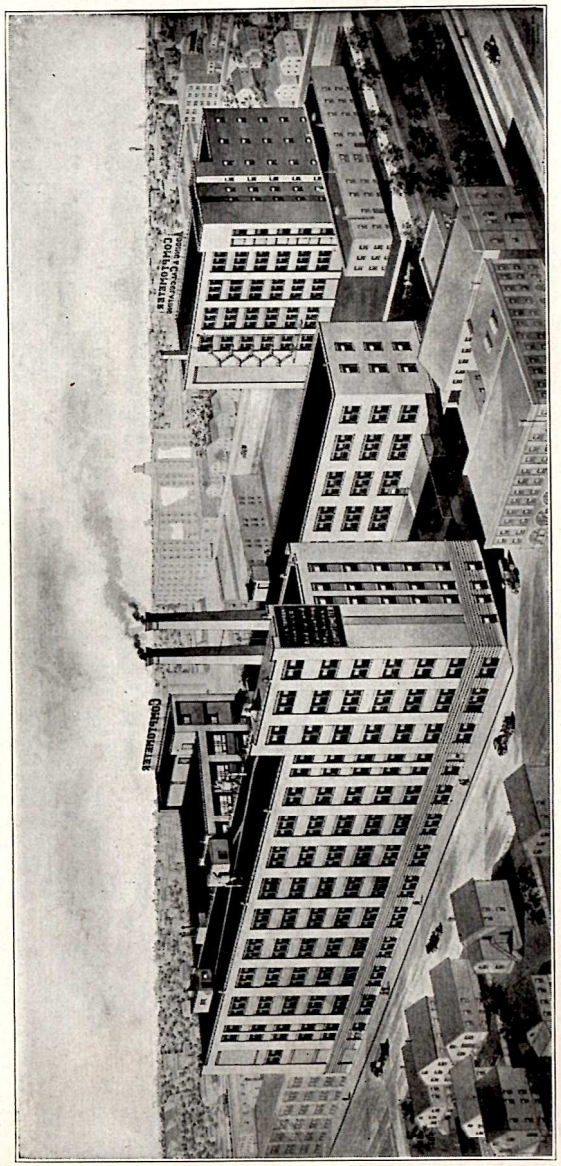
Methods of Operating

the

COMPTOMETER

TRADE MARK

FELT & TARRANT MFG. CO.
CHICAGO, U. S. A.



Factories devoted exclusively to the manufacture of the Comptometer

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PRICE OF THIS BOOK, $5.00

PREFACE

Anyone familiar with the meaning of common arithmetical terms can quickly learn to operate the Comptometer on all classes of business figure work. The operation is extremely simple because there are no handles to pull, no cranks to turn, in fact nothing to do but read the answer. Being a key-operated machine, like the typewriter, the volume of work which can be turned out is limited only by the skill of the operator.

One of the main reasons why business men universally prefer the Controlled-key Comptometer is because it is a four purpose machine capable of doing addition, multiplication, division and subtraction at a very high rate of speed. While an untrained operator will add and calculate as rapidly on the Comptometer as with any other machine, practice is necessary to take advantage of its unequaled speed. This is particularly true when adding by the touch method of operation, which permits of a speed-with-accuracy that has never been equaled by any other type of machine.

Anyone who has use for a Comptometer twenty minutes or more per day can easily become an accomplished operator in a short time. Speed comes with practice. The Comptometer has the capacity to receive the work as fast as the most expert operator can touch the keys.

No effort or expense has been spared to surround the Comptometer with all the protection necessary to enforce accuracy. An automatic safeguard known as the "Controlled-key" positively prevents the registering of an error caused from a partial or incomplete key depression. Thus an operator can breeze right along, feeling perfectly assured that if an error occurs she will be told of it immediately.

The "Clear-Signal" feature which eliminates the danger of forgetting to clear the machine before starting a new problem is another outstanding advantage found exclusively on the Comptometer.

A beginner who has reached the speed limit capacity of other machines, can, with a little practice, double his or her speed on the Comptometer, because of the ease and simplicity of operating, and the many safeguards which enforce accuracy.

The degree of accuracy which regular use of the Comptometer gives is well illustrated by the experience of a large department store in which the daily auditing room footings done by mental process did not balance with the cash in the case of ten to fifteen out of twenty-eight departments each day owing to errors in footing, and therefore had to be checked over and corrected each day.

A few months after the introduction of the Comptometer into this auditing room there was seldom a single day in a month when the footing in the auditing department did not, at the first time over, balance with the cash for every one of the twenty-eight departments. The use of the Comptometer reduced the errors in footing, and consequently the labor of checking up, to practically nothing, while reducing the time required for originally doing the work one-half.

Some not only do not practice long enough, but fail to obtain a correct understanding of the methods for operating, and therefore jump to the conclusion that it is not adapted to their particular work, when there are hundreds using it on precisely the same work at a large saving of time and trouble. We will be glad to write special instructions for any one who will send us a sample example in their principal work. This book is not intended to give the short cuts on the Comptometer, which can be employed on almost every kind of special work.

The Comptometer on the Bookkeeper's Desk

OILING INSTRUCTIONS

Unless a Comptometer is oiled regularly, one can not expect to get the best service out of it. The degree of wear is progressively greater the longer the machine is used unoiled.

It is to your own interest to see that your Comptometer is oiled regularly and with proper oil which will not gum. Much of the oil sold is utterly unfit because it contains traces of acids or substances which gum machinery of this kind, making it necessary to send the machine to the factory to have the gum boiled out. This is expensive. Where desired, we supply a pure, non-gumming oil. It is immaterial to us where you get your oil, so long as you get pure, non-gumming oil and oil the machine regularly.

To those who wish it, we supply a two-ounce bottle of absolutely pure, non-gumming and tested oil, made especially for the Comptometer. It comes carefully packed in mailing cases, containing one bottle each, or you can secure it by applying to any of our solicitors. The price is **35 cents a bottle,** postage paid.

No machine can be expected to wear well if it is not regularly and properly oiled

DIRECTIONS FOR OILING THE CONTROLLED-KEY CLEAR-SIGNAL COMPTOMETER

MODEL J

If the machine is used only once or twice a week, oil once every three months. If used regularly eight hours a day by a rapid operator, oil each Monday morning.

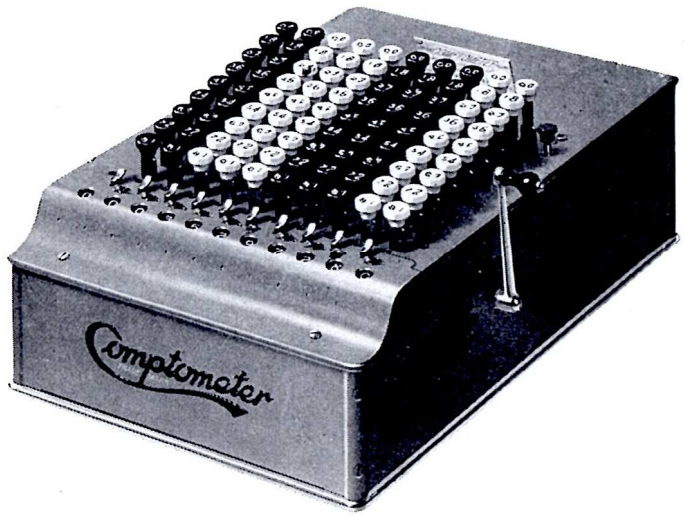
1. Set the machine with the back end toward you. Put one drop of oil on the back of each 9-key stem close up under the celluloid top. Do the same with each 8-key while holding down the 9-key in same column. Then each 7-key while holding down the 8-key in the same column. And so on with all keys.

2. Set the machine on a level desk and put three drops of oil in each oil hole back of the 9-keys.

3. Clear machine; strike 8-key in the units column. Put eight or ten drops of oil in the oil hole under the 1-key in that column; also in the oil hole in the face-plate between the units and tens columns below where the answer shows, after pressing back the spring that closes the oil hole. Operate the 9-key twenty or thirty times.

Clear machine. Set up 8 on the register in the tens column. Put eight or ten drops of oil in the hole under the 1-key in the tens column; then in the oil hole in the face-plate between the tens and hundreds column. Operate the 90-key twenty or thirty times. Repeat for each column.

4. Pull forward the zero crank and put three drops of oil in each hole on the right side of key plate near the front and work zero crank back and forth. Then with crank in normal or rearward position put another drop of oil in the rear one of the two holes.



CONTROLLED-KEY CLEAR-SIGNAL COMPTOMETER

MODEL J

SPECIAL DIRECTIONS FOR OPERATING MODEL J CONTROLLED-KEY DUPLEX COMPTOMETER

The Model J Comptometer embodies the best features of all previous models, to which have been added important improvements.

It has the duplex key-action, which permits the operating of two or more keys in separate columns at the same time, in unison or otherwise.

It has the Controlled-key device, which makes it proof against imperfect operation, whether due to carelessness or inexperience of the operator. Through the Controlled-key, means are provided for automatically locking all the other columns until the fault is corrected, when any key in any column is not completely depressed; also means to prevent starting any key down again, after starting on the up-stroke, until the up-stroke is completed.

In the Model J, **if a key is not given its full downward stroke,** the keys in all the other columns are immediately locked and the numeral wheel in the column where the error is made shows a figure in the answer register standing out of alignment in a direction nearer to the operator. He can tell which key was misoperated in that column by looking at the figure of the last item added in that column.

In case of such a misoperation **on addition,** if many numbers have already been added, correct the mistake by depressing clear down the key only partially depressed. Then depress the Correction-Key which stands close to the 9-key. Proceed with the

addition. Remember to touch the other keys in that item which remained unoperated before the mistake was made. Beginners, however, instead of trying to correct such a misoperation on addition as above explained, should cancel and start all over again, beginning with the first item to be added.

In case of such a misoperation on **multiplication or division,** cancel the machine, giving the canceling lever a complete stroke, thus unlocking the mechanism and setting everything back to normal.

If one or more keys are partially depressed at the same time, the error must be corrected in each misoperated column before the Correction-Key will unlock the machine and permit the operator to proceed.

If by accident the operator partially depresses a key in a certain column where no depression at all should have been made, he can nullify the effect of that partial depression by holding back the subtraction cut-off between that column and the next to the left and depress the 9-key in the misoperated column; then depress the Correction-Key and, still holding back the subtraction cut-off, strike the 1-key in the misoperated column. For example, if in adding a column you depress the **$5.00** key and at the same time, by an overlapping stroke, partially depress the **$50.00** key, all other columns of the keyboard except the one in which the partial depression occurred will instantly lock up. Then, to eliminate the result of the partial depression, proceed as follows: Push back the subtraction cut-off immediately to the left of the column in which the partial depression occurred, and, while holding it back, press the $90.00 key, touch the Correction-Key, then the **$10.00** key, and the machine will stand just as though this misoperation had not been made.

Remember, in adding, if you find a key cannot be depressed, it is either because you have only partially depressed one or more keys, or else you have not allowed one or more keys to come all the way up. In such a case the first thing to do is to lift your hands entirely from the keyboard, and then, if that key is still locked and you find no figure standing out of alignment in the answer register, cancel the machine and begin over again. If a figure does stand out of alignment, correct your misoperation as above explained.

WHEN THE "CONTROLLED-KEY" LOCKS THE MACHINE

When a Comptometer locks in adding, go back and complete the stroke on the **last key operated.**

1. If this key works, touch the red Correction-Key and continue the addition.

2. But if the **last key operated** is found locked, touch the Correction-Key and add in the **key used before the last.**

Example of Rule 1.

Intentionally press the 40-key part way down. The	.45
5-key is then locked. Go back and complete the stroke on	1.25
the 40-key, touch the Correction-Key and your correction is	.67
made. Complete the first item by striking the 5, and con-	.45
tinue the addition.	

Example of Rule 2.

In adding this column, intentionally press the 30-key part	.30
way down. Then give the 40-key a regular stroke. On attempt-	.45
ing to strike the 5-key you find it locked.	.56
To correct, go back to the **last key operated** (40) and you	2.80
will find it locked.	.47
Following the rule, touch the Correction-Key and add in	3.20
the **key before the last** (30).	
This completes the correction, and after adding in the 5,	
continue with the other items of the column.	

NOTE: If the **" key before the last "** is in the same column and is larger than the **" last key operated,"** cancel and re-add the column.

IN MULTIPLICATION AND DIVISION

When any key locks under the finger it is a positive danger signal of misoperation. Owing to the speed of the Comptometer, it is simpler and faster to cancel the machine and go over the problem than to stop and make the correction. The positive danger-signal prevents an error slipping into the answer without the knowledge of the operator.

THE NEW OPERATING FEATURES OF MODEL J COMPTOMETER

Several new features have been incorporated in the new Model J that greatly increase the freedom of operation. The most noticeable of these are represented in the canceling or zeroizing means provided and the increased snappiness of the keystroke.

The canceling or zero lever has been carefully placed and the stroke so shortened that the operator may clear the machine without removing the hand from the keyboard.

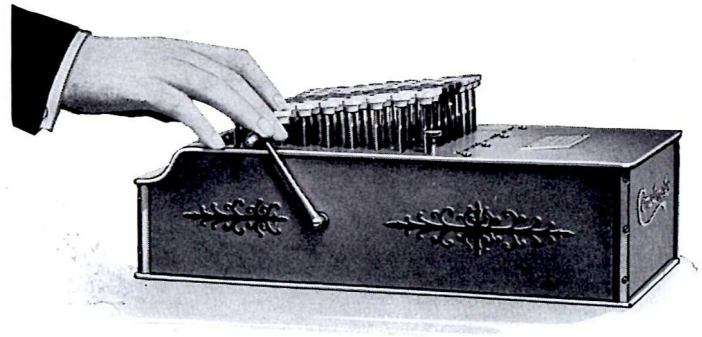
Special, visible, audible and sense of touch means have been provided to signal the operator that the machine is clear, without the usual method of looking through each of the openings for the cipher.

The cleared condition of the register leaves no figure or cipher centered in the sight holes; in other words, when in cleared position the zeros or ciphers of the register are partially eclipsed — only half advanced in the register. The advantage of this feature is that its variation from the usual registration serves at a glance as a visible signal to the operator that the machine is clear without examining each opening or pulling the canceling crank to make sure.

Again the cleared condition of the machine also provides means by which the audible signal is given when the operator makes the first keystroke. The signal consists of the ringing of a small bell, notifying the operator that the machine was cleared. This feature will be recognized by all operators as a great advantage. The sound of the bell is especially designed to be low so as not to become a nuisance to others in the room.

Another signal which serves to assure the operator that the machine was cleared is the fact that the first keystroke after clearing is noticeably harder than normal, but not enough to be objectionable. The absence of any one of these signaling features is proof to the operator before operation has advanced beyond the first keystroke, that the machine has not been cleared.

In former models the reverse key-action locks were purposely thrown out of action on account of movement of the parts they co-operated with, but in the Model J the new form of canceling or clearing the machine allows the reverse key lock to remain at normal, which is a locked position. The advantage of this will be found in the signal that it offers to the operator that a full lever stroke has not been made in clearing or canceling, as the keys will all be locked against depression.



Clearing the Register of Model J

HOW TO CLEAR THE REGISTER

To cancel or clear the register so that it shows zeros only: With the second and third fingers of the right hand, pull or flip towards you, as far as it will go, the lever on the right side of the machine. After the lever stroke is completed, let the fingers slip off the handle so it will fly back.

Clear-Register Signals

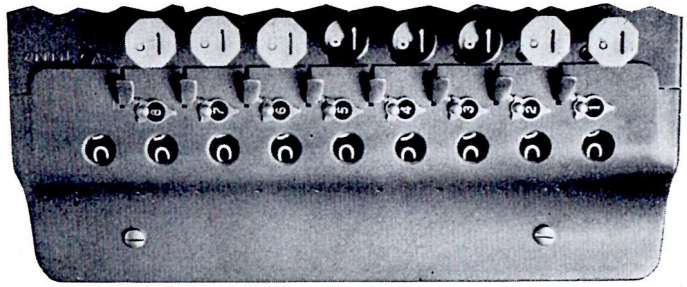
When the machine is canceled you will note that:

1st. Only tops of ciphers show in the answer holes of the register.

2nd. First key struck gives added resistance.

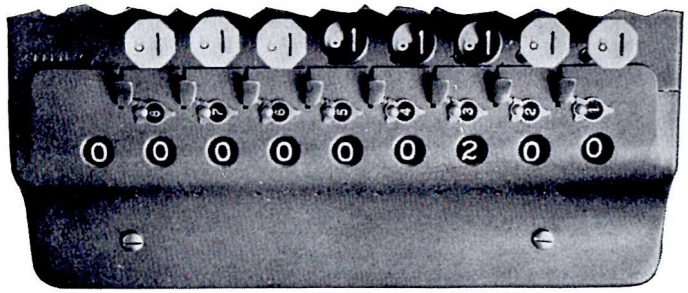
3rd. Bell rings on depression of first key.

These signals apply regardless of whether the failure to cancel is due to neglect or misoperation.



The Register Canceled.

The above is the way the register shows after canceling. When the register is canceled, only the tops of the zeros show.



The Register after Canceling and Adding 200.

With the register canceled as shown at the top of page, the machine is ready to begin a new addition or calculation. Then, when the first key is depressed—as 2 in the hundreds column of above illustration—all the figures become aligned centrally and the bell rings, signifying that the operator starts with a clear register. The first key-stroke being slightly heavier than normal, because it also operates the bell ringing mechanism, serves as an additional notification that the register was canceled.

METHODS OF USING THE DUPLEX COMPTOMETER

Do not attempt complicated examples, such as interest, exchange, square root, etc., until thoroughly familiar with handling the keys in the operations of addition, multiplication, subtraction, and division.

Always depress each key clear down with a full, light, quick stroke in both directions.

For Controlled-key Duplex Comptometer, see special directions, page IX.

Explanation of the Keyboard

It will be observed that there are two figures on each key, a large one and a small one. The large figures indicate the keys to be struck in addition and multiplication, and the small figures, those to be struck in division and subtraction.

The large figures on the keys indicate their power to add and will hereafter be called the "digits." The small figures on the keys are used only in operations of a negative character, like Subtraction, Division, Square Root, etc., and will be called the "co-digits."

The small figure on each key is the co-digit of the large one on the same key, i. e., that figure which added to the large one will equal **9.**

In the following rules and explanations those keys running in a line up and down are called a column, and those running in a line from left to right are called a row. Thus all the keys which bear the digit **4** stand in a row and are called the row of **4**s.

In explaining the keyboard for addition and multiplication, the keys are called by the digits on their tops. Beginning at the right of the machine, the first column running from **1** to **9** represents units; the second column, tens; the third, hundreds; the fourth, thousands, etc. Thus the **7** key in the fifth column indicates **70,000,** and the **3** key in the second column indicates **30;** therefore, to strike **467** on the machine, depress the **4** key in the third column, the **6** key in the second column, and the **7** key in the first or units column; **467** will then be indicated on the register of the machine. This number being left on the register and some other being struck, as, for example, **3261,** the register will show the sum of the two numbers; in this case, **3728.**

ADDITION

For Controlled-key Duplex Comptometer, see special directions, page IX

Many users of the Comptometer, after several months' practice, become so familiar with the keyboard that they do not look at the keys at all when adding. Therefore we make the tops of every other row of keys concave so that one can instantly tell by the feeling which row he is striking. It requires considerable practice to acquire sufficient skill to enable one to use the Comptometer rapidly on addition. It is not to *know how*, but it is to acquire *skill of the fingers*, which requires practice. In this respect it is precisely like the typewriter.

It is possible to begin by not looking at the keys at all, and this is the best method for acquiring accuracy and a high degree of speed in a comparatively short time, but under the conditions of ordinary office work one can not always spare the time at first for such practice, but must look at the keys so as to get out his work while learning.

It requires more practice to perform addition rapidly than it does to do any other class of examples. Doing actual work is the only practice that makes a good operator. But as addition constitutes the bulk of mathematical work, the Comptometer is used for addition more than for anything else. Do not imagine that you can estimate what you will be able to do after more practice, when you have only practiced ten days, for at that time you will just be beginning to learn how to use the machine, although you may think yourself quite an operator.

To perform addition, it is necessary merely to strike each number on the machine and the total will be indicated on the register.

A beginner should start touching the keys one at a time, always being sure to put all the keys clear down and to always let all the keys clear up. The Controlled-key Duplex Comptometer will lock up if you misoperate it by not pushing the keys clear down or do not let them clear up. **See special directions for Controlled-key Duplex Comptometer, page IX.**

ADDITION

Sight Method

Use only the first and second fingers. First, add the cents only, adding the tens with the first finger and the units with the second finger. Leave the

POSITION OF HANDS FOR ADDITION

Always begin at the top of the column and add downward, keeping the index finger of the left hand where it points to the next item to be added.

total of the cents in the answer register, then add the dollars, **adding both hundreds and tens with the first finger** and the units with the second finger.

Remember to push each key down until you feel it strike bottom. This push stroke differs distinctly from the sharp staccato blow of the typewriter and requires some practice to perfect it. It is the easiest known stroke on the finger, since the blow of hitting the key is done away with. This method of operating insures accuracy in the beginning and ultimately develops high speed after the first few days; therefore, it is best to go slowly, memorizing the keyboard and acquiring the stroke. Speed will come later.

Where each item must be added in full, as in making cross additions, adding slips, checks and scattered items not in columnar form, add all figures with the first finger except the right-hand figure, which should be added with the second finger.

In adding columns write down each total obtained and prove at once by re-adding the column.

ADDITION

Touch Method

The touch method is advised for the operator who uses the Comptometer for an hour a day or more and wishes to become a highly efficient operator. It is just as simple as the sight method but admits of almost unlimited speed. A large part of the time spent in operating an ordinary adding machine is lost in looking from the work to the keyboard. The easiest method to operate the Comptometer entirely by touch is to use only the lower half of the keyboard. Thus, every key to be operated is within easy reach of the fingers, with but slight movement of the hand up and down the keyboard.

Rule:

In beginning, place a blotter between the rows of **5** and **6** keys.

To add **9,** strike **4** and **5**	To add **8,** strike **4** twice
To add **7,** strike **3** and **4**	To add **6,** strike **3** twice

To make touch operating very simple, the odd keys **1, 3, 5,** etc., are made with cup-shaped tops and the even keys **2, 4,** etc., with flat tops. With this in mind, add the following columns, beginning at the top of each column and adding down. Use the first finger for adding in the tens column only and the second finger for adding in the units column only. (Keep each finger on its own column.) Find the keys by feeling, as much as possible.

MULTIPLICATION

For Controlled-key Duplex Comptometer, see special directions, page IX

In multiplication the first thing is to acquire the habit of rapidly giving the keys the proper stroke a number of times in succession. Therefore practice for fifteen minutes the following finger exercises:

Place the second finger of the right hand on the **7** key and strike four times; move to the **70** key and strike it four times, and continue clear across the machine, striking each **7** key four times. *Let the finger rise quickly off the key one-half inch each stroke,* not much more or less. Strike them just as rapidly as possible, always giving a full stroke. After practicing on the **7** keys for a few minutes, take the **5** keys, then the **9** keys, then the **2** keys. Then begin on the **7** keys again and strike the first one six times, the next four times, the next one six times, the next one four times, and so on across the row. Do this on some of the other rows.

Then practice on **77,** using one finger (the index finger) of each hand, and depressing both at once in rapid succession six times, moving one column to the left after each six strokes, then practice on **67, 98, 72, 84, 69,** and **23,** the same way.

Then practice, with two fingers of the right hand, on **77, 68, 22, 45, 89** and **505,** putting both keys down simultaneously in rapid succession five times in each column, taking care to depress each one clear down.

It is always better to use two fingers of one hand rather than one finger of each hand when handling two keys at once, provided the keys are conveniently located for handling both at once, because it leaves the other hand free to point the work.

Then practice on **66, 65, 302, 76** and **505,** with two fingers of the left hand, striking both together five times in each column.

Then practice on **3267,** using two fingers of each hand and striking all together.

Then practice on **3627,** using two fingers of the left hand for the **3020** and the fingers of the right hand for **607,** striking all together in rapid succession four times on each column, working from the right clear across the machine.

In Multiplying keep the eyes on the paper and not on the machine. By keeping the eyes on the paper the accuracy and rapidity of the work will be increased very much. It is advisable to glance at the keys each time when one starts on a new row, but not when moving from one key to another in the same row.

2053 x 8

MULTIPLICATION

MULTIPLICATION

Its simplicity as done on the Comptometer illustrated by rules and diagrams

Rule for a One-Place Multiplier

Begin at the right of the row of keys indicated by the figure of the multiplier, and strike each successive key in the same row towards the left as many times as indicated by the corresponding figure in the multiplicand.

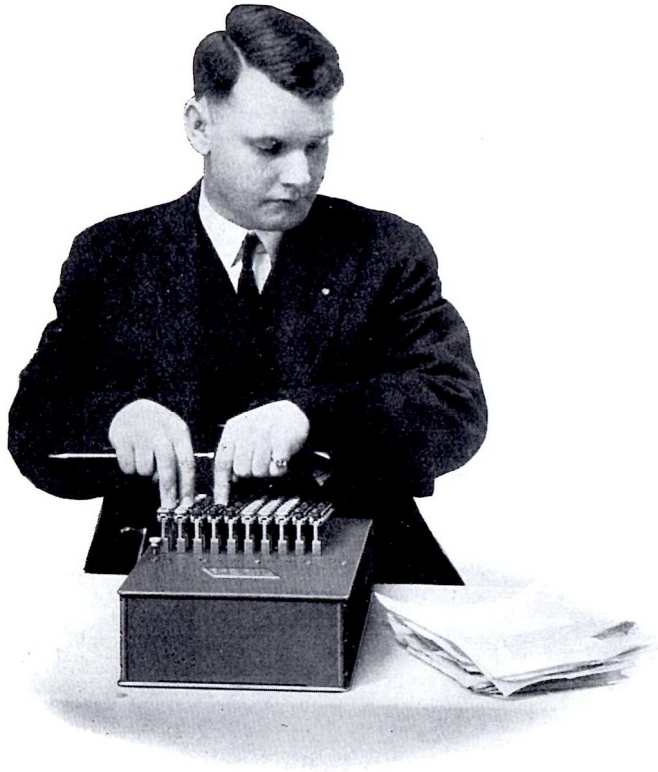
Explanation of Diagram

For Controlled-key Duplex Comptometer, see special directions, page IX

See black lines descending from arrow on cut. Each line represents a stroke on the key in performing the following example: **Example—2053×8.** **8** being the figure of the multiplier, begin on the first key of the row of **8s** and strike the first one three times, the second one five times, the third one being **0**, skip it, and strike the fourth one two times—that is, strike each key in succession the number of times indicated by the corresponding figure of the multiplicand **(2053)**, when the answer, **16,424,** is shown on the register in front. (See cut.)

Observe that in multiplying the finger only moves from one key to its next neighbor, therefore, keep the eyes on the paper, not on the keys.

NOTE.—Study the finger exercises on page **5** and position of hands on page **8.**



POSITION OF HANDS FOR MULTIPLICATION

Noting the figures of the multiplier, place the fingers on the proper key or keys and then, keeping the eyes on the paper, without even glancing at the machine, strike each succeeding key, as explained in the rules and diagram.

Rule for a Two-Place Multiplier

Place one finger of each hand on the keys which represent the multiplier. Strike both keys together the number of times indicated by the units figure of the multiplicand. Move one column to the left with each hand and strike the number of times indicated by the second figure of the multiplicand. Continue in the same manner until all the figures of the multiplicand have been registered.

Example: 2743×46. Place the index finger of the left hand on the **4** key in the tens column and the *second* finger of the right hand on the **6** key of the units column. Strike three times, move one place to the left with each hand and strike four times, then strike seven times one place farther to the left, and move once more and strike two times, when the answer, **126,178,** will appear on the register.

Both keys of an example like this may be carried by two fingers of one hand, but it is better to use one finger of each hand as explained above. See cut on page 8 for position of pencil and fingers.

For Larger Multipliers

For a three-place multiplier, if the keys which represent it are conveniently located, carry the hundreds figure with the first finger of the left hand and the other two with two fingers of the right hand.

Considerable time can with profit be devoted to the finger exercises on **page 5, because several fingers are used together a great deal, especially in** division and multiplication. In practicing this method strike rapidly, do not be too cautious, and you will soon acquire the right stroke.

Where the sum to be multiplied stands on the register of the machine, and the multiplier is not greater than **9,** to avoid taking it off, it can be conveniently multiplied by using the number one less than the multiplier. For example: We are required to obtain **4263×64×8.** After multiplying **4263** by **64,** as illustrated above, **272,832** appears on the register as the result. To multiply this amount by **8,** without turning the machine to naught, take the row of keys next lower than **8** (the **7**s) and beginning at the left of the multiplicand over the hundreds of thousands, strike twice, as **2** is in that order on the register; then moving to the right one column, strike seven times, as **7** is in that order; two times in the next order to the right, as **2** is in that order,

etc., until all the keys have been struck as many times as the corresponding figures on the register indicate. The product, **2,182,656,** will then appear on the register.

Where the multiplier consists of two figures and the multiplicand is already on the machine, deduct one from the multiplier and then proceed to strike it on the keys by striking each figure of the multiplier simultaneously (using one finger of each hand), and working from the left of the multiplicand just the same as in the example illustrated above.

Where one factor is on the machine and the other consists of three or more figures, the following method will be found advantageous.

WHERE THE AMOUNT TO BE MULTIPLIED STANDS ON THE REGISTER

With three or more numbers to be multiplied together, like **465x138x325,** you should multiply **465x138** on the right of the machine, leaving your result **64170** on the register. As **64170** is in the register once, you want it only **324** more times, so you hold **324** with the **4** over the left-hand figure (**6**) of the **64170.** Strike here the number of times indicated—six. Move to the right one column and strike the number of times indicated—four. Move one more column to the right and strike once. Move one more column to the right and strike seven times, and the answer is **20,855,250.** As you move from left to right, the figure in the answer register under the **4**-key on which your finger is shows the number of times the **324** should be struck.

Example: Multiply 45x267x457.

45x267=12015 (Let this result stand on the register).

457 minus one, equals **456.**

Holding **456** with the right-hand figure (**6**) over the left-hand figure (**1**) of **12015,** strike successively toward the right **1, 2, 0, 1** and **5** times. Answer, **5,490,855.**

MULTIPLYING HIGH DECIMALS

In multiplying examples in which high decimals occur it is desirable to reverse the system ot striking the keys and work from the *left to the right.* By doing so, examples which would otherwise be too large for an eight-column machine can be computed. Hold the multiplier with its left-hand figure on the left-hand column of the machine. Strike here as many times as is shown by the left-hand figure of your multiplicand, and then move one column to the right, etc. Point off as many register holes from the left as the sum of the whole places in the multiplicand and multiplier.

Example: Multiply 12.345x4.356

Hold **4356** with the **4** on the left-hand column of the machine and in this position strike once—move each finger one column to the right and strike two

times; one more column to the right and strike three times—then four times, then five times. The result as it stands on the register is **053774820.** There are two whole places in **12.345** and one in **4.356,** making together three register holes to point off from the left of the machine, and your answer is **53.77482.**

Where high decimals are used and the keys are struck *from the left,* point off as many *holes* from the left as there are places to the left of the points in the multiplicand *and* multiplier. There is one hole to the left of the highest column of keys, therefore, with the product of **2.487634×3.24692** we would have **08.07+** and with the product of **8.76342×6.76342** we would have **59.27+.**

ACCUMULATIVE MULTIPLICATION

By Permanent Decimal Point Method (With Fractions and Decimals)

Accumulated multiplication is used in hundreds of commercial houses for the proving of both incoming and outgoing bills. In billing we find decimals in both quantity and price, and to be able to accumulate these decimal multiplications, use the following rule:

In most cases hold the price, and it is easy to remember that in the first position the sixth white column of keys is units of dollars and the fifth and fourth (green or black) columns are cents.

Example: **4¾ (4.75) yards at $1.25**
16½ (16.5) yards at .34½
148¼ (148.25) yards at .06¼

Accumulated Product $20.895

Hold the price **$1.25** with the **1** in the sixth (white) column, and the **2** in the fifth (green or black) column and the **5** in the fourth (green or black) column. Multiply toward the right; strike four times, seven times and five times, and the answer shows **$5.9375.** Leave it on the register.

Then hold **34½c** with the **3** in the fifth, **4** in the fourth, and **5** in the third. As the yardage commences not in the units but in the tens column, move one column to the left before commencing the multiplication, then strike from left toward the right, one time, six times and five times, and the accumulation is **$11.63.** Leave this on the register.

Then hold **6¼c** or **625** with the **6** in the fourth (green or black) column. As the quantity **148¼** begins, not in its units but its hundreds, you should move two columns to the left before commencing to multiply. Starting here, strike successively one time, four times, eight times, two times and five times. If at any time any of your fingers run off the keyboard on the right, strike with fingers which still remain on keyboard. Your accumulated answer appears **$20.895.**

THE CO-DIGITS

Directions for using the Co-digits. The small figures on the keys are the "co-digits" of the large ones, which are the "digits." Hereafter we will call the small figures on the keys simply the "co-digits." In performing division or subtraction, both the digits and the co-digits on the keys are used to indicate the keys to be struck.

The arithmetical principle on which the use of the co-digits is based is explained in the appendix, but a knowledge of this principle is not necessary to the operator.

When a number is to be touched on the keys according to the co-digits we call it striking it "*negatively*." When a number is to be struck according to the digits on the keys we call it striking it "*positively*." When it is not specified whether a number is to be struck either according to the digits or the co-digits, it is to be understood that it is to be struck according to the digits; i. e., as in addition.

When striking a number according to the co-digits, always strike for the extreme right-hand figure a co-digit which is one less than that right-hand figure, unless the extreme right-hand figure is a cipher, in which case, strike a co-digit which is one less for the first right-hand figure which is not a cipher.

Thus, in using the co-digits we would

	Thousands	Hundreds	Tens	Units
for.....			3	600
strike.....			3	5
for.....			1	27
strike.....			1	26
for.....			3	47
strike.....			3	46
for.....	4	6	2	0
strike.....	4	6	1	

When a number to be struck according to the co-digits has a cipher or ciphers on the right, such ciphers must be disregarded in striking the keys, as illustrated above, but when ciphers occur to the left of or between other figures they must be struck the same as other figures.

Thus, in using the co-digits we would

	Thousands	Hundreds	Tens	Units
for.....		7	0	40
strike.....		7	0	3
for.....	4	6	0	05
strike.....	4	6	0	04
for.....			3	041
strike.....			3	040

Note that in this last couplet the extreme right-hand figure is **1**, which requires the touching of the co-digit **0** on the extreme right. It will be observed that there are no **0**s among the digits and no **9**s among the co-digits on the keys. This is because **9** is the co-digit of **0**. Whenever the figure **9** occurs in a number to be struck according to the co-digits, it is to be disregarded the same as **0** would be among the digits, and not struck at all, unless the **9** among the co-digits be the right-hand figure, when, of course, it would become a co-digit **8** on the keys.

Thus, in using the co-digits we would

	Thousands	Hundreds	Tens	Units
for.....		8	9	47
strike.....		8		46
for.....		1	6	95
strike.....		1	6	4
for.....			9	83
strike.....				82
for.....			3	79
strike.....			3	78

SUBTRACTION

*Extending out of the top of the machine, directly in front of the No. 1 keys, is a row of eight little levers, each of which is called a subtraction "cut-off." When a cut-off is pressed backward it prevents the carrying of the tens between the numeral wheels which it separates.

To perform subtraction, strike the minuend, according to the digits, on the keys. Then hold your left index finger straight out in front of you and slide it lightly over the cut-offs from the right towards the left until there is visible on the right of the index finger a number not less than the one to be subtracted.

Press in on the cut-off on which you then find your index finger and strike the number to be subtracted according to the co-digits on the keys. **Then release** the cut-off.

If there be more places exposed by the finger on the register than there be places in the number to be subtracted, touch the co-digit **0** in such column or columns.

In other words, a key must be touched in every column between the extreme right-hand figure and the finger except where **9** occurs.

Example: 1843 — 462.

After striking **1843** it appears on the register. Passing the left index finger from right to left over the register there becomes visible first **3**, then **43**, and then **843,** which latter number is greater than the one (**462**) to be subtracted. Pressing on the cut-off and touching **462** according to the co-digits, the answer **1381** appears on the register.

Thus the keys touched are:

Cut off

Digits..... 1843
Co-digits..... 461
Ans..... 1381

Example: 2143 — 642.

Cut off

Digits..... 2143
Co-digits..... 0641
Ans..... 1501

Example: 17036 — 85.

Cut off

Digits..... 17036
Co-digits..... 0084
Ans..... 16951

Example: 16474 — 2060.

Cut off

Digits..... 16474
Co-digits..... 205
Ans..... 14414

***NOTE.**—In the Model "A" Comptometer having the glass plate over the register, these subtraction "cut-offs" extend out of the front plate of the machine, just over the glass plate and just above and between each pair of Numeral wheels. On this model of Comptometer the left thumb instead of the left index finger is used to press in the cut-offs. In all other respects the above rules for subtraction apply to the Model "A" Comptometer also.

CORRECTING MISTAKES

For Controlled-key Duplex Comptometer see special directions, page IX

One seldom strikes a wrong key without noticing it before completing the stroke, and can immediately rectify the mistake by striking a key in the same column which is the same distance from the other end of the column while holding back the *proper* cut-off. Thus, if the **8** key in the thousands column is struck by mistake, it being the second key from the back end of the column, strike the second key from the front end of that column.

Thus, suppose that the **40** key has been struck by mistake. Positioning the left index finger over the register, immediately to the left of the second numeral wheel, suppose **8** is found on that numeral wheel. Press the cut-off and strike the fourth key from the back end of the column in which the mistake was made. This subtracts out the key wrongly struck.

If in the illustration just made a smaller number than **4** had shown on the second numeral wheel, the index finger would need to be moved to the left far enough to expose on the register an amount not less than **40.** Thus, if after striking **40** by mistake the second numeral wheel had shown a **3,** slide the index finger to the left, and then if the next numeral wheel shows **2** (making **23** to subtract the **4** from), press the cut-off and strike the fourth key from the other end of the column and also the co-digit **0** in the next column to the left.

If several keys are struck by mistake, simply subtract the amount which they represent and proceed as though no mistake had been made. Thus: Suppose **1783** had been struck, strike **1782** on the co-digits in the same columns while holding back the proper cut-off, and the amount on the register will be the same as though no mistake had been made.

The Controlled-key Duplex Comptometer has special features compelling the operator to correct the misoperation of not pushing any key clear down or of not letting it clear up. See special directions, page **IX.**

DIVISION

For Controlled-key Duplex Comptometer, see special directions, page IX

It is useless to attempt division until thoroughly familiar with the use of the co-digits on the keys. Practice on the two-finger exercises, page 5, is also necessary before division can be learned.

Rules for Division Illustrated by Diagrams

Rule.—Strike the number to be divided according to the digits on the keys.

Then place the fingers on the keys for the divisor according to the co-digits in those columns embracing on the left of the dividend the least number of places which, by themselves, represent an amount as large or larger than the divisor and strike the keys repeatedly until the *number of strokes* agrees with the *figure in the next column* to the left of that on which the keys are being struck, and then continue striking until those columns of the register in which the keys are being struck represent an amount less than the divisor; * after which the left-hand figure on the register is the first quotient figure.

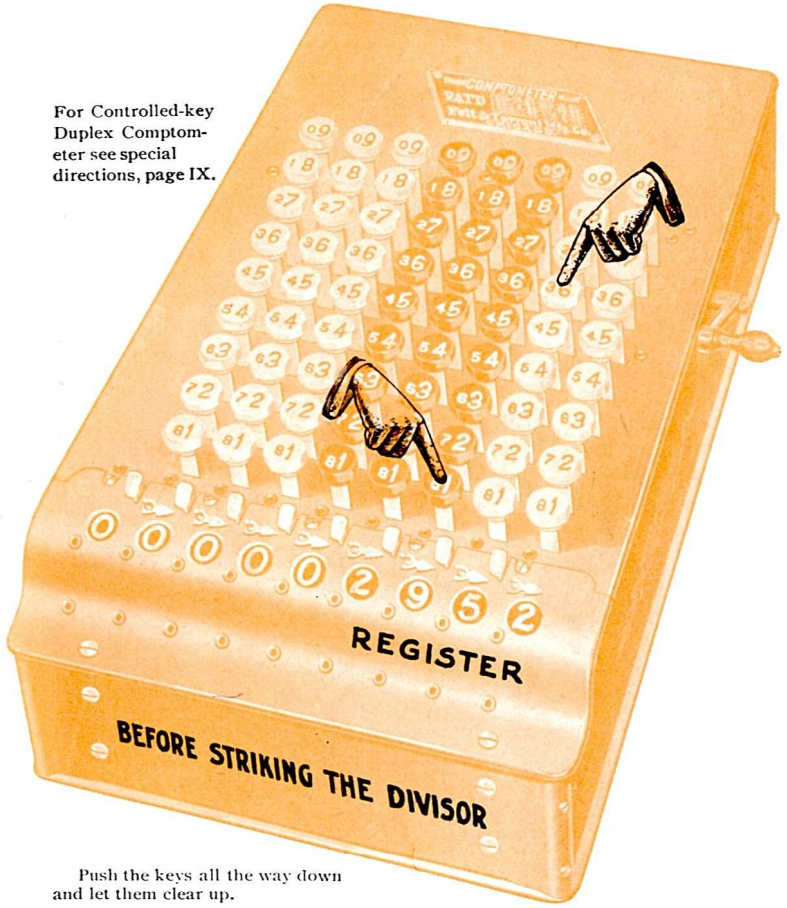
Then move the fingers one column to the right and proceed to find the second quotient figure in the same manner and so on until all the quotient figures have been obtained.

Point off from the right as many places as there are places in the divisor, when the figures at the left will be the quotient and those at the right the remainder.

*It is obvious that if **0** be in the next column to the left, you strike only to reduce those columns of the register in which the keys are being struck to an amount less than the divisor.

NOTE.—Do not worry about why the above process brings the answer. Consider it simply an arbitrary rule, by which any and all examples in division can be computed on the Comptometer. Once learned, the method is so simple that it cannot be forgotten. All there is to it is that you strike the divisor on the keys just as many times as indicated by the figure in the "next place to the left in the register" and then if the remainder is larger than the divisor strike the keys again one or more times until the remainder becomes smaller than the divisor. Eight strokes, *all on four different keys*, perform the following example, to do which requires only five seconds. There is no guessing how many times the divisor is contained as when computing mentally, for on the Comptometer every step is positive and assured. The machine tells you how many times to strike the keys, and after you have struck them it tells you what the answer is.

For Controlled-key Duplex Comptometer see special directions, page IX.



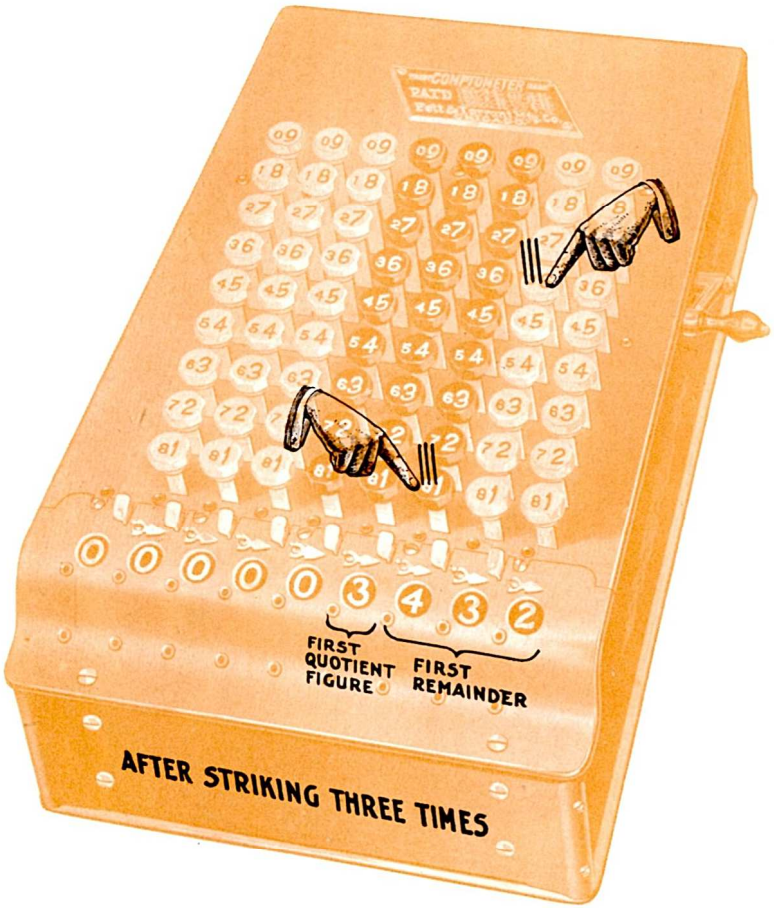
Push the keys all the way down and let them clear up.

Example: 2952 ÷ 84.

First strike the number to be divided (**2952**) according to the digits on the keys, which will cause it to show in the register as above.

The divisor is always struck according to the co-digits on the key tops. *Therefore, we place our fingers on the *small* **8** and on the *small* **3** over the units and tens of **295** in the register as shown above, because the two left-hand figures on the register (**29**) represent an amount smaller than the divisor (**84**), otherwise we would place the fingers on keys small **8** and small **3** over the **29.**

*See pages 12 and 13.



Having the fingers on the keys, as shown above and explained under preceding cut, we strike them both together twice, *because* **2** stands in the next column in the register to the left of the column of keys on which the fingers are placed (see register fourth column preceding cut), but after striking the keys twice **3** appears (as shown by above cut) where the **2** was (preceding cut) so strike once more, making three times, because in dividing the keys must always be struck repeatedly until the number of strokes on the keys agrees with the figure showing in the next column to the left in the register.†

After striking the keys three times, for the reasons specified, we have **3** as our first quotient figure and **43** as our first remainder, as shown above.

†See page 20.

Having obtained the first quotient figure, we now move our fingers one column to the right (as shown above) and find the second quotient figure in the same manner that the first one (**3**) was found.

Because in the register **4** shows (see register third column preceding cut) next column to the left of those on which the fingers now rest, strike four times, after which we have a remainder of **96.** Therefore, strike again because the remainder (**96**) is larger than the divisor (**84**), after which **5** shows as the second quotient figure and **12** as the remainder, as shown above.

Point off from the right two places because you have two places in the divisor, and the final answer, **35+12,** shows on the register.

†In other words, the figure in the register first column to the left of the keys being struck always *tells* how many times to strike the keys.

If, in the case illustrated on page **18** the figure in the fourth column of the register had been **5** instead of **3** we would have struck the keys five times instead of three times. Generally, after you start striking the keys the "next figure to the left" will change, but always keep right on striking the keys until the number of strokes on the keys agrees with it. It never changes so as to require more than nine strokes on the keys.

It is obvious that where there are ciphers on the extreme right of the divisor they are disregarded except in pointing off for the remainder.

Thus, if the divisor be **4,700,** divide just the same as though it was **47** and stop dividing as soon as the quotient figure in the fifth place from the right in the register is obtained, and point off four places. That is, do not strike any keys for the divisor on the two right-hand columns of the machine.

The figure in the next column to the left is always a check on the accuracy of the work. If you have struck the keys five times and the figure in the next column to the left is **4**, you have struck them once too much, so push back the cut-off immediately to the right of the **4** and *add* in the divisor once immediately to the right of the **4.**

In using large divisors, especially where high decimals are used, set the numbers to be divided on the left of the machine so that the quotient can be carried out decimally if desired.

Where either the divisor or dividend, or both, are decimals, set the dividend on the left of the machine, and if there be *one more* place to the left of the point in the dividend than there are to the left of the point in the divisor turn down the second pointer from the left of the machine: if *two more*, turn the third pointer, etc.; then proceed to divide and the decimal point in the quotient will be where the pointer is turned down. If there is one more place to the left of the point in the divisor than in the dividend, the decimal point in the quotient is to the left of the highest hole of the register.

If there be two more places to the left of the point in the divisor than in the dividend, the point in the quotient is one place to the left of the highest hole of the register, etc.

POSITION OF HANDS FOR DIVISION

In dividing keep the eyes on the register, not on the keys. There is no occasion to look at the keys after the fingers are once placed. After once understanding division and obtaining a little practice, strike the keys in rapid succession. Where one hesitates it is because of habit acquired in learning, not because of any necessity for proceeding carefully.

GRAPHIC DIVISION

It is useless to attempt division until thoroughly familiar with the use of the small figures on the keys. These small figures are called the "co-digits." (See page 12.)

Divide 63542 by 77

Strike the dividend **63542** in the machine on the left-hand side of the keyboard, according to the large figures on the keys.

Turn down the pointer on the machine two places to the left of the decimal point in **63542.** thus **635'42,** because there are two whole numbers in the divisor **77.**

The two-place divisor **77** is larger than the **63** represented by the first two figures on the left of the dividend. Therefore, place the fingers on co-digits **76** (the divisor **77** less **1**) over the units and tens of **635,** the first three figures of the dividend, as shown in above cut.

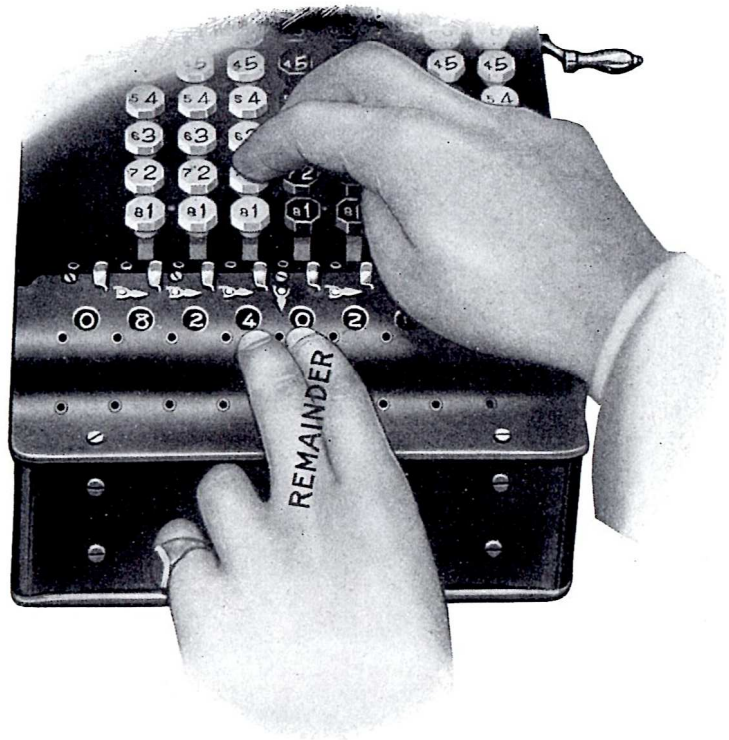
Press these keys representing the divisor repeatedly while counting the strokes out loud until the number of strokes made agrees with the figure standing in the register in the next column to the left of those on which the keys are being struck. See cut on opposite page where this figure is a "**6**" and is marked "Index."

Striking rapidly while counting "one," "two," "three," "four," "five," "six," we notice the **6** has now changed to a **7,** therefore, keep on striking and counting until on the seventh stroke the number of strokes made on the keys agrees with the next column to the left, as shown in above cut.

Leaving the fingers on the same keys and looking at the amount in the register in the columns on which the fingers rest, we note that the remainder now is **96.** As **96** is larger than the divisor **77,** strike the keys again.

This stroke on the keys reduces the remainder to **19,** which is smaller than the divisor. Were it still larger, we would continue to strike until the remainder became smaller than the divisor.

8 now becomes the first answer figure, and we move the fingers one column to the right as shown in above cut. Now we have **1** in the register hole immediately to the left of the columns on which fingers rest, so strike once,



and we now find that the figure in the register hole immediately to the left of columns on which fingers rest has changed to **2,** as shown in above cut. Therefore, strike another time. On the second stroke the number of strokes made on the keys (two) agrees with the figure **2** in the next column to the left, and we observe that our remainder, **40,** is less than the divisor **77.**

2 now becomes the second answer figure, therefore, we move the fingers on the keys one column farther to the right.

In this position the next figure in the column to the left of the keys on which the fingers rest is **4,** as shown in above cut. Therefore, we depress the divisor while counting out loud: "one," "two," "three," "four." As the four did not change to a five, or any higher figure, the number of strokes on the keys now agrees with the figure in the next column to the left of the fingers,

and the remainder **94,** as shown in cut above, being larger than the divisor **77,** we strike another time, which reduces the remainder to **17,** when **5** becomes the third answer figure and **17** the remainder.

The complete answer, **825,** with a remainder of **17,** now shows on the register.

In short, in all cases one strikes the keys until the number of strokes agrees with the figure in that place in the register next to the left of the columns in which the keys are being struck, and then continue to strike until the remainder in the register holes immediately below the keys which are being struck becomes less than the divisor. Then one moves the fingers one column to the right and does the same over again, and so on across the machine.

If one fixes these two points in his mind, division becomes as simple as A, B, C.

LONG DIVISION

FOUR-PLACE TRIAL DIVISOR METHOD

Easy Method for Dividing by Five or More Figures, Obtaining Three Answer Figures at a Time

Problem: **4567.89 ÷ 2436.65 =**

Rule.—Strike the **dividend 4567.89** into the machine, starting on the left side of the keyboard, and turn down decimal pointer to mark position of the **dividend** decimal point: Thus **04567'89.**

Then to mark the **answer** decimal point, turn down the pointer which is as many pointers to the left of the **dividend** decimal point as there are whole places in the divisor. Now turn up the **dividend** pointer and the register shows **0'456789.**

Divide by the first four figures of the divisor, **2436,** using small figures on the keys (not taking one less) and go on dividing until you get the **first three answer figures—187.** After getting the third answer figure, continue to hold the left-hand position on the two left-hand figures (**24**) of the divisor.

For the remaining unused figures* place fingers of right hand on small figures **64,** (**65** less one), in columns immediately to the right of the two columns held with the left hand. Meanwhile the left hand remains inactive in its position on the keyboard.

Depress keys held by the **right** hand the number of times indicated by the first answer figure (1) already obtained. Then **move** right hand one position to the right and strike **small figures 64** the number of times indicated by the second answer figure, (8). Again **move** right hand one position to the right and strike the number of times indicated by the third answer figure already obtained, (7). The register will now show **1'87113545.** With left hand still inactive on keyboard resume holding the first four figures of the divisor, the first two figures of which (24) are still being held by the left hand. With the right hand take position on small figures **36** on columns immediately to the right† of the left-hand position. Move finger position of both hands one place to right and divide again by **2436** to get the next three answer figures, in exactly the same way as the first three were obtained. It is not necessary to strike in the remaining figures of the divisor the second time as these figures would not effect the six-place answer, **1.87465.**

*If it is not convenient to hold at once with the right hand all the remaining unused figures of the divisor, then hold one or two of the remaining figures at a time.

†If the remainder in register under columns held should be equal to or greater than the divisor, depress complete divisor once more.

RULE WITH DIAGRAMS
FOR USING LARGE DIVISORS ON THE COMPTOMETER

TWO-PLACE TRIAL DIVISOR METHOD

The rule, illustrated on pages **16-21,** for computing division, applies to all examples, large or small, but where the divisor exceeds three or four places the following modification of the regular method is more convenient, because, by this modification, the fingers have to handle fewer keys at once.

It is useless for one to attempt to divide by this process until the process on pages **16-21** is thoroughly understood.

Rule.—Find a quotient figure by using the two left-hand figures of the divisor, and then, on the row of keys on which the "digit" (large figure) is the same as the quotient figure, strike, for each of the remaining figures of the divisor, as follows: Suppose a remaining divisor figure to be **6,** count "*six*, seven, eight," striking each time, which of course is three times altogether. Or, suppose the remaining divisor figure is **4,** count "*four*, five, six, seven, eight." Always start counting with the figure and stop at *eight*, except for the extreme right-hand figure which must be struck once extra.

NOTES.—If either of the two left-hand figures of the divisor be **9,** use the first three figures as a trial divisor, because that column in which **9** stands does not have to be struck at all.

If the keys for a divisor of less than three or four places are conveniently located for depressing all at one stroke, it is better to so use them. Otherwise, use as a trial divisor only two keys.

If any of the "remaining" figures of the divisor be **9,** of course no count of strokes is made for it unless it is the units figure (last figure) of the divisor, when one stroke is given.

If there be a naught (0) among the remaining figures of the divisor, count "*naught*, one, two, three," etc., just the same as for any figure.

In obtaining a quotient figure with the trial divisor it sometimes occurs that the remainder resulting from dividing by the trial divisor nearly equals the trial divisor, and that striking for the "remaining" figures of the divisor increases the remainder, until it becomes as great or greater than the trial divisor. In such cases strike the entire divisor on the keys according to the co-digits; this will increase the quotient figure and reduce the remainder.

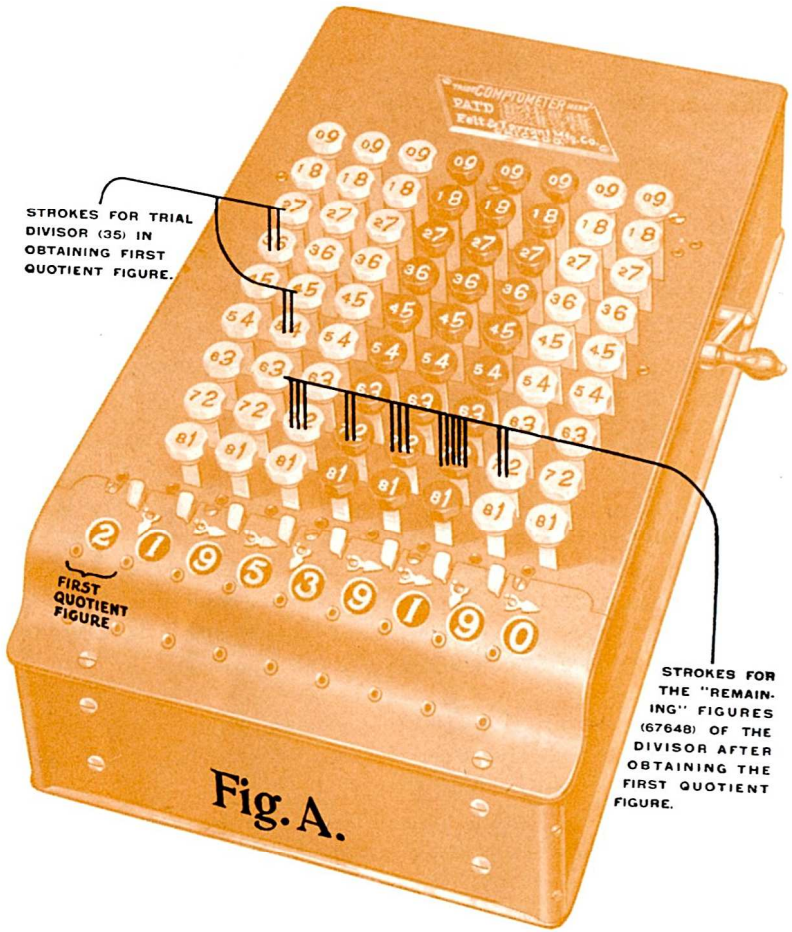


Fig. A.

Example:—90892150 ÷ 3567648.

Striking the dividend on the machine and then using **35** (on the co-digits but not one less) as a trial divisor, two strokes show that the first quotient figure is **2;** therefore leave the left-hand finger on the key to keep the place and move the right-hand finger one column to the right onto the *large* **2** key. The first of the remaining figures of the divisor (**67648**) being **6,** count thus: "*six*, seven, eight," striking the key each count; (the next "remaining" figure being **7**) move to the next **2** key, and count "*seven*, eight," striking each count; move one key to the right and count "*six*, seven, eight," striking each count; move one key to the right and count "*four*, five, six, seven, eight"; move one key to the right and count "eight," but this being the last figure strike one time more. **See Fig. A.**

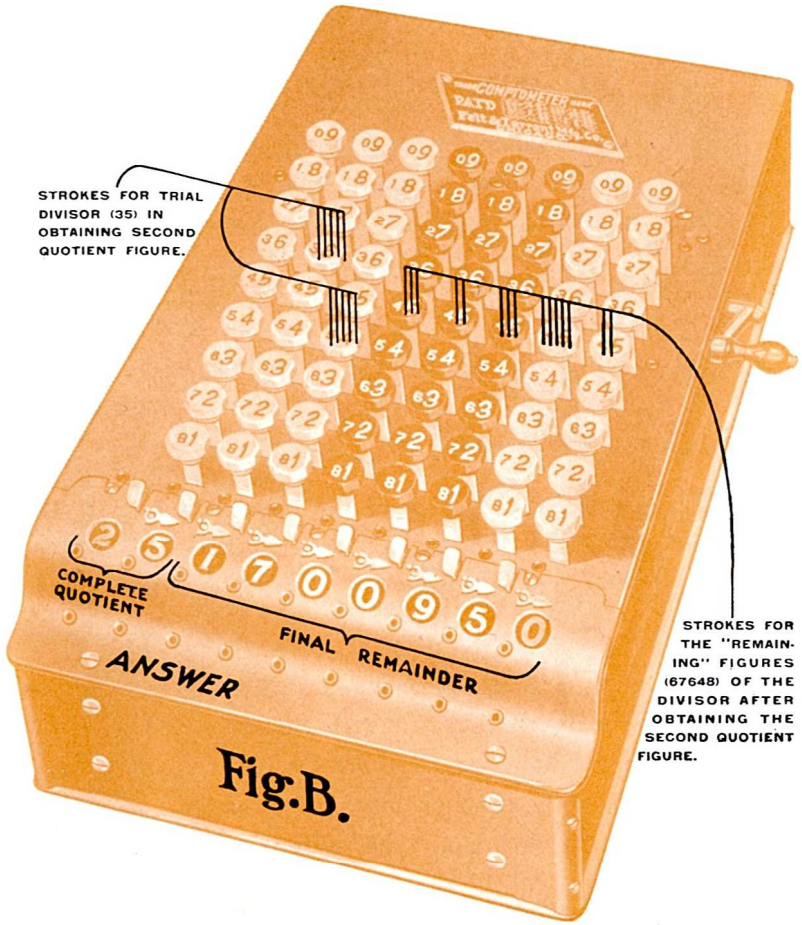


Fig.B.

Again using the two left-hand figures as a trial divisor we find that the second quotient figure is **5,** so put the right-hand finger on the large **5,** one column to the right and count "*six*, seven, eight"; move to the right and count "*seven*, eight," and so on for each of the remaining figures of the divisor; when pointing off we have **25 + 1700950. See Fig. B.**

It will be seen that, if desired, the quotient can be carried out decimally. To carry the quotient out decimally on an eight-column machine, one figure on the right of the divisor will be dropped as each decimal figure is obtained. But in the examples just illustrated this dropping of figures of the divisor will not make any difference in the answer until the fourth decimal place of the quotient is reached.

COMMON FRACTIONS

As in commercial computations common fractions very often occur, the most convenient method of multiplying a whole number by a fraction on the Comptometer is given below.

To Multiply a Whole Number by a Fraction. Multiply the whole number by the numerator first. As the product will then be indicated on the register, it can be divided by the denominator; and after pointing off the quotient, the remainder, if any, will constitute a new numerator.

Example: Find the value of **436** multiplied by 4/7. After multiplying **436** by **4, 1744** appears on the register. Now divide this amount by **7,** and **249** appears as quotient, and **1** as remainder. Ans. **249**1/7.

To Multiply a Whole Number by a Mixed Number. First multiply by the numerator of the mixed number, and then dividing by the denominator and leaving the result standing on the register, consider the units column of the quotient as the units column on the machine, and multiply by the integral part of the mixed number.

Thus, what is the product of **453** multiplied by **372** 5/16 ?

After multiplying by the numerator, **5, 2265** appears, which being divided by **16,** the denominator, **141** 9/16 is the result. As there are two places in the denominator, we ignore the first two columns of the machine and consider the third column as the units or first column, and multiplying by **372,** the result, **168,657** 9/16. appears on the register.

Squaring feet and inches by the Duodecimal Method

Example: **5** ft. **7** in. by **3** ft. **4** in.
To find sq. ft. and sq. in.

On the right-hand columns of the keyboard multiply the inches of one dimension by the inches of the other (**7** by **4**) and the register shows **28** sq. in.

To change **28** sq. in. to twelfths of a sq. ft., divide the **28** sq. in. by **12** and register shows **2** twelfths of a sq. ft. and **4** sq. in. over.

Add to the **2** twelfths of a sq. ft., by accumulative multiplication, the products of the feet of each dimension times the inches of the other (**5** by **4**) + (**7** by **3**) and register shows **43** twelfths and **4** sq. in.

To change **43** twelfths to sq. ft., divide the **43** by **12,** and register shows **3** sq. ft. **7** twelfths and **4** sq. in.

Add to the **3** sq. ft., by accumulative multiplication, the product of the feet of one dimension times the feet of the other, and register shows answer of **18** sq. ft. and **7** twelfths and **4** sq. in.

To change the twelfths and sq. in. all to sq. in., subtract the **7** twelfths out of the register, and add **7** times **12** to the **4** sq. in., giving an answer of **18** sq. ft. **88** sq. in.

Example: **37** ft. **5** in. by **19** ft. **11** in.
To find sq. ft. and sq. in.

On the right-hand columns of the keyboard multiply the inches of one dimension by the inches of the other (**11** by **5**) and the register shows **55** sq. in.

To change **55** sq. in. to twelfths of a sq. ft. divide the **55** sq. in. by **12** and register shows **4** twelfths of a sq. ft. and **7** sq. in. over.

Add to the **4** twelfths of a sq. ft., by accumulative multiplication, the products of the feet of each dimension times the inches of the other (**37** by **11**) + (**19** by **5**) and register shows **506** twelfths and **7** sq. in.

To change **506** twelfths to sq. ft., divide the **506** by **12,** and the register shows **42** sq. ft. **2** twelfths and **7** sq. in.

Add to the **42** sq. ft., by accumulative multiplication, the product of the feet of one dimension times the feet of the other (**37** by **19**) and the register shows answer of **745** sq. ft. **2** twelfths and **7** sq. in.

To change the twelfths and sq. in. all to sq. in., subtract the **2** twelfths out of the register, and add **2** times **12** to the **7** sq. in., giving an answer of **745** sq. ft. **31** sq. in.

BRITISH CURRENCY

Adding Pounds, Shillings and Pence.

To add English money on the Comptometer, the pence are added first, and when the bottom of the column is reached, a few strokes on the keys divide it by **12** and place the number of shillings thus found in the next higher column of the register, so that adding the columns of shillings up it will be included in the shillings, while the remainder of the pence will stand to the right. Then after adding up the shillings column and dividing the sum thus obtained by **20,** the pounds are added up and the entire sum total in pounds, shillings and pence is indicated on the register.

As each division is made the machine throws the quotient into the proper column, where it is included in the footing of the denomination to which it belongs. As compared to the mind, it saves even more time in adding pounds, shillings and pence than in adding ordinary numbers expressed by the decimal system.

Rule.—First add the pence on the two right-hand columns of the machine and divide by **12.** The quotient is shillings and the remainder pence. Leave this standing on the register; add up the shillings on the third and fourth columns of the machine. Divide the footing of the shillings by **20** (in doing which you do not touch the *three* right-hand columns of the keys). Then add the pounds on the fifth and higher columns of the machine, and the sum total in pounds, shillings and pence is indicated on the register; pence in the first and second columns of the register, shillings in the third and fourth columns of the register, and pounds in the fifth and higher columns of the register.

	£	s.	d.
Example:	178—	13—	3
	526—	9—	7
	3476—	6—	11
	216—	3—	2
	1276—	16—	4
	316—	19—	11
	124—	17—	3

Adding up the pence we have **41.** Placing our fingers on the keys (co-digits) **11** to divide by **12,** we find, after three strokes, that there are **3**s. and **5**d. Leaving this stand on the register and adding up the shillings on the third and fourth columns, the register indicates **86**s. **5**d.

Now divide the 86s. by 20 (co-digit 1 in the fourth column is the only key used in this case). Four strokes perform the division, when the register indicates £4 6s. 5d. Then adding the pounds on the fifth and higher columns the answer, £6116 6s. 5d., is shown by the register.

To Multiply an Amount in £ s. d. by a Whole Number

Place the fingers on the left-hand side of the keyboard on keys representing the whole number, and multiply towards the right by the number of Pounds.

Then continue the multiplication towards the right by the decimal equivalent of a Pound of the shillings and pence, which decimal is found by referring to the decimal table (Form 10) printed on Page 36.

Then determine the Pounds part of the answer by pointing off as many answer holes, counting from the left, as the sum of the whole places in the whole number and the Pounds.

Then on the decimal card (Form 10) find the decimal nearest in value to the decimal shown in the register, and then read its equivalent in shillings and pence.

Example: 245×£14 7s. **9**d.

Place the fingers on the extreme left side of the keyboard on keys **245.** Strike **1** time. Shift the fingers one position to the right and strike **4** times. **245** has now been multiplied by **£14.**

Shift the fingers one place to the right. Refer to the table for the decimal equivalent of **7**s. **9**d. Table shows **.3875,** so continue multiplying towards the right by **.3875,** and the register shows **035249375.**

The sum of the whole places in both factors is five, so point off from the left, five register holes, which makes the answer **£3524.9375.**

Refer to the table and the **.9375** is found to be equivalent to **18**s. **9**d., so the answer is **£3524 18**s. **9**d.

Decimal of a Pound Sterling for Each Shilling and Pence

	d.	Dec. of £		d.	Dec. of £		d.	Dec. of £		d.	Dec. of £
	1	.00416		1	.25416		1	.50416		1	.75416
	2	.00833		2	.25833		2	.50833		2	.75833
	3	.01250		3	.26250		3	.51250		3	.76250
	4	.01666		4	.26666		4	.51666		4	.76666
0s	5	.02083	**5s**	5	.27083	**10s**	5	.52083	**15s**	5	.77083
	6	02500		6	.27500		6	.52500		6	.77500
	7	.02916	.250	7	.27916	.50	7	.52916	.750	7	.77916
	8	.03333		8	.28333		8	.53333		8	.78333
	9	.03750		9	.28750		9	.53750		9	.78750
	10	.04166		10	.29166		10	.54166		10	.79166
	11	.04583		11	.29583		11	.54583		11	.79583
	1	.05416		1	30416		1	.55416		1	.80416
	2	.05833		2	.30833		2	.55833		2	.80833
	3	.06250		3	31250		3	.56250		3	.81250
	4	.06666		4	.31666		4	.56666		4	.81666
1s	5	.07083	**6s**	5	.32083	**11s**	5	.57083	**16s**	5	.82083
	6	07500		6	.32500		6	.57500		6	.82500
050	7	07916	.30	7	.32916	550	7	.57916	.80	7	.82916
	8	.08333		8	.33333		8	.58333		8	.83333
	9	.08750		9	.33750		9	.58750		9	.83750
	10	09166		10	34166		10	.59166		10	.84166
	11	09583		11	34583		11	.59583		11	.84583
	1	.10416		1	.35416		1	.60416		1	.85416
	2	10833		2	.35833		2	.60833		2	.85833
	3	11250		3	.36250		3	.61250		3	.86250
	4	11666		4	.36666		4	.61666		4	.86666
2s	5	.12083	**7s**	5	.37083	**12s**	5	.62083	**17s**	5	.87083
	6	.12500		6	.37500		6	.62500		6	.87500
10	7	.12916	.350	7	.37916	.60	7	.62916	.850	7	.87916
	8	.13333		8	.38333		8	63333		8	.88333
	9	.13750		9	.38750		9	.63750		9	.88750
	10	.14166		10	.39166		10	.64166		10	.89166
	11	.14583		11	.39583		11	.64583		11	.89583
	1	.15416		1	.40416		1	.65416		1	.90416
	2	.15833		2	.40833		2	.65833		2	.90833
	3	.16250		3	.41250		3	.66250		3	.91250
	4	.16666		4	.41666		4	.66666		4	.91666
3s	5	.17083	**8s**	5	.42083	**13s**	5	.67083	**18s**	5	.92083
	6	.17500		6	.42500		6	.67500		6	.92500
.150	7	.17916	.40	7	.42916	.650	7	.67916	.90	7	.92916
	8	.18333		8	.43333		8	.68333		8	.93333
	9	.18750		9	.43750		9	.68750		9	.93750
	10	.19166		10	.44166		10	.69166		10	.94166
	11	.19583		11	.44583		11	.69583		11	.94583
	1	.20416		1	.45416		1	.70416		1	.95416
	2	.20833		2	.45833		2	.70833		2	.95833
	3	.21250		3	.46250		3	.71250		3	.96250
	4	.21666		4	.46666		4	.71666		4	.96666
4s	5	.22083	**9s**	5	.47083	**14s**	5	.72083	**19s**	5	.97083
	6	.22500		6	.47500		6	.72500		6	.97500
.20	7	.22916	.450	7	.47916	.70	7	.72916	.950	7	.97916
	8	.23333		8	.48333		8	.73333		8	.98333
	9	.23750		9	.48750		9	.73750		9	.98750
	10	.24166		10	.49166		10	.74166		10	.99166
	11	.24583		11	.49583		11	.74583		11	.99583

If price contains ½d, add .002083 to above decimals.

Form 10. This table supplied in larger size on request.

Rule for Multiplying an Amount in Pounds, Shillings, Pence and a Fraction by a Whole Number and a Decimal

To multiply and point off use the method given for multiplying £ s. d. by a whole number, except of course hold all at once all the figures for both the whole number and the decimal, or else "split" it.

Example: £4 7s. 9¼d. × 43.6875.

The multiplication would be, from left to right, **4.3875 × 43.6875.** The **.3875** is the decimal part of a £ for **7**s. **9**d.

As it is inconvenient to hold all at once all the keys for **43.6875,** first hold keys **4368** on the four left-hand columns and multiply towards the right by **4.38750**—but there is also ¼d., the decimal equivalent of which is **.00104** of a £. Therefore in the **3**rd decimal position make **1** extra stroke and in the **5**th decimal position make **4** extra strokes—that is, after striking **7** times, in the **3**rd decimal position strike **1** extra time, then after striking **5** times in the **4**th decimal position move one place to the right and strike **4** times in the **5**th decimal position. The register now reads **191.69142+.**

Then, in the same manner multiply towards the right, holding **75,** the remaining figures of the multiplier, starting by holding the **7**-key in the **5**th column from the left. (The fingers may run off the keyboard at the right before all the decimal positions are multiplied, but even on an **8**-column Comptometer only a few thousandths of a pence are lost.)

Register now reads **191.7243+.** Refer to the table to get the nearest shilling and pence equivalent of **.7243,** and the answer is found to be **£191 14**s. **6**d.

Method for Multiplying an Amount in Shillings, Pence and a Fraction, by a Whole Number and a Fraction

Example: 2s.**7⅜**d.×**23¾.**

The **¾** in the number **23¾** is considered in the form of its decimal equivalent **.75.** On the left side of keyboard hold keys **23.75** and make **2** strokes for the **2**s. Then shift position one place to the right, and refer to decimal card entitled, "Pence and **16**ths of a Shilling" (Form 491) (See Page 38), which indicates that **7⅜**d. is **.614583** of a shilling. Continue the multiplication towards the right by the figures **.614583** and after pointing off **3** register holes from the left, because the sum of the whole numbers in the multiplier and multiplicand is three, the register shows **62.09634+.** Refer to the table for decimal closest in value to **.09634**d., and its equivalent is found to be **1 3/16**d., which makes the answer **62**s. **1 3/16**d.

Pence and Sixteenths of One Shilling

Quarters	d. / Sixteenths	0	1	2	3	4	5	6	7	8	9	10	11	
			.083333	.166667	.25	.333333	.416667	.5	.583333	.666667	.75	.833333	.916667	
1/8	1	.005208	.088542	.171875	.255208	.338542	.421875	.505208	.588542	.671875	.755208	.838542	.921875	1/8
	2	.010417	.09375	.177083	.260417	.34375	.427083	.510417	.59375	.677083	.760417	.84375	.927083	
	3	.015625	.098958	.182292	.265625	.348958	.432292	.515625	.598958	.682292	.765625	.848958	.932292	
1/4	4	.020833	.104167	.1875	.270833	.354167	.4375	.520833	.604167	.6875	.770833	.854167	.9375	1/4
3/8	5	.026042	.109375	.192708	.276042	.359375	.442708	.526042	.609375	.692708	.776042	.859375	.942708	3/8
	6	.03125	.114583	.197917	.28125	.364583	.447917	.53125	.614583	.697917	.78125	.864583	.947917	
	7	.036458	.119792	.203125	.286458	.369792	.453125	.536458	.619792	.703125	.786458	.869792	.953125	
1/2	8	.041667	.125	.208333	.291667	.375	.458333	.541667	.625	.708333	.791667	.875	.958333	1/2
5/8	9	.046875	.130208	.213542	.296875	.380208	.463542	.546875	.630208	.713542	.796875	.880208	.963542	5/8
	10	.052083	.135417	.21875	.302083	.385417	.46875	.552083	.635417	.71875	.802083	.885417	.96875	
	11	.057292	.140625	.223958	.307292	.390625	.473958	.557292	.640625	.723958	.807292	.890625	.973958	
3/4	12	.0625	.145833	.229167	.3125	.395833	.479167	.5625	.645833	.729167	.8125	.895833	.979167	3/4
7/8	13	.067708	.151042	.234375	.317708	.401042	.484375	.567708	.651042	.734375	.817708	.901042	.984375	7/8
	14	.072917	.15625	.239583	.322917	.40625	.489583	.572917	.65625	.739583	.822917	.90625	.989583	
	15	.078125	.161458	.244792	.328125	.411458	.494792	.578125	.661458	.744792	.828125	.911458	.994792	

Form 491. This table supplied in larger size on request.

TO COMPUTE DISCOUNT IN £ s. d.

Example: **£57 7**s. **9**d. less 17% discount. Find the discount.

The **7**s. and **9**d. by referring to the table (Form 10 on Page 36) is found to be **£.3875,** so the example is **.17×57.3875.**

Perform the multiplication and point off in the manner explained on Page 10 in the rule entitled, "Multiplying High Decimals."

After the multiplication is made, the register shows **9.75587**+.

Table (Form 10) shows that the decimal nearest in value to **.75587** equals **15**s. **1**d. Therefore, the answer is **£9 15**s. **1**d.

TO COMPUTE THE NET

Example: **£57 7**s. **9**d. less 17% discount. Find the net.

100% less **17%** is **83%**, which represents the net, so the example is **.83× 57.3875.** Put the fingers on keys **83** in the two extreme left-hand columns of keys and you will find that the small figures on these keys are **16,** so instead of subtracting the **17%** from **100%**, you could just put the fingers on keys having on them small figures that read **one less than the right-hand figure of the per cent of discount**—that is, on keys reading small **16**.

Make the multiplication as explained in the rule next above. The register then shows **47.631625.** Table (Form 10) indicates that **£.63162** equals **12**s. **8**d., so the net is **£47 12**s. **8**d.

To Reduce £ s. d. to Dollars and Cents at Any Rate of Exchange

Example: Change **£352 9**s. **7**d. Rate **$4.87⅞.**

The table (Form 10 on Page 36) indicates that **9**s. **7**d. is equivalent to **£.47916,** so the example is **352.47916 × 4.87875.** The end figures **(875)** in the number **4.87875** are the decimal equivalent of the ⅞.

The above multiplication is best made from left to right by the "split" method. That is, hold keys **487** on the three extreme left-hand columns of the keyboard and multiply towards the right by **352.47916** according to the

rule on Page 10 entitled, "Multiplying High Decimals," and the register shows **1716573+**. Then put the fingers on keys **875** which represent the remaining figures of the multiplier, holding the **8** in the fourth column from the left, and multiply towards the right by as many figures as possible of the **352.47916** and the register shows **1719657+**.

As the sum of the whole places in both factors is four, point off four holes from the left, and the register reads **1719.657+** or **$1,719.66.**

To Change Dollars and Cents to £ s. d.

Example: Change **$1719.66** to £. s. d. Rate of exchange **$4.87⅞.**

One method would be to divide **1719.66** by **4.87⅞**, but a much quicker and easier way is to use the table (See Form 489) on Page 41.

Opposite **487⅞** on the table is given the reciprocal **204970535** by which to **multiply** the dollar amount instead of **dividing** it by the rate **4.87⅞.**

The above example would then be **1719.66 × 204970535.** Make the multiplication from left to right according to the rule on Page 10 entitled, "Multiplying High Decimals," first holding keys **171** and multiplying by the figures on the table and then holding **966,** starting from a position next to the right of the first position for keys **171,** and the register shows **035247949** (on an 8-column Comptometer).

Point off from the left as many answer holes as there are whole dollar places in the example, and the result is **£352.4794.**

Find on table (Form 10, Page 36) the decimal nearest in value to **.4794** which indicates that **.4794** is equivalent to **9**s. **7**d., so the answer is **£352 9**s. **7**d.

Reciprocals of Rates of Exchange

483	—207	039	337
⅛	—206	985	770
¼	—206	932	230
⅜	—206	878	717
½	—206	825	233
⅝	—206	771	776
¾	—206	718	346
⅞	—206	664	944
484	—206	611	570
⅛	—206	558	224
¼	—206	504	904
⅜	—206	451	613
½	—206	398	349
⅝	—206	345	112
¾	—206	291	903
⅞	—206	238	721
485	—206	185	567
⅛	—206	132	440
¼	—206	079	341
⅜	—206	026	268
½	—205	973	223
⅝	—205	920	206
¾	—205	867	216
⅞	—205	814	253
486	—205	761	317
⅛	—205	708	408
¼	—205	655	527
⅜	—205	602	673
½	—205	549	846
⅝	—205	497	046
¾	—205	444	273
⅞	—205	391	528
487	—205	338	809
⅛	—205	286	118
¼	—205	233	453
⅜	—205	180	816
½	—205	128	205
⅝	—205	075	622
¾	—205	023	065
⅞	—204	970	535
488	—204	918	033
⅛	—204	865	557
¼	—204	813	108
⅜	—204	760	686
½	—204	708	291
⅝	—204	655	922
¾	—204	603	581
⅞	—204	551	266
489	—204	498	978
⅛	—204	446	716
¼	—204	394	481
⅜	—204	342	273
½	—204	290	092
⅝	—204	237	937
¾	—204	185	809
⅞	—204	133	708
490	—204	081	633
⅛	—204	029	584
¼	—203	977	562
⅜	—203	925	567
½	—203	873	598
⅝	—203	821	656
¾	—203	769	740
⅞	—203	717	851

Form 489. This table supplied in larger size on request.

INTEREST

To perform interest on the Comptometer, the following methods are so rapid that the most complex examples in interest can be computed in twenty-five seconds, and an ordinary example in ten seconds.

No one can compute interest one-half as rapidly mentally or by using an *interest table.*

Method of Computing Interest. If the number of days for the whole term is not known, first strike the number of days on the machine, as in addition; then strike the **30** key as many times as there are months and the **300** key and the **60** key as many times as there are years. The number of days will then be indicated on the register.

Multiply the principal by the number of days, without taking the number of days off the register, as illustrated on page **10,** and divide the product

By **90,** if the rate is **4** per cent;
By **72,** if the rate is **5** per cent;
By **60,** if the rate is **6** per cent;
By **45,** if the rate is **8** per cent;
By **40,** if the rate is **9** per cent;

and point off four places, if there are no cents in the principal; but if there be cents in the principal, point off six places.

Example: Find the interest on **$462** for **3** years, **7** months and **11** days at **8** per cent. First strike **11,** as there are **11** days, then strike the **30** seven times, as there are seven months; and strike the **300** three times, and the **60** three times, as there are three years. **1301** is now indicated on the register. Multiplying the principal by **1301** and **601062** is given as the product; dividing this by **45,** and there is a quotient of **13356$\frac{8}{15}$**; point off four places, and **$133.56** appears as the answer.

Where the rate per cent is 7, after multiplying the principal by the number of days, multiply this product by striking each **6** key as many times as the corresponding figure of the register indicates. (See rule, page **10.**) Then divide the amount now indicated on the register by **36,** and if there be no cents in the principal, point off five places; but if there be cents in the principal, point off seven places.

Example: What is the interest on **$273** for **6** months and **26** days, at **7** per cent? Computing the number of days, **206** is the answer; and multiplying **273** by **206, 56238** appears on the register. As the rate of interest is **7** per cent multiply by **7** by using the row of **6**'s as above directed, and **393666** appears on the register. Dividing by **36** causes **10935$\frac{6}{36}$** to appear, and pointing off five places, the answer, **$10.935,** is obtained.

DISCOUNT

Method of Discounting Bills. Multiply the amount of the bill by the negative of the rate of discount. The product will be the net amount of the bill.

Thus: **$524.25, 30** per cent off. To strike the negative of **30** we strike the co-digit **2** (see page **12**). Therefore we begin on the second key from the right on the row of co-digits **2**'s, and strike each co-digit **2** in succession toward the left, as many times as the corresponding figure in the multiplicand indicates. Thus, striking the co-digit **2** in the second column five times, the next co-digit **2** to the left two times, the next four times, the next two times, and the next five times; and pointing off four places, **$366.975** appears as the amount of the bill, after discounting.

For discounting bills like the following:

24	**½** in. M. I. Caps	**09**	**$2.16**	**22** per cent off
36	**1** in. M. I. Ells	**22**	**7.92**	**30** per cent off
24	**1** in. M. I. Tees	**28**	**6.72**	**15** per cent off

Multiply the first item negatively by its per cent off, and leaving the amount standing on the register, proceed to multiply the other items negatively by their per cent off. The sum of all the items with their discounts deducted will then be indicated on the register.

Thus: After multiplying **$2.16** by **22** negatively, **$1.6848** appears on the register, and leaving this amount on the register, and multiplying **$7.92** by **30** negatively we have **$7.2288,** and after multiplying **$6.72** by **15,** negatively, **$12.94** appears as the answer.

It is obvious that to find the discount, all that is necessary is to multiply the principal by the rate of discount.

WHERE THERE ARE SEVERAL DISCOUNTS ON ONE BILL

Example: **$452** less **70** per cent, **47** per cent and **10** per cent.

After multiplying **452** by the co-digit **6** (one less than the **7** of the **70** per cent) we have **135.60.** Multiplying this by **47** on the co-digits (not one less than **47** because **135.60** is already on the machine) we have **71.868,** and in the same manner multiplying this by the co-digit **1** (for the **10** per cent) we have **64.68,** the value of the bill after taking off **70** per cent, **47** per cent and **10** per cent.

In multiplying by the co-digits **47** and co-digit **1,** use the rule on page **10.**

In taking off any per cent less than **10,** remember that such per cent stated decimally has a cipher before it. Thus, **6** per cent is **.06,** therefore for **6** per cent multiply on the rows of co-digits **0** and **5.**

COMPOUND INTEREST

To Perform Compound Interest. Multiply the principal in *cents* by the rate of interest and add the principal. Set the amount down on paper in *dollars* and *cents*, leaving off the mills and tenths of mills, and begin on the unit key of the row of keys representing the rate per cent, and without turning the machine to naught, multiply the *amount set down* by the rate per cent, thereby placing the product two places to the right of the amount standing on the machine. Set down on paper the amount now on the machine, which is the amount of compound interest and principal for two years. Proceed in like manner, as many times as there are years remaining in the term for which the interest is to be compounded.

Example: What is the amount of **$326.21** for five years at **7** per cent compound interest?

Starting on the row of **7**s indicated by the rate per cent, strike the first one, one time, the next two times, the third six times, and so on. **$22.8347** appears on the register, as the interest for one year. Add the principal and **$349.04** appears as the amount of interest and principal for one year, *the mills and tenths of mills being disregarded.* Starting on the row of **7**s, strike the first **7** four times, the third nine times, the fourth four times, and the fifth three times. The amount of interest and principal will now be indicated on the register. Setting this down, continue the operation as directed by above rule, three times more, when the amount of compound interest and principal for five years will be indicated on the register.

SQUARE ROOT

Before trying to extract square root, practice division on at least fifty examples, employing those having one, two, and also five figures in the divisor.

The simplest way to extract square root on the Comptometer is to act on the principle that in the series of odd numbers **1, 3, 5, 7, 9,** etc., *the square of the number of terms always equals the sum of all the terms.*

Thus: In the series **1, 3, 5, 7, 9, 11, 13,** we have seven terms, and find that the sum of these terms is **49,** and that the square of seven, the number of terms, is also **49.**

Method where the first period on the left is not greater than 24. Strike on the keys the number to be operated on, so that it will appear on the register of the machine, and separate it by the pointers above the register into periods of two places each from the right.

To obtain the first root figure, strike the co-digit **0** key in the units column of the highest period, and each succeeding key towards the register in that column which has a concave top, until the figure in the tens column of that period indicates the number of key strokes, and the figures in the units column indicate an amount not greater than the co-digit on the next key to be struck. (This simply amounts to dividing by the series of numbers of which **1** is the starting point and **2** the common difference.) The figure which now stands in the highest column of the register (the column which was the tens of the first period) is the first root figure, and the figure in the next column to the right is the remainder of the first period.

To obtain the second root figure. To the remainder of the first period annex the next period on the right for a new number from which to obtain the second root figure. Multiply the root figure already obtained by **20,** and use the product as a starting point at which to begin striking on the co-digits the series of even numbers and strike it an each succeeding even number (example, **4×20=80-82-84-86-88-90-92,** etc.) until the number of even numbers struck coincides with the figure on the register in the column next higher than the highest key struck, and the figures in the column in which the keys are struck indicate an amount not greater than the next even number to be struck. If the first root figure multiplied by **20** is as large or

larger than the minuend, the second root figure is 0; therefore in such cases annex one or more periods to the remainder and proceed to find the third root figure.

To find the third and all succeeding root figures. Proceed the same as with the second, except that there are two or more root figures to be multiplied by **20.**

Two figures can be used as a trial divisor to find each root figure the same as in the method of dividing by three or more numbers, after which strike each of the keys which represent the rest of the even numbers to be struck, the number of times required as indicated by the quotient figure obtained by the trial divisor.

Example: $\sqrt{14334027}$. After striking **14334027** on the machine and pointing off, we find that **14** is the highest period. Striking the co-digit **0** in the units column of that period, then each succeeding key having a concave top, we find that the figure in the tens column of that period on the register does not coincide with the number of keys struck until three keys are struck; then as **5,** which stands in the units column of that period on the register is not greater than the co-digit figure on the next concave-top key, we have obtained the first root figure. Annexing the next period to the remainder of the first period, we have **533** as a new number from which to obtain the second root figure. The first root figure multiplied by **20=60,** therefore place the index finger of the left hand on the co-digit **6,** and the index finger of the right hand on the co-digit **0** of the tens and units columns of the **533,** and strike once; move the right-hand finger to the co-digit **2** of its column, strike **62;** then to the **4** (all the time watching the figure in the next higher column on the register, and counting the number of strokes), strike **64,** and then to the **6,** strike **66;** then to the **8,** strike **68,** then move the right-hand index finger back to the co-digit **0,** at the same time moving the left-hand finger to the co-digit **7,** strike **70,** then moving the right-hand to the co-digit **2,** strike **72.** Now having struck seven even numbers, to coincide with the seven standing on the register in the next higher column than the one on which the keys were struck, we observe the remainder which is **64,** and as **64** is not greater than **74,** the next even number, the second root figure has been obtained.

Annexing another period to the remainder **64,** we have **6440** as a number from which to obtain the third root figure. Multiplying the first two root figures **(37)** by **20, we have 740 as a starting point from which to begin striking**

the series of even numbers; use 74 as a trial divisor, and begin striking it on the co-digits of the tens and hundreds columns of the number **6440,** to find the next root figure. (After striking the trial divisor five times, move the right-hand finger one key towards the register, as it is apparent that the sixth succeeding even number is always ten greater than the one used as a starting point.) We find that not until the trial divisor has been struck 8 times, does the number of strokes coincide with the figure in the next higher column on the register, when the remainder being smaller than the trial divisor, **8** is the third root figure; therefore, we strike the co-digit **0** in the units column of the **6440** and each succeeding concave-top key towards the register, and coming to the last one, begin again on the same co-digit **0** key and strike it and the next two succeeding concave-top keys, making **8** strikes in all, because **8** is the root figure found by using the trial divisor **74. 456** now appears as the remainder.

Annexing the next period we have **45627** as a number from which to obtain the fourth root figure. **378,** the root figures already obtained, multiplied by **20** equal **7560.** Taking **75** as a trial divisor, we strike **6** times before the number of strokes coincides with the next higher figure (do not drop the right-hand finger one key towards the register after the fifth stroke, as when obtaining the third root figure, because **10** added to **7560** would not change either of the figures of the trial divisor), then place the finger on the co-digit **6** in the next column to the right, because **6** is the next figure to the trial divisor, and strike **6** times, because **6** is the root figure obtained by using the trial divisor (drop one key towards the register after the fifth stroke), then strike **6** times in rotation on the series of concave keys of the units column in the usual manner, when the root, **3786** will appear, with the remainder, **231,** standing to the right.

Method where the first period on the left is greater than 24. To obtain the first root figure, strike the co-digits **00** in the tens and units columns of the highest period, and then **02, 04, 06, 08, 10, 12,** etc., until the number of strokes coincides with the figure in the next higher column on the register and the remainder standing in the column in which the keys are struck is not greater than the amount represented by the co-digit figure on the keys next to be struck.

To obtain the second and all succeeding root figures, proceed the same as for the third root figure illustrated in the foregoing method and example.

EQUATIONS

There are many equations, in which one of the operations is to subtract the product of two numbers or to subtract the square of a number. The following will show how it can be done without finding what the product of the number is or what the square of the number is and thereby saving much time. We have not space in which to illustrate one of each class of such equations, but will illustrate examples in two classes which will suffice to illustrate the method.

Example 1. **(2742×58)—(864×74).** After multiplying **2742** by **58, 159036** appears as a product. Leave it on the register. Then multiply **864** by **74** *negatively* (see page **12**), using co-digits **73** for the multiplier and striking both together. Next annex as many ciphers to the multiplicand as there are *places* in the multiplier and subtract it from the amount on the register. In this case there are two places in the multiplier; therefore, subtract **86400,** when the answer, **95100,** appears on the register.

Example 2. The hypothenuse of a triangle is **1278** feet, the base is **473** feet; what is the perpendicular?

The equation is $\sqrt{1278^2-473^2}$. Squaring **1278** we have **1633284.** Leaving it on the register, we multiply **473** by **473** according to the co-digits, as illustrated in Example **1,** and then annex three ciphers to **473,** and subtract it, when **1409555** appears on the register. Extracting the square root, we have **1187+586.** If you desire to express the root as a mixed number, all that is necessary is to multiply the root figures already obtained by **2** and add **1.** Then place the result under the remainder as a denominator. In this case it would be as follows: **1187×2+1 = 2375;** therefore the root is $1187\frac{586}{2375}$.

It is evident that the periods of ciphers can be annexed to the remainder and the root carried out decimally if desired.

APPENDIX

To make a key-operated, multiple-order calculating machine so that it could be run both forward (additive) and backward (subtractive), would involve mechanism so complicated, especially in its carrying mechanism, as to be not only impracticable, but absolutely absurd.

Therefore on a key-operated machine, subtraction, division and other operations of a negative character are performed by touching on the keys the complements of numbers to be subtracted, the complements of divisors in division, and the complements of the terms of a geometrical ratio in square root, etc.

The complement of a number is that number which added to it, results in a series of ciphers directly beneath it, with **1** carried to the next column to the left, thus the complement

of	**13074**	of	**657**
is	**86926**	is	**343**
	100000		**1000**

It will be observed that in each of these illustrations the sum of the two figures in the first column is **10,** and that the sum of the two figures in each of the other columns taken by itself is **9** This is because the **1** carried from the first column into the second, added to **9** makes **10,** and the **1** carried from the second column to the third added to **9** makes **10,** and so on clear across.

Thus, **6+4** is.....**10**
2+7+1 to carry is.....**10**
9+0+1 to carry is.....**10**
3+6+1 to carry is.....**10**
8+1+1 to carry is.....**10**

13074
86926
10
100
1000
10000
100000

We call a number which added to a digit makes **10,** its complement, and a number which added to a digit makes **9,** its co-digit. Thus the complement of **6** is **4,** and the co-digit of **6** is **3,** because **6 +4 =10,** and **6 +3 =9.**

We can find the difference between two numbers by adding the complement of the smaller to the larger and canceling the **1** carried to the extreme left.

Example: 47631—13074

Larger number..... **47631**
Complement of smaller number (13074)..... **86926**
Answer..... **~~1~~34557**

In a calculating machine the carrying is a process entirely independent of the consciousness of the operator. Hence it follows that with the larger of two numbers on the register, if the operator merely touches in each column a key which will add the co-digital value of each digit of the smaller number except the one to the extreme right, and touches the complement of the extreme right-hand digit, he will then have on the register the difference between the two numbers, providing he can prevent

the carrying of the **1** from the extreme left-hand number to the next higher order, wherever that order happens to be.

It further follows that if there were placed on each *units* key, beside its normal digit, a number in smaller type indicating its complement, and if on all the other keys of the machine there were placed beside the digit a number indicating its co-digit, all the operator would have to do to subtract any number ending with a digit in the units column, would be to strike the keys indicating in smaller type the number to be subtracted, providing he has, as on the Comptometer, means for preventing carrying to the left of the highest column in which any key is touched.

In practice there is not always a digit in the units column of a number to be subtracted, and frequently it is desirable to make a subtraction from a number standing several columns to the left of the units column of the machine, such as in subtracting from a quotient at the conclusion of a performance in division, or in using decimal numbers or in correcting a mistake of the operator in touching the keys. Also in performing division the divisor needs to be touched in accordance with the small figures on the keys in a position where its units figure does not correspond with the units column of the machine. For this reason it is desirable to place co-digits on all the keys and direct the operator to always touch, for the extreme right-hand digit of a number to be struck on the keys according to the small figures, a key bearing a co-digit which is one less than the right-hand digit.

Since for each subtraction there is one carried to the left of the highest key touched unless prevented by the use of the subtraction cut-offs, a series of subtractions accomplishes division.

Example: 465 ÷ 222.

Keys touched:

Digits	465
Co-digits **221,** same as digits	778
	1 243
Co-digits **221** repeated again	778
	2 021

The quotient is **2** and the remainder is **21.**

Example: 1384 ÷ 645.

If we were doing subtraction proper the keys touched would be

	Cut off
Digits	1384
Co-digits	0644

But in division we may omit to strike the **0** under the **1** in the fourth column and simply strike the co-digits **644,** thus:—

Keys to be struck:

Digits	1 384
Co-digits **644,** same as digits	355
	1 739
Co-digits **644** repeated again	355
	2 094

The quotient is **2** and the remainder **94.**

In examples involving two or more places in the quotient the principle is just the same as above except that instead of beginning to subtract with the units of the divisor under the unit of the dividend, which would necessitate making a great number of subtractions, we begin subtracting from the fewest figures in the left of the dividend which will contain the divisor.

Example: 2863 ÷ 68.

Keys to be struck:

Digits	2 863
Co-digits **67** same as digits	32
	3 183
Co-digits **67** repeated again	32
	3 503
Co-digits **67** repeated again	32
	*3 823
Co-digits **67** repeated again	32
	4 1 43
Co-digits **67** repeated again	32
	41 75
Co-digits **67** repeated again	32
	42 07

The quotient is **42** and the remainder **7.**

*Here, for the first time, the number of strokes on the keys (subtractions) agrees with the quotient figures, but there is a remainder of **82,** so we continue to strike the keys until the remainder becomes less than the divisor **68,** which it does at the next stroke, showing the first quotient figure to be **4.**

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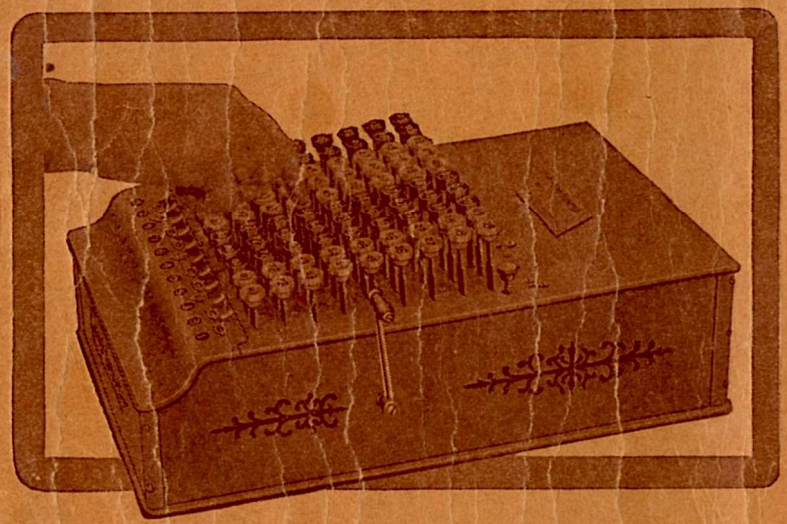

CONTROLLED-KEY CLEAR-SIGNAL COMPTOMETER

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