No. 826,732. PATENTED JULY 24, 1906.

A. MONACHIMOFF.

ABACUS.

APPLICATION FILED JUNE 17, 1905.

Fig. 1.

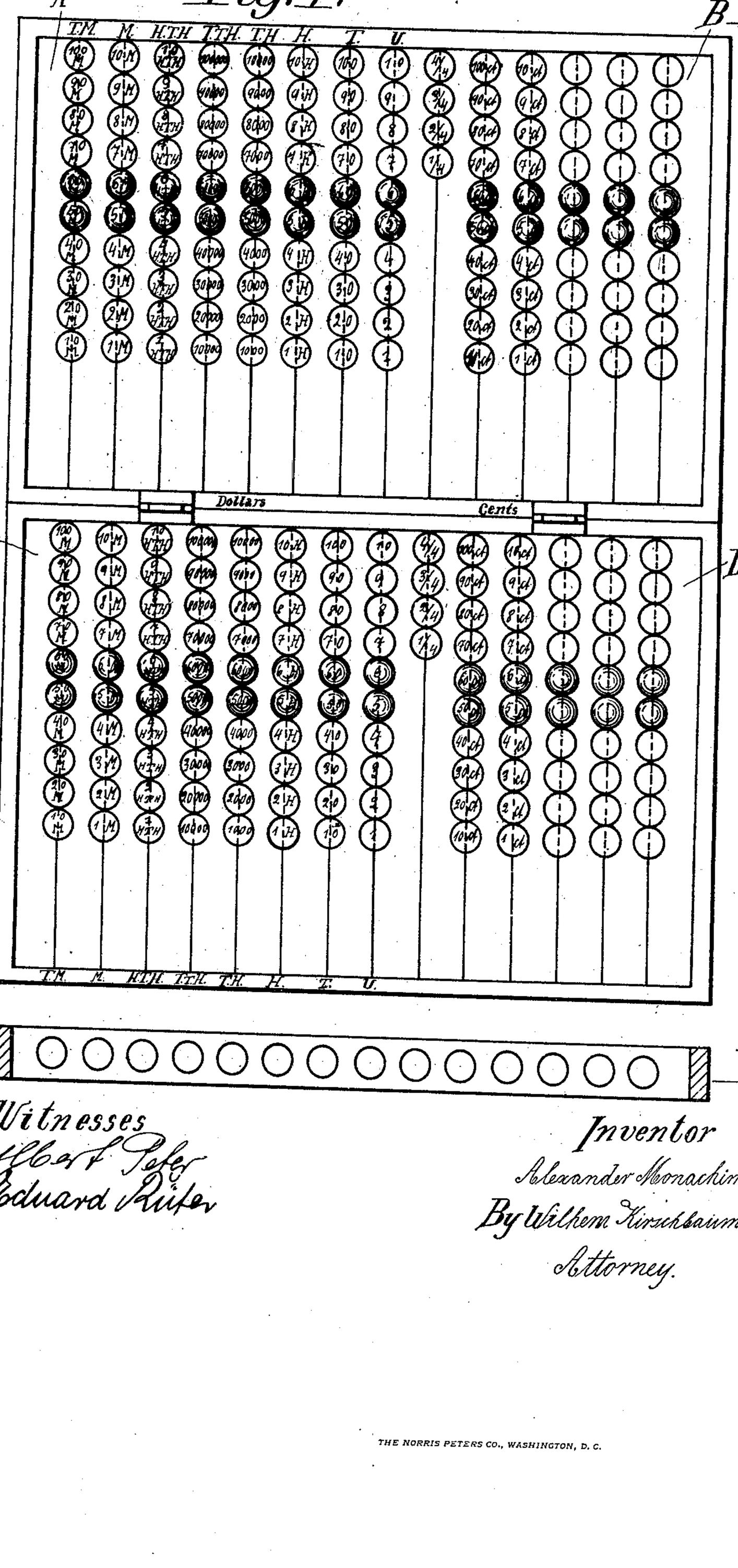

Fig. 2.

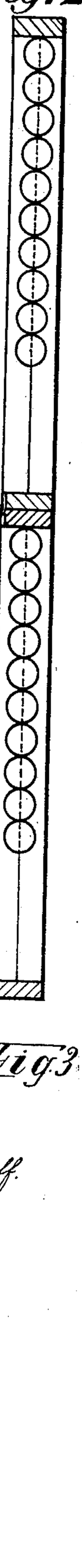

Fig. 3.

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UNITED STATES PATENT OFFICE.

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ABACUS.

No. 826,732. Specification of Letters Patent. Patented July 24, 1906.

Application filed June 17, 1905. Serial No. 265,683.

To all whom it may concern:

Be it known that I, ALEXANDER MONACHIMOFF, a subject of the Sultan of Turkey, and a resident of 39 Kettwiger Chaussee, Essen-on-the-Ruhr, Germany, have invented certain new and useful Improvements in Abaci, of which the following is a specification.

This invention relates to an abacus—*i. e.*, to an apparatus for carrying out the four fundamental processes of arithmetic.

The improved apparatus is distinct from apparatus of similar nature, such as are used in schools for the purpose of demonstration, by its construction, which comprises four groups of rods on which balls are slidably arranged in a frame divided into two spaces by a conspicuous horizontal separation connected together by hinges, so as to allow of the two parts of the frame being folded up when not in use. Each rod carries ten balls, with the exception of two rods (one in each half of the frame) which carry only four balls each. These two rods, with their balls, are employed in calculating fractions, and each of these two rods divides its frame half into two separate spaces, so as to form the four groups of rods.

In the accompanying drawings, Figure 1 is a plan. Fig. 2 is a longitudinal section, and Fig. 3 is a cross-section of the abacus embodying the invention.

As shown, the rods are divided into four groups—viz., A B C D—and each rod is designated according to the numerical value of the balls carried by it, thus: U, T, H, TH, TTH, HTH, M, TM, HM, representing, respectively, units, tens, hundreds, thousands, tens of thousands, hundreds of thousands, millions, tens of millions, and hundreds of millions. These designations, arranged to correspond with the respective rods in both halves of the apparatus, correspond with the ordinary system of numerical notation, the units-rod being situated at the beginning of each group at the right-hand end and the higher values succeeding progressively toward the left-hand end of each group.

Each ball represents a digit. Thus two balls on the rod in the second or tens place represent the number "20," five balls on the rod in the fourth or thousands place represent the number "5,000," &c.

In calculating with this apparatus the frames are opened out flat, as shown in Fig. 1, with the letters "U," "T," "H," &c., facing the operator and all the balls occupying the upper portions of their rods, as shown.

Addition: To add the numbers "6,789" and "4,321" together, the first number is set down by moving six balls on the rod in the T or thousands place (hereinafter termed for the sake of shortness "TH balls") to the bottom of the frame, then similarly seven H balls, eight T balls, and nine U balls. Then in order to set down the second sum and instead of moving down four TH balls one TTH ball is moved down, and the difference between these balls is made up by moving six TH balls up to the top of the frame. Then instead of three H balls one TH ball is moved down, and the difference is made up by moving seven H balls to the top of the frame. Then instead of two T balls one H ball is moved down and the eight T balls—viz., the difference—are moved up. Then instead of one U ball one T ball is moved down and nine U balls are moved up, and the sum is found by reading off the balls that remain at the bottom of the frame—viz., the number "11,110."

From the foregoing example it will be noted that instead of moving down several balls of a lower value one ball of the next higher value is moved down, and the difference is made up by moving up the corresponding number of balls of lower value. This, however, presupposes that sufficient balls of lower value are available for moving up; otherwise the full number of balls of lower value must be moved down.

Additions are always carried out on group C.

The rod carrying four balls between the groups C and D serves merely to separate these groups from each other and for reckoning fourth parts or quarters.

In adding and subtracting the first two places on the left of group D may be used for calculating tens and units in the same way as all the others.

Additions are checked by moving up the values that have been moved down, and if no balls remain at the bottom then the sum is proved to be correct.

Subtraction: To subtract, balls representing the minuend are moved down, and then, starting at the highest value, as many TH balls, H balls, &c., as are to be subtracted are moved up, and then the balls remaining at the bottom represent the remainder. For example, to subtract "1,849" from "3,849"

first one TH ball is moved up, and then the eight H balls, and then four T balls, and, lastly, nine U balls, and then the balls left at the bottom represent the remainder, "2,000."

Multiplication: This operation is performed in the same way as with written figures—namely, the first-place digit of the multiplier is multiplied, commencing in the first place, the second-place digit commencing in the second place, and the third-place digit commencing in the third place, and so on, the units, tens, hundreds, &c., being placed in their proper succession. The improved apparatus has, however, the advantage that, whereas in writing any excess over "nine" must be added to the next higher place, in the present case the tens and units of each result are moved down separately. For instance, to multiply "678" by "839" the multiplicand is first multiplied by the units, then by the tens, and then by the hundreds, &c., commencing with the highest place in each case—that is to say, first multiplying "678" by "9" as follows: Nine times eight equals seventy-two, "2" being moved down on the first or units rod and "7" on the second or tens rod. Then nine times seven equals sixty-three, "3" being moved down in the tens-rod and "6" in the third or H rod. Now as all the ten T balls are at the bottom they are moved up and again to continue the calculation, and a ball on the third or hundreds (H) rod is moved down instead. Nine times six equals fifty-four. Four balls are moved down on the third rod, but since there are only three balls at the top all the balls on that rod are moved up, and one ball—namely, the difference between four and three—is left; but since all the balls were moved up at first five balls must now be moved down on the fourth or TH rod. The balls at the bottom now represent the product, "6,102." Then the multiplicand is multiplied by three—*i. e.*, six hundred and seventy-eight times three—as follows: Three times eight equals twenty-four. Four balls are moved down on the second rod and two balls on the third rod. Then three times seven equals twenty-one. One ball is moved down on the third rod and two balls on the fourth rod. Then three times six equals eighteen. Eight balls are moved down on the fourth rod; but as there are only two balls there all the balls on that rod are moved up, and the difference between two and eight—equal to six balls—is left; but a ball is moved down on the next or fifth rod and then another ball for the "1" of "18." The multiplicand is multiplied by eight—that is to say, six hundred and seventy-eight times eight, as follows: Eight times eight equals sixty-four. Four balls are moved down on the third rod and six balls on the fourth rod; but since there are only four balls left on the fourth rod all the balls on that rod are moved up, and the difference—four minus two, equal to two balls—is left at the bottom, while one ball on the next higher rod is moved down. Then eight times seven equals fifty-six. Six balls are moved down on the fourth rod and five balls on the fifth rod. Then eight times six equals forty-eight. Eight balls are moved down on the fifth rod; but since there are only two balls left at the top of that rod all the balls on that rod are moved up, and the difference between eight and two—viz., six balls—are moved down, and one ball is moved down on the sixth rod and four balls of the number "48," and the final product is shown to be "568,842."

Division: This operation is commenced on the left-hand side of the dividend, as in the ordinary way, as many places being marked off as required by the divisor, and exactly the same numbers are moved down on the improved apparatus in the same places. These numbers are divided by the divisor, and then instead of first multiplying all the places and then subtracting as in the ordinary way each separate place of the divisor is subtracted immediately after multiplying the same, so that the numbers which are kept in mind each time in dividing in the ordinary way are with this apparatus subtracted immediately. For instance, to divide "989,986" by "2,876" the dividend "989,986" is set out on table or group A and the divisor "2,876" is set out in group B, and then the sixth, fifth, fourth, and third place of the dividend is moved down in the sixth, fifth, fourth, and third place in group C. They are then divided mentally by the divisor, "3" being noted as the first number of the quotient in group D. Then after multiplying $3 \times 6 = 18$ the number "18" is moved up—that is to say, eight balls on the third-place rod and one ball on the fourth-place rod. Then for $3 \times 7 = 21$ one ball is moved up on the fourth rod and two balls on the fifth rod. Three times eight equals twenty-four. Four balls are moved up on the fifth rod and two balls 40 on the sixth rod. Three times two equals six. Six balls are moved up on the sixth rod. Then after having thus multiplied the divisor by "3," which is the first number of the quotient, and subtracted it from the balls moved down in the fourth place of the dividend, leaving "1,271"—that is to say, one HTH, two TTH, seven T, and one H balls on the apparatus. Then the "8" of the dividend is moved down in the second place, thus giving the number "12,718." This is then divided again by the divisor, "4" being put down as the second number of the quotient, and the divisor is multiplied by it as follows: Four times six equals twenty-four. Four balls are moved up in the second place and two balls in the third place. Four times seven equals twenty-eight. Eight balls are moved up in the third place and two balls in the fourth place. Four times eight equals thirty-two. Two balls are moved up in the

fourth place and three balls in the fifth place. Four times two equals eight. Eight balls are moved up in the fifth place. Now having multiplied the divisor by the second number "4" of the quotient and subtracted it from the dividend there remains a remainder—namely, one TTH's, two TH's, one H, and four T's. The six U's of the dividend are then moved down in the first place, and the resulting number "12,146" is again divided by the divisor, "4" being noted as the third number of the quotient, by which the divisor is to be again multiplied and subtracted from the dividend, as follows: Four times six equals twenty-four. Four balls are moved up in the first place and two balls in the second place. Four times seven equals twenty-eight. Eight balls are moved up in the second place and two balls in the third place. Four times eight equals thirty-two. Two balls are moved up in the third place and three balls in the fourth place. Four times two equals eight. Eight balls are moved in the fourth place.

In this manner the divisor multiplied by the last number of the quotient is also subtracted from the dividend, and this completes the division. The remainder equals "642" remains at the bottom of the apparatus. The quotient can be read off from group D.

If any places of the quotient should be zeros, (naughts,) then if the quotient is being noted on group D those places are skipped and are reckoned as zeros or naughts, because according to the system of this reckoning-machine the bottom places which are not occupied by a ball or balls, if they occur behind a number that is carried forward, are reckoned as zeros or naughts.

Having fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. An abacus comprising in combination a frame divided into four spaces by a hinged horizontal conspicuous separation and by two vertical rods each provided with four slidable counters for calculating fractions, and vertical rods fixed in each space of said frame and each provided with ten slidable counters, the four spaces of the frame forming thus four groups comprising each a number of vertical rods, each of said rods in each group representing a numerical value according to its position, corresponding in horizontal succession with the values of the several numerals constituting an ordinal, and each counter a digit, the values of said rods being signified by marking on top of each a symbol representing such value such as U for units, T for tens, H for hundreds, TH for thousands, and so on, and each of the counters being marked with the figure representing the respective digit, substantially as shown and set forth.

2. An abacus comprising in combination a frame divided into four spaces by a hinged horizontal conspicuous separation and by two vertical rods each provided with four slidable counters for calculating fractions, and vertical rods fixed in each space of said frame and each provided with ten slidable counters, the four spaces of the frame forming thus four groups comprising each a number of vertical rods, each of said rods in each group representing a numerical value according to its position, corresponding in horizontal succession with the values of the several numerals constituting an ordinal, and each counter a digit, the values of said rods being signified by marking on top of each a symbol representing such value and each of said counters being marked with the figure representing the respective digit, and the fifth and sixth of the ten counters on each of said rods being made particularly conspicuous, substantially as shown and set forth.

In testimony whereof I have hereunto signed my name.

ALEXANDER MONACHIMOFF.

Witnesses:

PETER LIEBER,

WILLIAM ESSENWEIN.