procedures, particularly in the settlement of variations. Current work at the station in the application of network analysis suggested, however, that these difficulties were not insurmountable.

Mr H. W. McAughtry (Civil Engineer) wrote that, as he understood it, the Paper set out to give a method of fixing the 'reasonable and proper' rates referred to in Clause 52 of the I.C.E. Conditions of Contract.

237. First, the meaning of 'a reasonable rate' must be established, and the Author gave his definition in § 10, i.e., 'the rate which the contractor would have inserted . . . at the time of tender'.

238. This inferred that the original tender rates were reasonable. This assumption got no support from the wording of Clause 52 and he thought it was fundamentally wrong.

239. If the contractor made an arithmetical error when pricing the original tender, the rate would be wrong and could not be held to be reasonable. This was equally true if the error was one regarding the output of a machine or gang. In any case, how could the real rates be determined unless one knew how the on-cost had been spread (he had more to say on this below)?

240. If changes in the amount or nature of the work were substantial, Clause 52 protected the contractor against unreasonably low tender rates and the client against rates which were unreasonably high. This was surely the basic purpose of Clause 52.

241. A reasonable rate was one covering the true cost of doing the work with average efficiency, plus a fair margin of profit. It had no connexion with tender rates which might be quite unreasonable.

242. However, if the Author's definition of a reasonable rate was accepted, he felt that his method for determining it was open to serious objection. It seemed to him to be based on the assumption that the contractor prepared his tender in accordance with the 'usual practice'. But he submitted that there was no generally-accepted practice in estimating, and that even if there was, the contractor had no obligation to comply with it, or to explain his method of pricing to anyone. (The fact that a Paper whose main topic was 'how contractors price tenders' was written by an eminent consulting engineer underlined the point—contractors did not divulge this information.) Thus an engineer trying to use the Author's system must fall back on pure guesswork as to the method used in pricing a particular tender. This completely invalidated any claim that he was correctly determining the rate which the contractor would have inserted at the time of tender.

243. He thought that many of the more specific statements in the Paper were open to question too. He would mention just one example. The Author said that on-cost was spread on the rates in a pro-rata manner. He did add 'usually', but he seemed rather to imply that, if it was not, it ought to be.

244. A virtue of pro-rata spreading was arithmetical simplicity, but he could see few other virtues. He thought a very sound case could be made for the idea that pro-rata spreading of on-cost was unreasonable. But the real point was that the contractor had no obligation either to conform to alleged practice or to explain his methods in respect of on-cost. There was nothing improper about selective spreading of on-cost or even applying it as a lump sum. For the engineer to assume for rate fixing purposes that it was, or should be, spread pro-rata was neither reasonable nor just.

245. He regretted that his remarks were entirely critical, but feeling that both basis and method were fundamentally wrong, he thought the time-honoured method

was preferable. He doubted whether the subject could be satisfactorily dealt with in a paper of this kind. The Author specifically presented his Paper as a basis for discussion, and it had certainly provoked hard thinking about contract fundamentals; the attendance at the meeting showed how much interest it had aroused, and he would like to congratulate the Author on the clarity with which his views were presented.

Mr A. W. Shilston observed that in the measure and value type of civil engineering contract, unlike the lump sum form normally associated with building works, while the tender sum as such had no great contractual importance, the rates inserted in the Bill were most significant.

247. In § 5, the Author had referred to the principle of using existing rates in the Bill as a basis for valuing extra work where such rates were, in the engineer's opinion, applicable. Presumably there could be no argument that that related to the suitability of the use of the type of operation covered by a bill item, rather than the amount of the rate, *per se*.

248. Mr Shilston thought it reasonably followed from what the Author had said that because of the importance attached to rates in civil engineering bills that in the tender examination a close scrutiny of the rates inserted in the Bill was called for and that within reasonable limits it was the engineer's responsibility to satisfy himself that the rates inserted in the tender were realistic. The fact that at this stage, and until a contract was signed, the engineer was acting in the best interests of the employer, would seem to afford him some latitude in taking up with a tenderer apparent anomalies in the pricing structure of his bill.

249. The interesting question that then emerged was how far could an engineer reasonably proceed to endeavour to initiate modifications to rates at the tender stage, to ensure that before embarking on a contract a realistic schedule of prices was in existence but at the same time not vitiating the generally understood processes of competitive tendering? It was fairly well known that for various reasons, loading of certain items in a Bill did take place, being part of the art of estimating; there were other facets to estimating procedures which might be classed as part of a contractor's stock-in-trade and it was dangerous territory for an eagle-eyed engineer to explore!

250. As it was germane to the Author's thesis, it would be instructive to learn how he dealt with the question of loading, or weighting, of rates.

251. Overbilling sometimes introduced the question of the validity of the original rates inserted in the Bill for purposes of valuing the work as measured. The problem of under-measurement had two limbs. The first involved loss of profit on a particular item due to unproductive development of plant and labour associated with the operation, and the second was loss of profit in an overall sense.

252. The first situation might be treated empirically by saying that a *per se* case for an upward revision of a Bill rate could exist when the measured work involved, say, a 20% or greater diminution of that quantity billed. By the same token possibly it could be argued that a similar case for a downward revision of a Bill rate existed if the measured quantity was say 20% or more in excess of that billed. But a consideration of the review of a rate could not be divorced from the pricing structure of the tender as a whole and perhaps there was something to be said for adopting the procedure of expressing the estimated total of the preliminary items, site and head office overheads together with profit, as a percentage of the net estimated cost of direct work billed, excluding provisional and prime cost sums. This derived percentage addition could then be applied to the value of the measured work.

253. The second aspect of undermeasurement, the effect on estimated earnings of a marked overall dimunition of the work executed over that originally contemplated, involved considerations of breach of contract which was another matter and seemingly outside the scope of the Paper.

254. Mr Shilston wrote that he was somewhat bothered by certain of the Author's

remarks on the delineation of the boundary of rate fixing, as exemplified by §§ 32 and 33 of the Paper. It was important, as suggested in § 32, that there should be general agreement as between the employer and the engineer on this subject. In extension of this observation did the Author feel that there might be some obligation to inform the contractor, before entering into contractual relationship with the employer, of any limitation that might have been placed on the engineer's mandate?

255. § 33 implied, so he thought, that a situation had arisen in which the rejection of an item for rate fixing involved a disagreement of principle rather than amount. The combination of these two circumstances led to the consideration of co-lateral issues of a more contractual nature, which merited discussion.

256. However much it might be regretted, he thought that engineers, as realists, should understand that they no longer had the largely untramelled powers that they possessed in the past. The changing circumstances of the times in which there had been a great shift from private to public sponsorship of civil engineering projects, with the consequent need for exercise of control on the expenditure of public funds, had brought this situation about which reflected the prevailing administrative and political structure within the country together with the progressive emancipation of the position of the contractor. These were basic facts.

257. The engineer could be expected by the contractor to act in accordance with the definition of his responsibilities under the I.C.E. Conditions and in other respects under the contract terms, supplemented by what residual powers he possessed under common law. He did not have an unlimited mandate to adjudicate on all matters that might arise during the currency of the contract—this position might be modified to some extent if Clause 66 had been invoked—and Mr Shilston felt that the remarks in § 33 were open to question. It could be dangerous to foster the notion that contractual issues, on which no resolution had been reached during the execution of the works, could necessarily be refurbished as claims for presentation after the end of the contract period. This view was strengthened by the outcome of a recent High Court reference. Unless the contractor had complied with the procedural requirements laid down as conditions precedent to the submission of any claim, there existed room for doubt as to whether the engineer had any locus to deal with such claims.

258. Mr Shilston wrote, in conclusion, that there could be a danger of too clinical an approach to rate fixing. It was very much part of the engineer's job to foster an equable climate, conducive to negotiation. Perhaps the most important ingredient in a negotiator was the possession of a certain worldliness and a keen perceptivity of the art of human relationships.

Mr C. A. Gillott (Manager, Civil Engineering Division (Home), Cementation Co. Ltd), and **Mr J. F. Reeve** (Senior Quantity Surveyor, Cementation Co. Ltd) wrote that the Author was to be congratulated for his courage in publishing a Paper on such a controversial subject.

260. Whereas most of the text of the Paper contained a large amount of sound advice and good sense, they felt that the introduction of a formula would only serve to add more items to be agreed by the two parties concerned when fixing new rates.

261. When an item in a Bill of Quantities was priced, and formed part of the contract, it was the rate which was offered and accepted and not the method of arriving at such a rate. The ways and means of a contractor in determining his rates were legion, ranging from a complex arithmetical operation to a divine inspiration. Errors and omissions occasionally crept in. To try to analyse contract rates and prices afterwards, either singly or in groups, was a difficult task for either party to the contract—to do so jointly on an agreed basis, was virtually impossible. Where a simple and mutually acceptable analogy could be made, it was relatively easy to derive a new rate from an existing rate; otherwise there was little to be gained from resorting to complex and unrealistic analogies to develop new rates.

262. The agreement of new rates was influenced by many factors. There was

little time lost agreeing rates for small quantities of work—usually both parties conceded that it was not worth wasting much time over small amounts of money. The commercial interests of the purchaser and the contractor affected negotiations very much—the purchaser might wish to expedite the works to take advantage of an early start to a revenue earning project; the contractor might have 'bought' the contract too dearly; early progress might have been good or bad and the contractor was thereby influenced.

263. The human factor played a vital part in all negotiations and much depended on the personalities and experience of the negotiators.

264. It was accepted that the engineer should fix fair and reasonable rates, but it was always better for the engineer to agree rates with the contractor, rather than to take unilateral action and encourage claims and arbitration as a result.

265. They did not agree that a site meeting during the tendering stage would produce any improvement in the letting and submitting of contracts. The records of such meetings could never substitute for full and properly prepared tender documents. Queries raised by tenderers during the tendering period could be answered by a written statement to all competitors which might then become part of the tender documents.

266. §§ 31 and 37 of the Author's Paper provided the crux of the matter. It was necessary for the sake of all concerned in a contract that the engineer and his representatives be fully conversant with the construction industry and with the supervision and administration of contracts.

Mr J. A. Banks (Partner, Babtie, Shaw & Morton) wrote that the Paper dealt with rate fixing as a responsibility of the engineer in terms of Clause 52 of the I.C.E. General Conditions of Contract and, consequently, with rate fixing for work comprised within a contract as defined in Clause 5 of the I.C.E. Conditions.

268. The Author, in § 10, had stated that 'a satisfactory interpretation of his responsibility is for the engineer to determine, for new or substituted items, the rate which the contractor would have inserted against that item had it been included at the time of tender'. This, quite correctly, in Mr Banks' view, implied that rates fixed by the engineer must be analogous to the contract prices. The engineer was required to fix rates which 'he shall think reasonable and proper', and rates would be improper if they were other than as were regulated by the contract. Therefore, the engineer could not depart from what he might call the profit-or-loss complexion or pattern of the contract. If a contractor had highly profitable rates, then rates fixed by the engineer should reflect the same order of profit. If, on the other hand, the contractor had low or even under-priced rates, then the rates fixed by the engineer should bear comparison to them.

269. In the examples given in Appendix 2 the Author had, for purposes of illustration, adopted arbitrary percentage additions to cover overheads and profit. But the engineer, whose duty it might be to fix rates, did not know what percentages the contractor allowed under these heads in compiling the Bill rates, or, for that matter, if his profit anticipations, when he prepared his offer, were in fact being realized in the course of the contract. One approach was to endeavour to assess the net cost of specific operations and by deduction from the Bill rates, arrive at an approximation to the margin available to cover on-cost and profit. This was not, of course, as simple a solution as it might seem because of the impact of general items, and in some instances the balance of the Bill had been seriously disturbed by a late pricing of perhaps a single general item in finalizing the tender. These factors made it very difficult for an engineer to fix rates which were completely equitable in the circumstances of a contract. Usually, there would be consultations with the contractor and invariably the profit-and-loss aspect inherent in the contract was reflected in the discussions. As the Author had indicated, agreement was generally reached, although some contractors, and engineers too, were more amenable than others. The objec-

tive should be to fix rates which incorporated the same profit margin as the contractor had in the part of the works to which the extra or additional work was related. If it could be related only to the whole of the contract work, then the rates fixed, to be reasonable and proper, should neither increase nor decrease the overall percentage profit on the outcome of the contract nor offset any losses which the contractor would have incurred in the fulfilment of his contract.

270. There was, in fact, no standard formula for rate fixing which was of general application to all contracts or even to different parts of the work under one contract. The formula expressed by the Author provided a basis of assessment, but the engineer must satisfy himself by consideration of the particular circumstances and any information emanating from discussions he might have had with the contractor that the rates he fixed were reasonable and proper within the ambit of the contract.

Mr H. V. Phillips (Assoc. I.C.E.) wrote that the Author had given a clear outline of the procedure which was customary for the engineer and the contractor to agree rates in discussions at rate-fixing meetings after submission of proposed rates and supporting make-up by the contractor.

272. It was preferable, but not often possible, for new rates to be fixed before the work was started.

273. The Author contended in § 10 that a satisfactory interpretation by the engineer of his responsibilities was for him to determine, for new or substituted items, the rate which the contractor would have inserted against that item had it been included at the time of the tender. Without access to the contractor's tender make-up, this would be difficult, and such an interpretation was not usually acceptable to the contractor.

274. The four elements of cost, labour, materials, plant and on-cost were, as stated by the Author, calculated at the time of tender. It was also necessary to calculate labour and materials for the purpose of make-up of new rates. Plant, however, presented difficulties if calculated make-up was required for rate fixing. The rates so arrived at were usually contentious and not always acceptable. For the purpose of make-up of prices for new or varied work, it was suggested that Federation of Civil Engineering Contractors' daywork schedules, without the addition of on-cost or profit, were equitable in most cases. The percentage of on-cost to be added to labour and materials could be agreed early in the contract and used in the make-up of new rates without repetitive recalculation. Items of expenditure, classed as on-costs, were given below. It would be noted that certain non-productive costs of labour had been omitted from the on-costs. As would be seen from the specimen make-up given later on, these had been treated as prime cost. The application of these labour costs as a percentage in the on-cost resulted in unrealistic prices.

275. With regard to the typical 'make-up' given in the Paper, it was suggested here that labour costs should be derived from the more realistic gross earnings per week, which greatly exceeded any computation of probable hours at plain time rates. The use of the hourly rate made no allowance for plant servicing time, non-productive overtime, subsistence and other additional payments which were more accurately assessed in the prime cost than by inclusion in on-costs.

ON-COSTS

276. Salaries and allowances of agent, engineering staff, clerical staff and general foreman
Staff travel and car allowances
Staff pensions

Performance bond
General insurances—catastrophic, third party, common law

National Health Insurance—employer's contributions
Graduated pensions—employer's contributions
Holidays with pay

Welfare and messing
Temporary buildings and maintenance
Temporary roads and maintenance
Temporary fencing and maintenance
Water for the works and installation
Power and light (all costs)

Mobilization of plant
Temporary workshops
Fuel supply installations

Site cars, buses and general lorries
Tools and light plant
Engineer's instruments and drawing office requisites
Testing of materials

First aid
Sanitation
Storemen
Chainmen and setting out materials
Sundry general labour
Watching and flagging

Coal and coke
General unallocated consumable stores
Protective clothing

Office furniture and equipment
Printing and stationery
Telephones
Postages and sundries

Wet time
Finance
Head office charges

Resident engineers' office and maintenance
Inspectors' cabins and maintenance

Clearing up on completion and maintenance period costs

Total

The total of the above on-costs compared to the total prime cost gives the percentage of on-cost to be added to prime costs.

Notes: (*a*) Subsistence, travelling time and allowances, and non-productive overtime were treated as prime cost.
(*b*) Any of the above items included in Bills of Quantities would be deleted from on-costs.
(*c*) Plant spares and repairs, including black gang, included in plant rates.

EXAMPLE OF MAKE-UP

277. *New Item.* Excavation in soft ground below formation and disposal to tip off-site provided by the contractor. Estimated quantity 10 000 cu. yds. Allow $\frac{3}{8}$ cu. yd dragline—1000 cu. yds per 50-h working week. Tip 2 miles distance. Four No. 5-ton tipping lorries.

Labour	*Hours*	*Wages* £ s. d.	*Subsistence and travel* £ s. d.	£ s. d.	*cu. yd.* s. d.
Ganger	53 @ 6*s.*	15 18 0	3 17 0	19 15 0	
Excavator driver	64 @ 5*s.* 6½*d.*	17 14 8	3 17 0	21 11 8	
Banksman	53 @ 5*s.* 1½*d.*	13 11 8	12 0	14 3 8	
4 lorry drivers	212 @ 5*s.* 5*d.*	57 8 4	2 8 0	59 16 4	
2 labourers	106 @ 5*s.* 0½*d.*	26 14 5	1 4 0	27 18 5	
Dozer driver (tip)	64 @ 5*s.* 2½*d.*	16 13 4	3 17 0	20 10 4	
		£148 0 5	£15 15 0	£163 15 5	
* On-costs (as determined), say 20%				32 15 1	
Labour: total for 1000 cu. yds				£196 10 6	3 11
Plant					
$\frac{3}{8}$ cu. yd excavator	50 h @ 25*s.* 9*d.*			64 7 6	
40 h.p. tractor/dozer	50 h @ 33*s.* 9*d.*			84 7 6	
4 lorries (4 × 50)	200 h @ 16*s.* 6*d.*			165 0 0	
Pump (occasional) allow				5 0 0	
Plant: total for 1000 cu. yds				£318 15 0	6 4½

Sundries

	£		
Royalty to tip owner	200		
Soiling and seeding	150		
Navvy mats, sleepers	100		
	450		
On-cost, say 20%	90		
	£540	over total 10 000 cu. yds	1 1

† Add contractor's profit and contingencies

	s. d.	s. d.		
7½% on	3 11			
	1 1			
		5 0 =		4½
			‡ Rate	11 9

* On-cost percentage given here was nominal and would vary considerably.
† Profit and contingency percentage as agreed.
‡ Bonus incentive for increased output ignored here.

The Author, in reply, wrote that first of all he wished to thank all those who had attended the meeting and especially those who contributed to the discussion, for the interest they had shown in the Paper. The treatment of the subject, as he had hoped it would, had aroused considerable comment, and the remarks of the contributors seemed to him generally to indicate a desire from all sides of the civil engineering industry for the establishment, somehow, of an acceptable and expeditious procedure for rate fixing.

279. The treatment of on-cost was clearly a contentious matter and had been referred to by a number of contributors. In proposing that rates for new work should be negotiated on the basis that they should bear reasonable relationship with the original prices in the contract bills, namely that those rates would have been inserted by the successful tenderer had the corresponding items been included in the enquiry document, it had not been overlooked by the Author that the overall recovery of on-cost was liable to be affected.

280. However, this could not usually be appreciated until towards the end of a contract. In power station construction, for example, it was a particular and familiar feature that additions, variations, and omissions followed relentlessly upon one another, almost until the closing stages of the job. To avoid having to deal with an enormous backlog of unagreed variations, often when the details of the work were almost forgotten, rates negotiations had necessarily to keep pace with or precede construction. In such circumstances, neither the contractor nor the engineer could forecast with accuracy what the breakdown of the final contract cost would be in terms of labour, materials, plant and overheads.

281. It had therefore been suggested in the Paper that in negotiating rates, the percentages added by the contractor to the basic ingredients of his tender to cover his overheads should equally be applied to the new work. In the Author's view the advantage accruing either to the employer or to the contractor could be determined more effectively when construction worries were at an end, and before the final account was paid, or else it would be taken into consideration when claims were dealt with. In the interim period, however, the Author felt that his proposed method gave a reasonable approximation.

282. Some of the contributors had stated that the on-cost percentages used in tendering, and the method of their application were confidential matters not likely to be revealed. Certainly the engineer was never in a position to demand this information. However, the Author had seldom encountered reluctance, and indeed never a refusal to divulge this data. He could in fact see no other practicable way of negotiating rates fairly, and without undue delay and argument on any job where the quantity of variations was substantial.

283. Turning to specific queries, the Author wrote that Mr Leonard had referred to site investigation which was obviously very important. Engineers had tried to impress that upon employers, who were becoming much better aware of the true position; but there was always the difficulty that until authorization for a project had been obtained there was no money to be spent on any site investigation, so that very often although employers appreciated the necessity for proper investigation, there was not the money with which to carry it out.

284. Mr Leonard in dealing with rate fixing had spoken of the contractor having to wait a long time to obtain full payment. This point had been referred to by other contributors, notably Mr Mitchell in § 160 and Mr Clarke in § 183. In the Author's view, a delay of any appreciable extent should be unnecessary. While he had recommended the use of conservative 'on account' rates, these would only stand until the contractor had put forward his 'firm' rates and a rate fixing meeting had been held to reach a settlement. With regard to the suggestions made in § 36 of the Paper, upon which Mr Watkins had also later commented upon in § 209, this referred to circumstances somewhat outside the scope of normal rate fixing, and upon which it was difficult or impossible to form a considered opinion until the works were

completed. The Author could see no alternative to the postponement of a decision upon such matters, but it might be added that in cases of excessive hardship employers were generally prepared to assist contractors without prejudice to the final decision upon liability.

285. Mr Leonard had pointed out quite correctly several of the unnecessary causes which led to rate fixing, not a few of them stemming from human failings. Most of these could be cured in the Author's opinion by a better appreciation of the position of the engineer; on the latter's part he must always strive to establish and maintain his authority, his integrity, and his technical ability. The Author felt that perhaps Mr Leonard had gone a little too far in the results obtainable from proper site investigations: for instance, not everything could necessarily be forecast in a tunnel until the ground were opened up.

286. Mr Fitzherbert had answered to some extent the question of what were the causes for rate fixing. In an ideal world there would be no cause for rate fixing at all, but in the case of many major projects such as power stations where, as Mr Fitzherbert had said, great sums of money were being spent, the object was to take advantage of the advances in design of plant at the expense of the civil engineering, because the civil engineer was in effect merely the man who provided the foundation and housing for very expensive plant. Otherwise there would always be less efficient plant and hence more expensive electricity, from power stations on completion.

287. Mr Fitzherbert had made a very valuable contribution to the discussion and made possible a greater appreciation of the development of electrical power which was going on in this country. These new power stations would each unleash the power of approaching 3 000 000 h.p., all in four turbines, each easily encompassed in the lecture theatre of the Institution. It was an amazing thought.

288. He had asked one or two difficult questions, which required thought. There was the apparent conflict between Clauses 52 and 56 of the I.C.E. Conditions of Contract. The Author thought that he had not encountered any difficulties in the application of these Clauses, but that was not to say that they could not be improved upon; the question was worth studying. The matter of delays and lack of access referred to in § 102 was not generally taken into consideration in the calculation of on account rates, though daywork charges might be entertained if agreement were reached upon the relative responsibility. However, should the rates finally agreed be enhanced due to these causes, it was of course the engineer's responsibility to bear them in mind in assessing the entitlement under any claim, and in this connexion a record of the make-up of agreed rates should be retained.

289. There was also the question of the 10 cu. yd/hour in § 42 of the Paper, and only one lorry being needed. All these examples were, of course, quite arbitrary, but with regard to this particular one it could be said that the output was only 10 cu. yd/hour, but that was all measured work, and the machine might have to dig 13 or 14 cu. yd in open excavation to allow for working space and so on. The 5-ton lorries might take $3\frac{1}{2}$ cu. yd of solid material, and the loading time might be 15 min.: a period of travel, tip, and return of under 45 min. was allowed for; that was a long haul, but there might be a free tip some distance away of which it was desired to make use.

290. Mr Goldstein had made an interesting and stimulating contribution to the discussion. His criticism of any formula for rate fixing was valid: however, the formula proposed was used as an illustration of the principles involved as explained by the Author in his introduction; over and above this it was of paramount necessity for the engineer to be knowledgeable and experienced in the methods and costing of civil engineering works. The weighting of tenders and the loading of individual rates was not unusual but they required to be handled intelligently in relation to rate fixing. The Author agreed that on-cost percentages could and often did vary for different sections of a contract, but these could be ascertained from the contractor and applied to new rates as appropriate.

291. Obviously Mr Goldstein was quite correct in § 112 in asserting that all drawings should be completed at the tender stage: but this did not apply where the nature of the project precluded this course.

292. The Author could not agree with Mr Goldstein's remarks in § 113 in relation to site tenderers' meetings. Messrs Gillott and Reeves had also referred to these in § 265. In the Author's experience they had proved to be of positive value provided they were properly recorded and minutes distributed, and referred to in the letter of acceptance.

293. The Author admired Mr Goldstein's courage in saying that the I.C.E. Conditions were not particularly good: that was more than the Author had dared to suggest.

294. Mr Triggs' opening remarks were very much to the point: it was axiomatic that the employer, the engineer and the contractor should all perform their proper function as a prerequisite to a fair settlement of all financial matters.

295. With regard to Mr Triggs' problem of the wharf, unfortunately the client was often subject to a change of heart and it was necessary to put up with these difficulties but, as Mr Triggs had implied, the answer was that it was not a case of rate fixing at all. The contractor was entitled to the profit element which was in his tender.

296. Mr Gritton had made a useful suggestion concerning the introduction of bills of quantities and cost as a subject for the Institution's Part II examination and for universities: this seemed a valid point; indeed certain of the technical colleges already included papers on specifications, and bills of quantities.

297. Mr Gritton also raised the question of cost-consciousness. One of the vice-presidents of the World Bank had recently emphasized the importance of this, and in the Author's view the profession in general should take this question of costing far more seriously. It had to be taken seriously by contractors, because it involved their bread and butter: but it might be said that too few designers took sufficient notice of this important subject.

298. Mr Gritton's suggested formula for plant gave a useful basis for the negotiation of rates for heavy plant items. Originally plant hire rates were based on a fraction of the capital cost of the machine taken per week. Many contractors had made considerable profits during the Second World War because a fraction of between 1/50 and 1/100 was accepted.

299. With regard to Mr Bertlin's contribution, the Author appreciated, and was in full sympathy with his views. However, with all these matters of finance it was nowadays necessary to produce a series of figures for rate fixing and claims for submission to accountants. It was not possible to say 'They want £5565; I will give them £3000, which is probably right.' It might be right and probably was, but it was unfortunately necessary to produce a series of figures to substantiate it.

300. To arrange rates before the work had begun, has always been a good idea, in theory. Where this was not possible, the system which the Author had put forward left the initiative with the contractor and that was a fair way to tackle the problem. The contractor could always put in for a new rate, as Mr Mitchell had said. If it were left to the contractor to propose a new rate, however, he would often hold back, and it might be right and proper that he should do so. He might want to wait and see how things worked out before putting a rate in and should be allowed to do so. In the meantime he would receive on account payment in the usual way.

301. Mr Bertlin was quite correct, in the Author's view, when he stated that the engineer should not be influenced by the fact that the contractor might be losing money: he should have added 'or making money' as a corollary.

302. Mr Megaw's idea that new rates should fall into one of three categories was excellent in general but the application was, in the Author's opinion, controversial in some respects. For instance, the fine difference between a variation and an

additional work should not cause a change in the approach to rate fixing; for extra works it was another matter and this should be treated on its merits.

303. In the Author's opinion, Mr Edney's contribution to the discussion had shown a wise appreciation of the fundamentals of the contract system. The unqualified independence of the engineer was obviously of paramount importance and it was well that this should be emphasized at the present time when, as some speakers had mentioned, there existed doubts in the minds of some contractors. Mr Edney's remarks upon procedure were also of particular interest.

304. It had been most kind of Mr Mitchell, who was the power itself in the Federation of Civil Engineering Contractors and not simply the *eminence grise*, to give his wise views on many matters. He was, of course, correct in saying that the contractor could always claim for a new rate, or for anything.

305. Where did the boundary exist on rates? That was one of the most difficult questions to answer: it was really a question of judgement. Simply because it was not admitted strictly within the contract that did not mean in any way that the contractor did not receive fair consideration at the end of the job. He should be able to and did put in claims which were either admitted in principle and paid: or not admitted in principle but with a recommendation that a proportion, if not the whole, should be given him on an ex-gratia basis: or rejected. One did not want to agree a rate or an extra if in fact the situation might change during the period of the contract; otherwise one should agree or try to agree everything as it went along.

306. Mr Mitchell's query concerning § 29 arose out of the term 'rate fixing.' The engineer could either discuss and agree a rate with the contractor or, if compromise could not be reached, he held power to dictate the rate to be paid. The I.C.E. Conditions made no distinction, but clearly in the latter case the contractor, while generally accepting the situation, did not necessarily agree with it. He had then to recourse to a claim, which would go before the employer with the engineer's recommendation, or ultimately to arbitration if he so desired.

307. Mr Crosthwaite had drawn attention in § 169 to the plant rates and plant on-cost used in the examples. The Author had encountered a wide variety of methods used in building up this section of the rates, and a simple example had been given which could reasonably apply to a small contract. The Author agreed that the Federation daywork rates for plant might be excessive for contract work, as opposed to daywork, but they were nevertheless used by some contractors in tendering.

308. The Author did not consider it advisable or necessary to make the revelation of tender 'build-ups' a contract condition, as mentioned by Mr Cole in § 173 and later by Mr Clarke in § 182 (*d*), such a requirement would almost certainly and quite rightly be opposed by contractors.

309. Mr Miles in § 175 and later Messrs Weddell in § 208 and Culverwell in § 220 had all mentioned the importance of agreement between the resident engineer and the agent as to matters of fact and the keeping of records. The Author fully supported this, and considered that it was necessary also that the make-ups submitted by the contractor should indicate any special features of the work.

310. The Author did not agree with Mr Bridgeman's statement in § 179 concerning rates to be determined for new and substituted items. Most contracts of any magnitude incorporated a rise and fall clause permitting adjustments for materials and labour variations on a nett basis only. Basic rates should therefore be used in pricing new and substituted items. Where no rise and fall clause operated, contractors normally covered in their on-costs for price increases. Hence basic rates should again be used in pricing new and substituted items, unless the contractor could show that he had built up his tender prices in a different manner. This would emerge in discussion at rate-fixing meetings, where consideration could be given to the effect, if any, of the varied works upon the tender allowance for price variation.

311. Mr Clarke in § 184 had queried the method of deriving the on-cost per-

centages referred to in the Paper. The Author's practice was to invite the successful tenderer at a post-award meeting to submit the make-ups of a selection of his tender rates. Very often this was at director/partner level as the details were obviously of a confidential nature. These make-ups then formed the basis of future rate negotiations for new or varied work.

312. With regard to queries raised by Mr Manning in §§ 192–194, the Author did not consider that the averaging of rates for similar work in other contracts would give the correct answer for a particular contract. It could, of course, provide a useful indication where there were no analogous rates in the tender itself. In the absence of analogous rates, he considered that it was preferable to estimate the on-costs appropriate to that section of the works, and then discuss with the contractor. The output that could reasonably be or should have been expected with the plant available or such additional plant as might be necessary. This in part also answered Mr Manning's second query. Clearly, if the contractor carried out extra work in an uneconomical manner, the employer should not thereby be penalized. While the Author agreed that it should be left to the contractor to select the method of carrying out the work, if the engineer saw a cheaper way of achieving the desired result, while he should not insist upon it, he should at least discuss the matter with the contractor. As Mr Elliott had mentioned earlier in § 187, such problems should not present much difficulty to an experienced resident engineer and an efficient contractor. Care should be taken in these matters: only too often a contractor had gladly accepted an instruction from the engineer as to how the work should be done, leaving the employer—often unknowingly—the bearer of unnecessary extra cost.

313. Mr Manning's third query related to cut prices. In the Author's view variations should be based upon the tender prices, and this automatically took advantage of the proximity of other contracts in the area. Adjustment would, of course, be necessary in respect of the actual circumstances when the work was carried out as opposed to the contractor's expectations. It should not be impossible to arrive at a reasonable compromise.

314. Mr Navaratnarajah had referred in §§ 196–201 to a number of factors which made the exact application of a formula or the rigid application of contract rates to new work impossible. Such special conditions were matters for discussion at head office level, as referred to in §§ 29 and 31 of the Paper. In these special matters, as in so many others, the answer lay in a fair decision being given by the engineer based on his experience, judgement, and integrity.

315. Mr Weddell had raised in § 206 the difficult question of what variation in the volume of a particular work would justify revision of the tender rate: Mr Shilston in § 252 had also commented upon this matter. Contractors could usually be relied upon to put forward a case when the limit had been reached, but the Author considered that such matters could not be treated adequately except on an overall basis at the end of the contract. It could then be seen to what extent the contractor's overheads had been affected by variations in the volume of the works.

316. Mr Weddell had also mentioned the question of whether a low or high tendered rate should be projected through to negotiated rates: this had already been answered in the affirmative. Mistakes in tendered rates would, however, be spotted if the *vidimus* was properly prepared and studied.

317. Mr Watkins had rightly brought out points often not fully considered by the engineer: it was unfortunately true that in some cases ignorance of works practice was responsible. The Author did not advocate the principle of leaving *all* agreements to the end of the contract. There was always the special case which was related to the contract as a whole or which could vary in time and these were the sort of problems the Author felt were best left until the end of the contract.

318. Mr Culverwell in § 214 *et seq.*, had contributed some useful comments upon the keeping of records. It was truly said that engineers were often faced with

settling claims and even rates, several years after the particular work had been completed. The Author considered that the engineer had a duty to press the contractor to put forward not only his new rates promptly, but also to submit for agreement records of any work for which he considered a claim might be made.

319. Mr Briggs had commented upon the practice of weighting rates in order to recover overheads at an early stage of a contract, and it was evident that this particular matter had raised doubts in the minds of a number of contributors as to the impossibility of applying any logical system to the appraisal of new rates. Mr Weddell had provided one solution in § 207. The Author had no objection to the principle of advances, but preferred the more positive method of billing separately, specific and costly temporary works so that payment could be made for these as and when undertaken. Nevertheless, the Author considered that where a tender had been weighted, the extent would become evident in discussions at rate-fixing meetings and the on-costs appropriate to new work could be adjusted if appropriate, or account taken of any extra and unwarranted recovery of on-cost in the consideration of claims.

320. Mr Briggs had raised a similar point to Mr Megaw concerning the pricing of extra works, and as the Author had earlier stated, he did not consider that additional works should necessarily be linked with extra works in this connexion. There was usually time for negotiation of rates for extra works before the work was put in hand and contractors realized that if they raised their sights too high they might not be given the job, as Mr Bertlin had pointed out.

321. Mr Forbes had provided some interesting information concerning studies carried out at the Building Research Station, and it would be useful to have contractors' comments upon the suggested procedure.

322. The Author considered that many of Mr McAughtry's criticisms would disappear in the face of a reasonable attitude by contractors to the divulging of the build-up of their tenders. The Author had seen something of the 'time-honoured method' and although it had worked fairly satisfactorily in pre-war years, it now provoked much lengthy and unrewarding argument. There was also, as he had mentioned in the introduction to the Paper, and as Mr Shilston had pointed out in § 256, the fact this that method did not recommend itself to many present-day employers.

323. Mr Shilston's remarks and conclusions were of great interest and betrayed a keen insight into the problems involved in rate-fixing. The Author had already made certain comments upon the weighting of rates. The extent of this should emerge during discussions at rate-fixing meetings, and could be dealt with accordingly. He did not favour pre-award discussions with contractors concerning their prices unless the question of major errors arose. In reply to § 254, the Author considered that all tenderers should be advised of any limitations to be imposed by the employer upon the engineer's mandate, and that notification of this should be made either at a pre-tender meeting, or in the document itself.

324. With regard to the comments made by Messrs Gillott and Reeves concerning the preparation of tenders, the Author appreciated that there was a certain 'mystique' involved in tendering, and that prices were revised following last minute rulings from the directors and so on. He added that he did not agree that they were thereby disqualified from scrutiny, nor that they could serve no useful purpose in the compilation of rates for new or varied work. Anomalies in rates arising out of these causes would emerge in discussions at rate-fixing meetings if the particular items or set of items came up for comparison or adaptation for new and varied work. The Author, however, fully agreed with Mr Banks whose excellent remarks in § 268 were well balanced and very much to the point. His remarks also in § 269 were of particular application in situations where the contractor preferred not to reveal the method used in preparing his prices.

325. The example of make-up offered by Mr Phillips involved assumptions upon the amounts paid to individual operatives for subsistence and travel. The Author

felt that as these items could not be exactly calculated at tender stage, it was perhaps more common practice to decide a percentage addition to cover the whole labour force for the job. This would also include non-productive overtime, wet and guaranteed time, and other payments. The important point however was that all costs should be covered, and a comprehensive list of on-cost items such as that provided by Mr Phillips was a necessary preliminary to the preparation of a tender.

326. In conclusion, the Author wished to make it clear that he had been less concerned with proposing and defending a method of fixing rates than with striving towards a better understanding, particularly by young engineers, of the problems and in particular of the principles involved in this difficult subject. There was certainly a great deal that could be learned from the most interesting and expressive observations of those who had kindly contributed to the discussion, and the Author wished particularly to thank Mr Banks, who besides taking the chair at the discussion had found time later to add his valuable comments. The Author begged the indulgence of any who might feel that certain of their comments had been passed over, or inadequately answered. The examination of the many contributions and his endeavour to reply without excessive reiteration had been a massive task, but one which he had nevertheless found extremely rewarding.

Reference

1. W. S. Forbes *and* E. R. Skoyles. The operational bill. *J. chart. Surv. Instn.* February 1963, pp. 429–434.