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Retirement Provision for Marine Engineers.

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READ

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CHAIRMAN: MR. JAS. PATERSON (Member).

The CHAIRMAN: The paper to-night is "Retirement Provision for Marine Engineers," written by one of our members, Mr. W. W. Houfe, who is at present out in China. I will therefore call on Mr. Adamson, Hon. Secretary, to read the paper.

Introduction.—The national aspect dictates that the British Empire must continue to be largely interested in the world's Mercantile Marine, necessitating an adequate supply of men who should be in a position to marry at a reasonable age and raise families without suffering the depressing influence of insufficient provision for their declining years, while the sea-going Engineers' pay does not afford more—after payment of living expenses—than a reasonable Life Policy provision for wives and families.

The following quotations tend to indicate that it becomes the duty of the desirably large Shipping Companies to promote retirement allowances of some merit to their Floating Staffs:—

From "The Elements of Reconstruction" (Nisbet, 1s.):—"The minor employer deals with his men by the hour, day or job; he has to take them as they come 'out of the unknown' to him; he is unable to treat them generously as they age; he is powerless to help their children; indeed, to do his duty in any way beyond the immediate business in hand." . . . "The larger the scale of business the better." From Lord Inchcape's address at the P. & O. Coy.'s General Meeting, 14/12/16:—"In due time I hope the men of the Merchant Service will receive the distinctions which they have earned so well throughout the war." . . . "As regards the future, while it is impossible to say what may be ahead of us, you may feel perfectly satisfied, as I said a year ago, that we shall never distribute a sixpence beyond what we can well afford to pay, and I may add, after taking care of those who help us to grind out the corn—our Captains, our Officers and our Engineers, and our other employees."

That the floating staff of the Union Steamship Company of New Zealand is not to-day favoured with retirement provision appears to be the fault of the men themselves, as may be seen by reference to our Institute's Transactions, September, 1916, page 86, par. 6. The reference is to our esteemed President, Sir James Mills:—"He offered to establish and endow, in a very handsome manner, a superannuation scheme for his deck and engine-room officers. A scheme which, unfortunately, was rejected for some unknown reason, and which many now much regret that they did not accept." As the deck and engine-room officers serving on the "China Coast" are at present anticipating some concession in the way of retirement allowances, the writer is aware of the views and opinions held by many of the interested: and as a consequence he, in an elementary way, has looked into some of the difficulties attending the subject, and believes a little ventilation through the medium of our Institute may be attended with a somewhat better and wider understanding by Marine Engineers of schemes for retirement allowances generally.

In what follows, the endeavour will be to view the subject on broad lines; in an equitable manner; with due consideration towards employers and employees; using the simplest calculations and such data only as can be gathered from a Whitaker's Almanack.

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Disregarding any particular appropriativeness of the prefixes—Superannuation, Provident, Flat, etc.—to such schemes as here concern us, it is sufficient to consider the subject under the distinctive differences only of contributory and non-contributory, the former covering all schemes to which the employer and employees jointly contribute, and the latter such as to which the employer alone contributes.

More or less common to both forms are the following considerations, amongst which considerable compromise requires to be effected in any proposed scheme where reasonableness, fairness and equity are to preside:—

A. *Retirement Age.*—Taking axiomatically, that to promote indolence is undesirable; . . . and that a Marine Engineer's calling is such as may be followed throughout the most of his useful life-period. It is when, through age, a man's efficiency falls below the average of his rating, and a more efficient man is available to take his place, it will be profitable to retire him on a suitable pension; for thus will promotion be accelerated and general efficiency maintained. This climax in efficiency will occur at ages varying with different individuals and with the different conditions of service. Also, the life of an engine-room officer being largely one of isolation, tiedness, and lacking in healthy amusements, he more and more longingly looks forward to being able to spend some still enjoyable period of his declining years comfortably ashore in retirement. A further important consideration, particularly where no retirement consideration being operative, a scheme is about to be introduced, is the influence of age upon the purchase price for a given annuity.

As precedent compromises of such influences, the following quotations will be of service:—

1. Services trading to and from the United Kingdom: Optional retirement after a minimum age of 52, and compulsory at 60.

2. Services trading on the Indian Coast: Optional retirement after a minimum age of 52, and compulsory retirement at 57.

3. Services trading on the China Coast: Optional retirement after a minimum age of 52, or if 55, to be reducible to 52 the third year of inauguration; and compulsory retirement at 60 (submitted).

It may be well to bear in mind that such option periods are at the discretion of both employer and employee.

B. *Service Qualification.*—Duly regarding the axioms stated under paragraph A, and that in most large Companies the engine-room officer does not attain to maximum Chief Engineer's pay till he has well over 20 years' service in the Company, the minimum service qualification of 25 years, embodied in the schemes referred to above, under 1, 2 and 3, appears to be both reasonable and fitting. Such, where the maximum age is 60, giving the employer an age range for new employees, of men between 20 and 35, who will all be eligible for retirement benefits under the scheme.

With 52 as the minimum age limit, a man joining a service at 20 years of age will require to serve 30 years to attain to the minimum retirement qualification; while a man joining at 35 years of age can only just fulfil the minimum service period if he is compelled to retire at the age of 60.

Even though the elder, and presumably more experienced, man be of greater value to the Company than the youth straight from the works, it is felt that some proportionate consideration should accrue to the one of longer service. This will be seen to be compassed in the suggested schemes to follow.

C. *Expectation of Life.*—One's further expectation of life cannot be definitely stated, but the average further expectation from each year of age is regularly computed from the mortality returns ascertained for statistics. It is a very important matter with all Life Insurance Companies in their estimates of insurance and annuity undertakings, and while they will have tabulated averages for residence in probably all parts of the world, a page of Whitaker's Almanack always gives reliable and authentic averages for England and Wales for ages from 0 to 105 (see Table I., "Home Life"). These will here be used for "Home Service," and as a basis for lives spent largely in other parts of the world. In such manner the further expectation of life has been included in Table I. for men who have largely spent their lives on the "China Coast," and, again, for such on the "Indian Coast," the assumption being that the former is equivalent to that of a man of three years more age on "Home Service," and the latter to that of a man of six years more age on "Home Service." Throughout this article the average expectation of further life corresponding with the age and the service of the individual referred to will be denoted with (N).

D. *Interest Rate.*—Seeing the C.M. Life Insurance Company during 1915-16 earned interest on their mean fund of over 6.2 per cent., and the S. Life Insurance Company 6.36 per cent., it appears evident that 5 per cent. is a safe anticipation for all investments that concern us here. The calculations given in Table III. are compound interest tabulations as given in Whitaker's Almanack for 5 per cent.; reference can be made to Whitaker's if other percentages below 5 be required. The introduction of (R) into Table III. is to render the relationship of the parts more obvious and to aid in their correct use. While (R) denotes the amount of £1 at 5 per cent. interest in one year, it will be observed that where any multiple of £1 is to be considered the correct figures given for £1 multiplied by such multiple will give the amount required.

E. *Absorption Factor.*—This may be defined as the annuity (a), which £1 will exactly afford being paid annually for (N) years, while the outstanding purchase values or the yearly remaining portions of the £1 are interest bearing (5 per cent. herein considered); and in Table I. and hereinafter this factor is denoted with (Fn) where the (n) indicates the expectation of further life corresponding to the age of the individual referred to.

Let (M) be any given amount; (a) the amount of the yearly annuity; (R) the interest factor; and (n) the number of yearly payments it is anticipated will be made; then:—

1st year. 2nd year. 3rd year. 4th year. 5th year. nth year.

$$\Big[\Big(\Big\{\Big[(M - a).\ R - a\ \Big]\ R - a\ \Big\}\ R - a\Big)\ R - a..\text{etc.}\Big]\ R - a \qquad = 0.$$

i.e. $M.R^{n-1} - a.R^{n-1} - a.R^{n-2} - a.R^{n-3} - a.R^{n-4}..\text{to}.. - a.R^{1} - a \ = 0.$

i.e. $M.R^{n-1} = a(R^{n-1} + R^{n-2} + R^{n-3} + R^{n-4}..\text{to}.. + R^{1} + R^{0},$

$$i.e.\ \frac{M.R^{n-1}}{R^{n-1} + R^{n-2}..\text{to}.. + R^{0}} = a..-$$

The annuity which (M), with interest considerations accounted for by the factor (R) will pay over (n) years.

By taking n to the nearest whole number R^{n-1} can be taken direct from Table III.; and also the sum of the geometrical progression $R^{n-1}+R^{n-2}+R^{n-3}$..to..$+R^0$ (n.G in Table III); then by putting $M=£1$, a will be found by effecting the division to be practically identical with the Absorption Factor (Fn) in Table I., for which the actual figures for n were used in the same formula, but stated:—$a = \frac{£1\,(R-1)}{1-R^{-n}}$. Had M devoted £1,000, obviously the annuity a would have been 1000 x a.£.

F. *Mortality.*—While Whitaker's Almanack does not directly state the mortality percentages between various ages for England and Wales, they can be readily ascertained from the recorded numbers of survivors per million born for the ages required. This has been done, to a limited extent, for Table II.; where, again, the differences of 3 and 6 years in ages were allowed for "China Coasters" and for "Indian Coasters" respectively. In pension schemes generally it is thought that death during service continued, with age and service qualifications, at the Company's pleasure, should entitle deceased's estate to the cash surrender value corresponding to his age and service at the time of death. And if not to the whole, certainly to a part.

G. *Ordinary Immature Quittance.*—Under this heading is included Resignations, Discharges and Desertions, but not Deaths. While the percentages used hereinafter are somewhat arbitrary, they are probable approximations. Table II. gives statements for "Home Service" and "China Coast" service alike; and for "Indian Coast" service a somewhat higher percentage, as appears reasonable.

H. *Total Immature Quittance.*—This combines in one expression mortality and ordinary immature quittance, and is stated under Table II. for the three services considered. The mature quittances are, of course, retirements. While in non-contributory schemes the individuals cannot expect any monetary consideration under immature quittance, in contributory schemes they should be entitled to at least the return of their entire personally contributed accumulations under 5 per cent. compound interest, without prejudice or deductions of any kind whatever. This should be plainly and positively stated in the scheme's clauses and made plain to prospective employees.

I. *Actual Staff.*—While the nominal floating staff comprises just the number of men constituting the whole of the Company's ships' complements, due to sickness and home leave reliefs, the actual staff will be in excess of the nominal staff.

Denoting Actual Staff with Sa and Nominal Staff with Sn, we have:—Sa = Sn + continuous sickness and leave reliefs.

1. Taking 2 % continuous sickness and 9 months home leave after every 5 years of actual service:—$Sa = Sn.\left(1 + \frac{2}{100} + \frac{9}{69}\right)$ $= Sn.1{\cdot}1505$ (as for China Coast service).

2. Taking 3 % continuous sickness and 6 months home leave after every $3\frac{1}{2}$ years of actual service:—$Sa = Sn.\left(1 + \frac{3}{100} + \frac{6}{48}\right)$ $= Sn.1{\cdot}155$.

Thus: when comparing pension scheme costs in terms per unit of staff, where different service conditions obtain (Sn) should be employed in preference to (Sa), as it compasses the differing leave influences.

J. *Cycle Period.*—The average period from the time a man joins a service till his retirement constitutes one cycle period; and for pension schemes with minimum age 52, maximum age 57, and minimum service 25 years (all in), may reasonably be taken as $27\frac{1}{2}$ or 28 years. While if 60 be the maximum age a 30-year cycle period may be assumed.

Where a pension scheme is inaugurated early in the Company's life the cost estimate for the first cycle period will closely resemble that for further cycles, given constant staff conditions.

K. *Purchase Price of a Suitable Annuity.*—Any reliable Insurance Company, being out for competitive, although profitable, business, must offer its attractions to their prospective clients in the most equitable form possible; and when dealing with annuities the further expectation of life is a deduction from statistical averages for given ages, while the profit and expense charges are estimated upon the fulfilment, in the general course of the Company's business of such collective averages. These profit and expense charges would appear to be anything from 20 per cent. upwards of the free purchase price, and constitute the difference between the purchase price for a given annuity, at a given age, that is required by an Insurance Company, and the lesser purchase price, which, freed from the Company's profit and expense charges, is a mathematical deduction for given interest considerations and further expectation of life. Thus given the amount one is prepared to expend upon an annuity the individual's concern is to obtain, with reasonable security, the largest annuity offering at his age, and if the amount or purchase price be invested in the Company buying, or affording, the annuity, the profit and expense charges being regarded as saved, the annuity would be a simple mathematical deduction from the purchase price as mentioned above. Some employers make their retiring employees a bonus consideration based on service, which may be regarded as a cash surrender or purchase price for an annuity to be effected by, and at the *option*, of the retiring one. And while such annuity, purchased in any Insurance Company, could not be as large as one that could be afforded by the employer investing the amount in the business itself, it appears reasonable that under any pension scheme an option of a cash surrender, equivalent to the purchase price, or a corresponding annuity, should be offered to the retiring ones.

It is worthy of remark, as this war has shown, that annuities (or insurance policies) should not be effected in foreign Insurance Companies.

Using the data from Table I. at age 52 (Fn = ·09309) the annuity afforded from £1,100, invested under 5 per cent. interest considerations only, is £1,100 × ·09309 = £102 per annum, while about £1,270 would be required to purchase it from an Insurance Company.

If the purchase price be fixed, the annuity afforded is purely a consequence, and must increase with the age of the retiring one, or equity will not be maintained.

Accepting a minimum service qualification of 25 years' (total) service, where this is exceeded in attaining to the minimum age qualification, it appears most reasonable in non-contributory schemes, to first fix the purchase price for the minimum retiring age and service; then to increase the further purchase price by, say, 5 per cent. increments for each succeeding year to, say, a maximum at the 30th year.

With contributory schemes this matter is largely self-adjusting. And it would be satisfactory that the individual's contributed accumulation be regarded as additional purchase price for an annuity proportionately larger than it would have been had the scheme been non-contributory.

L. *The Funds.*—It has been shown that the monies provided for annuities and cash surrender values would be best yielding if invested (in the form of a 5 per cent. deposit) in the Company's business; and unless the scheme be non-contributory and provides for the payment of the full purchase price to the retiring one, or by mutual option, an equivalent equitable annuity; whether the scheme be contributory or non-contributory; whether the Company provide their total cost covering at the time of inauguration in whole or in part, add to it as their staff increases or deduct from it as their staff diminishes, a fund account must be kept and be regularly posted and audited; and if it be secured by a covering mortgage or similar undertaking on the shipping owned by the Company, and such be lodged with the Public Trustee, or a British Consulate, where a bill of sale on the ships would require to be issued, ample security, void of annoyance to the Company, would appear to be afforded. For contributory schemes the fund account would necessitate individual accounts, as well as the collective one, which, with other reasons, appear to make Companies avoid them.

M. *Efflux to Retirement.*—In any Company where Sa denotes the actual staff, the average number of men annually qualifying for retirement will be :—Sa ÷ cycle period × (1—total immature quittance). With a cycle period of 30 years, and total immature quittance 45 per cent. (Table II., "Home Service," ages 25 to 55), we have :—

Average qualifications per annum :— $\frac{\text{Sa}}{30}\left(1-\frac{45}{100}\right) = \text{Sa}\,\frac{11}{600}$ *i.e.* — Sa 0·01833

With a cycle period of 30 years, and total quittance 50 per cent. (Table II., "China Coast"), $\frac{\text{Sa}}{30}\left(1-\frac{50}{100}\right) = \text{Sa}\,\frac{1}{60}$ *i.e.* — Sa 0·01667

With a cycle period of 27½ years and total quittance 58 per cent. (Table II., "Indian Coast"), $\frac{\text{Sa}}{27\frac{1}{2}}\left(1-\frac{58}{100}\right) = \text{Sa}\,\frac{21}{1375}$ *i.e.* Sa 0·0153

N. *Cost Estimates.*—All pension schemes involve monetary charge upon the Company referred to, which for given conditions and benefits will be a minimum if inaugurated at the time of the Company's start in business (1st) increasing to a maximum, if inaugurated after the lapse of a full cycle period; (2nd) it is proposed, firstly, to consider what this charge would approximately amount to, where a non-contributory scheme be inaugurated at the time of the Company's start in business; the initial staff of (Sa) men increasing annually by (Sa) men throughout the first cycle period of 30 years, an annual covering 5 per cent. investment addition being put to the Pension Fund, which at the start stood only for (Sa) men, and at the 30th year would stand for Sa × 30 men. Thus for the survivors of each original batch of Sa men who retire on the average service of 30 years (the cycle period) the addition made to the fund by the Company will have received interest considerations at 5 per cent. for 29 years.

Let the scheme be such that the cycle period be 30 years and the total immature quittance 50 per cent.; then the survivors to retirement each year of each batch will be:—

$$\frac{Sa}{30}\left(1-\frac{50}{100}\right) = Sa\,\frac{1}{60}\ (1)$$

Let the purchase price afforded by the Company for the minimum service of 25 years be £1,100, increasing for each further year of service by annual 5 per cent. compound interest increments, the purchase price being regarded a maximum for the 30th year of service, although the maximum service will be of 35 years to constitute the cycle period of 30 years:—

Then the average purchase price will be:— $\frac{£1{,}100 \times 6G}{6}$ taking 6G from Table III. $\frac{£1{,}100 \times 6{\cdot}802}{6} = £1{,}247$. Or without the Table and 6 G—£ (1,100 + 1,155 + 1,213 + 1,273 + 1,337 + 1,404) ÷ 6 = £1,247 per retirement, 30 years after the addition to the fund: so that the addition to the fund when made by the Company would have been:—

£1,247 ÷ R29 = £303 per average retirement. And since the retirements per batch of Staff Sa have been shown to be $Sa\,\frac{1}{60}$ (from (1)...)

$£303 \times Sa\,\frac{1}{60} = Sa\,\frac{101}{20}$ £ per average yearly total retirements from each batch Sa. This will be yielded annually from a 5 per cent. investment of $Sa\,\frac{101}{20}\,£ \times \frac{100}{5} = Sa \times £101$ (per average yearly total retirements from each batch Sa). At the end of this first cycle period the retirements will begin to take place, and the accumulated fund will amount to:—Sa 101 × 30 = Sa £3,030, while the number of men then constituting the actual staff will be Sa $\times$ 30 = Sa.

Hence the final amount of the fund, in terms of the maximum staff Sa will be :— $\frac{Sa}{30} \times$ £3,030 = Sa £101 which will support the retirements from the service for ever, provided the number of staff remain constant. This is also the "Further retirements covering," as per inauguration conditions (2nd), *i.e.*, (Sa) £101 (1st). Consider now what the Company's charge or capital investment would have been had the inauguration of the pension scheme coincided with the end of their staff's first cycle period of 30 years. The retirements would begin with the inauguration of the scheme, and, as stated under (1) with 40 per cent. quittance in place of 50 per cent. will be :—Sa $\frac{11}{600}$ yearly (2)

To cover each of the immediate retirements—£1,247 $\div R^0$ = £1,247, will be required: and for the following year's men—£1,247 $\div R^1$ for each retirement (the money having been one year at 5 per cent. interest, being originally less than £1,247) for the 3 year men—£1,247 $\div R^2$, and so on till completion of the first cycle. The "cover" for the men who were just newly in the service at the time of the scheme's inauguration being :—
£1,247 $\div R^{29}$. This may be expressed collectively thus :—

$$£1{,}247 \left(\frac{1}{R^0} + \frac{1}{R^1} + \frac{1}{R^2} + \frac{1}{R^{29}} \textit{ i.e. } £1{,}247 \frac{R^0 + R^1 + R^2 \text{ to } + R^{29}}{R^{29}}\right)$$

i.e. £1,247 $\times \frac{66 \cdot 439}{4 \cdot 1161}$ £20,126 for the first cycle period if only one man retired each year; but from (2) there are :—

Sa $\frac{11}{600}$ men retiring each year—so the "covering" required will be £20,126 $\times$ Sa $\frac{11}{600}$ = £369 Sa for the whole of the first cycle retirements, (2nd).

By adding (2nd) and (1st) we have the capital investment covering, which if invested at 5 per cent. compound interest at the time of the scheme's inauguration will discharge the Company's obligations for the scheme for all time, it being understood that (Sa) continue constant.

Covering against first cycle retirements ...	... £369 Sa
Covering against all further retirements ...	... £101 Sa
Capitalisation of fund, if at Scheme's inauguration	£470 Sa

For the purpose of comparisons, this should be stated in terms of Sn. Taking the conditions under paragraph I., where Sa = Sn × 1. 1505—£470 Sa × 1.1505 = £541. Sn for the fund capitalisation, it naturally follows that where a scheme is inaugurated at some time *between* the inception of the Company and the end of its staff's first cycle, the capital covering will be *between*, such as under the first (£101 Sa) and second (£470 Sa) considerations just reviewed, the first cycle "covering" through the delayed capitalisation being entirely responsible for the difference.

Y. *Estimating*, upon such a non-contributory scheme inaugurated fully one cycle after the Company's inception; and where the basic purchase price statements (£1,100; £1,155; £1,213; £1,273; £1,337; £1,404) are to stand for Chief Engineers; and 1st Mates and 2nd Engineers, never attaining to the senior positions, 40 per cent. less than Chief Engineers (see Table VI.).

Let the whole staff of (Sa) men be equal in numbers of deck and of engine-room officials, and the retirements 49 per cent. Masters, 49 per cent. Chief Engineers, and 2 per cent. 1st Mates and 2nd Engineers. Then the capitalisation required will be (using the combined "covering" against first cycle retirements (2nd) £369 (Sa), and covering against all further retirements (1st) £101 (Sa), *i.e.*, £470 (Sa)—£470 × ·49 + 470 × 1·05 × ·49 + 470 × ·6 × ·02) (Sa) = £478 (Sa), which in terms of nominal staff (£478 × 1·1505) is £550 (Sn) (Y). Or with conditions of leave, 2, under paragraph I (£478 × 1·155), £552 (Sn) (Y).

From the above it will be seen that by the method of fixing the purchase price for either Master or Chief Engineer, and allowing any percentage of difference that may be insisted upon, the whole scheme and its estimates will be rendered comprehensive, flexible, simple to state, and the capitalisation estimate a ready means of comparison.

Although this article is particularly to Marine Engineers, pension schemes of Shipping Companies, directly or indirectly embody both Masters and Chief Engineers, and are capitalised as a whole.

While having stated a 5 per cent. distinction in favour of Masters, the excuse can only be that a distinctive difference is customary; but why some companies have issued pension schemes of non-contributory types, having unreasonable and non-equitable differences in the allowances to Masters and to Chief Engineers, is somewhat astonishing, for while an engineer officer during his apprenticeship must have cost his parents about £300, the deck officer in the sailing ship days need not have cost his parents anything like so much; and it is not evident that his initial training need be much more expensive to-day. Certainly there must be only "one Master in a ship," but neither Master nor Chief Engineer live retired on board a ship. Of course, a Company has every right to bestow its money where it desires, but given a definite sum that can be afforded for floating staff pensioning, its allocation should not show excessive generosity to the one calling at the expense of the other. While engineers feel that their employers should not disparage them in such manner, the writer feels that in stating herein a 5 per cent. difference in favour of Masters, the limit has been stated. With contributory schemes this matter is, more or less, self-adjusting.

Contributory Schemes usually call for a 5 per cent. of pay contribution from each of the whole staff, although it might simplify matters if it were 5 per cent. to the nearest 1s. And to this contribution from each employee the Company contribute a like amount. The contributory period may be the full service period, or, where wages are reasonable, one limited within the fullest service period, the individual's further service period (that which is still afforded him at the time of the scheme's inauguration) when permitting the accumulation of a sufficient amount toward the purchase price of a reasonable annuity. While in some cases it may be desirable to fix upon some other percentage than five, such is easy to calculate, and considered generally satisfactory.

If it be determined that the annuity afforded by the purchase prices—starting with £1,100 for 25 years' service—be adequate at the minimum age of 52, and the individual and the Company contribute equally till the joint accumulation reach £1,100, it may be that such half amount (£550) will require 5 per cent., more or less, of the pay throughout the individual's service; but the cost to the Company will be just half of what it would have been had the scheme been a non-contributory one. Should the Company undertake to provide the £1,100, etc., basic purchase values, and the individuals contribute to, say, the limited accumulation by the time of retirement of £550, the joint purchase prices would then be £1,650, etc., and the annuities afforded would be proportionately higher, *i.e.*, £153 in place of £102, etc. In such a scheme, inaugurated after the lapse of one cycle period, the Company would either be required to find, or make up, this further amount of £550 for those too near to retirement to be able to accumulate it from their own contributions. Some special further contribution would have to be permitted, or such individuals would have to suffer a lesser annuity than their younger and more fortunate colleagues.

Z We will now consider an original formula for a contributory scheme, which appears to be recommendable for its flexibility and equity. The several parts are as follows:—

Displacement Saving.—If it be given that a man has arrived at an age where his efficiency has fallen below average, and that the grades of pay be progressive, there will be a saving effected in the wage account by retiring him and promoting the successively lesser ratings. This in a certain service amounts to £780 for maximum pay Chief Engineers, to £890 for maximum pay Masters, and to £265 for maximum pay 2nd Engineers and 1st Mates. (See Table IV. for pay gradings and Table V. for displacement savings.) Such displacement savings being incoming, while the annuities to the displaced ones would be outgoing, no interest influences need be considered, and thus the amount of the saving for the rating considered (denoted by D), divided by the expectation of life (denoted by N) for the age of the retiring one, will give the annuity afforded therefrom, *i.e.*, $\frac{D}{n}$. If it be recognised that such saving should only be regarded as such for a part of the first cycle, and should be gradually supplanted within a given period (denoted by d) by percentage of pay contributed accumulation, the total period for which may be denoted by (y), this will be arrived at thus:— $\frac{D}{n} \times \frac{d - y}{d}$ = annuity from displacement saving. Permitting no negative value, when $y = d$, the annuity from this source will be nothing.

Past Service Contribution.—Further, to balance the annuities afforded first cycle men and future men, it will be seen to be satisfactory that first cycle men be permitted to contribute (upon the inauguration of the scheme, or as soon thereafter as may be mutually agreeable), a sum of (S) pounds. Where (S) denotes, say, £10 per year of past service, estimated up to the time of the scheme's inauguration. To this amount the Company will contribute an equal amount, and the whole will bear 5 per cent. compound interest (added annually) till retirement. Thus putting R^a for the interest factor for a years, this accumulation at the time of retirement will be :- $2.S.R^a$ pounds This ($S.R^a$) may reasonably be limited to £$300.R^a$.

Percentage of Pay Contribution.—Taking the usual contributory rate of 5 per cent. of each employee's pay, this in each individual account to be credited with 5 per cent. annual compound interest, it appears reasonable that under circumstances where the accumulation would be unnecessarily large to limit this percentage of pay contribution period, to the effect that in no case is the accumulation, while contributing, to exceed, say, £500. This contribution ceasing, the accumulated amount to be 5 per cent. compound interest, bearing till retirement. The Company will contribute equally with the individual, so the joint ultimate accumulation from this source at the time of retirement will be :—$2.C.R.^b$ where (C) denotes the individual's personally contributed accumulation, of, say, £500, or less where the contributory period be too short; R^b the further compound interest factor for (b) years, and the factor (2) being for the inclusion of the Company's equal contributory accumulation. For the service particularly referred to, and for which Table IV. is compiled under columns "Individual Accumulation," "$C.R^b$," is given the personal accumulations at the times of retirement for one man retiring each year throughout the first cycle period. Reading from the head of the column downwards, we have opposite 31st year of service the individual retiring, who under this understanding has had no time afforded him to contribute anything. Then the man of a year less service is regarded as being afforded one year in which to contribute; and so on until we come to the 1st year-of-service man, who is regarded as being nearly afforded the equal period of a newly joining further cycle-man.

Table IV. is a collective abstract of three charts—1, 3 and 2, the former being for Chief Enigneers, the next for Masters and the latter for Second Engineers and First Mates, their pays being identical, and the promotion from the junior ratings of about the same periods. That for Chief Engineers is appended hereto, and will serve to render this abstract

Table IV. obvious. The particular use of the table is for estimating approximate values for $C.R^b$, such being stated for any individual with from 1 to 30 years to serve before being retired (the average service period taken being 30 years). The average $C.R^b$ is also obtained from these charts, as will be seen at the foot of each division of the abstract; and while the individual values may, or may not, be approximately accurate, in view of the range of individual service period, the average $C.R^b$ over the cycle may reasonably be accepted as being approximately correct. The table in similar manner gives the average cost coverings, the Company's contributory investment provision made at the time of the scheme's inauguration (the interest rate used being 5 per cent.). In calculating Table VII. the values in Table IV. were used.

Bearing in mind that (Fn) denotes the absorption factor for (n) years average further life, with 5 per cent. compound interest considerations by assembling the several expressions.

the whole formula will correctly be :— $\frac{D}{n} \times \frac{d\text{-}y}{d} + 2\ (C.R^b + S.R^a)$ Fn. = Annuity for age given.

This for a man retiring immediately upon the scheme's inauguration will become :— $\frac{D}{n} \times \frac{D\text{-}o}{d} + 2\ (o + s)$. Fn. *i.e.* $\frac{D}{n} + 2.s.$Fn. = Annuity.

And for one retiring 15 years after the scheme's inauguration with 30 years' service $\frac{D}{n} \times \frac{d\text{-}15}{d} + 2\ (C.R^0 + 150.R^{15})$ Fn.; and where $D = 20$:— $\frac{D}{n.4} + 2\ (C + 150.R^{15})$ Fn.; and for the second cycle, or all retirements after the completion of the first cycle :— $2\ (C.R^b)$ Fn. = Annnity.

In estimating for Table VII. D was taken from Table V.; $d = 20$ years; $C.R^b$ from Table IV.; $s = £10$ per year of part service; R^b and R^a from Table III.; and Fn. from Table I. For such a scheme the Capital Investment Covering invested at 5 °/₀ compound interest (added annually) may be estimated as follows :—

Re Displacement.—(Cycle 30 years, Mortality 30 %, Ordinary Quittance nil). The total participants, where the whole Actual Staff (Masters, Engineers and Mates) number Sa men, will be :— $\frac{Sa}{30} \times 20\ (1- \frac{30}{100}) = Sa\ \frac{7}{15}$. And the necessary sum (saved and expended concurrently, so void of interest considerations) whether included in the Estimate or not, will be :— £779 × $\left(\frac{\frac{20}{20} + \frac{19}{20} + \frac{18}{20} \ldots to \ldots + \frac{1}{20}}{20}\right) + Sa.\ \frac{7}{15}$, if all Chief Engineers.

$$£779 \times \left(\frac{\text{Summary of the arithmetical progression series}}{20}\right) \times Sa.\ \frac{7}{15} = £779 \times$$

$$\frac{\frac{20}{2}\left(\frac{20}{20} + \frac{1}{20}\right)}{20} + Sa.\ \frac{7}{15} = £779 \times \frac{21}{40} \times Sa.\ \frac{7}{15} = £779 \times .245.Sa.$$

$= £190.9.Sa.\ (1)$; £890 × 245.Sa. = £218.8.Sa., if all Masters (2) ; £265 × .245.Sa = £64.9.Sa., if all 2nd Engineers and 1st Mates (3)

Taking the retirements to be 49 % Masters, 49 % Chief Engineers and 2 % 2nd Engineers and 1st Mates, the "sum saved and expended concurrently" will be :—

$$Sa.\ (190.9. \times .49 + 218.8. \times .49 + 65 \times .02) = £202.Sa.\ (4)$$

(Embodied in Z)

Should the Company prefer to capitalise a 5% investment at the time of inauguration, against this Displacement account, the amount would be :—

First, if all Chief Engineers.

$$£779 \left(\frac{20}{20} \div R^0 + \frac{19}{20} \div R^1 + \frac{18}{20} \div R^2 + \frac{17}{20} \div R^3 + \ldots to\ \frac{1}{20} \div R^{19}\right) \div 20 \times Sa.\ \frac{7}{15}.$$

$$i.e.,\ £779 \left(\frac{20.R^{19} + 19.R^{18} + 18.R^{17} + 17.R^{16} \ldots to + 1.R^0}{20.R^{19}}\right) \frac{7}{300}.Sa.$$

$$i.e.,\ £779 \times \frac{368.9341}{50.5} \times \frac{7}{300}.Sa. = £779 \times .17045.Sa. = £132.8.Sa.$$

if all Chief Engineers (1′).

£890 × .17045.Sa. = £151.7.Sa. if all Masters (2′).

£265 × .17045.Sa. = £65.12.Sa. if all 2nd Engineers and 1st Mates (3′).

$$Sa.(132.8 \times .49 + 151.7. \times .49 + 65.12. \times .02) = £140.7.Sa.\ (4').$$

(Embodied in Z.)

Past Service Contribution.—(Where S = £10 × years of past service, to the limit of £300; Immature Quittance 3 %; and Mortality 35 %.) The total participants (the whole Staff again being Sa.) will be:—$\text{Sa.}\left(1 - \frac{3}{100} - \frac{35}{100}\right) = \text{Sa.}62$. And the required Capitalisation (invested at 5 % at scheme's iuauguration) to cover, will be: —

$$£10 \times \left(\frac{1+2+3\ldots\text{to}+30}{30}\right) \times \text{Sa.}0.62.$$

$$i.e.,\ £10 \times \frac{\text{summation of the arithmetical Progression series}}{30} \times \text{Sa.}0.62.$$

$$i.e.,\ £10 \times \frac{\frac{30}{2}(30+1)}{30} \times \text{Sa.}0.62. \quad i.e.,\ £10 \times 9.61.\text{Sa.} = £96.1.\text{Sa.}$$

whether all Chief Engineers, Masters, 2nd Engineers or 1st Mates (5).

Percentage of Pay Contribution.—First Cycle men. (Allowing 10 % Immature Quittance; Mortality 35 %.) The total participants (Sa. as before) will be:—$\text{Sa.}\left(1 - \frac{10}{100} - \frac{35}{100}\right) = \text{Sa.}0.554$

And the required Capitalisation (invested as above) will be:— (From Table IV. the average "Capital Covering, as for one man retiring each year," is, for Chief Engineers £156.39, for Masters £178.15, and for 2nd Engineers and 1st Mates £120,908.)

£156.39 × Sa.0.55 = £86.Sa., if all Chief Engineers (1″).

£178.15 × Sa.0.55 = £97.98.Sa, if all Masters (2″).

£120.908 × Sa.0.55 = £66.5.Sa, if all 2nd Engineers or 1st Mates (3″).

Taking percentages—49, 49 and 2, as before:—

Sa.(86 × .49 + 97.98 × .49 + 66.5 × .02) = £91.5.Sa. (4″).

Percentage of Pay Contribution.—All future men. (Allowing 10 % Immature Quittance; Mortality 40 %). Total participants per annum:—$\frac{\text{Sa.}}{30}\left(1 - \frac{10}{100} - \frac{40}{100}\right) = \text{Sa.}\frac{1}{60}$. And the required Capitalisation, invested as above, will be: —

$$\frac{\pounds500.R^7}{R^{29}} \times \frac{100}{5} \times Sa.\frac{1}{60} = \pounds56\ 99.Sa., \text{ if all Chief Engineers } (1''').$$

$$\frac{\pounds500.R^5}{R^{29}} \times \frac{100}{5} \times Sa.\frac{1}{60} = \pounds59.84.Sa., \text{ if all Masters } (2''').$$

$$\frac{\pounds500.R^5}{R^{29}} \times \frac{100}{5} \times Sa.\frac{1}{60} = \pounds51.69.Sa., \text{ if all 2nd Engineers and 1st Mates } (3''').$$

Taking percentages—49, 49 and 2, as before :—

$$Sa\ (56.99 \times .49 + 59.84 \times .49 + 51.69 \times .02) = 58.28.Sa.\ (4''').$$

(In the above, R^7 is ascertained from Chart I., R^6 from Chart II., and R^5 from Chart III. The index in each case being the number of years before retirement that the percentage of pay contributing has ceased owing to the prescribed limit of £500.)

Total Capitalisation of Fund at Scheme's Inauguration, etc.—

Displacement	(4′)	£140.7.Sa	(4)	£202. Sa.		£ Nil.
Past Service	(5)	£ 96.1.Sa	(5)	£ 96.1.Sa.		£ 96 1.Sa
Pay Contribution, 1st cycle	(4″)	£ 91.5.Sa	(4″)	£ 91.5.Sa.		£ 91.5 Sa
Pay Contributions, Future men	(4‴)	£ 58.3.Sa	(4‴)	£ 58.3.Sa.		£ 58.3.Sa
		£386.6.Sa. .Z′		£147.9.Sa. .Z		£245.9.Sa . .Z″.

Taking the "Leave" influence, as stated under paragraph 1—
Sa = Sn.1.1505 we have for the above Capitalisations :—

£386.6.Sa = £448 Sn .... Z′
£447.9.Sa = £545.Sn .... Z
£245.9.Sa = £283.Sn .... Z″

The following non-contributory scheme will serve to demonstrate how the methods herein set forth can be used to ascertain approximately the capitalisation invested at inauguration after the lapse of one cycle period ($27\frac{1}{2}$ years). The scheme is not one to be recommended, as it disparages the Engineers, and is lacking in equity.

Chief Engineers. (Compulsory retirement at age of 57.)

Annuity for	25	years' service	£ 70 ÷ .10082 =	Purchase price	£ 694
Do.	26	do.	do.	£ 80 ÷ .10375 =	do.	do.	£ 768
Do.	27	do.	do.	£ 90 ÷ .10687 =	do.	do.	£ 842
Do.	28	do.	do.	£100 ÷ .11010 =	do.	do.	£ 908
Do.	29	do.	do.	£110 ÷ .11374 =	do.	do.	£ 974
Do.	30	do.	do.	£120 ÷ .11757 =	do.	do.	£1020
							6)5206

Average Purchase price per retirement £868

Masters. (Compulsory retirement at age of 57.)

Annuity for	25	years' service	£150 ÷ .10082 =	Purchase price	£1488		
Do.	26	do.	do.	£160 ÷ .10375 =	do.	do.	£1542
Do.	27	do.	do.	£170 ÷ .10687 =	do.	do.	£1590
Do.	28	do.	do.	£180 ÷ .11010 =	do.	do.	£1630
Do.	29	do.	do.	£190 ÷ .11374 =	do.	do.	£1675
Do.	30	do.	do.	£200 ÷ .11757 =	do.	do.	£1701
							6)9626

Average Purchase price per retirement £1604

Taking deck and engine-room staffs as equal in numbers and in retirements, the capitalisation of fund for one retirement each year throughout the first cycle period of $27\frac{1}{2}$ years will be approximately :—

$$(£868+1604) \div 2 \times \left(\frac{1}{R^0} + \frac{1}{R^1} + \frac{1}{R^2} \ldots \text{to} + \frac{1}{R^{27}}\right) = £1236$$

$$\times \frac{58.4027}{3.7335} = 19308.$$

Denoting the Total Actual Staff by Sa ; allowing 10 % Immature Quittance and 35 % Mortality, the annual retirements will average :—

$$\frac{\text{Sa}}{27\frac{1}{2}}\left(1 - \frac{10}{100} - \frac{35}{100}\right) = \text{Sa. } 0.02.$$

The Capitalisation is :—£19308 × Sa. 0.02 = £386.2.Sa , for the first cycle men (1).

And for all Future retirements (10 °/₀ Immature Quittance; Mortality 45 °/₀) the yearly retirements will average:—

$$\frac{\text{Sa}}{27\frac{1}{2}}\left(1-\frac{10}{100}-\frac{45}{100}\right)=\text{Sa}\,\frac{9}{550}$$; and the Capitalisation will be:—

$$\frac{£868+1604}{2}\div \text{R}^{27}\times\frac{100}{5}\times\text{Sa}\,\frac{9}{550}=331\times20\times\text{Sa}\,\frac{9}{550}=108{\cdot}3.\text{Sa} \quad (2).$$

The total Capitalisation will be:—(1) and (2) added, *i.e.*,

1st cycle requirements, £386.2.Sa.
All future requirements (after 1st cycle).. £108.3.Sa.

£494.5.Sa. (3).

Which in terms —Sn—, with "Leave" influence as stated under paragraph 1 (2):— Sa = Sn.1.155., we have for the above Capitalisation:—

£494.5.Sa = £561.Sn .... ϒ

While it is not necessary for a Company to fully capitalise its undertaking at the time of inaugurating a scheme, it appears to be the correct way to view the liability incurred, and, for purposes of comparative generosity, etc., the only reliable way.

Comparisons of the afore implied schemes based upon estimated capitalisation:—

Scheme	Contributory or Non-contributory.	Sa, Sn, Factor.	Basic Purchase Price.	Capitalisation and time of Scheme's inauguration.	% comparisons, taking ϒ as base.
ϕ ..	N-C.	1	£1,100, Chief Engineers only.	£101, Sn. Company's inception.	18%
θ ..	N-C.	1·1505	£1,100, Chief Engineers only.	£541, Sn. After 1st Cycle.	96%
Y ..	N-C.	1·1505	£1,100, + 5% Masters, − 40% Juniors.	£550, Sn. After 1st Cycle.	98%
Y″..	N-C.	1·155	£1,100, + 5% Masters, − 40% Juniors.	£552, Sn. After 1st Cycle.	98·4%
Z ..	Contributory, ‡	1·1505	(5% pay accumulations)	£545, Sn. After 1st Cycle.	97·1%
Z′ ..	Do. §	1·1505	Ditto.	£448, Sn. After 1st Cycle.	79·9%
Z″ ..	Do. ¶	1·1505	Ditto.	£283, Sn. After 1st Cycle.	50%
ϒ ..	N-C.	1·155	$\frac{694+1488}{2}$ = £1,091 mean	£561, Sn. After 1st Cycle.	100%

‡, including "Displacement" void of interest; §, including "Displacement" with interest; ¶, "Displacement" debited to running charges, so not included in Capitalisation.

Deferred Capitalisation.—If it be desired to extend the capitalisation (£M) over a number of years (p) and the annual increments are to be of equal amounts, the following formula may be used (R being the 5 per cent. interest factor):—

$$\frac{M}{p} \times \left(\frac{R^0+R^1+R^2\ldots\text{ to }+R^p}{p}\right) = \text{Annual increment required.}$$

(Using Table III.)

In conclusion, it may better be stated that the writer has avoided actual drafts of schemes, believing it better so. If, however, this article appears in our "Transactions," he hopes that by means of communication through the Institute the subject will receive further simplification and comprehensiveness at the hands of other members. Such the writer will be pleased to see, and respond to, as may appear to the general weal.

TABLE I.

Life on Indian Coast Service, taken as though the individual were six years older than if on Home Service, and China Coast Service as though three years older than if on Home Service.

Male Expectation of Life (N).—Basic statistics of home life, taken from Whitaker's Almanack (Paragraph C).

Absorption Factor, Fn, estimated from formula $\frac{R-1}{1-R^{-n}}$. See Paragraph E.

MALES ONLY	HOME LIFE.		CHINA COAST.		INDIAN COAST.	
Age of Individual.	Expectation of further life —n, in par. C.	Absorption Factor—Fn, in par. E.	Expectation of further life —n, in par. C.	Absorption Factor—Fn in par, E.	Expectation of further life —n, in par, C.	Absorption Factor—Fn, in par. E.
50	18·9	·08075	17·1	·08837	15·19	·09553
51	18·26	·08486	16·4	·09079	14·61	·09807
52	17·63	·08667	15·79	·09309	14·04	·10082
53	17·1	·08837	15 19	·09553	13·48	·10375
54	16·4	·09079	14·61	·09807	12·93	·10687
55	15·79	·09309	14·04	·10082	12·39	·11010
56	15·19	·09553	13·48	·10375	11 87	·11374
57	14·61	·09807	12·03	·10687	11·35	·11759
58	14·04	·10082	12·39	·11010	10·84	·12173
59	13·48	·10375	11·87	·11374	10 34	·12620
60	12·93	·10687	11·35	·11759	9·86	·13103
61	12 39	·11010	10·84	·12173	9·38	·13615
62	11·87	·11374	10·34	·12620	8·93	·14157
63	11·35	·11759	9·86	·13103	8·48	·14757
64	10 84	·12173	9 38	·13615	8·05	·15394
65	10·34	·12620	8·93	·14157		
66	9·86	·13103	8·48	·14757		
67	9·38	·13615	8·05	·15394		

TABLE II.

Mortality.—Calculated from basic statistics given for England and Wales in Whitaker's Almanack, with age considerations for China Coast and for Indian Coast, the same as for Table I. (see paragraph F):—

Ages considered.	England & Wales.		China Coast Service.		Indian Coast Service.	
	Period.	Mortality.	Period: equivalent.	Mortality.	Period: equivalent.	Mortality.
20 to 55	35 years	33·11%	38 years	38·51%	41 years	44·53%
25 to 55	30 years	31·42%	33 years	37%	36 years	43·1%
30 to 55	25 years	29·3%	28 years	35%	31 years	42·84%
35 to 55	20 years	26·59%	23 years	32·5%	26 years	37·56%

Ordinary Immature Quittance.—(See paragraph G).

Ages.	Period.	Home Service.	China Coast Service.	Indian Coast Service.
20 to 55	35 years	15%	15%	20%
25 to 55	30 years	13%	13%	17%
30 to 55	25 years	11%	11%	14%
35 to 55	20 years	9%	9%	11%
40 to 55	15 years	6%	6%	9%

Additional % to Mortality %

Total Immature Quittance.—Combining immature quittance and mortality (see paragraph H):—

Ages.	Period.	Home Service.	China Coast Service.	Indian Coast Service.
20 to 55	35 years	33 + 15 = 48%	39 + 15 = 54%	45 + 20 = 65%
25 to 55	30 years	31 + 13 = 44%	37 + 13 = 50%	43 + 17 = 60%
30 to 55	25 years	29 + 11 = 40%	35 + 11 = 46%	43 + 14 = 57%
35 to 55	20 years	27 + 9 = 36%	33 + 19 = 42%	38 + 11 = 49%

TABLE III.

Figures taken from Whitaker's Almanack, with introduced notation (see paragraph D):—

The amount which £1 accumulating at compound interest will reach in 1 to 33 years, 5%.			The sum to which £1, paid annually, will accumulate to in 1 to 34 years, 5%. G denotes Geometrical progression. R denotes the amount of £1 at 5% in 1 year, and is introduced to make the Table more obvious.		
0	R^0	1·0000	1·000	1 G.	R^0
1	R^1	1·0500	2·050	2 G.	R^0+R^1
2	R^2	1·1025	3·153	3 G.	$R^0+R^1+R^2$
3	R^3	1·1576	4·310	4 G.	$R^0+R^1+R^2+R^3$
4	R^4	1·2155	5·526	5 G.	$R^0+R^1+R^2+R^3+R^4$
5	R^5	1·2765	6·802	6 G.	$R^0+R^1+R^2+R^3+R^4+R^5$
6	R^6	1.3401	8·142	7 G.	R^0+R^1+ ......to...... R^6
7	R^7	1·4071	9·549	8 G.	$R^0\div R^1+$ ......to...... R^7
8	R^8	1·4775	11·027	9 G.	R^0+R^1+ ......to...... R^8
9	R^9	1·5513	12·578	10 G.	R^0+R^1+ ......to...... R^9
10	R^{10}	1·6289	14·207	11 G.	R^0+R^1+ ......to...... R^{10}
11	R^{11}	1·7103	15·917	12 G.	R^0+R^1+ ......to...... R^{11}
12	R^{12}	·1·7959	17·713	13 G.	R^0+R^1+ ......to...... R^{12}
13	R^{13}	1·8856	19 599	14 G.	R^0+R^1+ ......to...... R^{13}
14	R^{14}	1·9799	21·579	15 G.	R^0+R^1+ ......to...... R^{14}
15	R^{15}	2·0789	23·657	16 G.	R^0+R^1+ ......to...... R^{15}
16	R^{16}	2·1829	25·840	17 G.	R^0+R^1+ ......to...... R^{16}
17	R^{17}	2·2920	28·132	18 G.	R^0+R^1+ ......to...... R^{17}
18	R^{18}	2·4066	30·539	19 G.	R^0+R^1+ ......to...... R^{18}
19	R^{19}	2·5270	33·066	20 G.	R^0+R^1+ ......to...... R^{19}
20	R^{20}	2·6533	35·719	21 G.	R^0+R^1+ ......to...... R^{20}
21	R^{21}	2·7860	38·505	22 G.	R^0+R^1+ ......to...... R^{21}
22	R^{22}	2·9253	41·430	23 G.	R^0+R^1+ ......to...... R^{22}
23	R^{23}	3·9715	44·502	24 G.	R^0+R^1+ ......to...... R^{23}
24	R^{24}	3·2251	47·727	25 G.	R^0+R^1+ ......to...... R^{24}
25	R^{25}	3·3864	51·113	26 G.	R^0+R^1+ ......to...... R^{25}
26	R^{26}	3·5557	54·669	27 G.	R^0+R^1+ ......to...... R^{26}
27	R^{27}	3·7335	58·403	28 G.	R^0+R^1+ ......to...... R^{27}
28	R^{28}	3·9201	62·323	29 G.	R^0+R^1+ ......to...... R^{28}
29	R^{29}	4·1161	66·439	30 G.	R^0+R^1+ ......to...... R^{29}
30	R^{30}	4·3219	70.761	31 G.	R^0+R^1+ ......to...... R^{30}
31	R^{31}	4·3580	75·299	32 G.	R^0+R^1+ ......to...... R^{31}
32	R^{32}	4·7649	80·046	33 G.	R^0+R^1+ ......to...... R^{32}
33	R^{33}	5·0032	85·067	34 G.	R^0+R^1+ ......to...... R^{33}

TABLE IV.

Summaries from Charts I., II., III., capital investment covering *re* 5 per cent. pay contribution; existing conditions; cycle period taken as 30 years:—

CHIEF ENGINEERS. From Chart I.

Years of Service.	Monthly pay.	Individual accumulation, C.R.^{b}		Capital Covering as for one retirement each year.	
	£ s. d.			Interest factor.	
31st	Retirement.	0·00		—	0·00.
30th	36 10 0	21·90	÷	R^0	21·90.
29th	36 10 0	27·65	÷	R^1	26·33.
Home	Leave				
28th	36 10 0	51·79	÷	R^2	46·79.
27th	36 10 0	77·14	÷	R^3	66·55.
26th	36 10 0	103·76	÷	R^4	85·36.
25th	36 10 0	131·71	÷	R^5	103·12.
24th	36 10 0	161·06	÷	R^6	120·12.
Home	Leave				
23rd	33 15 0	168·18	÷	R^7	119 52.
22nd	33 15 0	198·10	÷	R^8	134·08.
21st	33 15 0	229·51	÷	R^9	147·95.
20th	33 15 0	262·50	÷	R^{10}	161·15.
19th	33 15 0	297·15	÷	R^{11}	173·73.
18th	{ 33 15 0 31 2 6 }	323·71	÷	R^{12}	180·25.
Home	Leave				
17th	31 2 6	341·32	÷	R^{13}	181·01.
16th	31 2 6	378·29	÷	R^{14}	191·06.
15th	31 2 6	417·10	÷	R^{15}	200·63.
14th	31 2 6	457·85	÷	R^{16}	209·74.
13th	29 5 0	496·93	÷	R^{17}	216·84.
12th	24 3 0	514·28	÷	R^{18}	213·28.
Home	Leave				
11th	23 2 0	518·11	÷	R^{19}	205·00.
10th	22 1 0	549·14	÷	R^{20}	203·20.
9th	21 0 0	586·62	÷	R^{21}	210.56.
8th	19 19 0	578·52	÷	R^{22}	197·76.
7th	18 18 0	596·59	÷	R^{23}	194·11.
6th	17 17 0	604·85	÷	R^{24}	187·48.
Home	Leave				
5th	17 17 0	625·69	÷	R^{25}	184·74.
4th	16 16 0	656·15	÷	R^{26}	184·55.
3rd	15 15 0	666·81	÷	R^{27}	178·60.
2nd	14 14 0	699·73	÷	R^{28}	178·50.
1st	13 13 0	690·67	÷	R^{29}	167·80.
		30)11432·81			30)4691·71
	Average per man	381·094			156·39

2ND ENGINEERS AND 1ST MATES. From Chart II.

Years of Service.	Monthly pay.	Individual accumulation, C.R.^{b}	Capital Covering as for one retirement each year.	
	£ s. d.		Interest factor.	
31st	Retirement.	0·00	—	00·0.
30th	24 3 0	14·49 ÷	R^0	14·49.
29th	24 3 0	18·29 ÷	R^1	17·34.
Home	Leave			
28th	24 3 0	34·27 ÷	R^2	31·08.
27th	24 3 0	51·05 ÷	R^3	44·10.
26th	24 3 0	68·65 ÷	R^4	56·48.
25th	24 3 0	87·14 ÷	R^5	68·35.
24th	24 3 0	106·55 ÷	R^6	79·51.
Home	Leave			
23rd	24 3 0	111·19 ÷	R^7	79·55.
22nd	24 3 0	133·33 ÷	R^8	90·24.
21st	24 3 0	155·81 ÷	R^9	100·44.
20th	24 3 0	179·41 ÷	R^{10}	110·14.
19th	24 3 0	204·19 ÷	R^{11}	119·27.
18th	24 3 0	223·71 ÷	R^{12}	124·57.
Home	Leave			
17th	24 3 0	237·37 ÷	R^{13}	125·89.
16th	24 3 0	266·06 ÷	R^{14}	134·38.
15th	24 3 0	296·18 ÷	R^{15}	142·42.
14th	24 3 0	327·81 ÷	R^{16}	150·13.
13th	24 3 0	361·02 ÷	R^{17}	157·51.
12th	24 3 0	378·46 ÷	R^{18}	153·10.
Home	Leave			
11th	23 2 0	404·73 ÷	R^{19}	160·16.
10th	22 1 0	438·83 ÷	R^{20}	165·39.
9th	21 0 0	473·93 ÷	R^{21}	170·11.
8th	19 19 0	502·31 ÷	R^{22}	171·71.
7th	18 18 0	529·83 ÷	R^{23}	172·50.
6th	17 17 0	535·21 ÷	R^{24}	165·58.
Home	Leave			
5th	17 17 0	571·07 ÷	R^{25}	177·07.
4th	16 16 0	590·84 ÷	R^{26}	166·19.
3rd	15 15 0	608·90 ÷	R^{27}	160·09.
2nd	14 14 0	624·67 ÷	R^{28}	159·43.
1st	13 13 0	658·67 ÷	R^{29}	160·02.
		30)8600·65		30)3627·24
	Average per man	286·688		120·908

MASTERS. From Chart III.

Years of Service.	Monthly pay.	Individual accumulation, C.R.^{b}		Capital Covering as for one retirement each year.	
	£ s. d.			Interest factor.	
31st	Retirement.	0·00		—	0·00.
30th	44 0 0	26·40	÷	R^0	26·40.
29th	44 0 0	33·33	÷	R^1	31·74.
Home	Leave				
28th	44 0 0	63·44	÷	R^2	56·63.
27th	44 0 0	93·00	÷	R^3	80·34.
26th	44 0 0	125·09	÷	R^4	102·83.
25th	44 0 0	158·78	÷	R^5	124·41.
24th	44 0 0	194·16	÷	R^6	144·88.
Home	Leave				
23rd	41 5 0	202·88	÷	R^7	144·18.
22nd	41 5 0	239·45	÷	R^8	162·06.
21st	41 5 0	277·85	÷	R^9	179·11.
20th	41 5 0	318·17	÷	R^{10}	195·33.
19th	41 5 0	359·50	÷	R^{11}	210·20.
18th	{ 41 5 0 / 37 2 6 }	391·72	÷	R^{12}	218·12.
Home	Leave				
17th	37 2 6	412·72	÷	R^{13}	218·89.
16th	37 2 6	456·82	÷	R^{14}	230·73.
15th	37 2 6	503·13	÷	R^{15}	242·02.
14th	37 2 6	526·57	÷	R^{16}	241·22.
13th	33 0 0	565·04	÷	R^{17}	246·53.
12th	24 3 0	553·37	÷	R^{18}	220·10.
Home	Leave				
11th	23 2 0	579·63	÷	R^{19}	229·37.
10th	22 1 0	584·16	÷	R^{20}	220·16.
9th	21 0 0	619·26	÷	R^{21}	222·28
8th	19 19 0	624·49	÷	R^{22}	213·48.
7th	18 18 0	659·34	÷	R^{23}	214·66.
6th	17 17 0	668·03	÷	R^{24}	207·14.
Home	Leave				
5th	17 17 0	667·61	÷	R^{25}	197·15.
4th	16 16 0	703·46	÷	R^{26}	197·74. (?)
3rd	15 15 0	709·09	÷	R^{27}	187·25.
2nd	14 14 0	729·43	÷	R^{28}	186·08.
1st	13 13 0	763·17	÷	R^{29}	185·41.
		30)12809·11			30)5344·44
	Average per man	426·97			178·15

TABLE V.

Displacement Saving.—With rates of pay as per Table IV. denoted in article under (N) by D.

Saving effected through retiring a maximum paid *Master* and promoting junior ratings: —

	Master's ratings.		Mate's ratings.		2nd Mate's ratings.			
1st year	132	+	63	+	37·8	=	£232 8	
2nd do.	82	+	50·4	+	25·2	=	£157 6	
3rd do.	82	+	37·8	+	12·6	=	£132 4	
4th do.	82	+	25·2	+	0	=	£107 2	Master
5th do.	82	+	12·6	+	0	=	£ 94 6	D
6th to 10th year	(33	+	0	+	0)5	=	£165 0	£889 6.

Saving effected through retiring a maximum paid *Chief Engineer* and promoting junior ratings:—

	Chief Engineer's ratings.		Second Engineer's ratings.		Third Engineer's ratings.			
1st year	75	+	63	+	37·8	=	£175 8	
2nd do.	70·5	+	50·4	+	25·2	=	£146 1	
3rd do.	70·5	+	37·8	+	12·6	=	£120 9	Chief
4th do.	70·5	+	25·2	+	0	=	£ 95 7	Engineer
5th do.	70·5	+	12·6	+	0	=	£ 83 1	D
6th to 10th year	(31·5	+	0	+	0)5	=	£157 5	£779 1.

Saving effected through retiring a maximum paid *Chief Mate* or *Second Engineer* and promoting junior ratings:—

	2nd Engineer's ratings.		3rd Engineer's ratings.			
1st year	63	+	37·8	=	£100 8	
2nd do.	50·4	+	25·2	=	£ 75 6	2nd Engineer
3rd do.	37·8	+	12·6	=	£ 50 4	or 1st Mate
4th do.	25·2	+	0	=	£ 25 2	D
5th do.	12·6	+	0	=	£ 12 6	£264 6.

TABLE VI.

Tabulated surrender values and annuities for Chief Engineers, under conditions of Scheme Y (non-contributory):—

Years of Service.	Purchase Price or Surrender Value, £.	Absorption factor, Fn, for China Coast Service, Table I.								
		Age 52 .09309	Age 53 ·09553	Age 54 ·09807	Age 55 ·10082	Age 56 ·10375	Age 57 ·10687	Age 58 ·11010	Age 59 ·11374	Age 60 ·11759
25	1100	102	105	108	111	114	118	121	125	129
26	1155	107	110	113	117	120	124	127	131	135
27	1213	112	116	119	122	126	130	133	138	142
28	1273	118	122	125	129	132	137	140	145	149
29	1337	124	128	131	135	139	144	147	152	157
30	1404	130	134	138	142	145	151	154	160	165

6)7482 For annuities for those over 60 take Fn from Table I.

£1247 Average per Chief Engineer. For other Services use other Fn, from Table I. Add 5% to above values for Masters, and deduct 40% for 2nd Engineers or 1st Mates.

Capital Covering *re* 5 per cent. Pay Contributions. Taking Average Service Cycle to Retirement of 30 years. R^{0} to R^{29} is Comp. Int. Factor.

Limit of Pay contributing being £500 accumulation, when Interest accumulation only. Thus new men living to Retirement costs Company.

CHIEF ENGINEERS ONLY.

Attaining to Chief Engineer in 13th year of service, a man newly joining will accumulate £500 in his 23rd year of service, which in a further 7 years would become £500 R^{7} = £703·55 & ÷ R^{29} = £170·93.

Years of Service at inception of Scheme. 31st	Monthly Pay Rates. Retirement.	5 per cent. of Pays per annum exclusive of Home Leave. 0·31st.	30th	29th	28th	27th	26th	25th	24th	23rd	22nd	21st
	£ s. d.											
30th	36 10 0	21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90
29th	36 10 0	5·48		R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75
	Home Leave											
28th	36 10 0	21·90			R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14
27th	36 10 0	21·90				R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35
26th	36 10 0	21·90					R^{4} 26·62	R^{4} 26·62	R^{4} 26·62	R^{4} 26·62	R^{4} 26·62	R^{4} 26·62
25th	36 10 0	21·90						R^{5} 27·95	R^{5} 27·95	R^{5} 27·95	R^{5} 27·95	R^{5} 27·95
24th	36 10 0	21·90							R^{6} 29·35	R^{6} 29·35	R^{6} 29·35	R^{6} 29·35
	Home Leave											
23rd	33 15 0	5·06								R^{7} 7·12	R^{7} 7·12	R^{7} 7·12
22nd	33 15 0	20·25									R^{8} 29·92	R^{8} 29·92
21st	33 15 0	20·25										R^{9} 31·41
20th	33 15 0	20·25										
19th	33 15 0	20·25										
18th	33 15 0 31 2 6	14·80										
	Home Leave											
17th	31 2 6	9·34										
16th	31 2 6	18·67										
15th	31 2 6	18·67										
14th	31 2 6	18·67										
13th	29 5 0	17·05										
12th	24 3 0	7·245										
	Home Leave											
11th	23 2 0	10·395										
10th	22 1 0	13·23										
9th	21 0 0	12·6										
8th	19 19 0	11·97										
7th	18 18 0	11·34										
6th	17 17 0	2·6975										
	Home Leave											
5th	17 17 0	10·59										
4th	16 16 0	10 08										
3rd	15 15 0	9·45										
2nd	14 14 0	8·82										
1st	13 13 0	8·19										
Individuals actual Cash Contributions			21·90	27·38	49·28	71·18	93·08	114·08	136·38	141·94	162·19	182·49
Individual Accumulations ..			21·90	27·65	51·79	77·14	103·76	131·71	161·06	168·18	198·10	229·51

Years of Service	20th	19th	18th	17th	16th	15th	14th	13th	12th	11th
30th	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	R^{0} 21·90	1
29th	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{1} 5·75	R^{0} 5·48
Home Leave										
28th	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{2} 24·14	R^{1} 23·00
27th	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{3} 25·35	R^{2} 24·14
26th	R^{4} 26·62	R^{4} 26·62	R^{4} 26·62	R^{4} 26·62	R^{4} 26·62	R^{4} 26·62	R^{4} 26·62	R^{4} 26·62	R^{4} 26·52	R^{3} 25·35
25th	R^{5} 27·95	R^{5} 27·95	R^{5} 27·95	R^{5} 27·95	R^{5} 27·95	R^{5} 27·95	R^{5} 27·95	R^{5} 27·95	R^{5} 27·95	R^{4} 26·62
24th	R^{6} 29·35	R^{6} 29·35	R^{6} 29·35	R^{6} 29·35	R^{6} 29·35	R^{6} 29·35	R^{6} 29·35	R^{6} 29·35	R^{6} 29·35	R^{5} 27·95
Home Leave										
23rd	R^{7} 7·12	R^{7} 7·12	R^{7} 7·12	R^{7} 7·12	R^{7} 7·12	R^{7} 7·12	R^{7} 7·12	R^{7} 7·12	R^{7} 7·12	R^{6} 6·78
22nd	R^{8} 29·92	R^{8} 29·92	R^{8} 29·92	R^{8} 29·92	R^{8} 29·92	R^{8} 29·92	R^{8} 29·92	R^{8} 29·92	R^{8} 29·92	R^{7} 28·60
21st	R^{9} 31·41	R^{9} 31·41	R^{9} 31·41	R^{9} 31·41	R^{9} 31·41	R^{9} 31·41	R^{9} 31·41	R^{9} 31·41	R^{9} 31·41	R^{8} 29·92
20th	R^{10} 32·99	R^{10} 32·99	R^{10} 32·99	R^{10} 32·99	R^{10} 32·99	R^{10} 32·99	R^{10} 32·99	R^{10} 32·99	R^{10} 32·99	R^{9} 31·41
19th		R^{11} 34·63	R^{11} 34·63	R^{11} 34·63	R^{11} 34·63	R^{11} 34·63	R^{11} 34·63	R^{11} 34·63	R^{11} 34·63	R^{10} 32·99
18th			R^{12} 26·58	R^{12} 26·58	R^{12} 26·58	R^{12} 26·58	R^{12} 26·58	R^{12} 26·58	R^{12} 26·58	R^{11} 25·31
Home Leave										
17th				R^{13} 17·61	R^{13} 17·61	R^{13} 17·61	R^{13} 17·61	R^{13} 17·61	R^{13} 17·61	R^{12} 16·77
16th					R^{14} 36·97	R^{14} 36·97	R^{14} 36·97	R^{14} 36·97	R^{14} 36·97	R^{13} 35·20
15th						R^{15} 38·81	R^{15} 38·81	R^{15} 38·81	R^{15} 38·81	R^{14} 36·97
14th							R^{16} 40·75	R^{16} 40·75	R^{16} 40·75	R^{15} 38·81
13th								R^{17} 39·08	R^{17} 39·08	R^{16} 37·22
12th									R^{18} 17·35	R^{17} 16·60
Home Leave										
11th										R^{18} 25·00
Individuals actual Cash Contributions	202·69	222·94	237·74	247·08	265·75	284·42	303·09	320·14	327·35	315·84 493·44 ×R^{1}=
Individual Accumulations ..	262·50	297·15	323·71	341·32	378·29	417·10	457·85	496·93	514·28	518·11

Years of Service	10th	9th	8th	7th	6th	5th	4th	3rd	2nd	1st	Individual's accumulations at times of Retirement. (From 5% Pay Contributions.)	÷ Int. Factor.	Capital Cost covering at time of Scheme's inception: 5% Comp. Int. Investment, as for one retiring each year.
30th										7 years Compound Interest.	21·90	÷ R^{0}	21·90
29th											27·65	R^{1}	26·33
Home Leave	2	2											
28th	R^{0} 21·90	R^{0} 21·90	3								51·79	R^{2}	46·79
27th	R^{1} 23·00	R^{1} 23·00	R^{0} 21·90	4	4						77·14	R^{3}	66·55
26th	R^{2} 24·14	R^{2} 24·14	R^{1} 23·00	R^{0} 21·90	R^{0} 21·90	5	5				103·76	R^{4}	85·36
25th	R^{3} 25·35	R^{3} 25·35	R^{2} 24·14	R^{1} 23·00	R^{1} 23·00	R^{0} 21·90	R^{0} 21·90	6	6		131·71	R^{5}	103·12
24th	R^{4} 26·62	R^{4} 26·62	R^{3} 25·35	R^{2} 24·14	R^{2} 24·14	R^{1} 23·00	R^{1} 23·00	R^{0} 21·90	R^{0} 21·90		161·06	R^{6}	120·12
Home Leave													
23rd	R^{5} 6·45	R^{5} 6·45	R^{4} 6·15	R^{3} 5·85	R^{3} 5·85	R^{2} 5·58	R^{2} 5·58	R^{1} 5·31	R^{1} 5·31	R^{0} 5·06	168·18	R^{7}	119·52
22nd	R^{6} 27·14	R^{6} 27·14	R^{5} 25·85	R^{4} 24·61	R^{4} 24·61	R^{3} 23·44	R^{3} 23·44	R^{2} 22·33	R^{2} 22·33	R^{1} 21·27	198·10	R^{8}	134·08
21st	R^{7} 28·60	R^{7} 28·60	R^{6} 27·14	R^{5} 25·85	R^{5} 25·85	R^{4} 24·61	R^{4} 24·61	R^{3} 23·44	R^{3} 23·44	R^{2} 22·33	229·51	R^{9}	147·95
20th	R^{8} 29·82	R^{8} 29·82	R^{7} 28·60	R^{6} 27·14	R^{6} 27·14	R^{5} 25·85	R^{5} 25·85	R^{4} 24·61	R^{4} 24·61	R^{3} 23·44	262·50	R^{10}	161·15
19th	R^{9} 31·41	R^{9} 31·41	R^{8} 29·82	R^{7} 28·60	R^{7} 28·60	R^{6} 27·14	R^{6} 27·14	R^{5} 25·85	R^{5} 25·85	R^{4} 24·61	297·15	R^{11}	173·73
18th	R^{10} 24·11	R^{10} 24·11	R^{9} 23·96	R^{8} 21·87	R^{8} 21·87	R^{7} 20·83	R^{7} 20·83	R^{6} 19·83	R^{6} 19·83	R^{5} 18·89	323·71	R^{12}	180·25
Home Leave													
17th	R^{11} 15·97	R^{11} 15·97	R^{10} 15·11	R^{9} 14·49	R^{9} 14·49	R^{8} 13·80	R^{8} 13·80	R^{7} 13·14	R^{7} 13·14	R^{6} 12·52	341·32	R^{13}	181·01
16th	R^{12} 33·53	R^{12} 33·53	R^{11} 31·93	R^{10} 30·41	R^{10} 30·41	R^{9} 28·96	R^{9} 28·96	R^{8} 27·58	R^{8} 27·58	R^{7} 26·27	378·29	R^{14}	191·06
15th	R^{13} 35·20	R^{13} 35·20	R^{12} 33·53	R^{11} 31·93	R^{11} 31·93	R^{10} 30·41	R^{10} 30·41	R^{9} 28·96	R^{9} 28·96	R^{8} 27·58	417·10	R^{15}	200·63
14th	R^{14} 36·97	R^{14} 36·97	R^{13} 35·20	R^{12} 33·53	R^{12} 33·53	R^{11} 31·93	R^{11} 31·93	R^{10} 30·41	R^{10} 30·41	R^{9} 28·96	457·85	R^{16}	209·74
13th	R^{15} 35·45	R^{15} 35·45	R^{14} 31·16	R^{13} 32·25	R^{13} 32·25	R^{12} 30·62	R^{12} 30·62	R^{11} 29·95	R^{11} 29·95	R^{10} 27·78	496·93	R^{17}	216·84
12th	R^{16} 15·81	R^{16} 15·81	R^{15} 15·00	R^{14} 14·35	R^{14} 14·35	R^{13} 13·67	R^{13} 13·67	R^{12} 13·38	R^{12} 13·38	R^{11} 12·74	514·28	R^{18}	213·28
Home Leave													
11th	R^{17} 23·81	R^{17} 23·81	R^{16} 22·68	R^{15} 21·60	R^{15} 21·60	R^{14} 20·57	R^{14} 20·57	R^{13} 19·59	R^{13} 19·59	R^{12} 18·66	518·11	R^{19}	205·00
10th	R^{18} 31·91	R^{18} 31·91	R^{17} 29·69	R^{16} 28·94	R^{16} 28·94	R^{15} 27·57	R^{15} 27·57	R^{14} 26·25	R^{14} 26·25	R^{13} 25·00	549·14	R^{20}	203·20
9th		R^{19} 33·04	R^{18} 30·32	R^{17} 28·88	R^{17} 28·88	R^{16} 27·50	R^{16} 27·50	R^{15} 26·19	R^{15} 26·19	R^{14} 24·95	586·62	R^{21}	210·56
8th			R^{19} 30·25	R^{18} 28·81	R^{18} 28·81	R^{17} 26·44	R^{17} 26·44	R^{16} 26·13	R^{16} 26·13	R^{15} 24·89	578·52	R^{22}	197·76
7th				R^{19} 28·66	R^{19} 28·66	R^{18} 27·29	R^{18} 27·29	R^{17} 25·99	R^{17} 25·99	R^{16} 24·75	596·59	R^{23}	194·11
6th					R^{20} 6·80	R^{19} 6·92	R^{19} 6·92	R^{18} 6·90	R^{18} 6·90	R^{17} 6·19	604·85	R^{24}	187·48
Home Leave													
5th						R^{20} 28·09	R^{20} 28·09	R^{19} 26·76	R^{19} 26·76	R^{18} 25·49	625·69	R^{25}	184·74
4th							R^{21} 28·08	R^{20} 26·75	R^{20} 26·75	R^{19} 25·47	656·15	R^{26}	184·55
3rd								R^{21} 26·33	R^{21} 26·33	R^{20} 25·07	666·81	R^{27}	178·60
2nd									R^{22} 24·57	R^{21} 24·57	699·73	R^{28}	178·50
1st										R^{22} 23·96	690·67	÷ R^{29}	167·80
Individuals actual Cash Contributions	326·62 498·19 ×R^{2}=	336·22 531·24 ×R^{3}	326·29 199·76 ×R^{3}	315·73 490·82 ×R^{4}=	318·25 497·62 ×R^{4}=	306·43 486·14 ×R^{5}=	316 52 512·24 ×R^{5}=	294·06 497·58 ×R^{6}=	312·88 522·15 ×R^{6}=	299·17 490·72 ×R^{7}=	11432·81		4691·71
Individual Accumulations ..	549·14	586·62	578·52	596·59	604·85	625·69	656·15	666·81	699·73	690·67			Average per head, **£156·39**

TABLE VII.

Tabulated:—Annuities, cash surrenders and individual's cash contributions, as examples under Scheme Z (contributory). Formula:—

$$\frac{D}{n} \times \frac{d-y}{d} + 2\ (\text{C.R.}^{b} + \text{S.R.}^{a})\ \text{Fn.}$$

If retirements, with 30 years' service at time of scheme's inauguration:—

	Retiring at age 55.			Retiring at age 60.			Retiring at age 65		
	Mas	C.E.	2/E or 1/M	Mas	C.E.	2/E or 1/M	Mas	C.E.	2/E or 1/M
£ p.a. Annuity	124	116	80	149	139	94	185	172	115
£ Cash Surrender	600	600	600	600	600	600	600	600	600
£ Individual's C. Contribution.. ..	300	300	300	300	300	300	300	300	300

If retiring with 30 years' service—15 past and 15 after scheme's inauguration:—

£ p.a. Annuity	168	150	118	197	176	138	239	213	167
£ Cash Surrender	1510	1353	1128	1510	1353	1128	1510	1353	1128
£ Individual's C. Contribution.. ..	472	416	336	472	416	336	472	416	336

If retiring with 30 years' service, all subsequent to scheme's inauguration:—

£ p.a. Annuity	146	142	129	170	165	150	205	199	181
£ Cash Surrender	1448	1407	1276	1448	1407	1276	1448	1407	1276
£ Individual's C. Contribution.. ..	331	299	283	331	299	283	331	299	283

The following chart shows for Chief Engineers the average accumulation from 5% pay, contributed, per Chief Engineer retiring during the first 30 years' cycle period—£11,432.84 ÷ 30 = £381.094, and the Company's capital at time of scheme's inception to cover same—£4,691.71 ÷ 30 = £156.39. For 2nd cycle men, £170.93.

The CHAIRMAN: We have listened to a very interesting paper; the author has taken a lot of time and trouble, and has gone very deeply into the subject. He shows us charts of the different schemes, contributory and non-contributory ones, and a chart of scheme from one of the large lines, giving details of science and amounts of pension paid. Charts are also given showing cost to shipowner in order to give those pensions.

I am convinced that as time goes on all shipowners of any standing will have a pension scheme for their chief engineers. The only men who are likely to be left out in the cold are the engineers who are appointed by consulting engineers and the single-owned ships.

It is regrettable that those men have no retirement allowance. I do not think that this Institute or any other Engineers' Institute could start a pension scheme, and it appears too big a job to expect the State to take the matter up, as it would mean that the general public would be taxed to pay these pensions.

The only thing I see is that engineers should get very much higher pay, and by insuring their lives for a certain sum, payable at age sixty, that might tide them over, or should the sum not be sufficient it could be turned into an annuity. The rate of interest in most Insurance Companies at that age is 8 per cent. The subject of the paper is such a deep one it is impossible to discuss it in every detail in such a short time. We appreciate highly what has been put before us, and I am sure we shall accord a hearty vote of thanks to the author for his valuable paper, which he must have spent a long time in preparing, and we are deeply indebted to him for placing the subject before us to ponder over and study at our leisure. Contributions are invited to the discussion when members have had an opportunity of reading the paper carefully, and any members present who can give their views on the subject now, we shall be glad if they will do so.

MR. F. O. BECKETT: This is not an engineering paper, but it is an engineers' subject that requires deep consideration.

The age of retirement is doubtful as regards being definite, as some men are only as old as they feel; some are fresh at 60 or 65, and feel that they can live very much longer, whereas some are old at 55. This is brought about constitutionally and largely, I fear, by worry—perhaps by want of capacity—as all do not commence life alike or from the same foundation and stock.

Mr. Houfe and the Institute are to be congratulated for bringing this subject forward for ventilation at such a time as we live in, and when life is being sacrificed in such a war as now prevails.

Adequate remuneration should be the aim of each individual, so that every one can consider and provide for the future, or perhaps, as some firms do, provide a non-contributory allowance of about one-eighth of pay for each year's service on retirement at 60 or 65. I am informed that the Constructional Department of the Government adopted such a plan, and that the average pensioner's life in the Civil Service is but three years.

If a national question is raised similar to the National Insurance scheme, where everyone—the employer included—contributes, then the cargo, as well as the passenger service owners, will be included, and every engineer would have an equal chance for his future retirement, but at the same time he must not overlook private enterprise either as to provision for his family or to the possible outlook for an appointment on shore or that of superintendent engineer.

I think Mr. Houfe is, indeed, very modest in putting the cost of apprenticeship at a total expenditure of £300. Many parents pay £300 to the firm, and there is double this for the four or five years' expenses to add. The payment made for accepting an apprentice is much less frequent now than formerly, but even without it the cost amounts to over the £300 when a qualifying training is carried out, to include technical study and reference library, and parents require to keep in view the ever-advancing steps of engineering, involving closer study and wider experience, to keep abreast of the times, and we want our engineers to be trained and educated to hold their own, and when put on their mettle not to be lacking when the emergency arises, whether afloat or ashore.

Mr. John B. Harvey: Mr. Houfe, in dealing with the above subject, has gone very deeply into mathematics, and has undoubtedly spent a great deal of time and pains in working out his scheme. His paper would therefore require long and careful study in order to follow all the calculations which he has adopted in preparing same.

There is no doubt that "Retirement Provision" is a subject that every Marine Engineer should take a deep interest in and do his best to assist to materialise.

It is useless looking to the smaller shipping companies for any assistance individually, even if they were willing to consider such a thing, because once a man leaves a ship it might be some time before he could get another ship, and he very often has to strike out into another Company and re-commence at the bottom rung of the ladder, whereas in the larger Companies it is a different thing; if he leaves one ship for any just reason he can very soon obtain another, and not start with another firm, as in the case of the smaller companies referred to.

I think the correct Retirement Provision should be a national scheme; then every man would have a percentage of his wages deducted before he received them; this, with a percentage paid by the Government and the employer, would secure for him a certain amount according to his position in life when he arrives at the age of compulsory retirement, or sooner, if his health should break down so that he cannot follow his employment.

There is in Belgium such a scheme which has been in vogue for some years, and, as far as I know, it has always worked very satisfactorily for all parties concerned.

Mr. F. A. Corns: The author seems to have gone into this subject in a very thorough manner, but, notwithstanding the many complications which would have to be dealt with, I think the pension scheme could be so formulated that not only those serving aboard the first-class liners, but also those aboard the tramp class of vessels would benefit in the same degree.

We know that managers very often have little regard for a man's length of service in the company, and if his ship is sold he is discarded and left to find empolyment elsewhere; again, there are men who have served for many years under the same superintending engineers, but who may have served in the ships of several companies at the same time, the pension scheme before us would not be workable in either of the cases cited. It should undoubtedly be a national scheme. Are not the officers and men of the Merchant Service doing more for the country than a majority of the "Civil servants," whose declining years are so well looked after? The Mercantile Marine is being eulogised every day, yet what is being done by the country in a practical way to show their appreciation for "services rendered"? If a pension scheme were brought before Parliament by the different committees who have the interests of the Merchant Service at heart, I believe a satisfactory solution would be found.

On the other hand, the scheme might be worked by the shipowners as a body, in conjunction with the different societies looking after the men of the various branches of the service.

The author allows a 5 per cent. distinction in favour of masters on the strength of a distinctive difference being customary. This is not equitable, even if customary, and the sooner the chief engineer's responsibility aboard a steamship is fully recognised the better it will be for owners and all concerned.

I have pleasure in moving a very hearty vote of thanks to the author.

The Progress in Propelling Machinery for the Merchant Service.

The following, which was kindly written for our Transactions by Mr. Alexr. Lawrance (Member), is a summary of the interesting address delivered by Mr. Alexander Cleghorn, M.Inst.C.E., F.R.S.E., President of the Institution of Engineers and Shipbuilders in Scotland, on October 23rd, 1917. We are indebted to the Institution and to the President for permission to print this contribution which has been kindly revised by Mr. Cleghorn.

The address is in the form of a sketch of the progress made in Marine Engineering from 1908 to 1917, during which time the geared steam turbine has rapidly pushed forward into its present position, a position which bids fair to establish this type of propelling machinery as the most economical for all classes of vessels.

In 1908 the direct-coupled turbine had already proved its superiority over the reciprocating engine for fast, high-powered ships. Its development had made possible higher sea speeds, but below a rough value of about 18 knots the superiority of the turbine drive could not be demonstrated.

The essential compromise involved in the adoption of the direct coupled turbine arrangement lies in the fact that the turbine runs more economically and is due to high speeds, whereas the screw propeller rapidly loses its efficiency as its speed of revolution is raised beyond a comparatively moderate figure. This antagonism between turbine revolutions and propeller revolutions, which is inherent in the direct driven turbine, greatly limits its field of application in marine practice.

In the form of "combination type" machinery, wherein reciprocating engines coupled to wing shafts exhausted into turbines on centre shafts, the turbine next invaded the domain of the intermediate class of liner in which moderate powers are required. This "combination" is capable of utilising to a greater extent the heat energy of the steam at the lowest pressures, and shows a distinct improvement either over the reciprocating engine or the turbine used alone.

It may be said that about a decade ago the reciprocating engine had given place to the direct turbine for warships, fast liners, and cross-channel vessels, had compromised with it for vessels of the intermediate class, and had refused to recognise it as having any claims on that extensive class comprising the low-speed types.

But even at that time the solution to the problem of the general applicability of the turbine to all types was in sight in the form of mechanical gearing; and, to a less extent, of either electrical or hydraulic transmission. Although the two latter systems have certain advantages, it is the mechanical system which at present makes the pace, and that pace seems likely to be rather too severe for the other forms.

From the original form of single spur and pinion drive, geared transmission passed quickly to the double reduction arrangement, which increases considerably the possible reduction ratio, and, by permitting very high turbine speeds to be combined with low propeller revolutions, makes the application of the turbine an economical proposition even in the low-power low-revolution tramp steamer.

The double reduction gear drive can, however, also, with considerable gain in weight and efficiency, be applied to high-powered vessels, as figures quoted below will show.

In coincidence with all these changes there has been a marked revival in the marine use of superheated steam, so that the latest achievement in this period of restless progress in steam-propelling machinery is the superheat-geared-turbine equipment, transcending its forerunners in practically all respects and marking an epoch of advance without equal in the history of marine engineering.

The appended table gives average figures based on the reaction type of turbine for various classes of vessels. Roughly similar results may be expected for other turbine types.

TABLE I.

COMPARATIVE FIGURES FOR DIFFERENT MACHINERY TYPES.

Type of Ship and Machinery. S.=screw. S.S.=single screw.	Relative Fuel Consumption.	Relative Machinery Weight.	Relative Superficial Areas.	
			Engine Room.	Boiler Room.
1.—FAST OCEAN LINER.				
(a) Four S. triple series direct-coupled turbines; cylindrical boilers—saturated steam	100	100	100	100
(b) Two S. single-geared turbines; cylindrical boilers—saturated steam	89	93	90	92
(c) Two S. single-geared turbines; cylindrical boilers 100° F. superheat	84·5	93·5	90	86
(d) Two S. double-geared turbines; cylindrical boilers—200° F. superheat	75	88·5	86	77
2.—INTERMEDIATE LINER.				
(a) Three S. combination machinery; cylindrical boilers — saturated steam	100	100	100	100
(b) Two S. single-geared turbines; cylindrical boilers — saturated steam	93	80	87	92
(c) Two S. single-geared turbines; cylindrical boilers—100° F. superheat	88	81	87	91
(d) Two S. double-geared turbines; cylindrical boilers—200° F. superheat	74	72	83	80·5
3.—CROSS-CHANNEL STEAMER.				
(a) Three S. compound direct-coupled turbines; cylindrical boilers—saturated steam	100	100	100	100
(b) Two S. single-geared turbines; W.T. boilers—saturated steam..	91·5	75	100	97
(c) Two S. single-geared turbines; W.T. boilers—100° F. superheat	86·5	76	100	97
(d) Two S. double-geared turbines; W.T. boilers—200° F. superheat	73·5	68	95	86
4.—CARGO STEAMER.				
(a) S.S. triple expansion reciprocating engine; cylindrical boilers—saturated steam	100	100	100	100
(b) S. S. single-geared turbines; cylindrical boilers—saturated steam..	83·5	79	85	95·5
(c) S. S. single-geared turbines; cylindrical boilers—100° F. superheat	79	79·5	85	94
(d) S. S. double-geared turbines; cylindrical boilers—200° F. superheat	66	72·5	80	87·5

In all cases (a) denotes the standard design of nine or ten years ago; (b) and (c) are present geared proposals; and while (d) is only so far utilised in type 4, it has been embodied in the others because of its possible and very probable application thereto. The figures for relative fuel consumption are estimated for coal-fired boilers in all cases, and it is assumed that where super-heat is employed all auxiliaries work also on superheated steam.

Although of recent application, the great appeal made by the superheat-double-gear installation, is clearly reflected in the increasing number of cargo ships, building or on order, to be equipped with the system. The performances of these new ships, when they have been well tried on service, will be studied with great interest.

In case (a) for all classes of vessels the water consumptions taken for comparison have been obtained on long full-power trials of actual vessels.

Cases (a) and (c) for the ocean liner class are from actual ships, and detailed figures are subjoined.

TABLE II.

WATER CONSUMPTION FOR LARGE LINERS.

Machinery Type.	S.H.P.	Steam condition at Turbines.	Lbs. per S.H.P. per hour.		
			Turbines only.	Other purposes.	All purposes.
Four S. direct coupled triple series turbines with parallel L.P.'s on inner shafts ..	23,000	Saturated.	11·2	2·2	13·4
Two S. single geared compound turbines, 1 H.P. turbine and 1 L.P. turbine per set	14,500	85° F. superheat	9·7	2·3	12·0

With double gearing there is a further gain in turbine consumption as follows :—

TABLE III.

RELATIVE TURBINE CONSUMPTION FOR GEARED ARRANGEMENTS.

Geared Type.	Steam Condition.	Relative consumption per S.H.P. per hour. Turbines only.
Single reduction gearing	Saturated	100
Double ,, ,, ...	,, ...	91
,, ,, ,, ...	100°F. superheat ..	82·5
,, ,, ,, ...	200°F. ,, ..	74·5

These figures apply very directly to the low speed type in Class 4 of Table I., and while they may vary somewhat with other classes, the gain in propeller efficiency made possible by the adoption of double gearing in the highest speed vessels must be emphasised.

No summary would be complete which failed to deal with the advent of the oil-engined ship, made possible by the gradual evolution of the Diesel engine, although its application has, so far, been limited to the cargo boat. When originally applied to marine propulsion it had to meet only the heavy reciprocating steam engine with a consumption of anything over $1\frac{1}{2}$ lbs. of coal per H.P. per hour, and its comparative advantages could be demonstrated. Now, however, as against the highly efficient double geared turbine, this demonstration becomes of greater difficulty.

Comparison between the oil engine and the latest turbine system is not easy in view of the uncertain factors involved, *i.e.*, oil supply, initial outlay, repair bills, etc., but it might be considered that the two types of machinery are not unevenly matched on the whole, except perhaps as regards running troubles, of which the oil engine still possesses its full share.

The super heating of steam brings in its train an aggravation of ordinary difficulties, which must be met by increased care and watchfulness in the actual running of the plant, but perhaps the main trouble is metallurgical, being the difficulty of finding materials capable of withstanding the effects of high temperature steam, particularly in the case of the turbine, in which blade failure and the cracking of casings present two problems of exceeding importance.

The cracking of casings is particularly liable to occur in astern turbines, and in view of the fact that the hydraulic and electric forms of transmission allow of the abolition of a separate astern steam unit, and give in addition a higher reversing power than is usual when dependence is placed on a special astern turbine, these forms of transmission possess features of value which render them suitable in certain spheres.

Comparative estimates of the three transmission systems for a 20,000 H.P. ship are given below:—

TABLE IV.

COMPARISON OF MECHANICAL, HYDRAULIC AND ELECTRICAL TRANSMISSION SYSTEMS FOR A 20,000 H.P. SHIP.

Machinery Type.	Turbines with Double Mechanical Gearing.	Turbines with Hydraulic Transformer.	Turbines with Geared Electrical Generators and Motor-driven Screws.
Superheat	200° F.	200° F.	200° F.
Propeller revolutions	90	140	90
Turbine revolutions	2,400 & 1,500	About 1,000	2,400 & 1,500
Transmission efficiencies..	·965	·92	·885
Relative fuel consumption .. .	100	123	109
Relative machinery weights	100	109	108

It will be seen that on both counts of fuel and weight the all-geared arrangement wins, and there is great probability that on a cost basis the differences would be augmented.

Of the mechanical system of drive there are two types, commonly known as the " rigid " and the " floating frame " gears, the latter of which is lighter in weight and is claimed to have an inherent power of correcting pinion alignment.

TABLE V.

COMPARISON OF RIGID AND FLOATING FRAME GEARS.

Type.	Rigid Gear.	Floating Frame Gear.
Power and revolutions per minute ..	8,000 S.H.P. at 1,150 Revs.	8,000 S.H.P. at 1,150 Revs.
Pinion diameter	17¼ ins.	12½ ins.
,, face length	72 ins.	50 ins.
Pressure per inch run. lbs.	705	1,400
Power constant	1·35	3·55
Relative torsional error	1·0	0·8
,, bending ,, ...	1·0	4·5 - 2·0
,, bearing length	1·0	1·4
,, weight	1·0	0·65

Because of the very high speed of the geared turbine it becomes possible to greatly reduce the size of unit necessary to develop a given horse power. The end thrust is thereby greatly diminished, and the total pressure can be taken by a minute "Michell" thrust collar. This arrangement eliminates the dummy element of the rotor, does away with the objectionable dummy leakage, and removes the necessity to maintain the fine dummy clearances essential for high economy.

In all turbine designs very great care must be taken to ensure that no dangerous vibrations arise under running conditions, and painstaking research is necessary to fathom causes and discover methods of elimination, where such are possible.

The later part of the address is devoted to some interesting and thoughtful remarks on the great industrial problems of to-day, the problems of Industrial Unrest, Industrial Co-operation, and Industrial Research.

A great deal of attention has recently been given to the promotion of research work in many branches of industry. A separate Government Department for Scientific and Industrial Research was established towards the end of 1916, and Parliament placed the sum of one million pounds at its disposal. The Advisory Council of the Privy Council recommended that the money should be spent in the form of grants to aid research undertaken in any industry by firms which may combine to conduct it on a co-operative basis, it being considered that the best means to that end is the establishment, under the Companies' Act, of Associations for Research, limited by guarantee and trading without profit.

Apart from Government grants-in-aid, the expenses of the Associations are to be met by contributions from the combining firms, who are permitted for taxation purposes to include such contributions in their working expenses.

Associations have already been formed by the Marine oil-engine Manufacturers and by the British iron puddlers; others are in process of formation by Scottish shale oil firms, by electrical and engineering firms, and by firms interested in the non-ferrous metals.

The Department itself has appointed a Fuel Research Board to deal with the urgent and many-sided problem of fuel economy.

Concerning the formation of an Association for Scientific and Industrial Research in Scotland, it has been established that great need exists for an institution or laboratory, situated conveniently to the industries it would benefit, for authoritatively standardising all classes of measuring instruments and for carrying out all descriptions of physical tests of material.

The laboratories of the Royal Technical College at Glasgow have since 1910 been used for these purposes, and it is now proposed that the engineering and physical laboratories of the University of Glasgow be also made available, as far as practicable, to render a "first-aid," by co-operating with an Association as now contemplated.

A draft Memorandum of Association and Articles of Association have been prepared after consultation between representatives of the Government Department and of the various scientific and manufacturing bodies concerned, and Mr. Cleghorn made an appeal for liberal financial support from all firms and individuals who have the industrial and economic welfare of Scotland at heart.

Notes.

Retirement Allowance.—It has been reported that the Clan Line has recently adopted a system of Retirement Allowance.

The undernoted subjects are at present occupying the attention of the Council and of our Representatives in connection therewith. Members specially interested in one or other of these are invited to express their views to assist in our aims for the good of all:—

1. Engineering education and training.
2. Certificates for pupils and students in Marine Engineering technique.
3. Revision and improvement of the Patent Laws in order to give all encouragement to invention and design for the benefit of the Empire.
4. The desirability of encouraging Marine Engineering apprentices to become Graduates of the Institute.
5. The advantages of the Awards Section of our work and the advantages to be derived from writing essays and papers on the prescribed subjects.

J. A.

ADMIRALTY NOTICES.

The following notice is published by request for the information of members:—

Applications having been received from time to time from Marine Engineers and skilled mechanics serving in the Imperial and Overseas Dominions Forces in Egypt for transfer to commissioned rank or skilled rating in H.M. Naval Service, the Admiralty have instructed the Senior Naval Officer, Egypt and Red Sea, to make arrangements for the necessary personal interview of candidates for commissioned rank, or trade test for skilled ratings, at the base at Alexandria.

Candidates desiring transfer should make application direct to the Rear-Admiral (Egypt), Alexandria, consent of their Commanding Officers having been first obtained, who will notify if the candidate can be spared.

It is essential that the consent of the respective G.O.C.'s (Imperial and Overseas Dominions Forces) to their release from military service be obtained in the event of their being found suitable for naval service.

Correspondence.

The following letter has been received from one of our members who is interned in Austria. The Transactions referred to in the letter were forwarded in the parcel, but have apparently been removed before delivery to Mr. Strain.

J. A.

Raabs a/d Thaya,
Austria, 4/3/18.

James Adamson, Esq.,
Hon. Secretary,
Institute of Marine Engineers.

Dear Sir,—To-day I received a packet of books from the Marine Engineer and Naval Architect, which was exceedingly welcome. Packet did not contain any of the Transactions of the Institute, but I feel sure that this was only on account of Censor restrictions. I have written to *Mr. A. T. Davies, of the Board of Education, asking him to advise the M.E. and N.A. if or how they can be sent. There is no change here since I wrote last. We have a large classroom, where the children attend in the forenoon, and in the afternoon and evening we have classes for slide rule, maths., languages, machine construction and drawing, naval architecture, book-keeping, economics, etc., for adults, and all are well attended, and on the whole we are much better off here than in another country I could mention. If any members of the Institute have an old book to spare on any of the following subjects—foundry practice, high-speed engines, engine and boiler testing, boiler construction, superheating, turbine design, Diesel engines, or anything of that nature, they would be very useful to me, as from all I can see and hear it will be *some* time yet before I am at liberty to work for my living. I hope this does not seem like asking too much, but the prospect of being here for an indefinite period with nothing to study is my excuse.

The only way to forward them would be to send them to *Mr. A. T. Davies, Board of Education, Whitehall, London, with instructions to send them to the Secretary, Education Committee, Raabs a/d Thaya, Austria. Hoping you are well, and thanking you again for your kindness.

I remain,
Sincerely yours,
JAMES STRAIN.

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* Now Sir A. T. Davies.

Election of Members.

Members elected at a meeting of the Council held on Tuesday, March 19th, 1918:—

As Members.

Fergus Cameron, 81, Edinburgh Street, Goole, Yorks.

Gerald Cox, The Croft, Gyllingvase Road, Falmouth.

David Robertson, 3, Rodenhurst Road, Clapham Park, S.W.4.

William Geo. R. Snellgrove, Wyalong Street, Willoughby, N.S.W.

Arthur Edwin Phillipps Stephens, 65, Pentre Street, Cardiff.

Alexander Storey, 104, Winchester Street, Sherwood, Notts.

Charles A. Sydney, 31, Carmunnock Street, Cathcart, Glasgow.

Edwin Gladstone Thompson, 38, Musgrave Road, New Cross, S.E.

Alfred Kingston Warner, 17, Springwell Avenue, Harlesden.

Associate-Members.

William George Elcoat, 1, Hotspur Street, Heaton, Newcastle-on-Tyne.

Leslie Harold Priestley, 3, Ulverston Road, West Norwood, S.E.27.

Associate.

John Roy Beveridge, c/o Messrs. Shaw Savill and Albion Co., Ltd., Royal Albert Docks, London, E.

Transfer from Associate-Member to Member.

S. V. Reynolds, 159, Barton Road, Stretford, Manchester.

Transfer from Graduate to Associate.

J. D. A. Ness, 36, Gordon Avenue, Southampton.