

B.—Exhaust Gas deprived of carbon dioxide and oxygen, and mixed with air in the proportion of 40 parts of treated exhaust gas with 60 parts of fresh air.

I.	?	—	No obvious effect in 6
II.	105	—	No obvious effect in 6
V.	30	135	Death in 4 $\frac{3}{4}$

These results, taken in conjunction with those of the first set of experiments, indicate that Mixture II. when undiluted was fatal, chiefly owing to absence of oxygen, and that Mixture V. owed its lethal property chiefly to carbon monoxide.

CONCLUSIONS.

From these experiments I conclude:—

1 That the main cause of danger when my experimental gas engine was overloaded was the considerable reduction in the amount of oxygen contained in the exhaust gas; the proportion of carbon dioxide was also very large. The danger began to be rapidly manifest when the quantity of exhaust gas exceeded 50%.

2 That the main cause of danger when the supply of air to my experimental gas engine was insufficient, was the presence in the exhaust gas of a large amount of carbon monoxide. This danger began to be manifest when the proportion of exhaust gas reached 1 part of gas to 40 or 50 parts of air. The CO present in the exhaust gas is partly derived from the unburnt coal gas, and partly from the imperfect combustion of the gas that is utilised. It is probable therefore that the use of power gas is attended with greater danger than the use of ordinary lighting gas.

Anything blocking slightly the entrance of the air pipe is sufficient to bring about this danger.

I propose to give a fuller account of my investigations at a later date when I have had the opportunity of studying other forms of internal combustion engines. It is obvious from this that care should always be taken that the exhaust pipe of a gas engine does not directly or indirectly discharge its contents into more or less confined space to which persons may have access. The discharge of exhaust gases into sewers should entirely be forbidden.

DR. H. W. ROBERTS, who has been Medical Officer of Deptford for twenty-seven years, has tendered his resignation,

METHODS OF CALCULATING MID-YEAR POPULATIONS.*

By S. G. MOSTYN, M.A., M.B., D.P.H., Medical Officer of Health, South Shields.

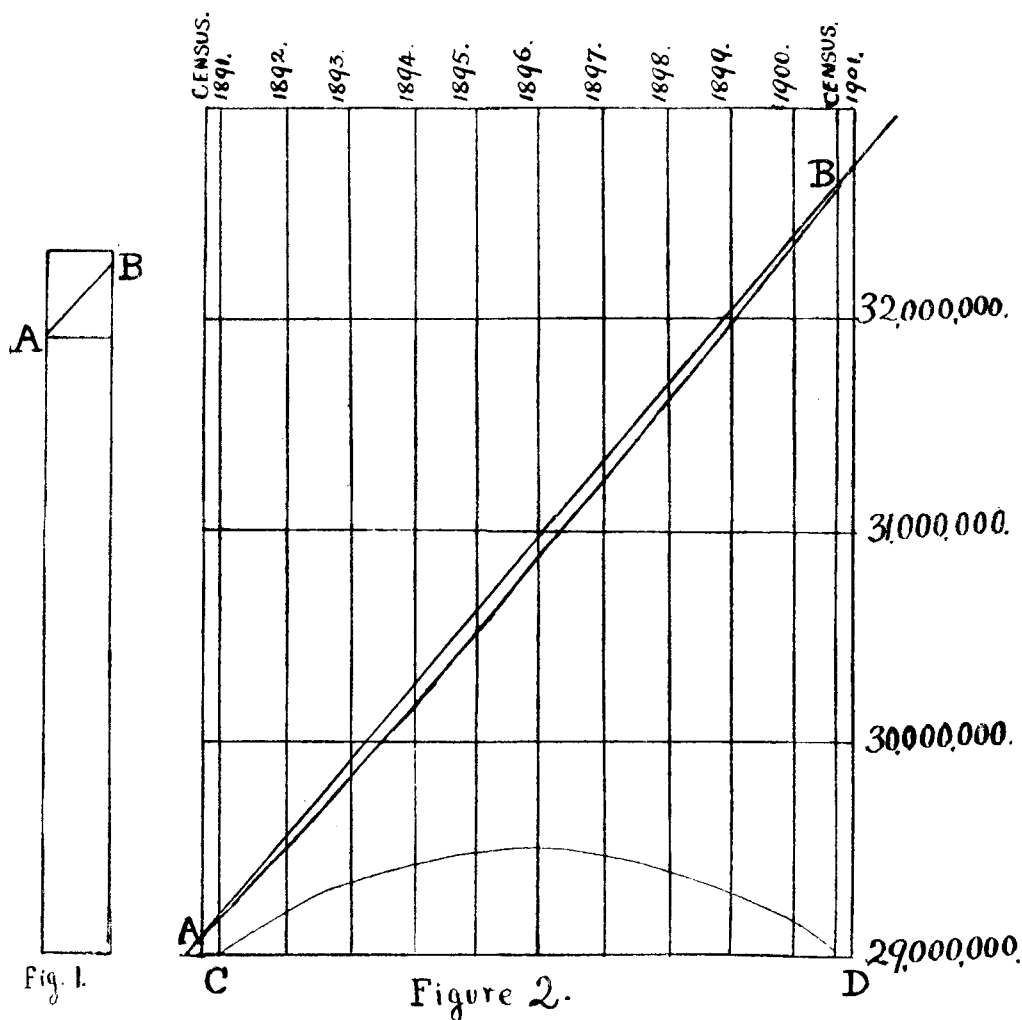
IN books on statistics relating to public health two methods are usually given for the calculation of the population of a country or a district for the years intervening between the census years. One of these assumes that the population increases in the same way as a sum of money put out at simple interest, while the second assumes that the increase will be that of a sum of money put out at compound interest. The problem of calculating the population for any intermediate year is thus the same as that of finding the amount at a given time of a sum of money put out at interest whose amount is known at the times of taking the census. It is frequently said that the compound interest method is that made use of by the Registrar-General in determining populations of districts. This, however, has not been the case since 1901, and I thought it might be of interest to the Society to explain the method that the Registrar-General used, and for this purpose I set out the calculations in the case of South Shields, thinking that a concrete example would explain the method more readily than a description of the theory. I also hoped that the arithmetical process explained might be of use to members of the Society who wished to estimate the populations of their districts for the coming years. On Wednesday last, February 22nd, I received a copy of the Report for 1909 of the Registrar-General, which has just been published. In this he sets out the method which it was my intention to explain, but states that it is proposed to substitute another method for it in the future. I therefore think that the general question of methods, and also an explanation and description of the new method, might be more useful.

The fundamental assumption of the compound interest, or geometrical progression, method, is that the increase of population in each year bears a fixed ratio to the population for that year. This ratio depends on the birth-rate, the death-rate and the rates of emigration and immigration, and it is highly unlikely that the variations in these rates will destroy one another, so that the rule will hold good. A still more serious objection is that if the

* Read before the Northern Branch of the Society of Medical Officers of Health on February 24th, 1911.

populations be calculated by this method for several districts, each from its two consecutive census values, the sum of the populations thus obtained is not the same as the population for the districts taken together, calculated by the same method from the values of the population of the combined districts at the same census times. This objection does not hold to the simple interest, or arithmetical progression, method, but the simple interest method makes an improbable assumption, that the number by

the simple interest method. Populations thus estimated for a number of districts separately have as their sum the population obtained by the same method for the districts taken as a whole. The Registrar-General mentions that this method is open to objection, particularly in the case of areas with a decreasing population. The method which it is proposed to make use of for the future is a modification of a method devised by Mr. A. C. Waters, I.S.O., Chief Clerk in the General Register Office.



which the population increases is the same during each year of the intercensal period. The method used by the Registrar-General for the last ten years combines these two methods. The population is calculated for each district by the simple interest method and multiplied by a factor which is determined for each year for the whole country. This factor is the ratio of the population of the whole country obtained by the compound interest method to the population of the whole country obtained by

In 1901, Mr. Waters explained a method based on two suppositions, one of which was that the population of the whole country changed by the compound interest rule, and the other that the ratio of the population of a district to the population of the whole country varied by the simple interest rule. This method led to the very striking result that the population of any district whatever at any given intermediate time can be found as the sum of two quantities, one of

which is the population of the district at the first census multiplied by a certain factor, and the other the population at the second census multiplied by another factor, the important point being that these factors are determined by the time in question and the census populations for the whole country, but are independent of the special district whose population is to be calculated. In the Decennial Supplement (1890-1900) of the Registrar-General's Report, Mr. Waters points out "that the supposition of geometrical progression was not essential, but that the method would be equally applicable if

1901 on the assumption that the simple interest rule holds good. The upper part of figure 1 is shown magnified ten times in figure 2. In figure 2, the lower line, AB, gives the population in the same way on the assumption that the population increases by the compound interest rule. It will be seen that the population according to the compound interest rule is in the intercensal period always less than the population by the simple interest rule. The difference between them is shown magnified ten times again in the curved line, CD, at the bottom of figure 2. Though the difference

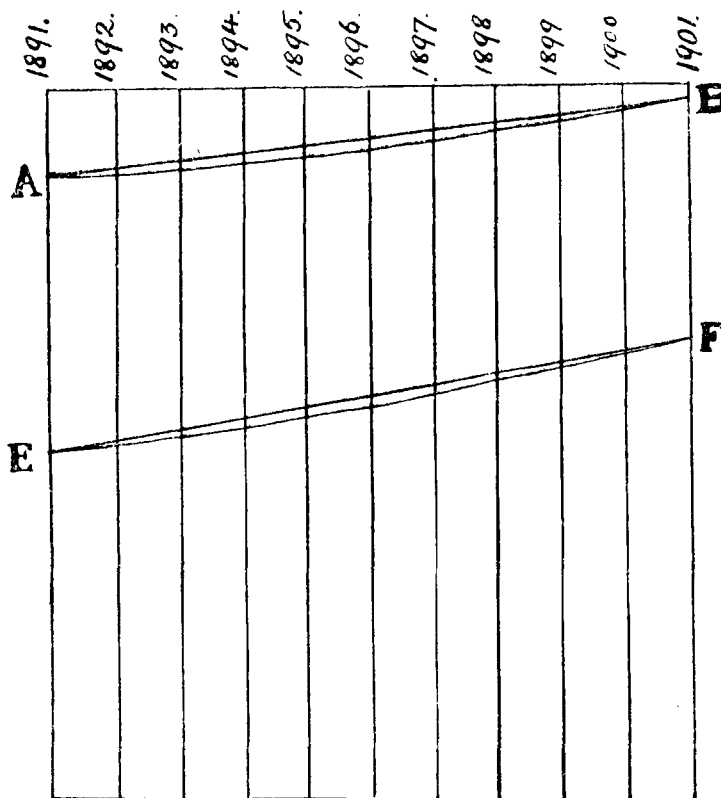


Figure 3.

any other supposition were made, or if the intermediate population of the whole country could be ascertained without any supposition whatever by the help of complete statistics of emigration and immigration." This last method is the one which the Registrar-General now proposes to use.

The various methods of calculation can be easily explained by diagrams, and the essential part of the method now proposed comes out, I think, more clearly from a geometrical explanation than by analysis.

In figure 1, the sloping line, AB, gives the population for England and Wales for 1891 to

of population by the two methods is small compared with the total amount, yet taken by itself it amounts to as much as 51,000 for the whole country at the middle of the intercensal period, about one six-hundredth of the whole.

The method adopted until this year by the Registrar-General is shown in figure 3. Here the upper lines, AB, refer to England and Wales and give the populations on the assumption of the increase by the simple interest and the compound interest rules respectively. The lower lines, EF, refer to a district—South Shields—but in order to get these lines on to the same diagram the scale for South Shields

is 200 times as large as the scale for England and Wales. The Registrar's method consisted in diminishing the populations for a district found for each year by the simple interest rule in the same ratio as it is necessary to diminish the population of England and Wales found for that year by the simple interest rule, in order to obtain the population of England and Wales as found for that year by the compound interest rule. In this way the lower line, EF, is obtained. It can easily be shown that the sum

a district. In the previous diagrams the lines for consecutive years were drawn parallel at equal intervals. The method proposed amounts to drawing parallel lines for various years in such a way that they will determine on the line AB the value which is thought to be most probable for the population of the whole country. The point in which one of these lines intersects the line for a district will give the population of the district according to this method. It will be noticed that

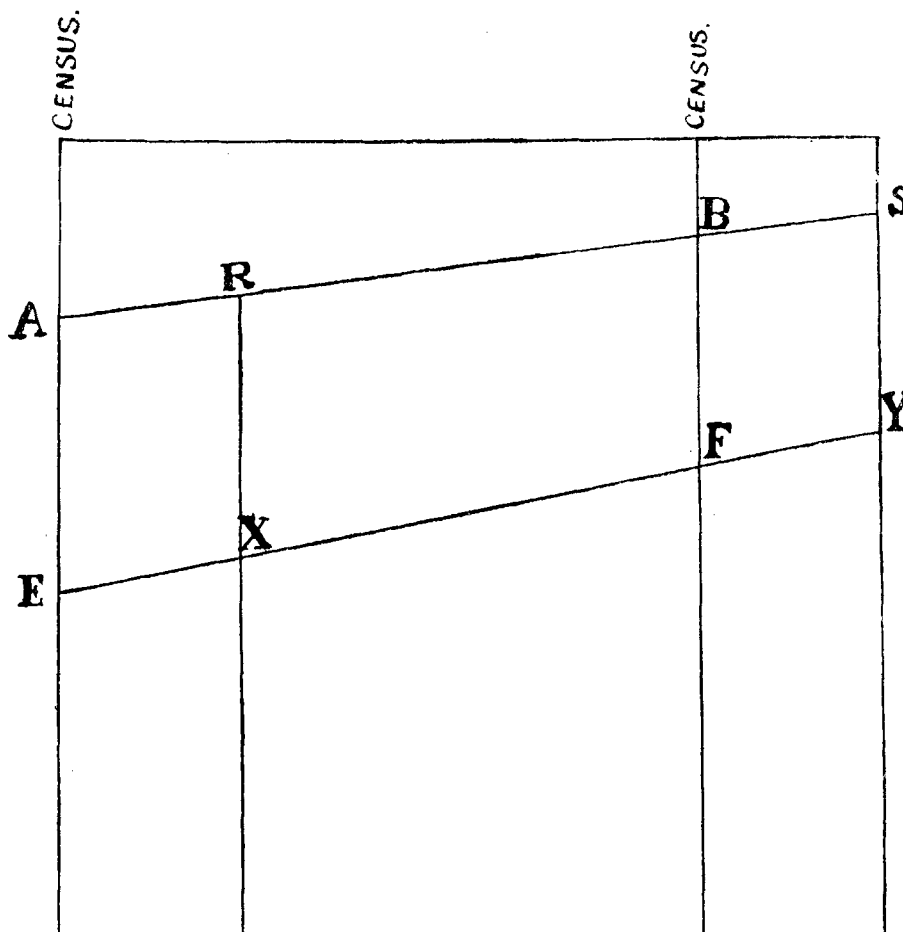


Figure 4.

of the populations of all the districts will be the population of England and Wales determined by the compound interest rule. A weak point in this method is that the compound interest rule will probably not give us as accurate a total population as we might get by consideration of births, deaths, emigration and immigration for the year in question. The new method about to be adopted is shown in figure 4. The line AB here is a straight line joining the two census values of the population of England and Wales; the line, EF, the corresponding line for

these lines will no longer be equi-distant.

So far I have only mentioned populations for years between two census values. The various lines used in calculation can all be produced outside the intercensal period, and values for the following years can be calculated by the methods described. From figure 4 it is apparent, by elementary geometry, that if a and b are the populations of England and Wales at the first census and the second census respectively, and if r be the value, as published by the Registrar-General, of the population of England

and Wales for some intermediate time, and s the estimated population of England and Wales for some time subsequent to the second census, and if e , f , x and y are the populations of a specified district for the same time drawn to any convenient scale but to the same base line as a , b , r , and s , the values of x and y will be determined by the new method from the following equations:—

$$x = \frac{r-a}{b-a} f + \frac{b-r}{b-a} e$$

$$y = \frac{s-a}{b-a} f - \frac{s-b}{b-a} e$$

To find the values of x or y for any specified date it is evidently only necessary, as mentioned above, to know the values of the fractions multiplying the quantities e and f , which are the same for that date for all districts, as they depend only on the enumerated and estimated populations of England and Wales.

By the new method we shall be dependent on the Registrar-General for the estimate of the total population for England and Wales at the middle of each year. When these values are published for the years of the intercensal decade now ending, it will be possible to determine for those years the corresponding populations for any district, but it is evident that if the mid-year value of the population is to be published at the beginning of the year, as has been done previously, this can only be an estimate. A provisional population can be found from the populations for previous years by one of the methods of the calculus of finite differences as soon as the statistics are available for the previous years. It would be very convenient if this provisional population for the ensuing year could be published not later than the end of December, at the same time as the corrected value of the estimate for the current year. The corrected value could then be used in calculating rates for annual reports, while the provisional population could be used in weekly or monthly reports for the ensuing year.

THE NEGLECT OF VACCINATION.—I fear that the conscientious objector, is laying the train for an extensive epidemic at no distant date. The argument that improved sanitation will be sufficient protection is not good enough, although such improvement will certainly assist. I would suggest to the believers in that argument; to what extent has improved sanitation abolished scarlet fever? This infectious disease is almost as rife throughout the country as it ever has been.—*Annual Report of Dr. Gooding, Medical Officer of Health, Bideford.*

THE OPEN-AIR TREATMENT OF ACUTE INFECTIOUS DISEASES.

By PHILIP BOOBYER, M.D.,
Medical Officer of Health, Nottingham.

I HAVE received numerous enquiries of late respecting the open-air treatment of scarlet fever and other acute specific diseases, which has been practised at the Nottingham City Isolation Hospitals for some time past.

I think, therefore, the time has arrived for me to make a short statement on the subject, in addition to what I have said in my Annual Reports, for the information of those who may be disposed to extend the experiment in their own districts.

It must be obvious at once that if such treatment can be shown to be beneficial to patients, then the task of providing public hospital accommodation for cases of such acute specific diseases as can be so treated with advantage will be greatly cheapened and simplified.

In the first place I will give a brief description of the hospital at which the principal part of the experiment has been carried out.

The existing City Isolation Hospital was completed in 1891. It stands within an enclosure of 12½ acres. The permanent buildings consist of four ward-blocks, each capable of accommodating 24 patients, with an allowance of 2,000 cubic feet per head; an administrative block, with staff laundry and other necessary offices; covered corridors connecting all the blocks with one another and with the administrative block; a general laundry, engine house, steam disinfecting station, and stables, and an entrance lodge. Some improvements and additions, *e.g.*, the substitution of two large Lancashire boilers for one small Cornish boiler, the construction of a railway siding (within the hospital enclosure), and of a shelter at the main entrance, have been made since 1891; and the cost of the whole permanent hospital, inclusive of these items and of the laying out of the grounds and enclosing the whole with walls and fences, has been some £32,000.

The temporary and adapted buildings within the enclosure consist of one wooden ward-block of 26 beds (divided equally between the two sexes, as in the case of the permanent buildings), two corrugated iron hospitals of 12 beds each, and a farm house and farm buildings adapted to the purposes, respectively, of an administrative block and small emergency wards. The