J. VERMEHREN.

MACHINE FOR CALCULATING FRACTIONS.

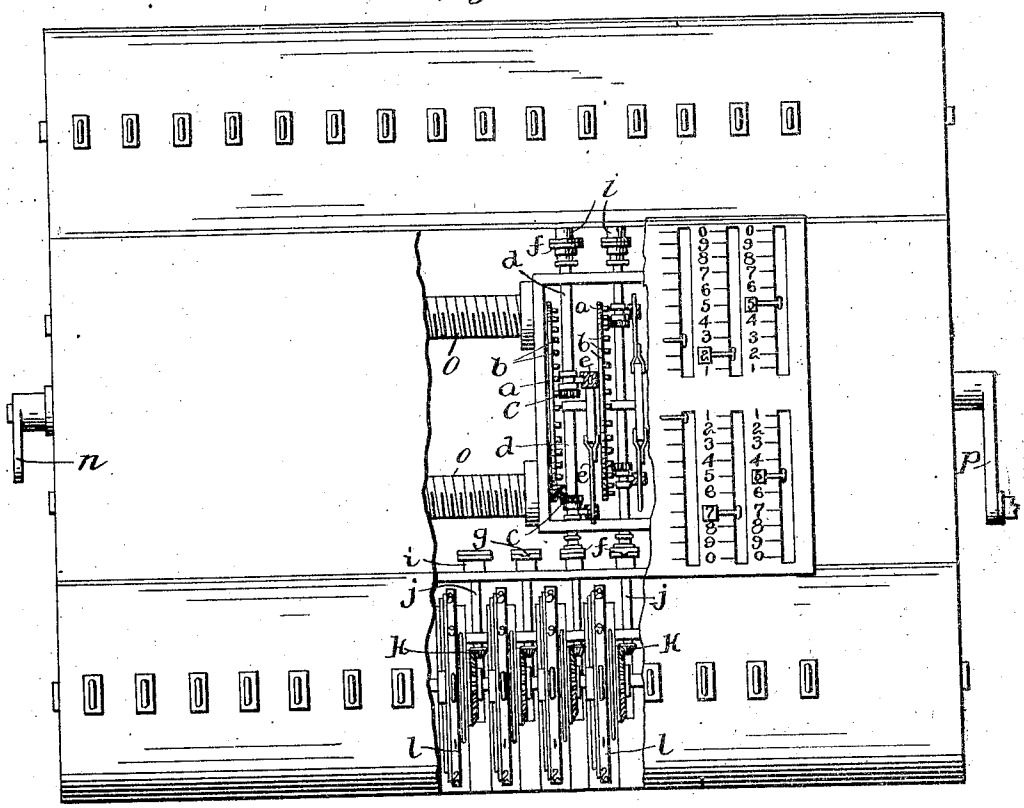
APPLICATION FILED JULY 16, 1909.

953,160.

Patented Mar. 29, 1910.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 2.

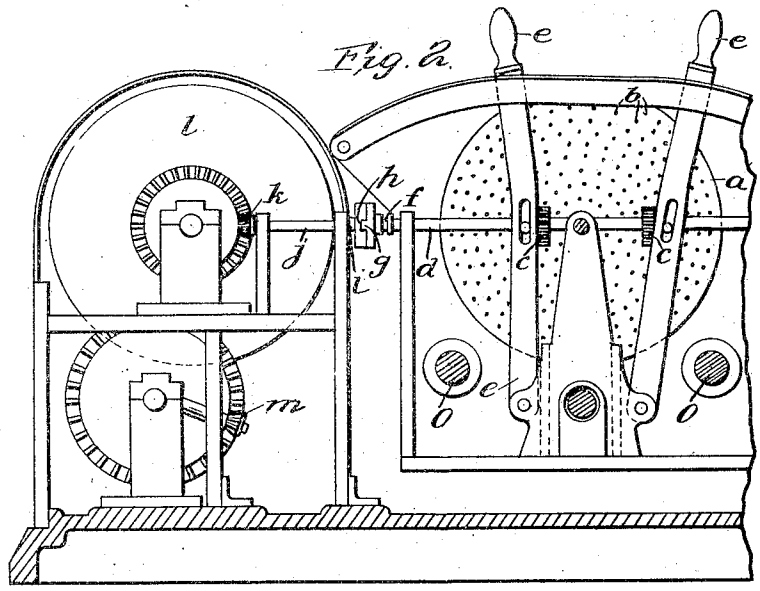


Fig. 3.

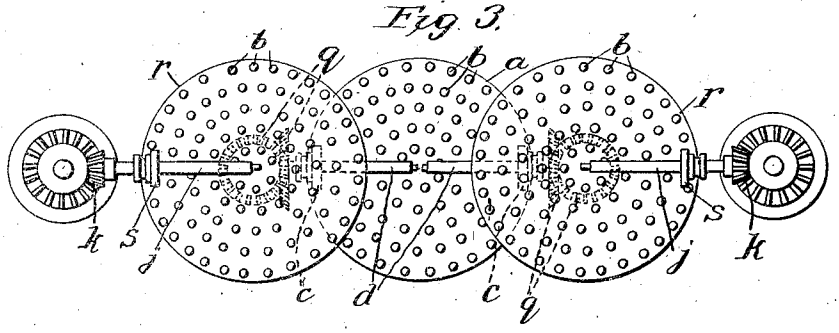
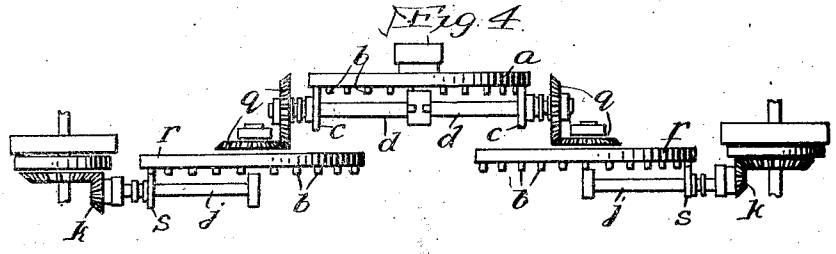


Fig. 4.



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UNITED STATES PATENT OFFICE.

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MACHINE FOR CALCULATING FRACTIONS.

953,160. Specification of Letters Patent. Patented Mar. 29, 1910.

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To all whom it may concern:

Be it known that I, JOHANNES VERMEHREN, director, a subject of Denmark, residing at No. 9 Johannevej, Hellerup, Denmark, have invented certain new and useful Improvements in Machines for Calculating Fractions, of which the following is a specification.

Calculating machines are already known which consist of one counting mechanism and one actuating device, and in which the counting mechanism and the actuating-device can be moved in relation to each other, the counting mechanism being stationary in some of these machines and the actuating device stationary in others, the other part of the machine being moved. Moreover, calculating machines with two counting mechanisms and one actuating device are known, in which the actuating device engages with the one counting mechanism and this in turn with the other counting mechanism. With the machines first mentioned, problems in addition and subtraction, multiplication and division, can be worked out in whole numbers; with the latter mentioned machines it is possible, by means of the other counting mechanism, to preserve the products or sum obtained by the first counting mechanism. None of the machines mentioned, however, can simultaneously work out a sum in multiplication and division, or in other words, can perform the calculation

$$a \cdot \frac{b}{c}.$$

In the British Patent No. 2172 of 1904, a machine for calculating fractions is described, the characteristic feature of which is that one actuating device engages simultaneously with two counting mechanisms. In that machine the actuating device which, as described in the specification, may be a cone (or be otherwise arranged), is stationary, while the two counting mechanisms are moved along the cone, whereby their extreme right-hand wheels, which are in engagement with holes arranged in circles on the cone, run in contact with different cone-circumferences. Accordingly, on the cone being rotated on its axis, the counting mechanisms rotate at different rates and thereby effect the fractional calculation. If one counting mechanism be adjusted to a cone-diameter b, the other to a cone-diameter c, and the cone be rotated until the last mentioned counting mechanism indicates a, the other will indicate

$$a \cdot \frac{b}{c}$$

and thus the machine will have simultaneously effected a multiplication and a division. As, however, the counting mechanisms are only actuated through their extreme right-hand wheels, they cannot be advantageously employed for calculating with amounts having more than four places of figures, as the production of numbers with more figures would involve the expenditure of too much time in rotating the cone. Likewise b and c must be small numbers (two places at the utmost), as the limit of the precise adjustment of the counting mechanism is very quickly reached.

The present invention relates to a machine for calculating fractions, adapted not only to give a large number of figures in the products, but also to enable fractions to be calculated, both the numerators and denominators of which have several figures. In order that the machine may be able thus to give a product with an increased number of places, the actuating device (which, for example, may consist of five parts on each side) must be able to engage simultaneously a corresponding series of number-wheels belonging to the counting mechanism, and further must be movable along the same, unless it be preferred to move the counting mechanisms while the actuating device remains stationary. This latter arrangement is, however, not generally to be recommended, because the counting mechanisms are far larger than the actuating device.

One form of the invention is illustrated in the accompanying drawings, wherein—

Figure 1 is a plan of the machine with a portion of the cover removed; Fig. 2 is an end view with a portion of the end plate removed; while Figs. 3 and 4 are diagrammatic representations in elevation and in plan respectively, of a further form of the invention.

In the example illustrated, the actuating device is in the form of a circular disk a provided with projecting pins b which are arranged in nine concentric circles whose radii are in the ratio 1:2:3: . . . 9. Each disk drives two small wheels c c splined on in-

pendent horizontal shafts *d*. The wheels *c*, *c* are longitudinally movable on the shafts by means of the levers *e*, but are not rotatable independently of the shafts and thus can be put in engagement with any desired circle of pins *b* or (if the lever be adjusted to zero) can be moved entirely out of gear with the disks. The shafts *d* each carry at one end a half-coupling *f* which engages, by means of a projection *g*, in a corresponding groove *h* formed in the other half *i* of the coupling, which latter is fast on a shaft *j* carrying a conical pinion *k* whereby it is connected with a number-wheel *l* in one of the counting mechanisms.

If now, for example, one of the lower levers *e* shown in Fig. 1, be adjusted to 7, and the disk *a* is rotated once, the corresponding wheel *c* will make seven revolutions, because it is momentarily in engagement with a circle of pins which has seven times as many pins as the wheel has teeth. Accordingly the wheel *k* will rotate seven times and the number-wheel will move forward (or backward) to the extent of 7 figures (from 0 to 7). If at the same time the other wheel *c* driven by the same disk *a* is put (by means of the other lever *e*) at 3 for example, then the number-wheel situated opposite the number-wheel first mentioned and belonging to the other counting mechanism will be moved forward simultaneously to the extent of three figures (from 0 to 3), that is to say a fractional calculation has been effected, multiplication having been effected with 3/7 (7.3/7=3) and the upper counting mechanism in Fig. 1 of the drawing, shows 3/7 of the number shown in the other counting mechanism.

As one revolution of the disks *a* always rotates the wheels *c* a whole number of revolutions (because one revolution of the crank *p* corresponds to 0, 1, 2 . . . 9 revolutions of the wheels *c* according to the momentary position of the lever *e*), if the couplings are simply placed at starting with the parts *g* horizontal, they will always be in the same position after every revolution of the crank, and with the couplings in this position the actuating device can be moved along the counting-mechanisms without hindrance.

The counting mechanisms are provided with transferring or carrying mechanism of any suitable kind as indicated at *m*.

The whole action of the machine will be most readily understood from an example. Suppose that 53837.44 marks, at the rate of exchange of 23.73 are to be converted into francs at the exchange rate of 19.21. 02373 is adjusted in one half of the actuating device (for example, that shown above in Fig. 1), and 01921 in the other (below). By turning a handle *n* connected with the screws *o*, the actuating device is shifted toward the left until its left-hand disk comes opposite the second number-wheel of the counting mechanisms, reckoning from the left, and a start is made with the turning of the handle *p* of the actuating device. After one revolution of the disk *a* 1921 (or 19210) will be read off the lower counting mechanism, and 2373 (or 23730) off the upper one (that is to say 1921 marks=2373 francs, or 19210 marks=23730 francs). After two revolutions 38420 and 47460 are read off. As at present we are only considering the lower counting mechanism, it will be seen that if it were once more rotated it would pass the number 53837.44, as it would indicate 57630. Accordingly, the actuating-device is shifted to the right to the distance of a single number-wheel, and the rotation is proceeded with. The left-hand number-wheel (that is to say of those hitherto used) will then become stationary, until a ten has been completed, which in the example selected occurs twice, and after 8 further revolutions the lower counting mechanism will indicate

$$53788 (= 38420 + 8.1921).$$

If now a shifting were effected to the extent of only one distance, then, after one further revolution, the counting mechanism would indicate

$$53980.1 \left(= 53788 + \frac{1}{10}.1921\right),$$

and therefore a shifting to the right to the extent of two distances is effected, and after 2 revolutions

$$53826.42 \left(= 53788 + \frac{2}{100}.1921\right)$$

is read off. After a further shifting to the distance of a single number-wheel and 5 further revolutions, the counting mechanism shows

$$53836.025 \left(= 53826.42 + \frac{5}{1000}.1921\right);$$

after a further shifting and 7 revolutions

$$53837.3697 \left(= 53836.025 + \frac{7}{10000}.1921\right);$$

further shifting to the extent of one distance apart is effected; 3 revolutions are made; and

$$53837.42733 \left(= 53837.3697 + \frac{3}{100000}.1921\right)$$

is read off. Finally after two shiftings and each time 6 revolutions

$$53837.4400086 \left(= 53837.42733 + \frac{6}{1000000}.1921 + \frac{6}{10000000}.1921\right)$$

is read off. At the same time the upper counting mechanism will indicate

$$66505.0729518 (= 2373.28.0257366)$$

that is to say 53837.44 marks =66505.07 francs.

In order to facilitate comprehension, it is assumed that, in making this calculation, the cranks of the disks have always been turned in the same direction forward. In practice, however, the calculation will be easily made after a little experience with far fewer revolutions, by using a combination of forward and backward rotations; as for example $8a=10a-2a$. That is to say instead of rotating 8 times forward with the actuating device constantly in a determined position, the device is shifted to the left to the extent of one distance and one revolution forward is effected, and then to the right to the extent of one distance and two revolutions backward are effected. Or in other words, before shifting to the right, one more turn forward is effected as mentioned above, and after the shifting, a corresponding number of revolutions is effected backward. If the same calculation were carried out by means of an ordinary calculating machine, it would be necessary to effect the multiplication with 2373 and the division with 1921 separately, and after the calculation had been made, it would not be possible to prove its accuracy, as the intermediate calculations would have been obliterated. In the present machine, on the contrary, all the numbers 53837.44, 1921, 2373 and 66505.07 are visible, so that before the final product is written down it is possible to see whether the correct numbers have been used, which is a further advantage of the machine. If the crank p be turned in the opposite direction the machine will effect a division with the same fraction.

The invention can be extended by the use of one or two actuating devices which would be interposed between the principal actuating-device and the one or two counting mechanisms, and which would be adjusted in the same manner as the principal actuating device whereby it would be possible to calculate with expressions of the formula

$$a.\frac{b}{c}d, \text{ or } a.\frac{b.d}{ce},$$

which would be of great advantage in calculating interest.

A serviceable device for the latter kind of calculation is shown in Figs. 3 and 4. From the disk a of the principal actuating-device (of whose nine circles of pins b only five are partially shown) not the counting-mechanisms themselves, but (through the medium of conical wheels q) other driving disks r, similar to the disks a, are driven by means of the displaceable wheels c on the shafts d. Across these disks r, move displaceable wheels s, of the same kind as the wheels c and adjustable in the same way. These wheels s slide on the shafts j, which by means of the conical wheels k drive the counting mechanisms as above described.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is.

A machine for calculating fractions comprising two counting mechanisms, a double actuating device slidable along the counting mechanisms, means for adjusting separately both halves of the actuating device, means for driving simultaneously both halves of the actuating device, and means for transmitting the movements of said halves to the respective counting mechanisms.

In testimony whereof I have affixed my signature in presence of two witnesses.

JOHANNES VERMEHREN.

Witnesses:

MARCUS MÖLLER,

HANSEL TROST.