

May 7, 1935.

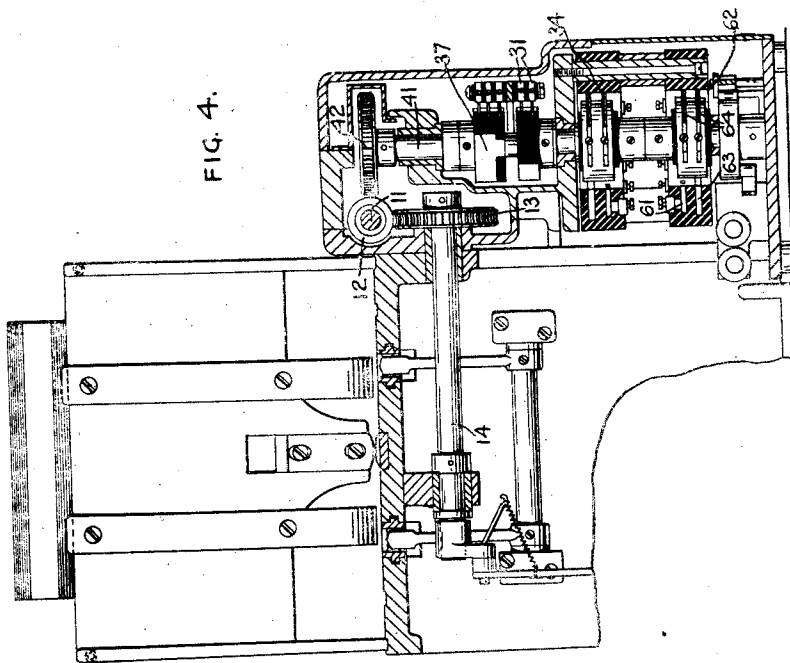
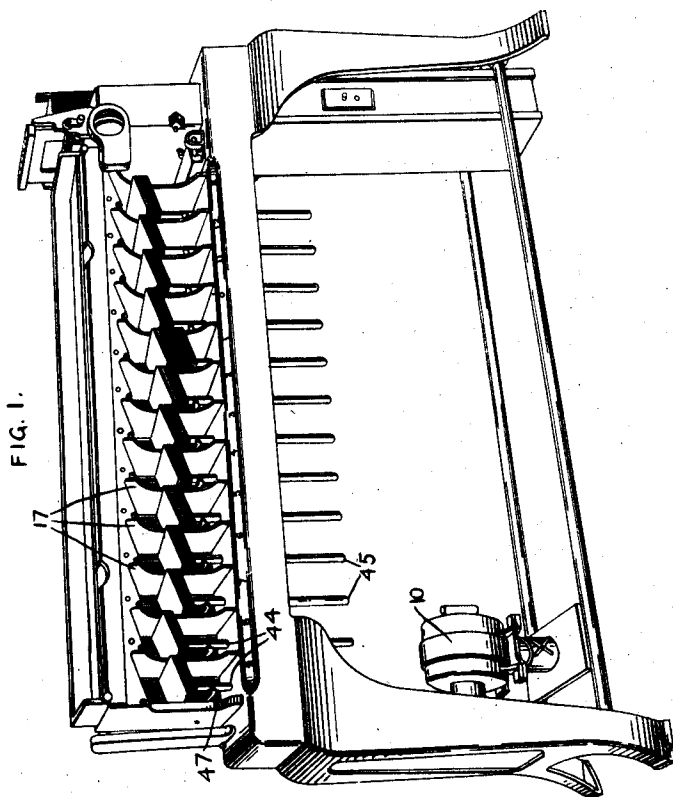
C. CAMPBELL

2,000,214

APPARATUS FOR SORTING AND COUNTING FROM STATISTICAL RECORD CARDS

Filed Nov. 19, 1930

3 Sheets-Sheet 1



Inventor
Chas. Campbell.

May 7, 1935.

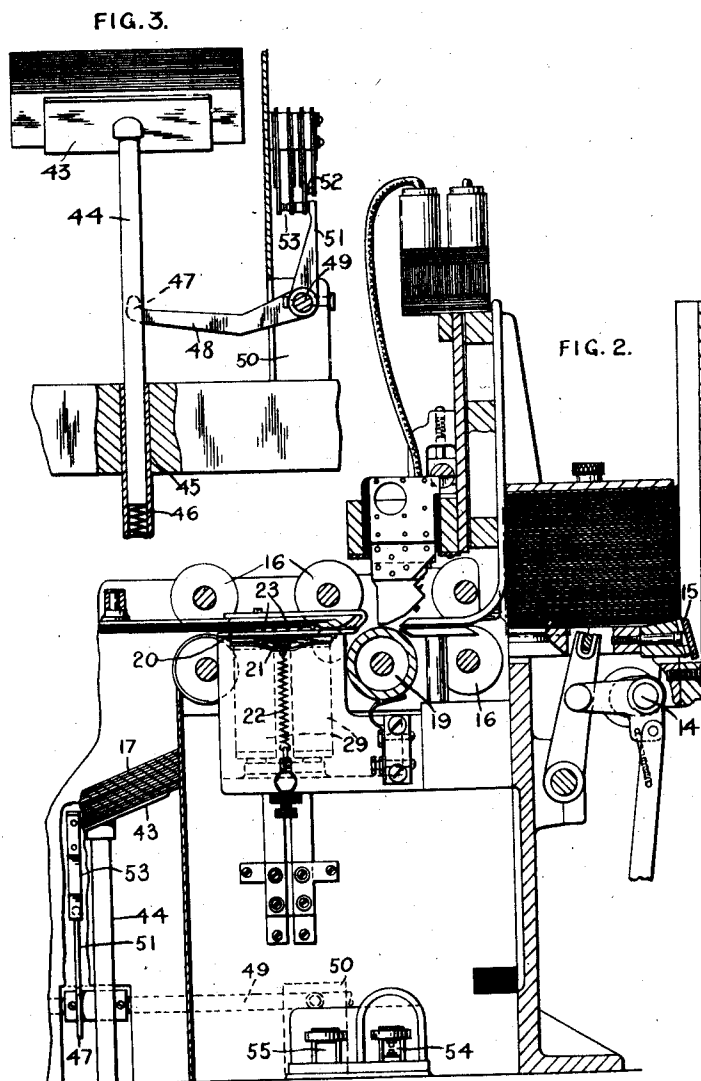
C. CAMPBELL

2,000,214

APPARATUS FOR SORTING AND COUNTING FROM STATISTICAL RECORD CARDS

Filed Nov. 19, 1930

3 Sheets-Sheet 2



Inventor
Chas. Campbell.

May 7, 1935.

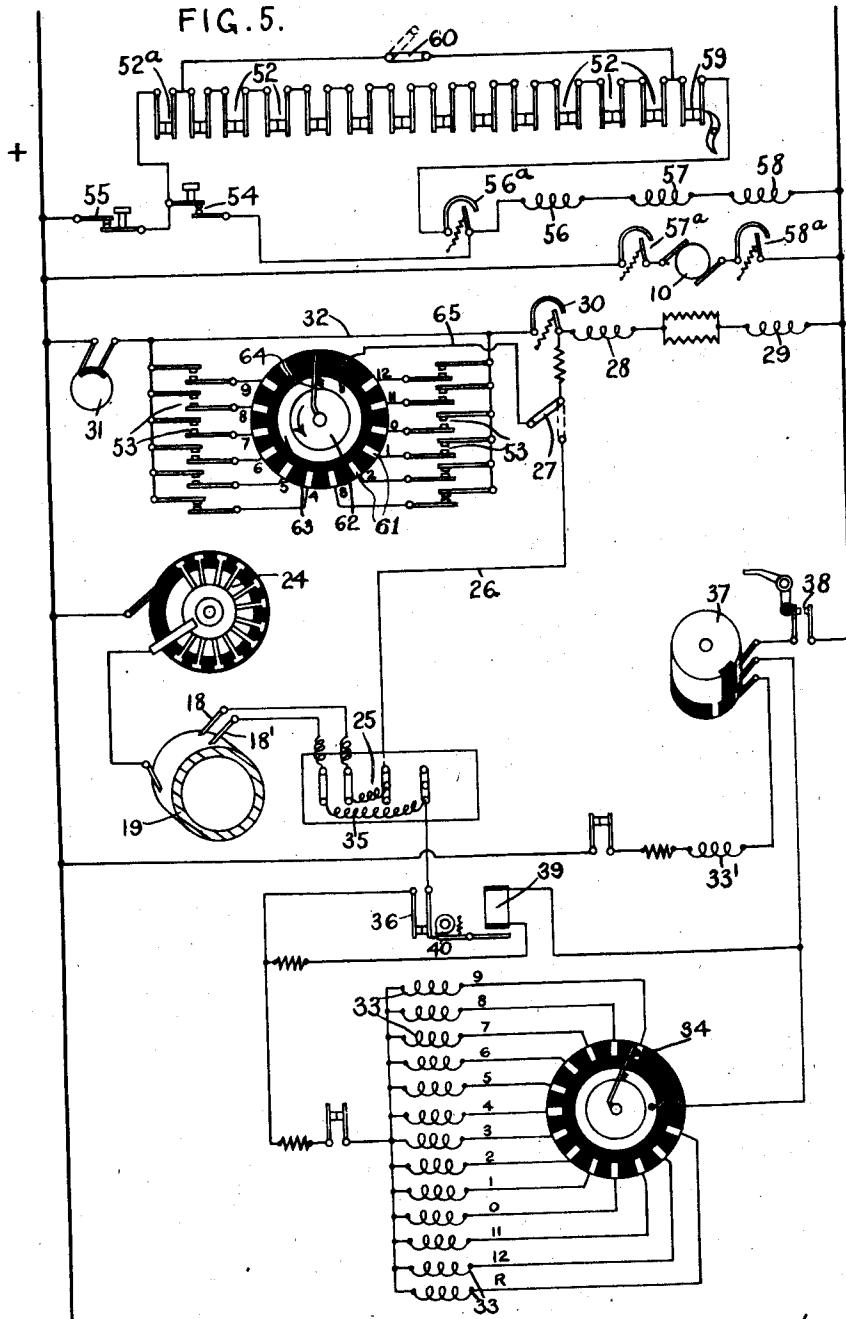
C. CAMPBELL

2,000,214

APPARATUS FOR SORTING AND COUNTING FROM STATISTICAL RECORD CARDS

Filed Nov. 19, 1930

3 Sheets-Sheet 3



Inventor
Chas. Campbell.

UNITED STATES PATENT OFFICE

2,000,214

APPARATUS FOR SORTING AND COUNTING
FROM STATISTICAL RECORD-CARDS

Charles Campbell, London, England, assignor, by
meane assignments, to International Business
Machines Corporation, New York, N. Y., a cor-
poration of New York

Application November 19, 1930, Serial No. 496,690
In Great Britain December 13, 1929

14 Claims. (Cl. 203-110)

This invention relates to apparatus of the kind comprising the combination of (a) a machine which, for sorting statistical records, has a card reading device, a plurality of card receptacles and sorting mechanism operable under the control of the card-reading device to distribute the cards to the receptacles in accordance with the position of a hole or holes in a selected column on the cards, and (b) counting apparatus which has a plurality of units-counters each operated under the control of the said card-reading device to count the number of cards having, in a selected column or columns, a hole in a particular position or positions allocated to that counter.

It is an object of this invention to provide means whereby the capacity of such apparatus may be increased when it is used for compiling census returns and for other analogous purposes.

For simplicity of explanation it will be assumed that the present apparatus is to be employed for compiling census returns as being one of its most important uses but the apparatus can be employed with advantage for other similar purposes.

In such work each fact is recorded on a separate card for each person by means of a special hole, for example a particular hole would denote that the card related to a man, so that by counting the number of cards containing this hole the number of men can be counted. In the same way the number of women could be counted.

By sorting the cards into, say, a male group and a female group and then counting the cards to ascertain the number of single and of married persons in each group, these totals can be obtained separately for each sex. Thus it will be seen that both sorting and counting operations are involved and, while these operations may be carried out on separate machines, it is preferred to use a combined apparatus as described above partly because the cards can then be counted and simultaneously sorted into a new order in readiness for a subsequent counting operation.

In commercial apparatus of this kind the cards feed at the rate of 400 cards per minute and the capacity of the receptacles is 800 cards. When, as frequently occurs in census-work, the order of the cards is not to be disturbed during several counting operations, the sorting mechanism is disconnected from the card-reading device and the cards are delivered to a reject receptacle. This receptacle will therefore become full after two minutes' running so that the apparatus must be stopped, the receptacle emptied and the apparatus restarted, thus the capacity of the apparatus is

inadequate under these conditions since only one sorting receptacle is being used although it is adequate when sorting is being effected.

According to the present invention apparatus of the kind described above is provided with a plurality of change-over devices each associated with a separate one of a series of the card receptacles of the sorting machine and each so arranged as to be actuated as the result of the associated receptacle becoming fully loaded, and an automatic mechanism operable by the actuation of one of the change-over devices to cause the sorting mechanism to pass the cards to the next receptacle in the series. Thus, it will not be necessary to stop the machine until after all the receptacles in the series have become full.

When the sorting mechanism is of the kind wherein the cards are read while in motion and wherein the time in the card cycle at which an impulse is received determines into which receptacle the card will be passed, the automatic mechanism preferably includes a plurality of normally ineffective impulse-transmitting devices each associated with a separate card receptacle in the series and each so arranged as to be rendered effective by the actuation of the change-over device associated with the preceding receptacle in the series, to transmit an impulse to the sorting mechanism at such a time in each card cycle as will result in the sorting mechanism delivering the cards to the receptacle associated with the said impulse-transmitting device. When the sorting mechanism includes an electro-magnet for controlling its operation the automatic mechanism is conveniently constituted by a commutator having a conducting segment associated with each receptacle and a brush which is connected to said magnet and is operated in synchronism with the card feed to make contact with the commutator segments in succession at the proper times in the card cycle, and the change-over devices each includes a normally open pair of contacts closed when the device is actuated and connected in series with the commutator segment associated with the succeeding receptacles in the series.

A preferred embodiment of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a sorting machine embodying this invention.

Figure 2 is a cross section showing the sorting mechanism employed.

Figure 3 is a transverse section through a card receptacle of the sorting machine.

Figure 4 is a transverse section through the sorting machine showing various commutators employed and,

Figure 5 is a circuit diagram for the apparatus.

Like reference numerals indicate like parts throughout the drawings.

The present apparatus comprises a sorting machine which is shown in Figure 1 and a counting machine. These two machines form separate units which, however, operate jointly and are generally similar to the machines described in the co-pending application of Ford No. 234,329 filed 19th November 1927, now Patent No. 1,926,896 granted September 12, 1933.

Referring to Figures 1 to 4, the sorting machine is driven by a motor 10, which, through suitable gearing, drives a worm shaft 11 which extends from end to end of the machine and carries a worm 12 at the right-hand end (Figure 4). The worm 12 meshes with a worm wheel 13 on a shaft 14 which, through suitable mechanism, drives a picker 15 (Figure 2). The picker advances one card at a time to pairs of feed rolls 16 which feed the cards along the machine over sorting pockets 17. The feed rolls are driven by suitable gearing from the shaft 11. The first pair of feed rolls feed the cards between brushes 18, 18' and a contact roll 19 and onto the side plates 20. There are two brushes and they are adjustable so that they can be set to read any two columns of the card. Located between the side plates 20 is a movable plate (not shown) which is normally held up by an armature 21 and a spring 22. A series of guide blades 23 rest on the top of this plate. These guide blades form passages along which the card can pass, each of which passage terminates over a different one of the sorting pockets 17, for example, if the card passes between the two uppermost sorting blades it will be passed into the pocket marked S in Figure 1. If it passes between the second and third from the top it will pass into the pocket marked R and so on. Any card which passes the lowermost blade is passed into the pocket marked R. As the leading row of holes, that is the row of S holes, passes the brush 18, the leading edge of the card is located under the uppermost sorting blade. As the next row of holes comes under the brush the leading edge is below the second blade from the top and so on.

Referring to Figure 5, when the brush 18 encounters a hole a circuit will be completed through a sorting commutator 24, the contact roll 19, the brush 18, a plug wire 25, a line 26, a switch 27, which is in the dotted line position, a relay magnet 28 and a sorting magnet 29. When the magnet 28 is energized it closes its contacts 30 and establishes a holding circuit through a contact roll 31, a line 32, the contacts 30 and the magnets 28 and 29. The sorting magnet 29, when thus energized attracts its armature 21 against the action of the spring 22 and lowers the movable plate on which the blades 23 rest. Those blades which are in front of the card move down with the plate to below the level of the card while those which are above the card are held up by the card. The card thus passes between two of the guide blades and is led along until it reaches the appropriate sorting pocket to which it passes. The circuit through the sorting magnet is interrupted at the end of the card cycle by the contact roll 31.

The mechanical construction of the counting

mechanism does not enter into the present invention and it will be sufficient to explain that it comprises 14 counters each of which is advanced one step when an electro-magnet 33 associated with it is energized. One of these counters is a grand total counter and its magnet 33' is energized during each card cycle of the sorting machine in which a card is fed past the brushes. This counter therefore counts the total number of cards passing the brushes of the sorting machine. Twelve of the counters each count the number of cards having a particular hole in the column of the card while the last counter counts the number of cards having no holes in that column. The sorting machine is provided with a commutator 34 which is operated in synchronism with the passage of the cards beneath the brushes to connect each sorting magnet in circuit at the moment when the corresponding hole position is being read, the commutator 34 connecting the magnet 33R in circuit when the trailing edge of the card has passed the brushes. The brush 18' has been shown as controlling the counting mechanism and when the brush encounters a hole a circuit is established through the commutator 24, contact roll 19, brush 18', a plug connection 35, a pair of contacts 36, one of the magnets 33, the commutator 34, a commutator 37 and card lever contacts 38. The magnet 33 thus energized advances its counter one unit space. Simultaneously a circuit is established through a magnet 39 which attracts its armature 40 and unlatches the contacts 36 which then open so that only one of the magnets 33 can be energized during one card cycle. If the brush 18' does not encounter a hole and energize one of the twelve magnets 33 which count cards having holes, then a circuit is established through the counter 33R when the trailing edge of the card passes the brush 18', the circuit being similar to that already traced. The magnet 33R can only be energized if the contacts 36 are closed at the end of the cycle and it therefore actuates its counter to count the cards not counted by the other counters. The commutators 31, 37, 34 together with another commutator which will be described later are driven by a shaft 41 (Figure 4) which carries a worm wheel 42 in mesh with the worm 12 of the main driving shaft 11 of the machine so that these commutators are driven in synchronism with the card feed.

As previously explained the apparatus may be used to count the cards in accordance with the holes in one column and to sort them in accordance with the holes in another column. It can also be used to sort the cards only, the counting machine being put out of action by disconnecting the plug connection 35 or removing the brush 18'. Further it can be used for counting the cards without sorting them if the switch 27 is moved to the full line position of Figure 5 to disconnect the sorting mechanism from the brush 18. When the sorting mechanism is out of action the cards pass in unchanged order into the pocket marked R in Figure 1. As previously explained this pocket will become full at the end of two minutes and means is provided for causing the sorting machine to pass the cards into the pocket marked 12 as soon as the pocket marked R is full and so on in turn into each pocket as soon as the preceding one becomes full. Within each pocket is a shelf 43 (Figures 2 and 3) which is supported by a rod 44, the lower end of which slides within a fixed tube 45. A spring 46 within the tube 45 bears against the lower end of the rod 44 and presses it upwards.

As the cards accumulate on a shelf the latter moves downwards under the weight of the cards, the spring 46 yielding. When the full number of cards have been deposited on a shelf, the shelf will engage the end 47 of the arm 48 of a bell crank lever which is loosely mounted on a shaft 49. The shaft 49 extends along the full length of the machine and is supported in brackets 50. There is a bell crank lever for each of the pockets 17 and the vertical arm 51 of each lever, except that for the card pocket marked 9, co-operates with two pairs of contacts 52 and 53. The arm 51 for the extreme lefthand pocket co-operates with a normally closed pair of contacts 52a only. When a pocket becomes full it rocks the bell crank lever 48-51 counter-clockwise so that it opens the contacts 52 and closes the contacts 53.

Referring now to Figure 5 the machine is started by depressing start key contacts 54 thus providing a circuit through stop key contacts 55, a relay magnet 56 and two motor control magnets 57 and 58. The relay magnet 56 then closes its contacts 58a to provide a holding circuit through the contacts 52a, all the contacts 52 in series and card lever contacts 59, the relay contacts 56a, the relay 56, and the motor control magnets. The motor control magnets close their relay contacts 57a and 58a so as to provide a circuit through the motor 10. If the machine is sorting the cards a switch 60 will be in dotted line position so that the opening of any of the contacts 52, 52a or of the card lever contacts 59 will break the circuit for the motor control magnets which will in turn interrupt the motor circuit. Thus the machine will stop as soon as the cards cease to feed or one of the card pockets 17 becomes full and opens its associated contacts 52. When the machine is to count without sorting the switch 60 which is interconnected with the switch 27 for joint actuation will be adjusted to the full line position. The machine will then continue in operation until either the contacts 59 open owing to the cards failing to feed or until the contacts 52a are opened as the result of the extreme lefthand pocket 17 becoming full.

The twelve pairs of contacts 53 are connected on one side in parallel to the line 32. Each of these contacts is also connected to a separate conducting segment 61 of a commutator 62 which is driven from the shaft 41 of the sorting machine. A conducting ring 63 of the commutator is connected by a line 65 to the switch 27. A movable brush 64 connects each segment 61 to the conducting ring in turn concurrently with the passage of a hole position under the brush. The brush 64 rotates counter clockwise in Figure 5 and will make contact with the segment labelled 9 at the 9 time in the cycle, the segment labelled 8 at the 8 time cycle and so on. It should also be explained that the pair of contacts 53 connected to the 9 segment is the pair associated with the pocket 17 labelled 8; the pair of contacts connected to the 8 segment are associated with the 7 pocket and so on, the pair of contacts connected to the 12 segment being associated with the pocket marked R.

The operation of the apparatus when the switches 60 and 27 are in the full line position and counting without sorting is proceeding as follows. The operation of the machine proceeds until the pocket marked R becomes full and the associated contacts 53 are closed. During the ensuing cycle the brush 64 sweeps over the segments until it reaches the 12 segment at which time the 12 hole

position of the card is beneath the reading brush. A circuit is then established through the contact roll 31, the line 32, the pair of contacts 53 closed by the pocket marked R, the 12 segment of the commutator 62, the brush 64, the conductor ring 63, the line 65, the switch 27, the relay magnet 28 which thereupon establishes a holding circuit through its contacts 30, and the sorting magnet 29. The sorting magnet 29 is thus energized at the 12 time in the card cycle and rocks its armature 20 so as to cause the card to pass between a pair of blades which will lead it to the 12 pocket. The action of the sorting mechanism is as previously explained, except that the magnet 29 is now energized at the proper time by the commutator 62 instead of by the reading brush 18. The same circuit is established during the succeeding card cycles until the 12 pocket becomes full. The pair of contacts 53 connected to the 11 segment of the commutator will then be closed and the commutator will establish the circuit for the sorting magnet 29 when it makes contact with the 11 segment, that is at the 11 time in the cycle. Thus during the succeeding cycles the sorting magnet will be energized at the 11 time in each cycle and the cards will pass into the 11 pocket. The pairs of contacts 53 become closed successively as the sorting pockets fill up until finally the pair associated with the sorting pocket marked 8 are closed and the 9 spot on the commutator becomes alive. The cards will then be passed into the extreme lefthand sorting pocket (as shown in Figure 1) until this pocket becomes full when the contacts 52a will be opened and the holding circuit for the motor control magnets 57 and 58 will be interrupted. The motor will then come to rest.

It will be seen that the apparatus will continue in operation, when adjusted for counting only, until all 13 sorting pockets have been filled. Thus instead of the machine being stopped every two minutes it will continue in operation for 26 minutes and the operator's time will not be wasted in constantly emptying the sorting pockets. Further the order of cards is unchanged. It will be apparent that the machine may be adjusted to continue in operation until any desired number of the 13 pockets have become full. Thus, if it is wished to stop the machine after the pocket labelled 2 has become full the switch 60 would be connected across the contacts 52 for the 5 righthand pockets only so that the pair of contacts 52 for the pocket marked 2 will be in series with the switch. The machine will then stop as soon as this particular pair of contacts opens.

I claim:

1. In apparatus for sorting, and counting from, statistical record cards, the combination with a series of card receptacles, of sorting mechanism, a plurality of change-over devices each associated with a separate one of the receptacles for actuation as the result of the associated receptacle becoming fully loaded, and automatic mechanism operable by the actuation of one of the change-over devices to cause the sorting mechanism to pass the cards to the next receptacle in the series.

2. In an apparatus for sorting statistical records, a series of record receiving stations, sorting mechanism operable to distribute the records to said stations, sensing mechanism associated with the record receiving stations and controlled by the actual quantity of records accumulated in said stations, and a rotary selector controlled by the sensing mechanism for modifying the action of the sorting mechanism to distribute the records

to the next station of the series when one of said stations has received a predetermined quantity.

3. In apparatus for sorting, and counting from, statistical record cards, the combination with a series of card receptacles of impulse actuated sorting mechanism for passing a card to a receptacle in accordance with the nature of the actuating impulse, an impulse emitter for creating impulses corresponding to the various receptacles, and a plurality of impulse transmitting devices each associated with a separate receptacle for actuation by the latter on it becoming full to transmit the impulses corresponding to the next receptacle in the series from the emitter to the sorting mechanism.

4. In apparatus for sorting, and counting from, statistical record cards, the combination with a series of card receptacles, of sorting mechanism whose operation is determined by the time in a card cycle at which an impulse is transmitted thereto, a plurality of normally ineffective impulse transmitting devices each associated with a separate receptacle in the series and arranged to be rendered effective as the result of the associated receptacle becoming full and a switch device operable in synchronism with the sorting mechanism to connect each impulse transmitting device to the sorting mechanism at a different time in the cycle.

5. In apparatus for sorting, and counting from, statistical record cards, the combination with a series of card receptacles, of sorting mechanism, an electromagnet for actuating the sorting mechanism to pass the card to a receptacle determined by the time in the cycle at which the magnet is energized, a plurality of normally open pairs of contacts connected in parallel to the magnet and each associated with a separate receptacle for closure by the latter on its becoming full, and a commutator for connecting each pair of contacts in the magnet circuit at the time appropriate to the receptacle next in the series to the one with which that pair of contacts is associated.

6. In apparatus for sorting, and counting from, statistical record cards, the combination with a series of card receptacles, of sorting mechanism, card feeding mechanism for feeding the cards through the sorting mechanism in succession, stopping means for interrupting the operation of the card feeding mechanism, automatic mechanism for actuating the sorting mechanism to pass the cards to a selected receptacle, over-load devices each actuated on a separate associated receptacle becoming full and selecting means for alternatively placing either the stopping means or the automatic actuating means at will under the control of the overload devices.

7. In apparatus for sorting, and counting from, statistical record cards, the combination with a plurality of card receptacles of sorting mechanism, a sorting electromagnet for actuating the sorting mechanism, card feeding mechanism, an electromagnet for maintaining the card feeding mechanism in operation, a series of normally closed pairs of contacts arranged in series with the second electromagnet, a switch arranged in parallel with said pairs of contacts, a series of normally open pairs of contacts arranged in parallel, an analyzing brush, a switch arranged to connect the sorting magnet either to the brush or to the normally open contacts, a commutator arranged to complete a circuit to each of the normally open pairs of contacts in succession during each card cycle, and a plurality of mem-

bers each associated with a separate receptacle and arranged to be actuated by the associated receptacle when the latter becomes full and to close an associated pair of the normally open contacts and to open an associated pair of the normally closed contacts.

8. In a machine for sorting records, a series of record receiving stations, sorting mechanism operable to sort the records into said stations; mechanism associated with the sorting stations for controlling the sorting mechanism to sort the records into a predetermined station of the series until said station becomes full and operative when said station becomes full to cause the records to be delivered to the next station of the series, including detecting mechanism associated with each station for determining when such station becomes full; and means controlled by the detecting mechanism associated with the last station of the series for interrupting operation of the sorting mechanism when the last station becomes full.

9. In an apparatus for sorting statistical records, each having a predetermined capacity, a series of record receiving stations, sorting mechanism operable to distribute the records to said stations, detecting mechanism associated with each station for ascertaining when a pocket becomes full to capacity, and a rotary selector device controlled by the detecting mechanism for modifying the action of the sorting mechanism to fill said stations to capacity in prearranged order.

10. In an apparatus for sorting statistical records, a series of sorting stations, sorting mechanism operable to distribute the records to said stations, sensing means associated with each pocket for determining when a pocket becomes full, means controlled by the sensing means for modifying the operation of the sorting mechanism to fill the stations in prearranged order, and means controlled by the sensing means associated with the last station to be filled for interrupting operation of the sorting mechanism when the last station becomes full.

11. In a machine for sorting statistical records, record receiving stations, sorting mechanism for distributing the records to said stations including a sorting circuit, an electrical circuit closing device operatively connected to said circuit to control the time of closure of said circuit and thereby determine the station to receive records, means for predetermining the quantity of records delivered to each individual pocket during a continuous run of the machine, and means controlled by the last named means for controlling the circuit closing device whereby to determine a different station to receive the records when a given station has received its full quota of records.

12. In an apparatus for sorting and counting statistical records, sorting mechanism including sorting stations, feeding means, and driving means therefor including a circuit for maintaining said driving means in operation; sensing devices, one for each station and operable independently of each other as the corresponding station becomes full; pairs of contacts operated by each sensing means, said pairs of contacts being in series in said circuit and operative when any given station becomes full to interrupt said circuit and prevent further operation of the driving means; and manual means for confining the operative effect of the circuit to one pair of contacts.

13. In an apparatus for sorting statistical records, a series of sorting pockets each having a predetermined capacity, mechanism operable to sort the records into said pockets including a
5 single pocket selecting element, detecting mechanism controlled by the accumulation of records in each pocket for ascertaining when said pocket becomes filled to capacity with records, and a selector device controlled by said detecting mechanism and operative to modify the operation of
10 the pocket selecting element when a given pocket becomes filled to capacity to cause the sorting mechanism to sort the records into the next pocket of the series without interrupting the
15 continuity of operation of the sorting mechanism.

14. In combination, in a sorting machine, a plurality of sorting pockets, means for feeding record cards successively, pocket selecting mechanism, record analyzing mechanism adapted to
5 control said selecting mechanism to select a pocket for each record card in accordance with the data sensed by the analyzing mechanism, further means independent of said analyzing mechanism for causing said selecting mechanism
10 to automatically select said pockets in a predetermined order to receive successively fed records in such order, and settable means for selecting either the analyzing mechanism or said last
15 named means for control of said selecting mechanism.

CHARLES CAMPBELL.