CARD FEEDING AND SENSING

THE IBM card has been called the operating unit of IBM machines. All information pertaining to a particular transaction is placed in this card in the form of punched holes. IBM cards are 7 3/8″ wide, 3 1/4″ high, and 0.0065″ thick. There are 12 vertical punching positions, and 80 columns of punching possible. Figure 1 shows the IBM card and the code punching used to store alphabetical and numerical information in the card.

Figure 2 shows an original document which gives a man's number and the number of hours he has worked in a given pay period. This information is representative of a customer's transaction. It is to be processed by accounting machines, and this necessitates its conversion to punched-hole form.

The information is to be classified and punched in a predetermined field in a card. A field, as shown by Figure 3, is a group of columns reserved for certain information. The size of a field may vary from one column to as many as are needed to contain the information. When the card is designed, the fields are laid out to contain a sufficient number of columns for the information to be punched.

After the customer has punched the information into cards, the cards can be arranged and classified by other machines, a check or a printed report showing the desired information can be prepared automatically as shown in Figure 4.

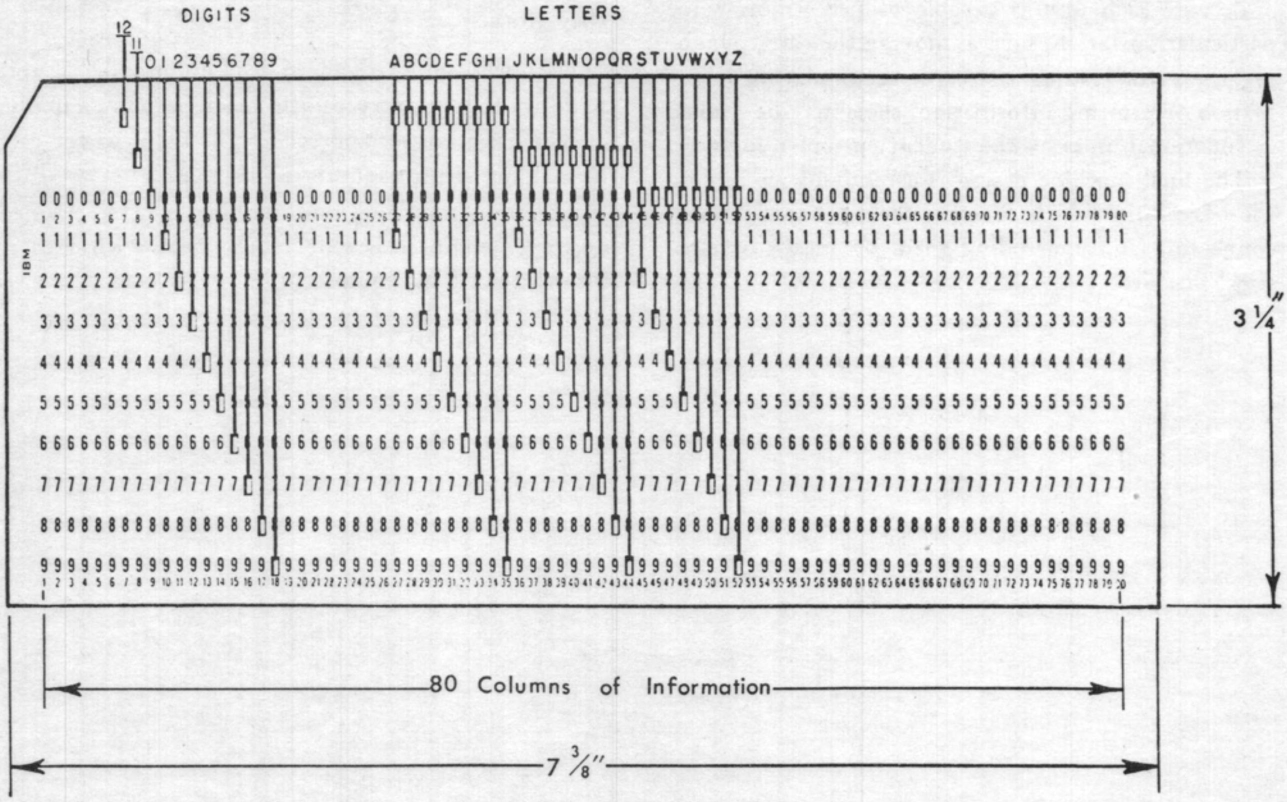


Figure 1. IBM Card and Punching Codes

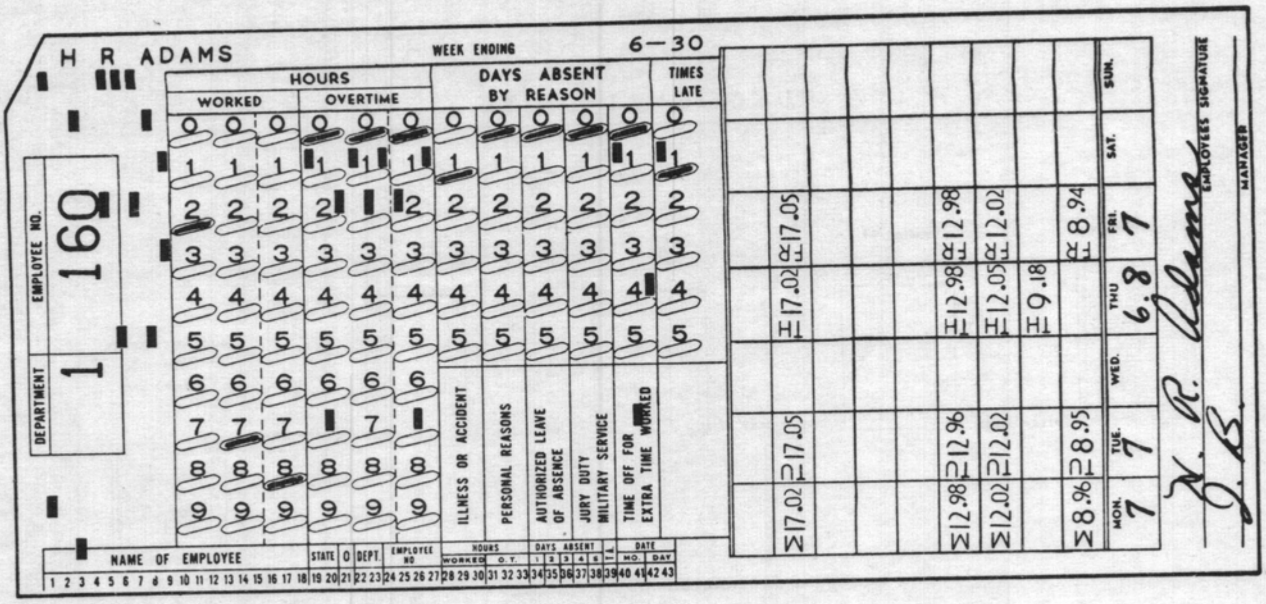


Figure 2. Time Card

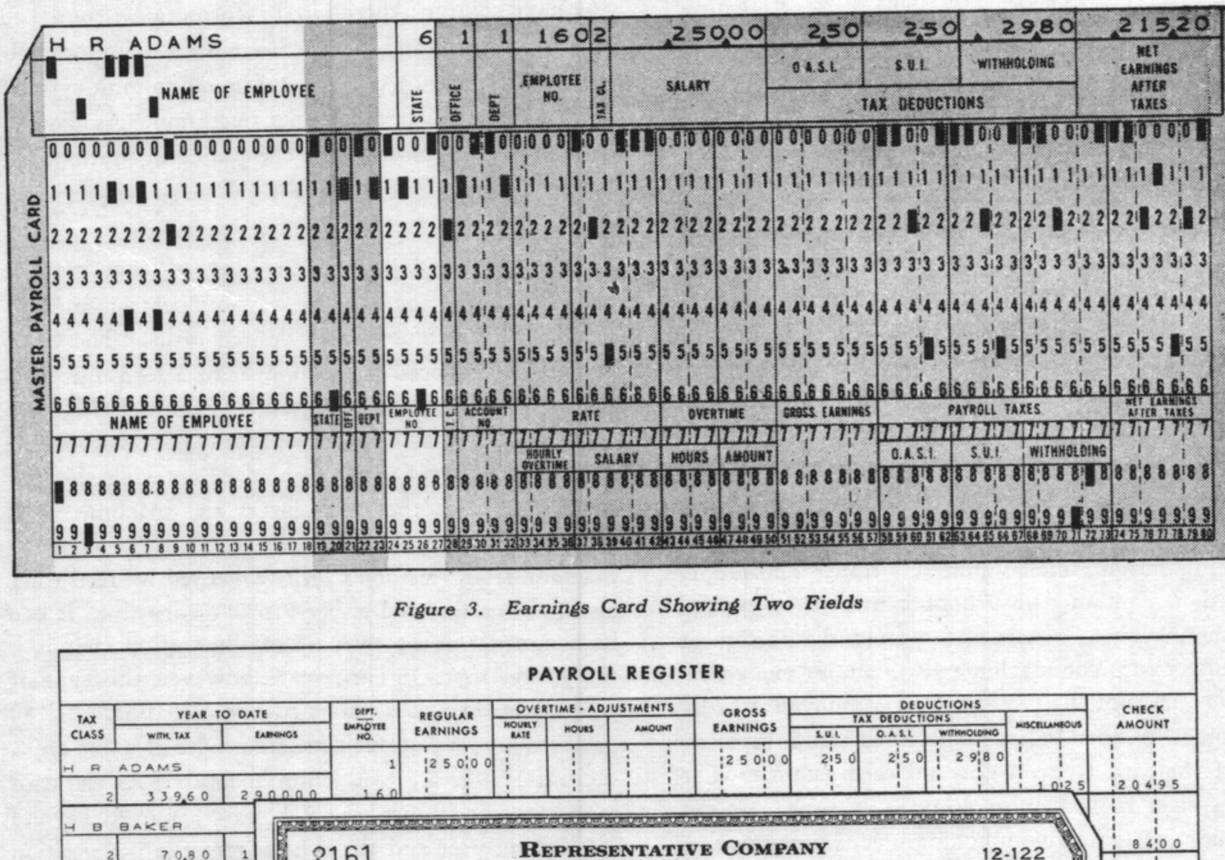


Figure 3. Earnings Card Showing Two Fields

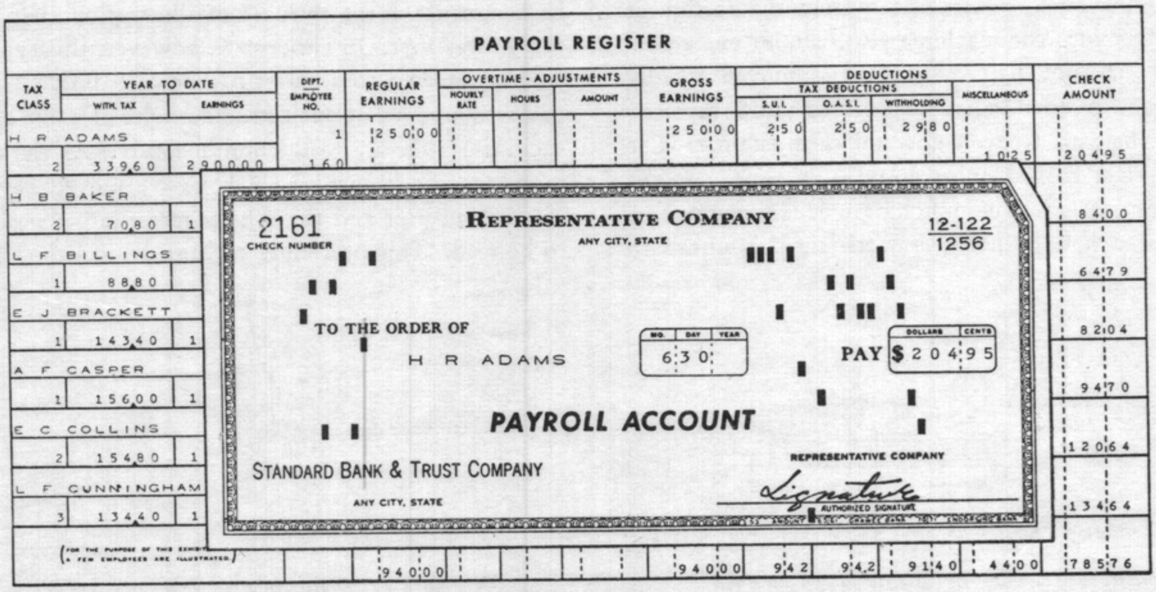


Figure 4. Payroll Register and Check

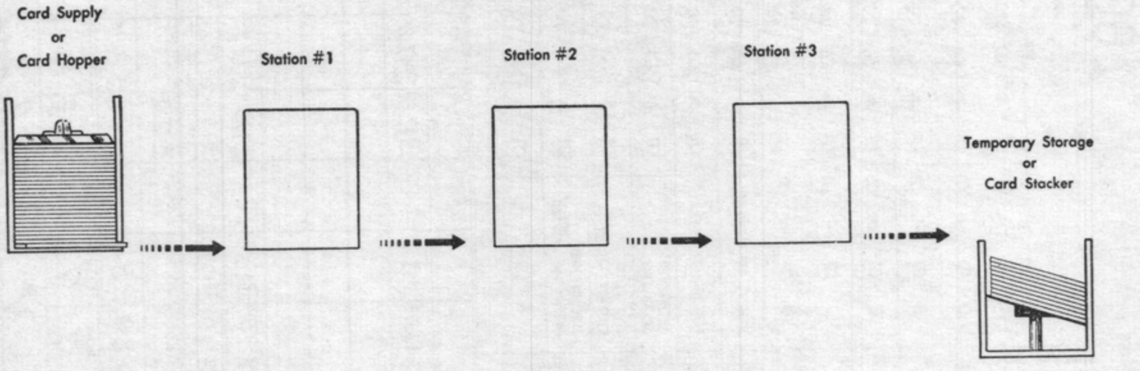


Figure 5. Components of a Card Feed

CARD FEED UNIT

BEFORE information can be punched, sensed, or printed, the card must be moved to a punching or sensing station of a machine. A means for moving the card is provided by a card feed unit, which will also contain operating assemblies, such as punching or sensing stations. The card feed unit, therefore, becomes the first functional unit to be studied.

In addition to this primary objective of the card feed unit, it must also perform the following: contain a supply of cards for the machine, draw from that supply one card at a time, and stack the cards in a temporary storage place after they have passed the operating assembly. Figure 5 is a schematic of a card feed unit showing the functions it must perform.

Figure 6 shows a feed unit used to feed cards past a punching station, one column at a time. The supply of cards is contained in a hopper until they are fed into the machine. A card is fed from the bottom of the hopper into the machine with column one entering the machine first. The card is moved rapidly and smoothly until it has been placed under the control of the card feeder right and card retainer. The card is then moved one column at a time past the punching station. The punching mechanism punches the desired hole or holes, and the card is moved to the next column; the desired information is punched in this column, and the card is moved one more column. This is known as a column-by-column type of feed unit as suggested by its operation. As soon as column 80 has moved past the punching station, the card is placed in the stacker by means of an eject mechanism.

After the cards have been punched, they may be removed from the stacker by an operator and arranged by machine in the desired order. The cards may then be placed in the hopper of a feed unit similar to the one shown in Figure 7. This feed also feeds cards from the bottom of the supply, but with either the top or bottom edge of the card entering the machine first. As the card enters the machine, it is gripped by feed rolls, and its movement through the machine from this point on is governed by feed rolls. Since the card is fed either 9 or 12-edge first, it can be assumed for the purpose of illustration that it is fed 9-edge first. In either case, however, this type of feed is referred to as digit-by-digit feeding. All 80 columns are read at one time, and holes of a like digit, such as all 9's, are read simultaneously. As the card movement continues, the 9 holes are moved beyond the sensing unit and the 8 holes move into a position to be read. This procedure continues until the entire

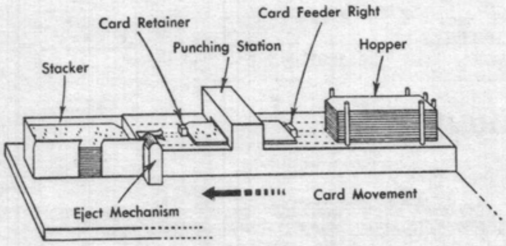


Figure 6. Column-by-Column Type of Feed

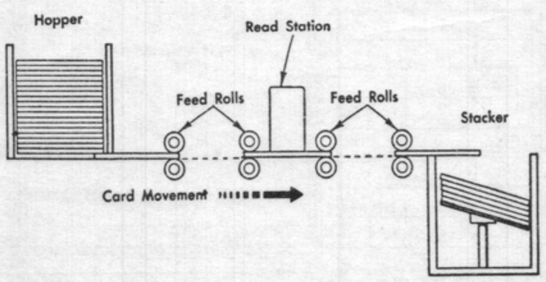


Figure 7. Digit-by-Digit Type of Feed

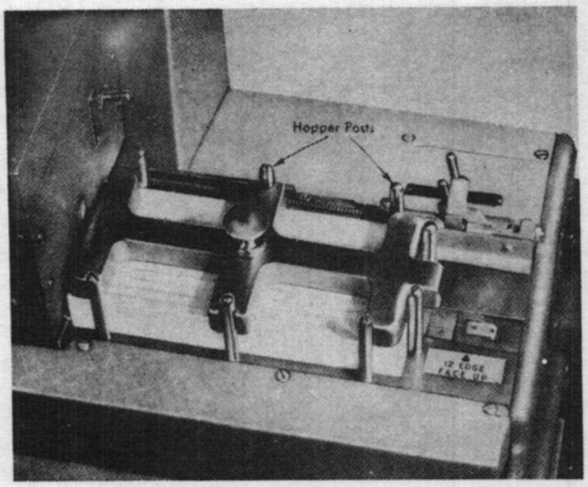


Figure 8. Hopper Used on Type 31 Card Punch

card has been read, but the card will continue to move until it reaches the stacker.

Many details of both types of feed units, column-by-column and digit-by-digit, and the principles of many adjustments will now be given in order to provide a more complete understanding of feeding mechanisms.

Card Feed Knife

When the cards are located in the feed hopper, it is necessary that only one card be picked and sent through the machine. The device used for picking the card is a card feed knife located in the feed hopper, shown in Figure 8. The feed knife moving in one direction engages the edge of a card, moving it into the machine. The feed knife then returns preparatory to picking the next card. The feed knife projection above the card surface of the feed knife block must be such that it will engage one card only. To insure proper feeding the projection must not be greater than the thickness of one card, or it would attempt to move two cards into the machine. However, the projection should be as great as is practical to prevent the knife from slipping under the card. The thickness of the card is .0065″, and the proper projection for the type of feed knife shown in Figure 9 is .004″ to .0055″.

Feed Throat

While the feed knife itself will engage the edge of one card only, the friction between cards will cause

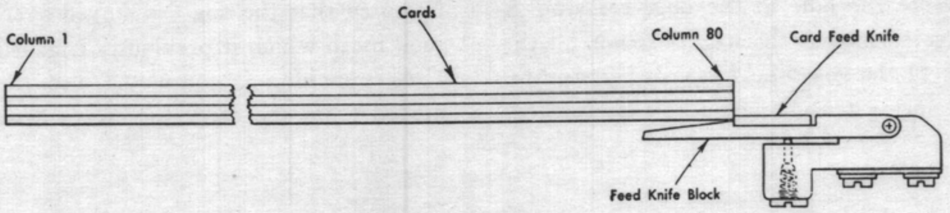


Figure 9. Feed Knife

COLUMN-BY-COLUMN FEED

FIGURE 8 shows a card hopper used with the column-by-column type feed just described. It consists of eight hopper posts which hold the cards in a position to be fed.

more than one card to be fed if some means is not provided to prevent it. The device used to overcome this is a throat, placed at the point where the cards attempt to enter the machine, which permits the passage of one card only. A throat of the type shown in Figure 10 consists of a throat knife and throat

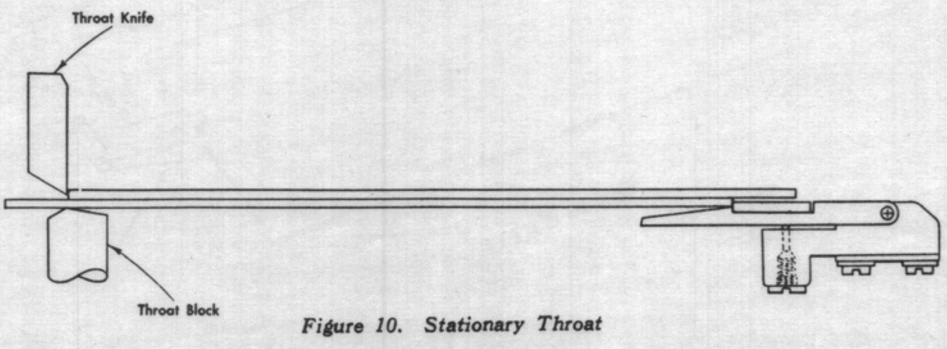


Figure 10. Stationary Throat

block. The throat block is adjustable so that the high part of the block is directly beneath the throat knife which is necessary to insure proper and consistent feeding. The throat knife is also adjustable to provide the proper clearance between the throat knife and throat block to permit one card to pass freely but not permit two cards to pass. The clearance between the throat knife and throat block should be .008″.

Feed Rack

When a card has been fed into the machine completely, it will be under the control of a feed rack. The card is held in position by means of a card feeder right and card retainer (Figure 11). The card feeder right actually positions the card, while the card retainer holds the card against the card feeder right under slight spring tension. The rack is under spring tension in the direction of the arrow, but is held in position by the dog engaged in a tooth in the rack.

The rack will space or move the card one column at a time, under the control of the dog and escapement. Figure 12 shows the dog holding the rack when the dog and escapement are in their normal position. The dog and escapement pivot about studs *A* and *C*, respectively. Note the hole in the dog, for stud A is slightly elongated so that the stud does not fill the hole. In Figure 11 the dog is held against the stud by the rack under spring tension. As a hole is punched, the escapement mechanism is operated, and the dog lever pin and pin *B* move together rotating counterclockwise about stud *A*. The dog lever pin lifts the dog out of the rack, but before the dog clears the rack tooth, the escapement moves down and engages a rack tooth preventing the rack from moving. The dog continues to be lifted clear of the rack teeth, and the rack load is then borne by the escapement. The dog, under spring tension and free to move

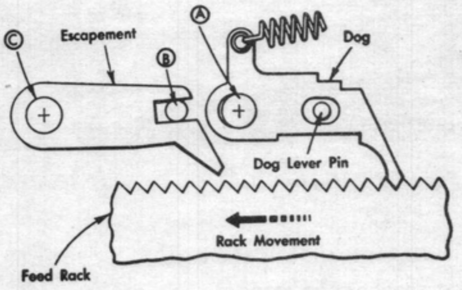


Figure 12. Dog and Escapement in Normal Position

within the limits of the hole, now moves to the right until stopped by stud *A*. Figure 13 shows the dog and escapement in the operating position. It should be noted that the dog has moved over the top of the rack tooth which it previously engaged.

As punching is completed and the punch is removed from the card, the escapement mechanism is

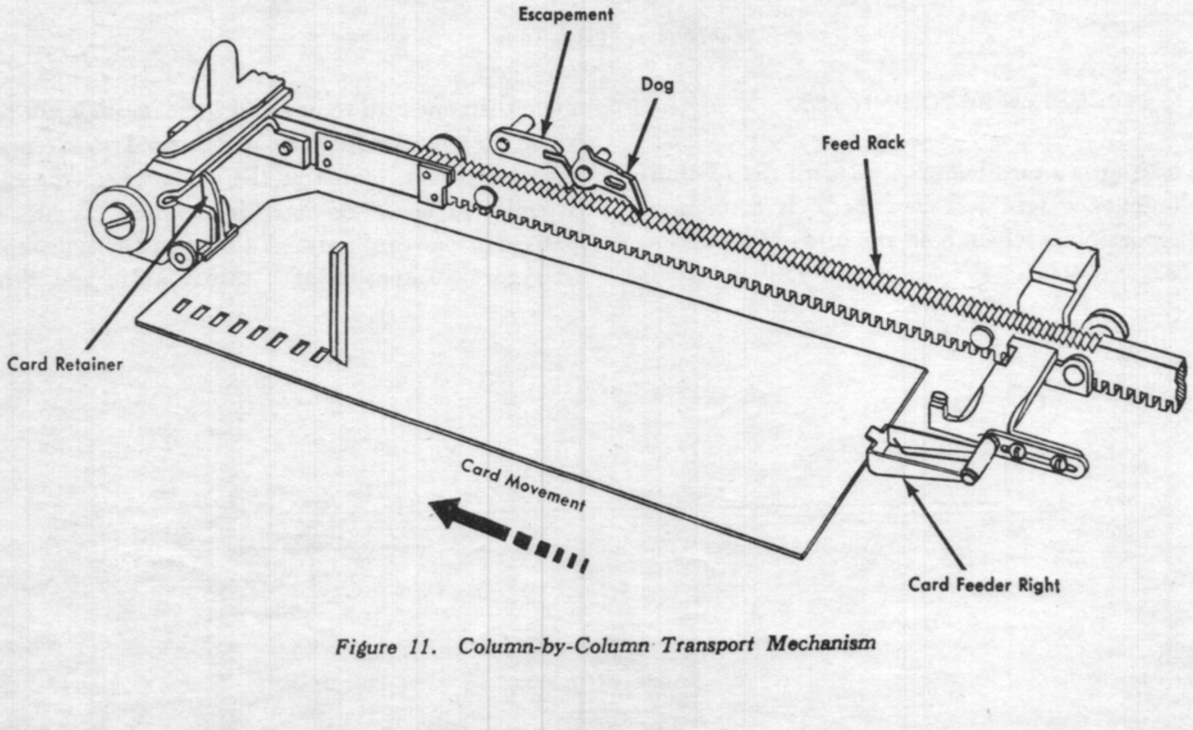


Figure 11. Column-by-Column Transport Mechanism

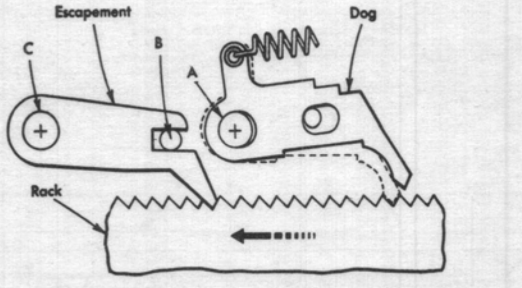


Figure 13. Dog and Escapement in Operated Position

permitted to return to normal. The dog is permitted to move down to engage a rack tooth, and the escapement is lifted from the rack. However, since the tooth on the dog now overlaps the tooth it previously engaged, it will engage the next tooth on the rack. This permits the rack to advance the card one column.

Card Stacker

It is desirable to place the cards in a stacker as soon as they have been completely punched. The ejector mechanism accomplishes this by picking the card from the card bed and placing it face down in the stacker. The eject mechanism is shown in Figure 14, and consists of a pair of card grippers, a latch for holding the gripper assembly in position to receive the card, a magnet for releasing the latch, a dash pot assembly to prevent ejecting too rapidly, and a rack and train of gears for relatching the card gripper after it has ejected a card.

The card gripper assembly is normally latched open in a position to receive the card as it spaces into the last few columns. When the card rack moves into the last column punching position, the card retainer left (Figure 14) operates against its release pin, and the card is held in position by the positive card stop. This is done to free the card and yet keep it in accurate registration for the last column punching.

After the last column has been punched, or if the card has been spaced or released beyond the last column, the last column contact is closed by the rack movement to energize the stacker magnet. The movement of the magnet armature causes the card gripper latch to release the card grippers, which close, hold-

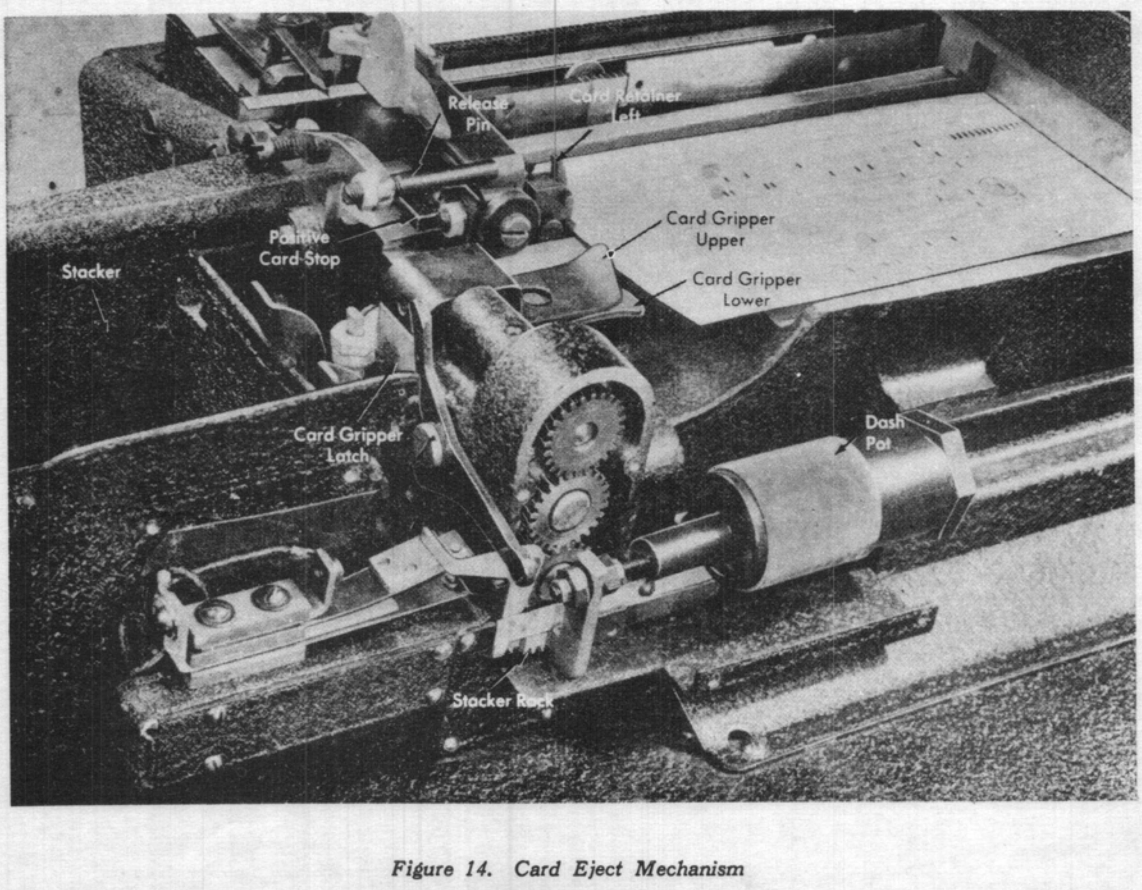


Figure 14. Card Eject Mechanism

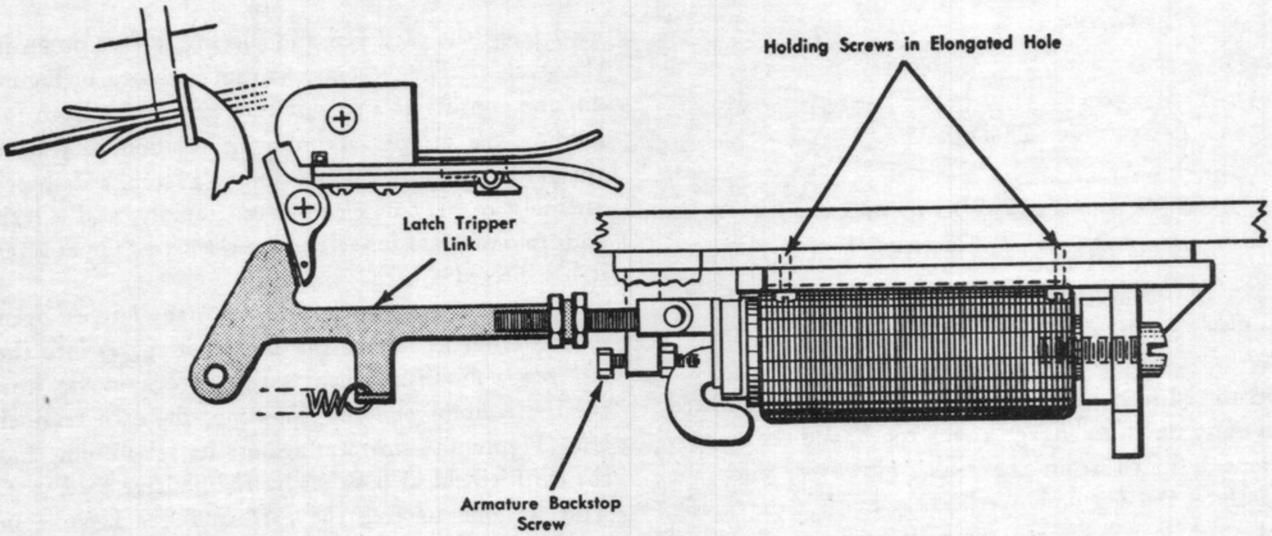


Figure 15. Eject and Stacker Mechanism

ing the card by spring action. The latch tripper link (Figure 15) also moves the stacker fingers to the right to clear the card while it is being ejected.

When the latch releases the card gripper assembly, the pressure of the spring operating against the stacker rack moves the card gripper assembly in an arc to the left until the card gripper opener stud left operates against a floating lever in the gripper assembly. This opens the card gripper jaws, releasing the card, which is guided into the card box by the return of the stacker fingers to their normal position. The explanation for the return of the stacker fingers follows.

As the stacker rack reaches the limit of its travel to the right, it operates a bell crank which closes the auto start contact. This contact completes a circuit to the trip magnet and automatically starts a new card feed cycle.

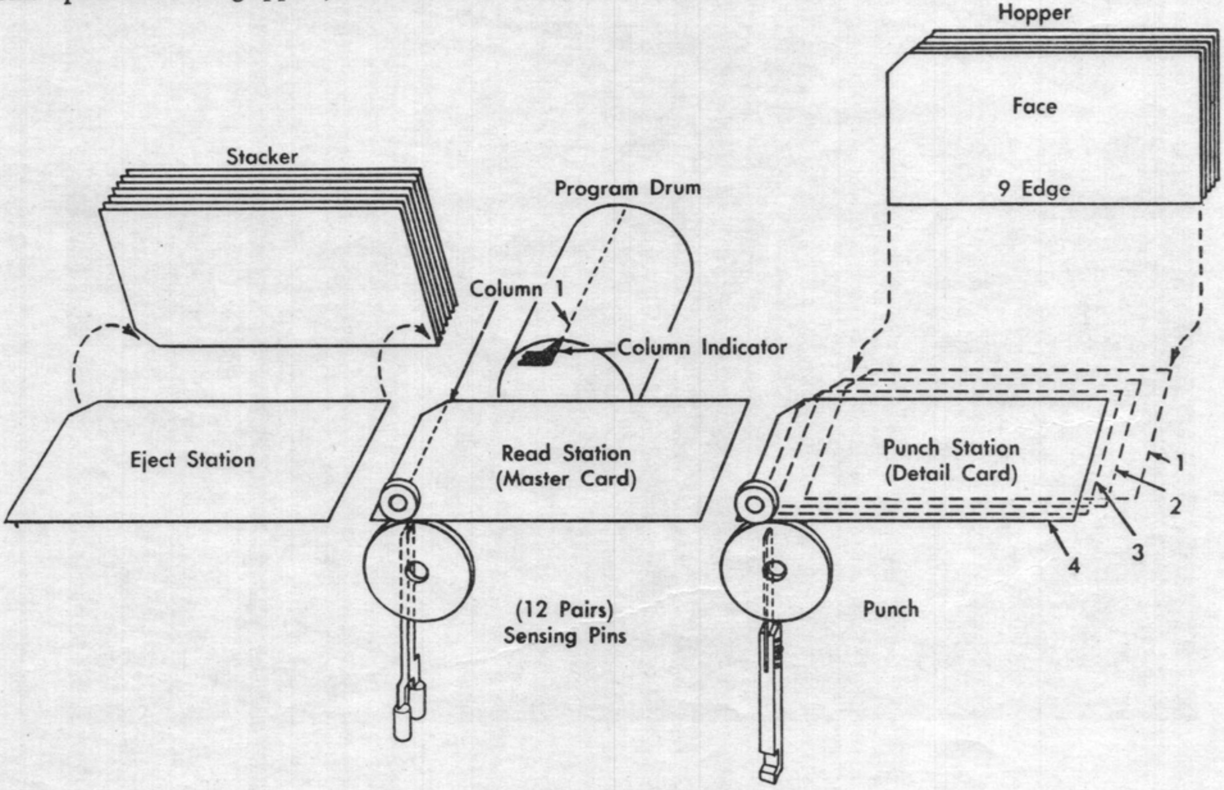


Figure 16. Card Path through Machine

As the card rack returns to the right from the last column at the beginning of the feed cycle, the stacker magnet circuit is opened by the opening of the last column contact, allowing the card gripper latch and the stacker fingers to return to their normal positions. This kicks the cards from the card grippers. As the card feed rack nears the end of its feeding stroke, it operates against the plunger in the right end of the stacker rack and through the gear train returns the card gripper assembly to its normally latched position. The latch spring pulls the latch into position, and the card grippers are again ready to receive a card.

An adjustable dash pot causes a smooth card ejection without unnecessary rebound of the card gripper assembly on the card gripper opener stud left. The dash pot consists of a piston in a cylinder which tends to compress air as the stacker rack moves to the right. A slow escape for the air provides the means of governing the ejection speed.

Card Feed Unit

Card feeding in the Types 24-26 is quite different from that in other older types of IBM punches. Under normal operating conditions two cards are in the punch station at all times. By registering the second card shortly after the first card is punched in column 80, three-fourths of the feeding time is saved. Figure 16 shows the card path from the feed hopper to stacker. On the first card feed cycle a card leaves the hopper, passes through stage 1 and ends at stage 2. On the earliest portion of the second card feed cycle, a card is aligned at position 3 and pushed to 4 preparatory to punching.

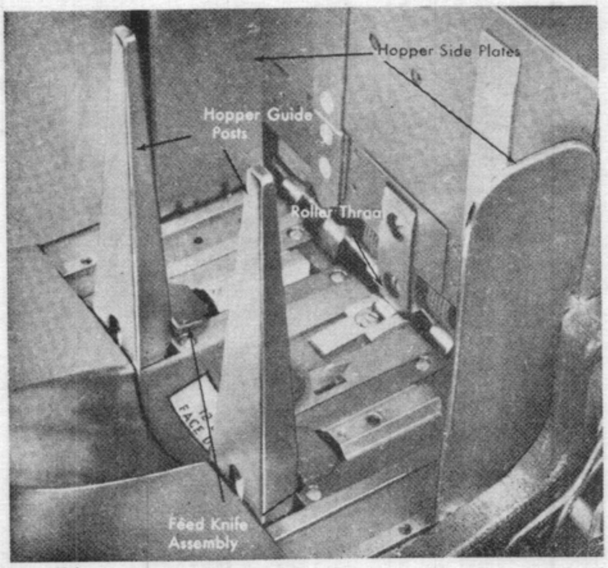


Figure 17. Feed Hopper

Attention is called to the column at which cards are registered in Figure 16. The program drum and master cards are standing in column one while the detail card is in column zero. It can be seen why lower left corner cut cards should not be used. While cards are advancing through the punching and reading stations, they are held and moved by a large feed roll underneath the card and a smaller pressure roll on top of the card. These two rolls grip the card at its bottom edge. If lower left corner cut cards were used, these feed rolls would be unable to grip the card, especially in the punching station where the card is registered in column zero.

DIGIT-BY-DIGIT FEED

Figure 17 shows a typical hopper used in digit-by-digit type feeds. It consists of two feed knife assemblies, one roller throat, two hopper guide posts, and two hopper side plates.

Feed Knives

The feed knives (Figure 18) are different in construction from the feed knife in the previous feed. However, in principle they operate in the same manner with an oscillating motion, and the knife will engage and feed one card only. The knife slide adjusting screw provides an adjustment to bring the knife back far enough to be sure it gets behind the card after the card is stopped by the hopper guide posts.

Feed Throat

The throat used with this type of feed knife is also slightly different in construction. Figure 19 shows a feed knife feeding a card through a roller throat into a set of feed rolls. The throat knife is very similar to the one studied, but instead of a block, a roller is used to form one side of the throat. The knife itself

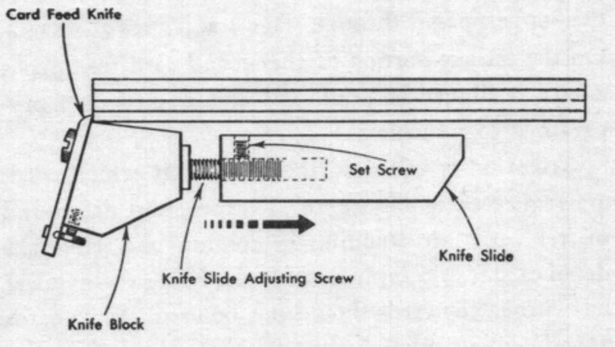


Figure 18. Feed Knife

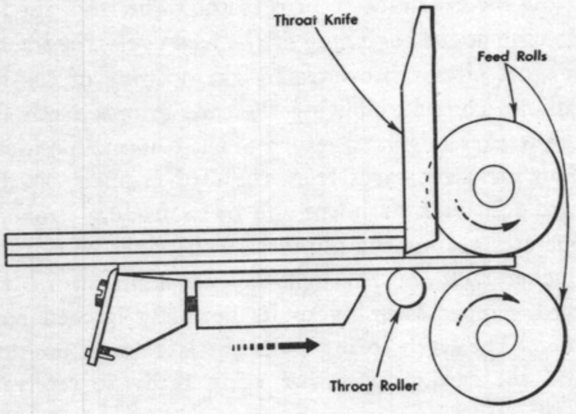


Figure 19. Roller Throat

is adjusted vertically to provide the proper throat opening which should be .010″ for this type of throat. The roller may be moved to insure that the high position of the roller is directly beneath the throat knife.

Hopper Guide Posts

The hopper guide posts form one side of the hopper and serve as a guide for the cards as they settle in the hopper to a position to be fed. They also prevent the cards from moving away from the feeding mechanism when the knife returns to pick another card.

Hopper Side Plates

The hopper side plates are adjustable from side to side by means of elongated screw holes so that the card may be shifted to cause the holes in the card to be aligned to the subsequent mechanism.

Feed Rolls

As the cards are fed from the hopper into the machine, they are placed under the control of feed rolls. Feed rolls are used to move the cards through the machine to the operating stations and on to the stacker. The first set of feed rolls gain control of the card movement before the feed knives lose control as seen in Figure 20. The feed rolls are so spaced that before one set of feed rolls loses control of a card the next set grips it. This positive control continues until the card has passed all stations and is stacked.

Feed rolls are of varying size and materials (Figure 21) to meet the requirements of the existing conditions. Rubber rolls are used where more gripping surface is required due to speed, and phenolic rolls are used where a nonconductor is required. Steel is used in most cases where no unusual requirements are made; in some cases combinations of materials are made.

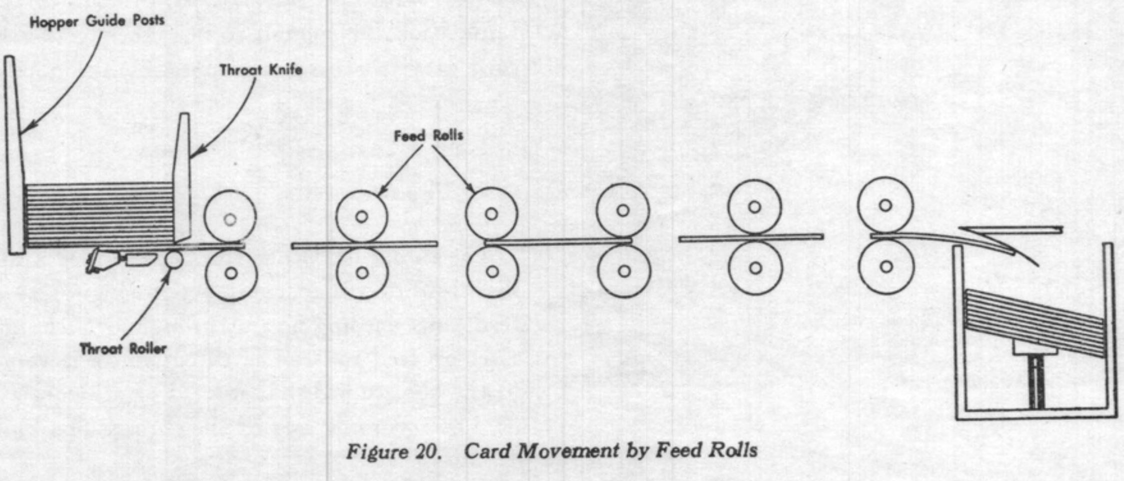


Figure 20. Card Movement by Feed Rolls

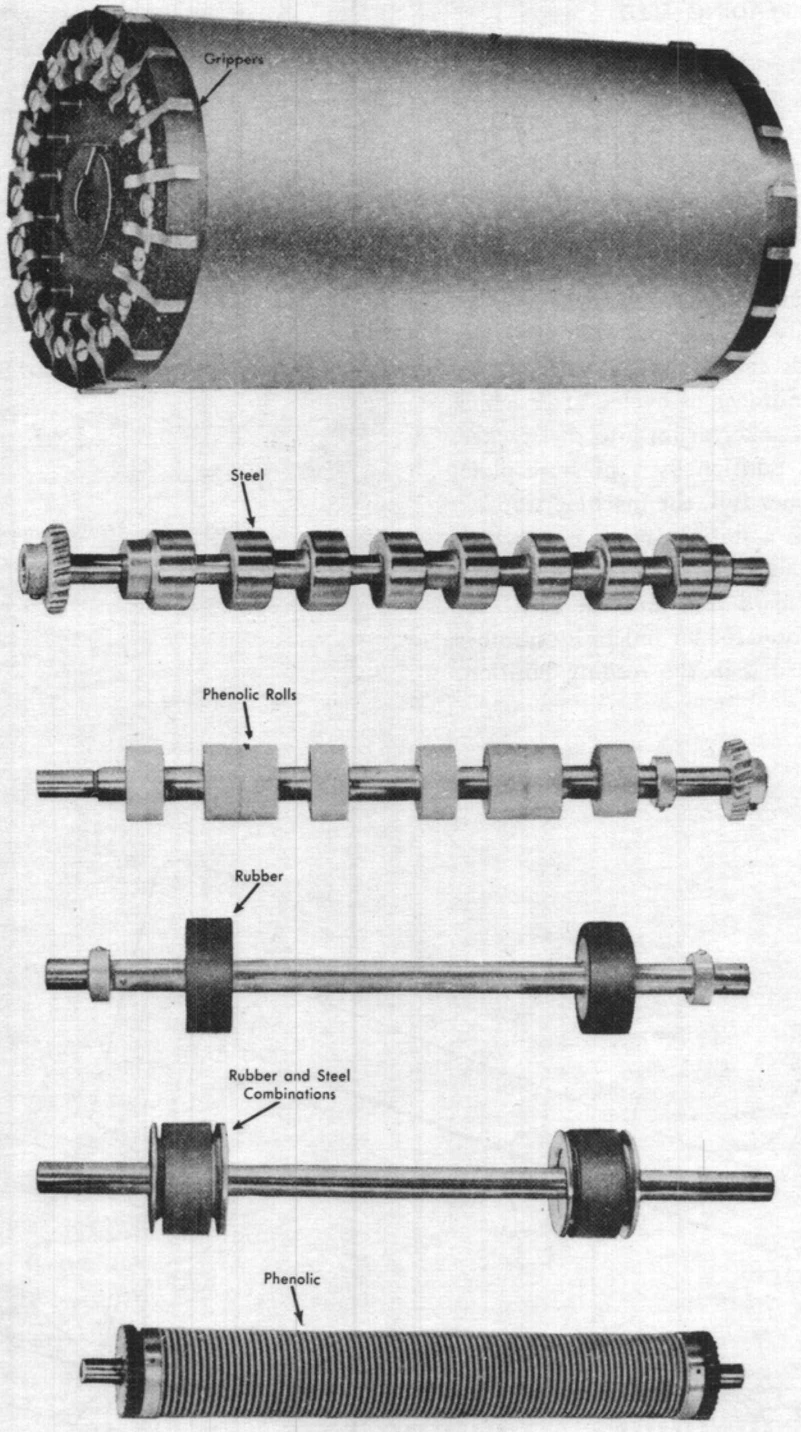


Figure 21. Types of Feed Rolls Used

STATIC READING FEED

Feed Unit of the 407

Cards are placed in the hopper (Figure 22) with the 9-edge toward the throat. They feed into the machine from the bottom, under control of the feed rolls. The hopper holds approximately 1,000 cards. Each card in turn is positioned at the first, then at the second reading stations by means of card grippers which move horizontally as indicated by the arrows in Figure 23. The cards can be held at the reading stations for any given number of cycles, after which they move around the stacker drum into the stacker, where they are held in position by a pressure plate. When the stacker becomes full, the machine stops.

The card feed unit is a static reading unit which provides for single and multiple line reading (Figure 23). With this type of card feed unit the card may be held in reading position for an indefinite number of cycles. While the card is in the reading position,

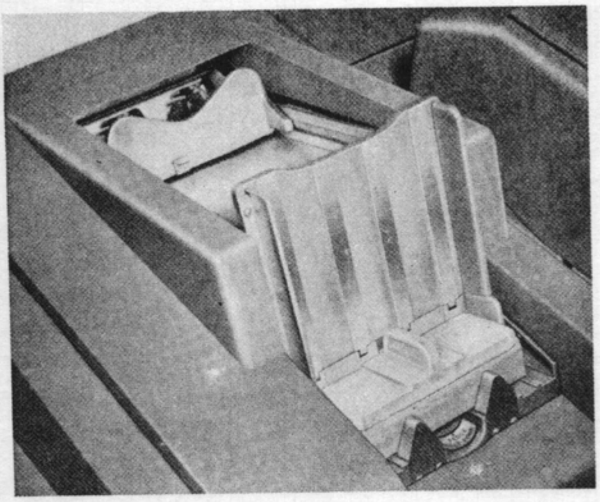


Figure 22. Hopper and Stacker

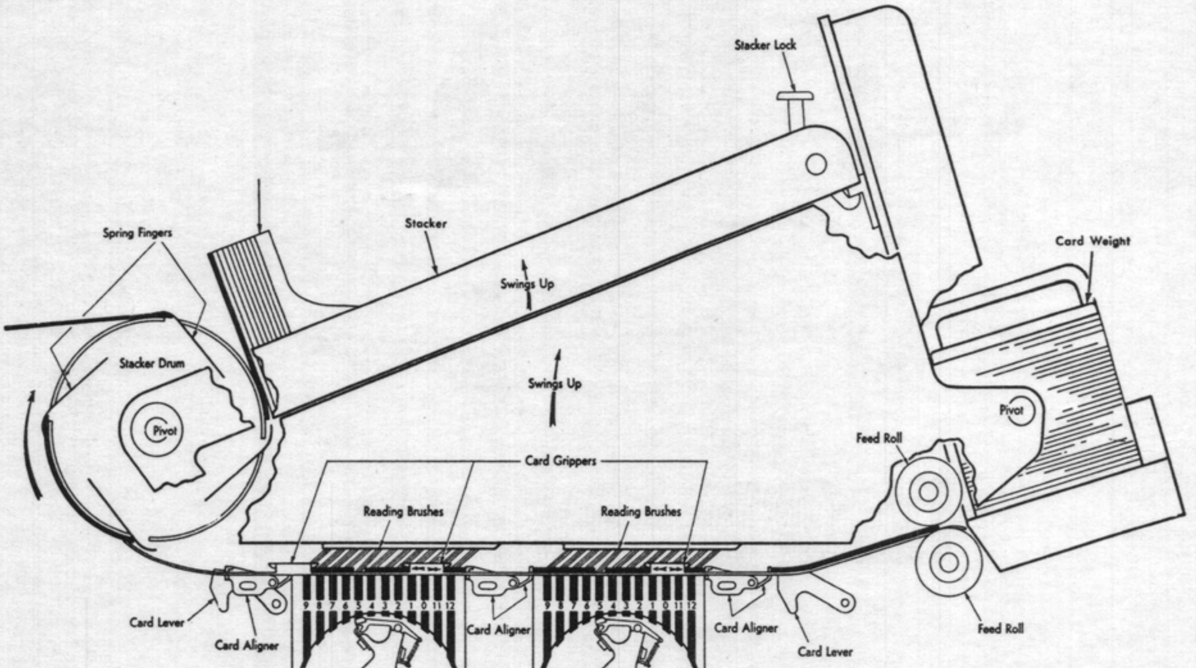


Figure 23. Feed Unit Schematic

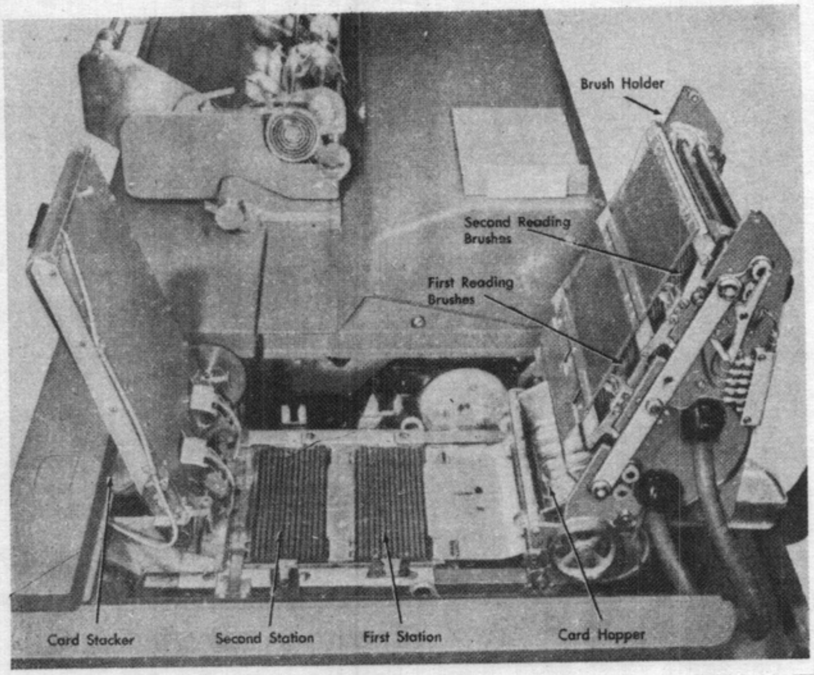


Figure 24. Feed Unit

960 brushes are in contact with the card, one brush for every possible hole in the card. A commutator assembly reads the holes as long as the card remains in position. This arrangement facilitates a method of crossfooting several amounts from a single card, as well as printing name and address on separate lines from a single card. The feed has two sets of brushes to provide a means of controlling for particular operations and for groups of cards. The card picker knives, which move the cards from the hopper, and the card grippers, which move the cards through the brush stations, are operated independently of each other. This keeps the cards in step if a card fails to feed from the hopper.

Access to the cards after they have left the hopper may be obtained by first depressing the stacker lock, then raising the stacker itself, which swings toward the back of the machine, and raising the brushes which swing toward the front of the machine. The cards may then be easily removed from the machine by hand. The brushes which normally protrude slightly below the brush separator (pressure plate) recede into the separator when it is in a raised position; this prevents any possible damage to the brushes (Figure 24).

CARD SENSING

The most common method of sensing in use in present types of IBM machines is to read the holes in the card electrically by means of brushes. There are many brush types designed to read a hole under as many different conditions. However, the most common type of brush found in current machines is the three-group brush. Figure 25 shows a brush of this type which consists of a die cast ferrule which holds three groups of wire strands with six strands per group. It can also be seen from this figure that as a card passes a brush of this type, it first encounters the heel of the brush, the short strands, and as it continues to move it encounters the toe, or long strands.

When a brush encounters a hole in the card, the brush strands drop through the hole onto the contact roll. This makes an electrical connection between the brush and the contact roll. Figure 26 is a theoretical circuit which shows how the brush contact initiates action. The brush permits the circuit breaker to complete the circuit to the punch magnet. The energizing of the punch magnet results in the actuation of the punching mechanism. A three-group brush is held in place by a brush clamp screw and nut, and

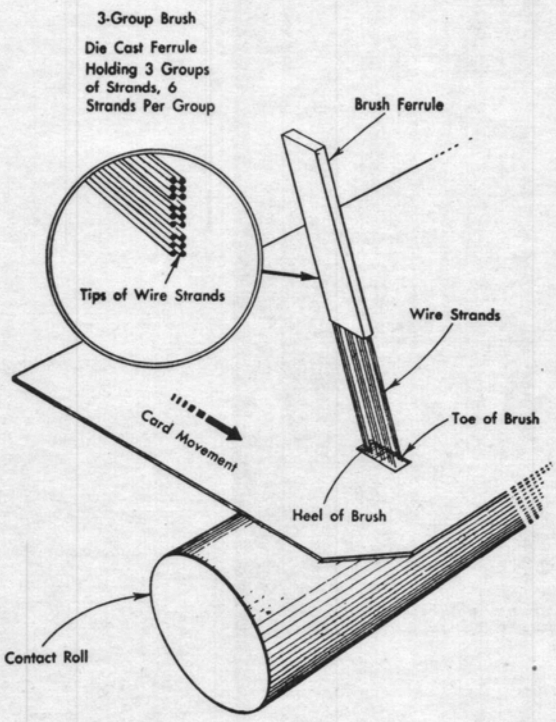


Figure 25. Brush, Card and Contact Roll

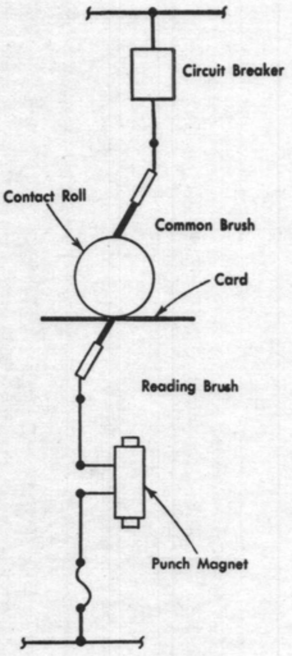


Figure 26. Theoretical Brush Sensing Circuit

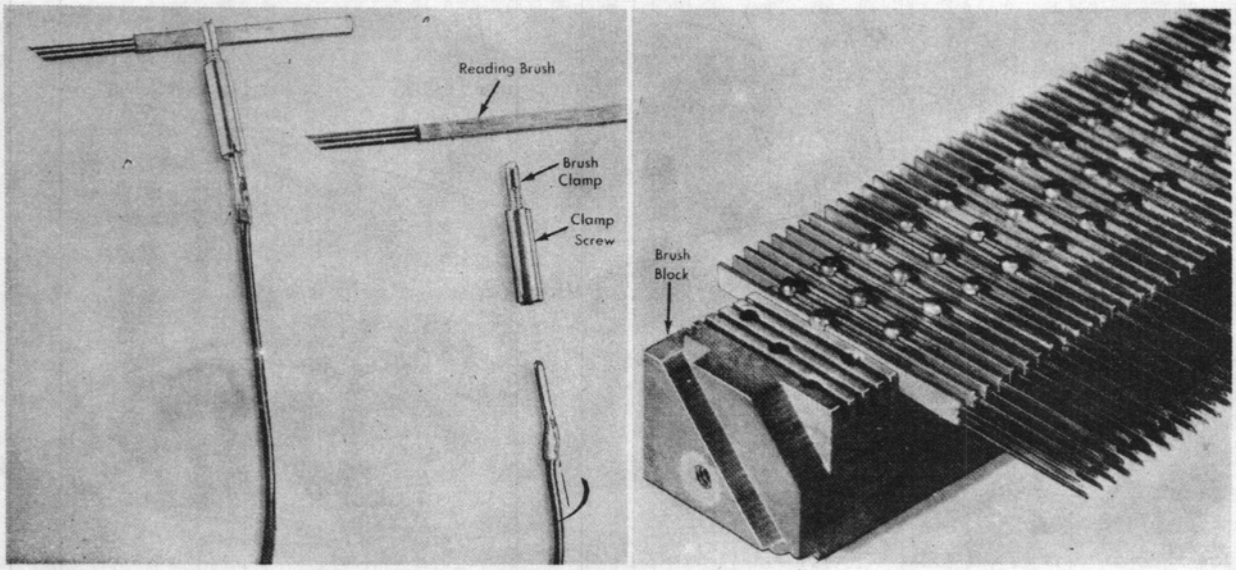


Figure 27. Brush, Brush Block, and Circuit Connections

a brush holder as seen in Figure 27. The electrical connection to the brush is made through the brush clamp screw and nut, and a wire lead which has a plug on the end, fits the hole in the nut.

In a digit-by-digit type feed, the brushes are held together by means of a brush block which contains 80 brushes. However, each brush has its own clamp screw and nut, and individual circuit connection. A card passing a set of brushes such as this can be completely read by passing the brushes only once. As each brush reads its respective column, it completes a circuit from the contact roll through the reading brush to a particular magnet or relay and on to one side of the line. However, since that circuit must also be completed to the other side of the line, regardless of which brush completed it, a connection is made by means of a common brush to the contact roll. The common brush is situated physically so that the card will never pass between it and the contact roll and a connection will always exist between the contact roll and one side of the line through the circuit breaker.

Card Reading of the 407

The complete sensing assemblies consist of 80 individual sensing bar assemblies as shown in Figure 28. These individual sensing bar assemblies consist of 12 dual groups of music wire which are cast in one mould, thus making the 12 groups common to each other. Each dual group of music wire on the individual sensing bar assembly consists of two separate wire groups for reading one hole in the card. Each one of the sensing bar assemblies is used to read one column of the card. Consequently, 80 individual sensing bar assemblies are needed for each sensing station to read all 80 columns of the card. This calls for a total of 960 dual wire groups for each sensing station. Each of the 80 individual sensing bar assemblies are insulated from each other. Consequently each column is insulated from the adjacent positions but the 12 dual wire groups of one individual assembly are common. It is still possible to get a definite value from a particular column, however, because of the *time* that the impulse is received through the sensing bar and the fact that the columns are insulated from each other.

After the card is positioned at one of the sensing stations and is held by the pressure plate, the holes in the card are read by the commutator rotor (Figure 29) which sweeps past the commutator stators. The commutator rotor is continuously turning regardless of the operation of the gripper clutch. This is necessary if one card is to be read for more than one cycle.

The commutator rotor assembly is common so that all 80 positions are "hot" at the same time. This makes it possible to have one connecting wire on one collector ring for the entire assembly. The impulses that are used are from the sensing bar hubs and correspond to the columns of the card; since the columns are insulated from each other, the impulse will be completed to the hub only when a hole is punched in

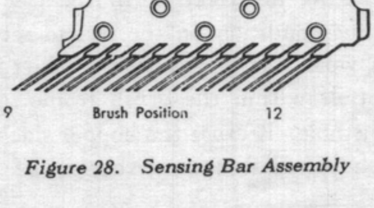


Figure 28. Sensing Bar Assembly

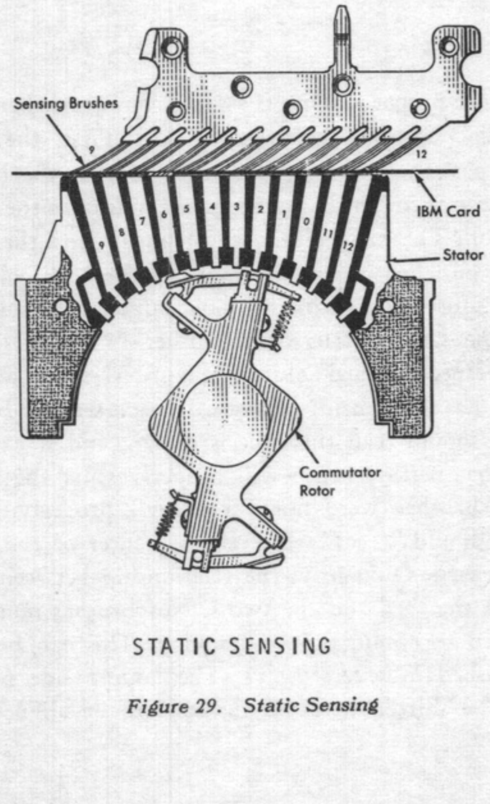


Figure 29. Static Sensing

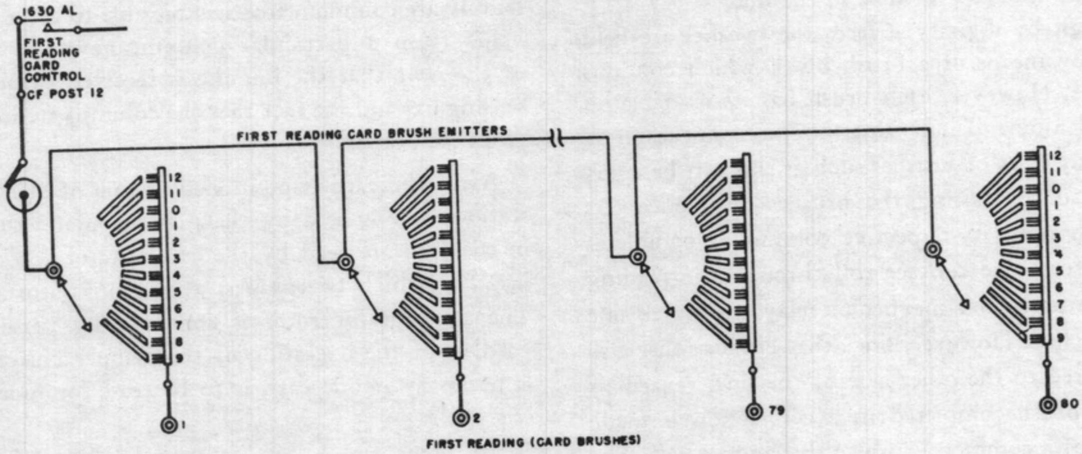


Figure 30. Reading Card Brushes

the card for that column and at a time corresponding to the value of the hole punched. Thus the cable to each sensing station consists of one wire to the commutator rotor through the collector ring and 80 wires to sensing bars, one for each column (Figure 30).

Brush Tracking

Before proper reading is assured, however, there are several conditions which must exist. First, the hole must pass the brush in alignment so that the brush will drop through the center of the hole onto the contact roll. The first column brush must drop through a hole punched in column one, and the 80th column brush must drop through a hole punched in column 80. The same is true of the other 78 brushes and their respective card columns. Figure 31 shows a feed which has two sensing stations. In each set, the brush which should read this hole is shown, and it can be seen that neither brush will properly sense the hole. These brushes were not "tracking" properly. The brush should "track" through the center of the hole in the card. Obviously, the relationship between the hole in the card and the two sets of brushes must be changed to obtain proper tracking. This can be accomplished in several ways. The hopper side plates could be shifted to cause the hole to be aligned to

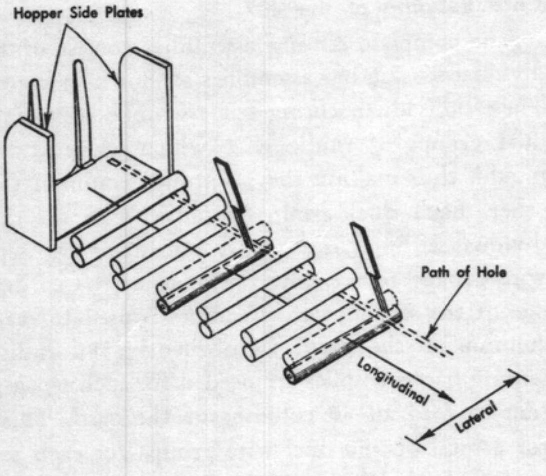


Figure 31. Brush Tracking

one set of brushes. This will also change the relationship of the other set of brushes, but they may still be tracking incorrectly. In the case shown in Figure 31 the condition on the second set would be made even worse. It is necessary to shift the second brush set itself within the brush frame to align the brush to the hole. Because the hopper side plates may have been adjusted to cause either set of brushes to track properly, both sets of brushes are adjustable laterally. There are brushes in some machines which are not adjustable laterally; this necessitates the adjustment of the hopper side plates to those brushes. Any other brush sets in the feed must then be aligned to the hole. If all but several brushes are tracking correctly, the brush ferrules should be formed with a brush bending tool to provide proper tracking of the few which are out of alignment.

Brush Tension

With the brush tracking properly, the second necessary condition is that the brush have sufficient tension to cause the brush to drop through the hole in the card and make good, firm contact against the contact roll. Figure 32 illustrates the three general conditions of brush tension: correct brush tension, too little, and too much brush tension. Brush tension is governed by the length of brush projection above the brush separators. If there is a given clearance between the brush separators and the contact roll, the greater the brush projection the greater the brush tension will be. In general, brush projection will be 1/8″ above the brush separators.

Brush Position

Still another condition to be considered is the position of the brush with respect to the centerline, or high point, of the contact roll. For the best possible contact conditions, the center of the brush should be on the high point of the contact roll. If the brushes are too far to the left or right of this point, either the heel or the toe will not be making properly and may result in burned brushes and contact roll. Figure 33 shows the brush position in relation to the contact

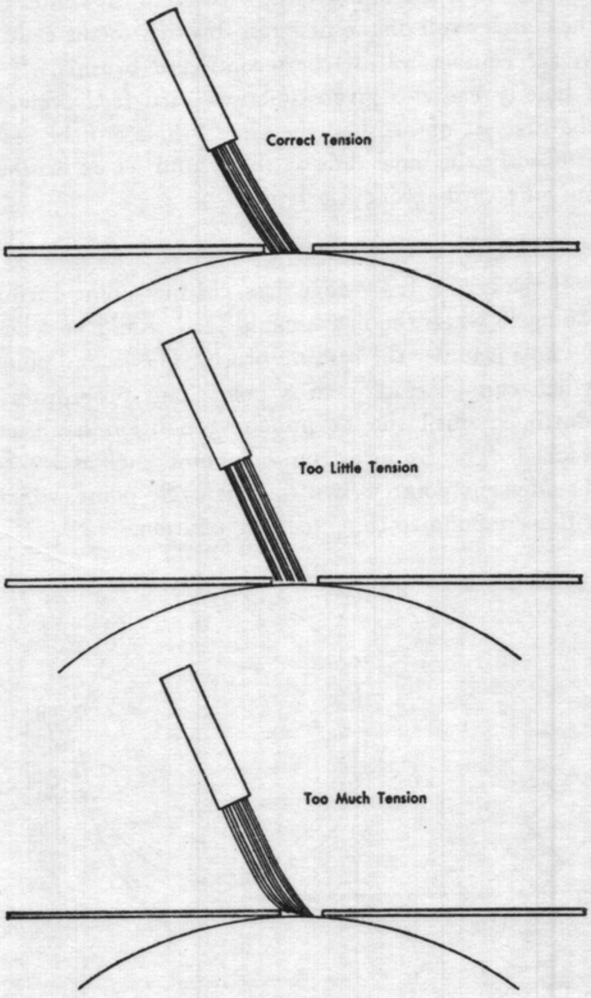


Figure 32. Brush Tension

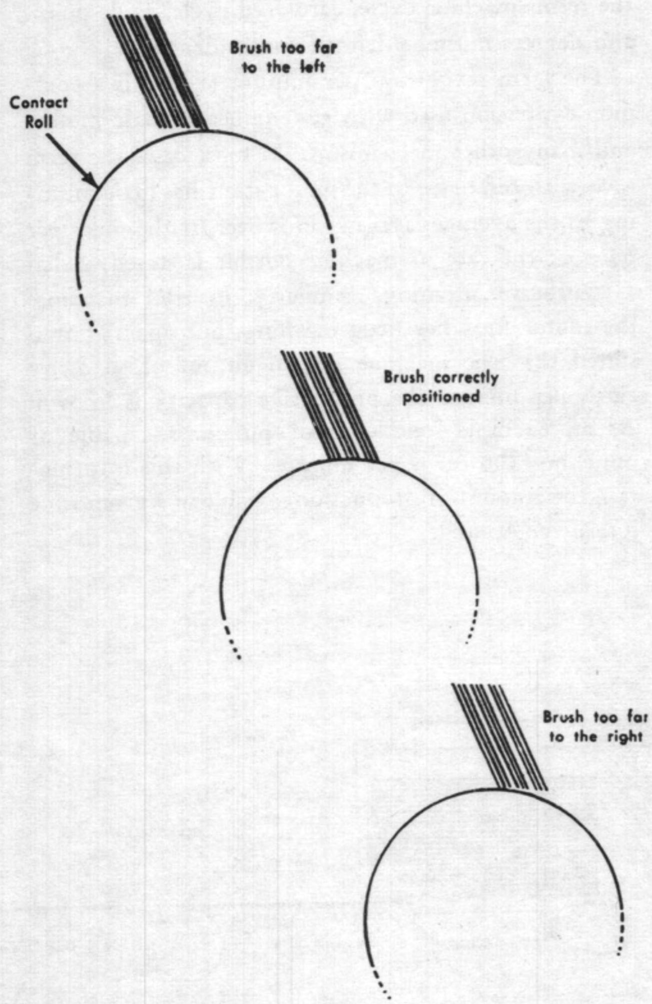


Figure 33. Brush Position

roll. The brush separators are scribed with a line to indicate the position of the heel for best contact condition.

TIMING

IF THE IMPULSE is to be recognized and used by another mechanism, the brushes must be located to read a hole at the proper time. The impulse may result in a digit being printed, punched, stored, accumulated, or compared with another. The mechanism which receives the impulse must also be timed so that it will properly recognize the impulse. For this reason all mechanisms must be timed so that they move in synchronism when operating. The timing for other mechanisms will be considered as they are studied as a functional unit. Before brush timing is discussed, the terms machine cycle, card feed cycle, cycle point, and degrees must be defined and understood.

The term revolution per minute (RPM) is a common expression used with gas engines, electric motors and many other mechanisms. In most cases the term RPM with reference to the motor itself has little meaning to the average layman. However, if the miles per hour or the rate of machine output is stated, it has a significant meaning. Similarly, in IBM machines the motor RPM has little meaning, but again if it is stated that the machine has an output of so many cards per minute the productive capacity is known. As an example, one type of punch is capable of punching 100 cards per minute. With this information the amount of production possible in a given time is easily computed.

Cycle Definition

With respect to cylcs this information has another significance. It indicates that 100 times in one minute it starts and completes a sequence of operations. This sequence of operations is referred to as a cycle, and can be termed a machine cycle or a card-feed cycle. Because cards must be feeding so that punching can take place, it would be a card-feed cycle. A machine cycle is any cycle that the machine operates. It should be concluded that a machine cycle can, and does, often occur without it being a card-feed cycle, but for a card-feed cycle to occur, a machine cycle must be coincident.

During a card-feed cycle, a card will move a given distance in a given machine. If there is more than one operating station, such as two sensing stations in the feed, they will usually be spaced exactly one cycle apart. Figure 34 shows this relationship. It will take exactly one cycle to move the card from the center of the contact roll of the first read brushes to the center of the contact roll of the second read brushes. If a 5 hole is read at a given time in a card-feed cycle at the first set of brushes, the same 5 hole will be read at exactly the same time at the second set of brushes but one card-feed cycle later.

Cycle Point

If the card is fed 9-edge first, the first point during the cycle when the brush could read would be when a 9 hole is under the reading brush. The second point which can be read is an 8 hole. This procedure is continued until the 12 punching position has been reached. The distance from one point, such as a 9, to the adjacent point, 8, will be one cycle point, which will correspond to the punching position.

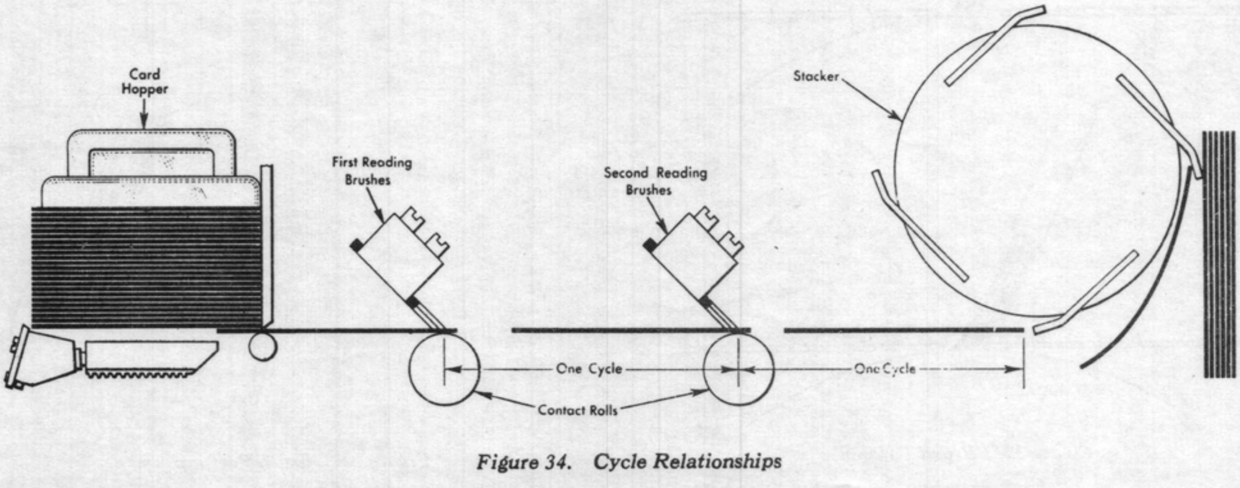


Figure 34. Cycle Relationships

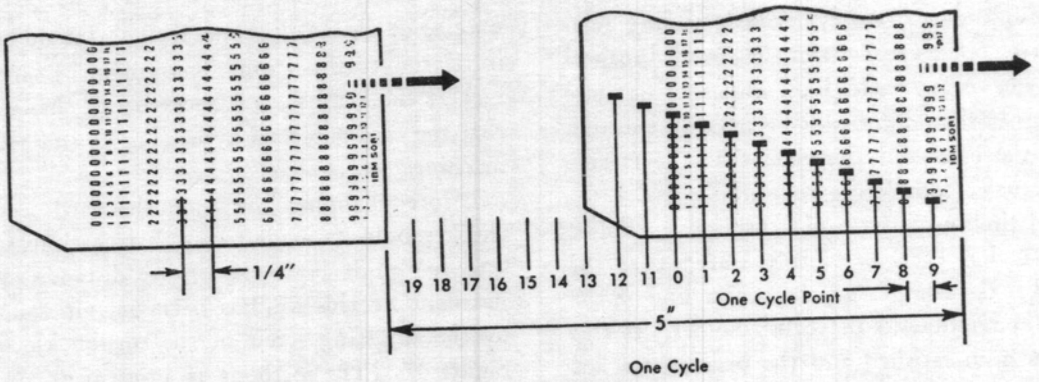


Figure 35. Cycle, Cycle Points, and Card Relationships

The distance between centers of adjacent punching positions is 1/4", which means that one cycle point must result in a 1/4" movement of the card. While there are 12 punching positions on the card, because there is 1/4" of card above and below the first and last punching position, the card is 3 1/4" from top to bottom. Because a cycle point represents 1/4" card movement, a card is equivalent to 13 cycle points. If cards were fed edge to edge, it would result in a cycle which would contain 13 cycle points. However, because some time is required to restore operating mechanisms to a normal position, a space is allowed between cards. To provide this time and space, the feed rolls are geared to move the card a distance greater than 3 1/4", and for this discussion assume it to be 5". This results in a distance of 5" between operating stations, 1 3/4" between cards, and 20 cycle points per cycle. For the 12 punching positions the cycle points will be identified with the corresponding digit. Figure 35 illustrates a 20-cycle point machine cycle and its relationship to card movement. The distance between cards, and as a result, the number of cycle points in a machine cycle, vary from one machine to another. However, the most common number of cycle points per cycle are 14, 16, and 20.

Degrees

Many mechanisms on a machine are timed to start or complete an operation at a specific time during a cycle. For this reason, an index is attached to the machine, and geared to make one revolution per machine cycle. The index is marked with graduations representing cycle points or degrees so that mechanisms can be timed to the index. An index with all 360 degrees indicated is in general use because a finer definition of timing is available. On a machine having a 20-cycle point machine cycle there will be 18 degrees per cycle point or per 1/4" movement of the card.

Figure 36 shows a timing chart which represents the machine index and timing relationships. The chart shown indicates a division both in cycle points

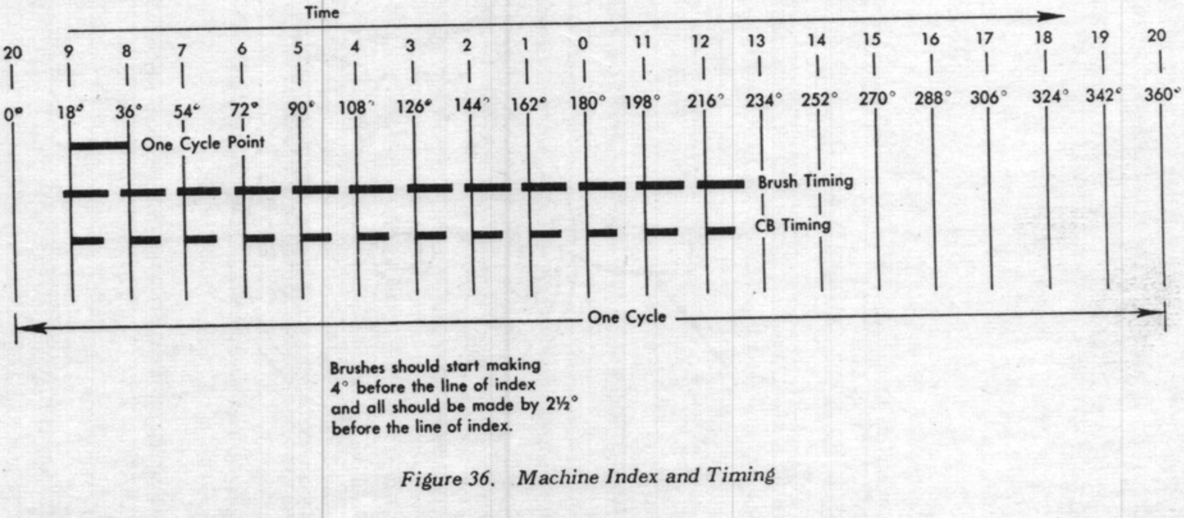


Figure 36. Machine Index and Timing

and degrees and shows one cycle. The timing relationships between the brushes and the circuit breakers are given. The heavy solid lines indicate the time that the brushes should actually be making through the hole in the card and the time that the circuit breaker is actually completing the circuit.

The actual timing of the read brushes can now be considered. It has been previously stated that the brush should make contact on the center line of the contact roll in relation to the brush holder. If this condition has been satisfied and the brushes are not making at the correct time, the hole should be changed in relation to the brush. To change the time the card reaches the brushes, it is necessary to change the time that the card is picked by the knives and fed into the machine.

Before changing the time the card is picked, a check should be made to see that the knives go back into the guide posts the proper distance. If an adjustment of this kind is necessary, it can be made by the adjusting screw or the turnbuckle shown by Figure 37. (The methods of adjustment available on

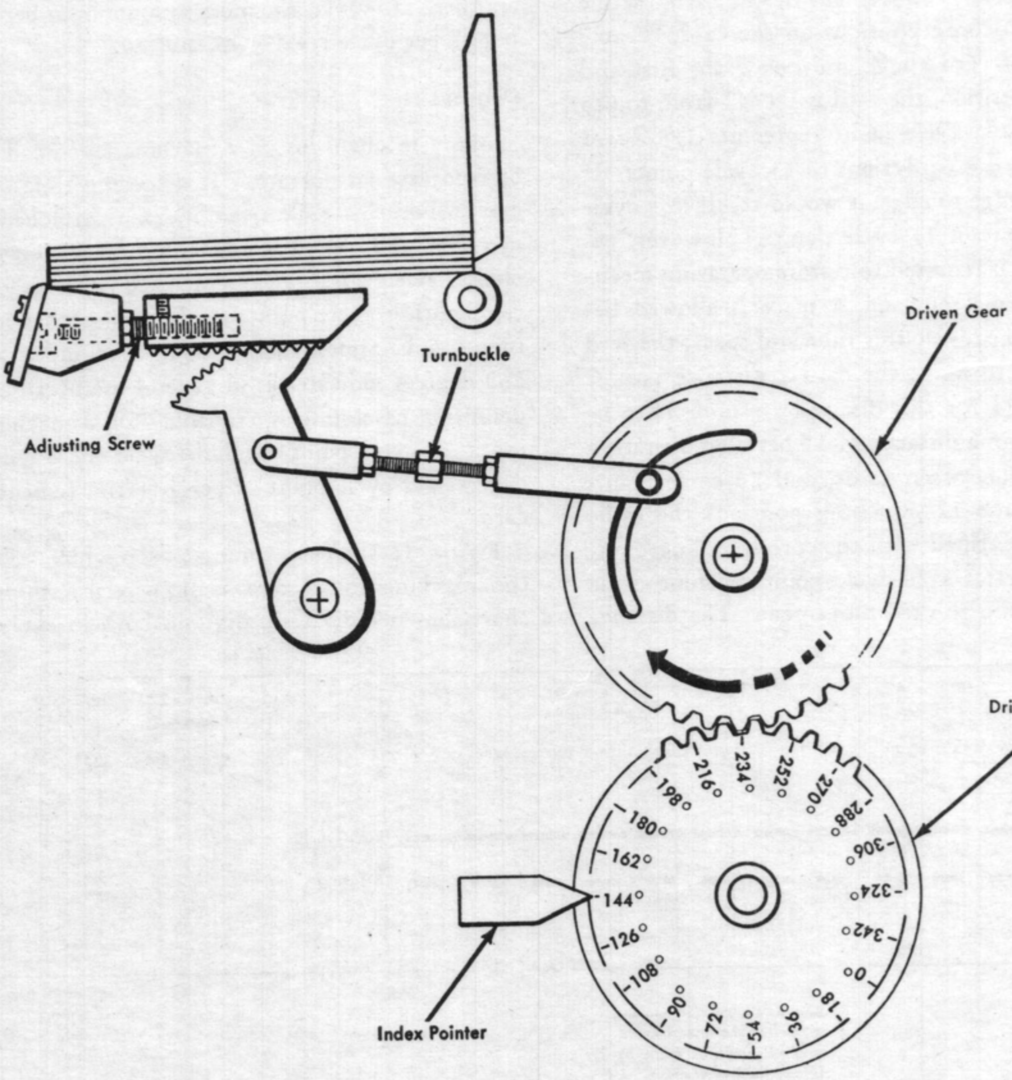


Figure 37. Methods for Timing Adjustments

this figure represent a composite of methods which exit on some machine, but no one machine has all of those shown.) This adjustment will shift the limits of knife travel and consequently the time the card is engaged by the feed knives, but does not affect the length of stroke. Because this adjustment does affect timing, it must be made first. Also at this time the cards should be checked to be sure that they are feeding straight. If the cards are feeding straight, both ends of the card will be engaged by the first set of feed rolls at the same time. One of the two adjusting screws should be adjusted to obtain this condition.

Knife Timing to Obtain Proper Reading

When all necessary adjustments have been checked or made and it is desirable to time the card movement, it can be accomplished by shifting the screw in the slot of the driven gear. This will not affect any other adjustment, the limits of feed knife travel, or length of stroke. In some cases it may be necessary to unmesh the driving and driven gear to make a change. Also, in some cases the change in time may be made with the adjusting screw if its travel into the guide posts is still within the permissible tolerance.

Where two or more sets of brushes are involved, the feed knives may be timed to cause proper reading at one brush set only. Because both sets have been set to the scribed lines, both sets should read correctly. However, if there is a variation, the second set may be shifted slightly to obtain the correct timing.

The factors necessary for proper brush sensing in flight are: brush tension, brush making on the center of the contact roll, brush tracking, and brush timing.

Stacker

After the cards have passed the reading station, or other operating station, the card is moved to a stacker. The stacker may be one of several types each of which is particularly adaptable to some machine or machines. There are three main stacker types which are listed below along with a description of each.

The *gravity type stacker* in which cards are thrown at high speed into a pocket and are permitted to settle on a spring balanced plate is one of the simplest forms. This device does not perfectly align the cards so that they may be inserted in a file drawer without jogging. However, this is not a serious disadvantage in some types of machines. The gravity type stacker

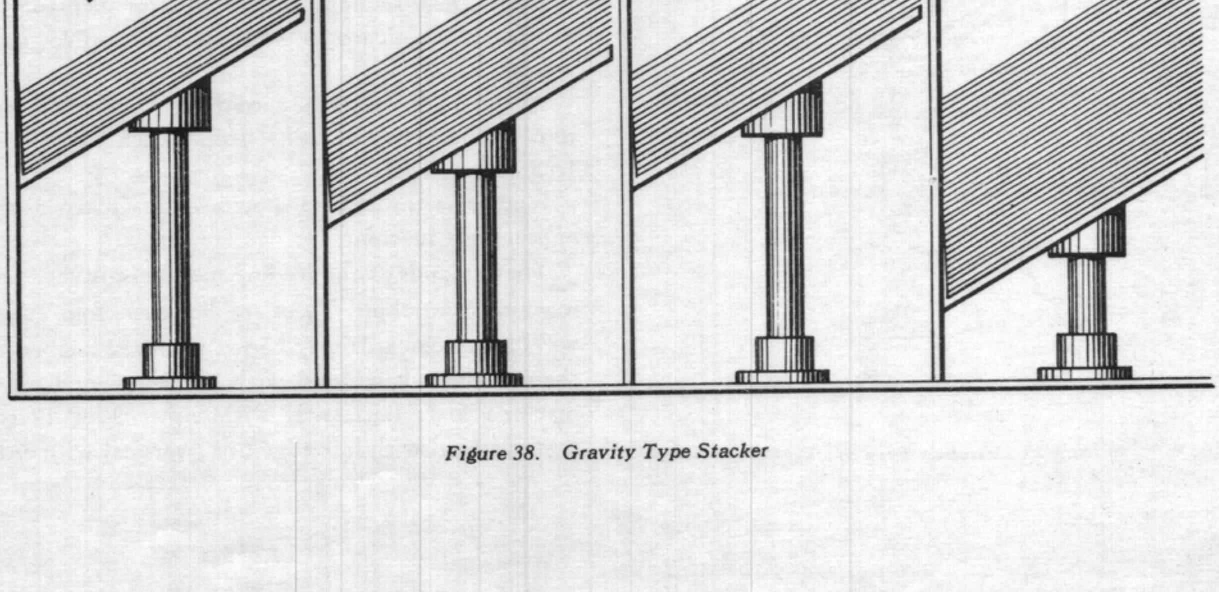


Figure 38. Gravity Type Stacker

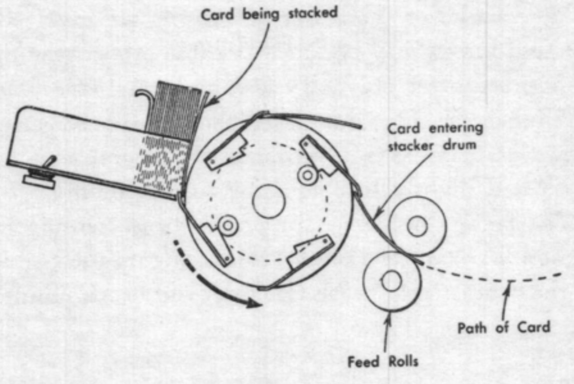


Figure 39. Drum-Type Stacker

does not operate well at low speeds because static electricity may cause the cards to adhere to one another before settling on the stacker plate.

The positive *drum-type stacker* is used on many types of machines. This drum stacker is equipped with fingers or grippers which positively engage each card as it passes from the station-to-station transport system. It deposits all cards positively and in a neat alignment on a stacker plate.

Friction-type stackers are employed in a successful manner on some machines, though they are subject to wear and subsequent misalignment of cards in stacking to a far greater degree than the drum stacker.

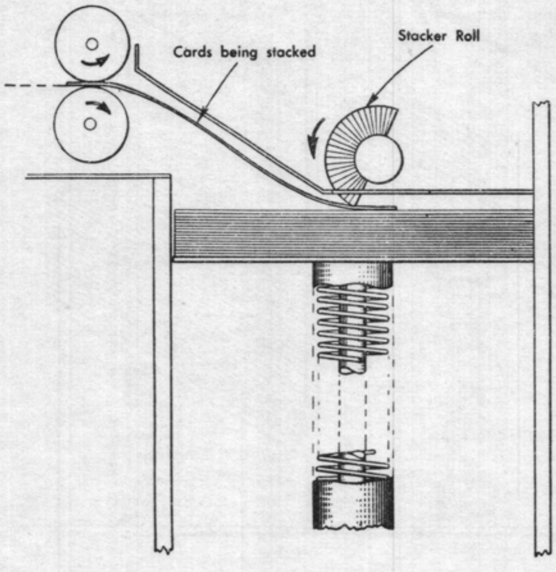


Figure 40. Friction-Type Stacker

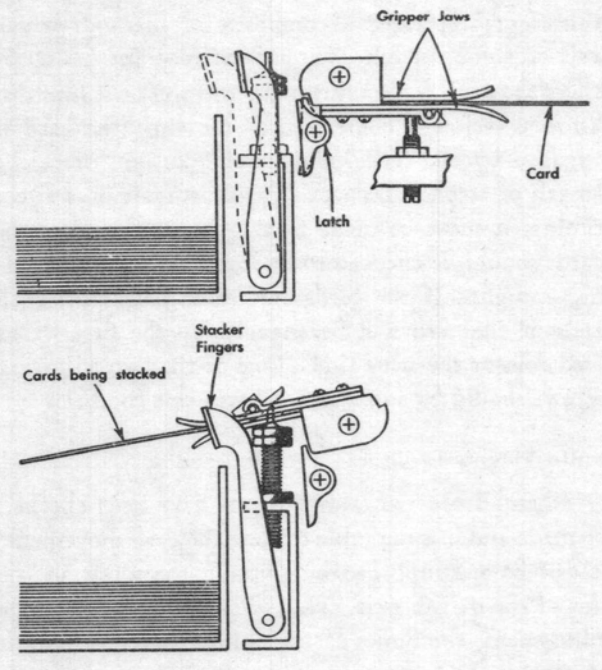


Figure 41. Combination Gripper and Gravity-Type Stacker

They were employed on some machines because space limitations did not permit the use of the more positive drum type stacker.

Radial-type stackers. As a card enters the pocket (Figure 42), the column-1 end rests on a pivot assembly, while the opposite end falls freely in an arc until stopped by spring-loaded alignment levers (see Figure 43). When approximately 5 to 10 cards accumulate at the aligners, they drop onto the oscillating card pusher that steps the cards to the front.

Card-retaining levers mounted on the pivot plate prevent the cards from falling backward into the stacker. These retaining levers are free to pivot forward to allow a card to pass, but cannot pivot backward.

As the stacker fills, the card deck is pushed outward until it activates the pocket-stop switch to stop card feeding.

Figures 38 through 43 show several stackers as they appear in a machine.

The demands of the feeding mechanisms vary from machine to machine. There are, however, four general ways in which cards may be fed from the hopper into the machine: horizontal with left edge entering the machine first; horizontal with either 9 or 12-edge first; vertical with left edge first; vertical with either

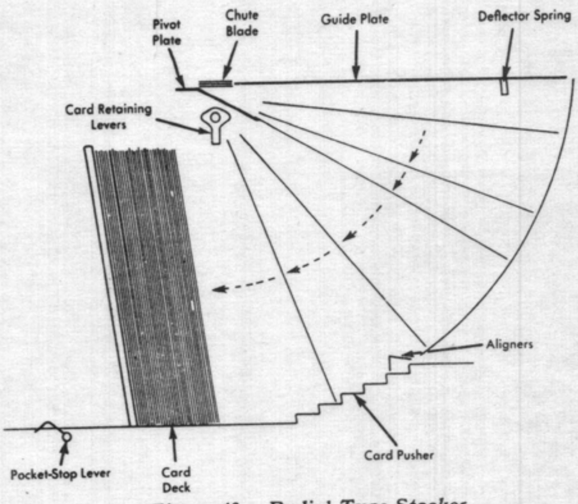


Figure 42. Radial-Type Stacker

9 or 12-edge first. Figures 44 through 47 each show a machine feed using one of the four general type feeds. Each is shown with the type of feed knife and throat used in that feed.

Several types of hoppers and feeding mechanisms, feed rolls, and stackers have been discussed and illustrated. Figures 48 through 53 show how some of these mechanisms are combined to form a card feed unit on a specific IBM machine.

In the hypothetical feed used to illustrate digit-by-digit feed only brush sensing was considered as a means of recognizing a hole. There are, however, many methods available for recognizing or sensing information. Electrical brush sensing through a hole in a card was considered first because it is the most

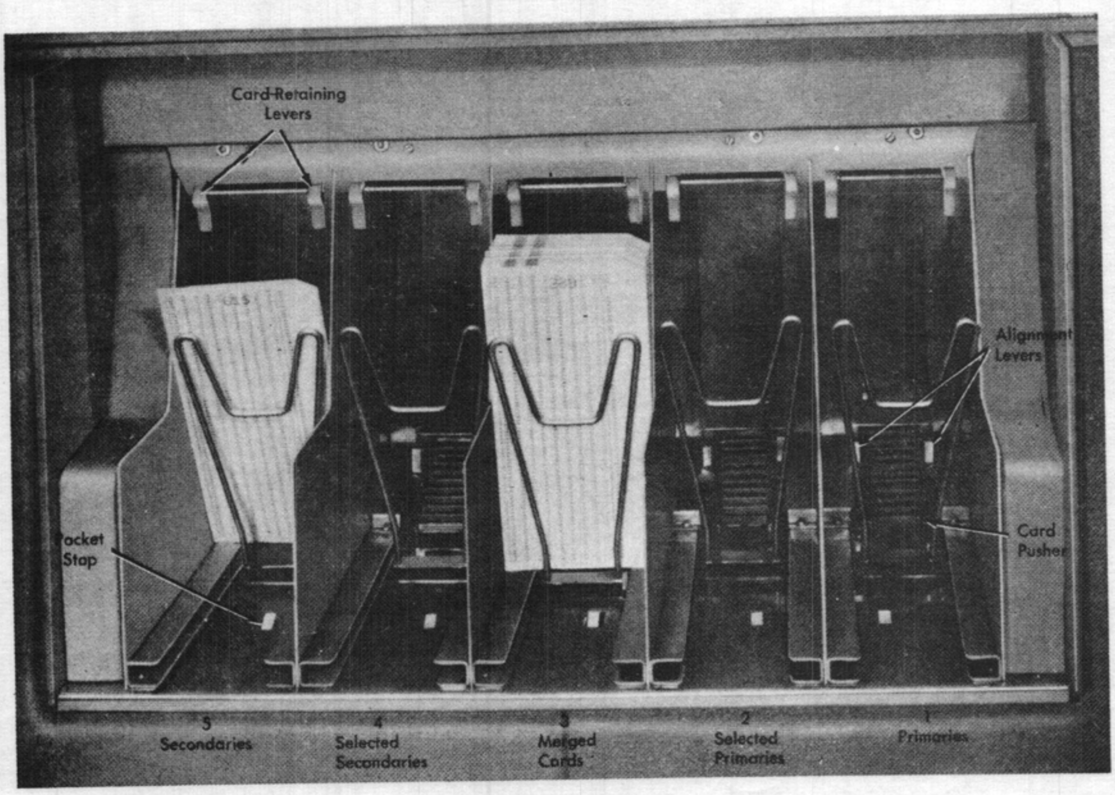


Figure 43. Radial Stackers

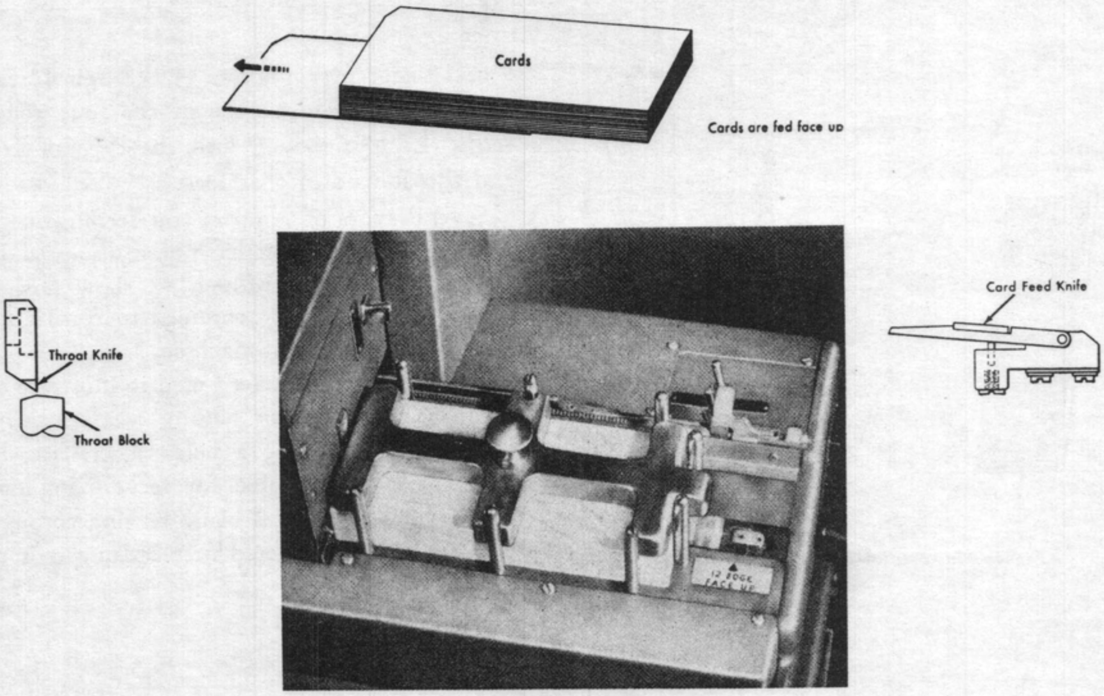


Figure 44. Horizontal Feeding — Left Edge First

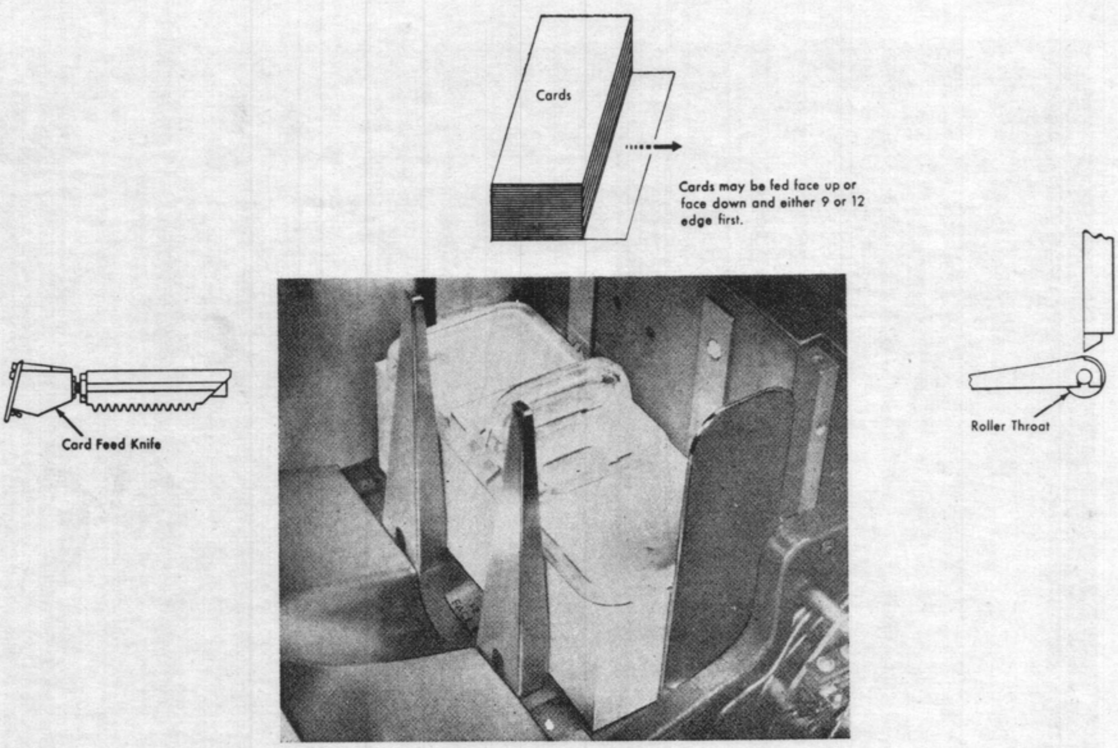


Figure 45. Horizontal Feeding — 9 or 12-Edge First

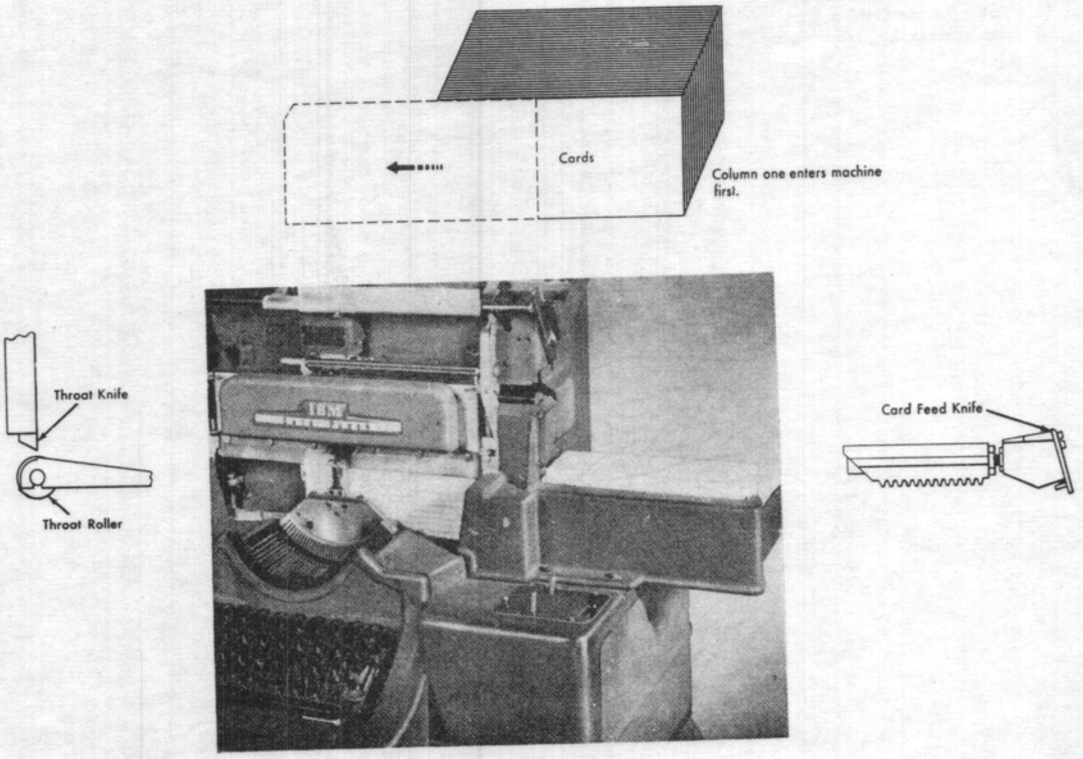


Figure 46. Vertical Feeding — Left Edge First

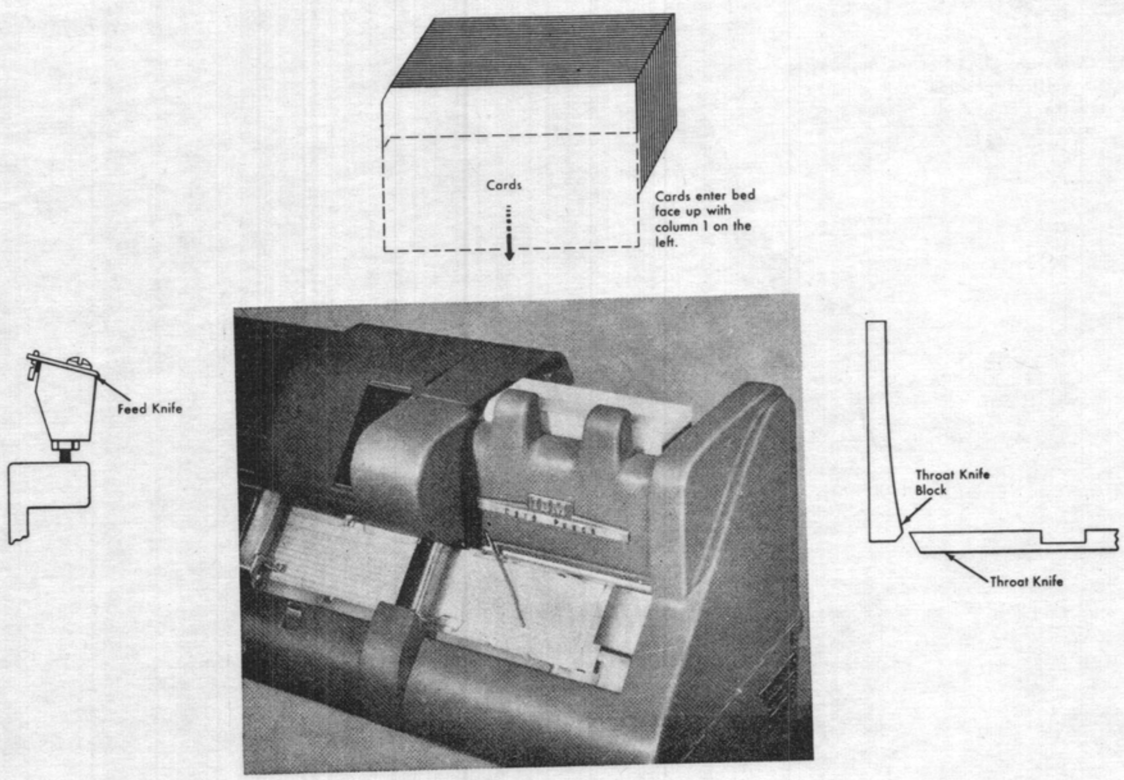


Figure 47. Vertical Feeding — 9 or 12-Edge First

Note: Cards are placed in the hoppers face down 9 edge first. A gravity type stacker is used.

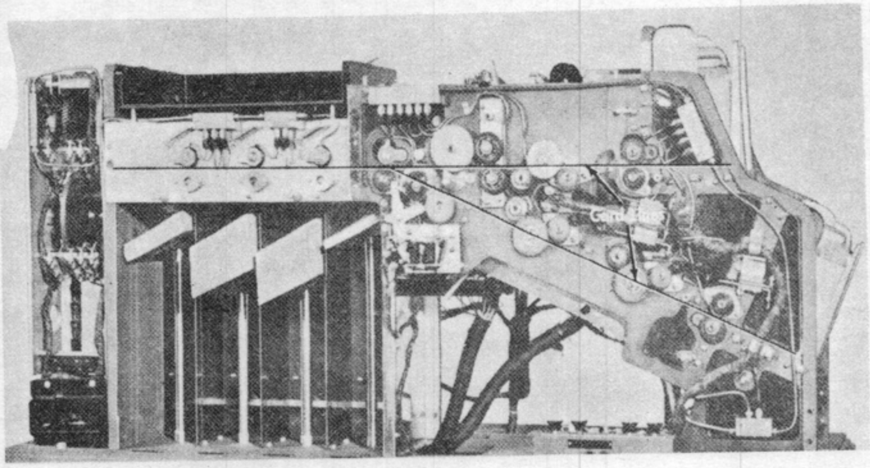


Figure 48. Card Feed Unit — Type 77 Collator

Note: Cards are placed in both hoppers face down 12 edge first. A friction type stacker is used.

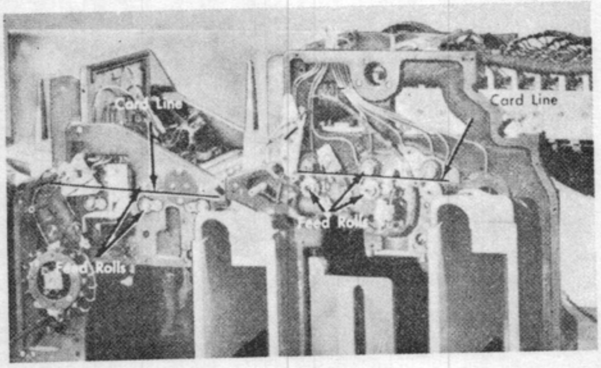


Figure 49. Card Feed Unit — Type 514 Reproducing Punch

Note: Cards are placed in the hoppers in a vertical position with the face to the front. A drum type stacker is used.

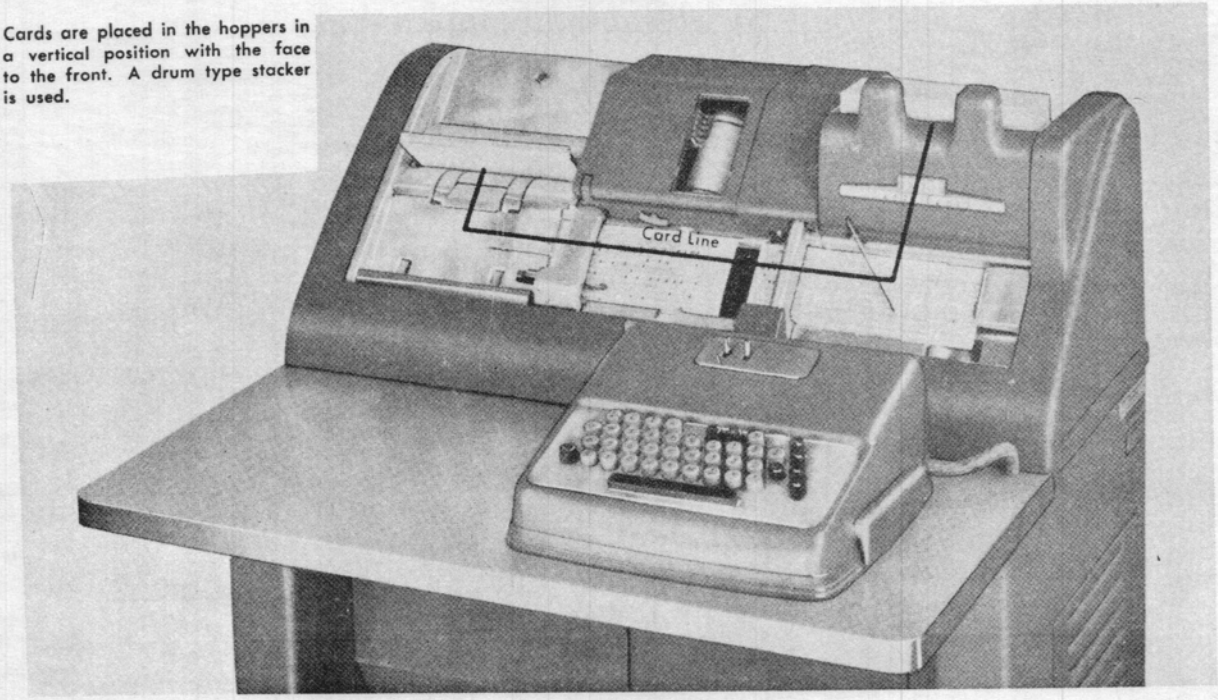


Figure 50. Card Feed Unit — Type 24 Card Punch

Note: Cards are placed in hopper face down 9 edge first. A gravity stacker is used.

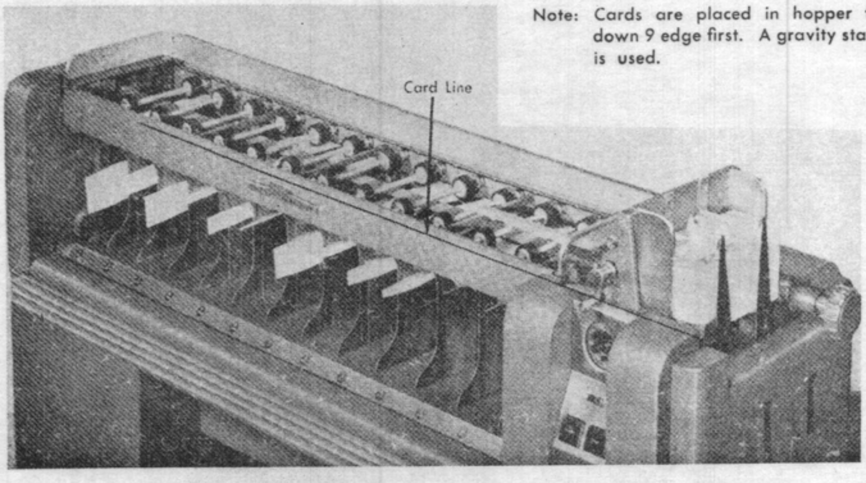


Figure 51. Card Feed Unit — Type 82 Card Sorter

Note: Cards are placed in the hopper face down 9 edge first. A drum type stacker is used.

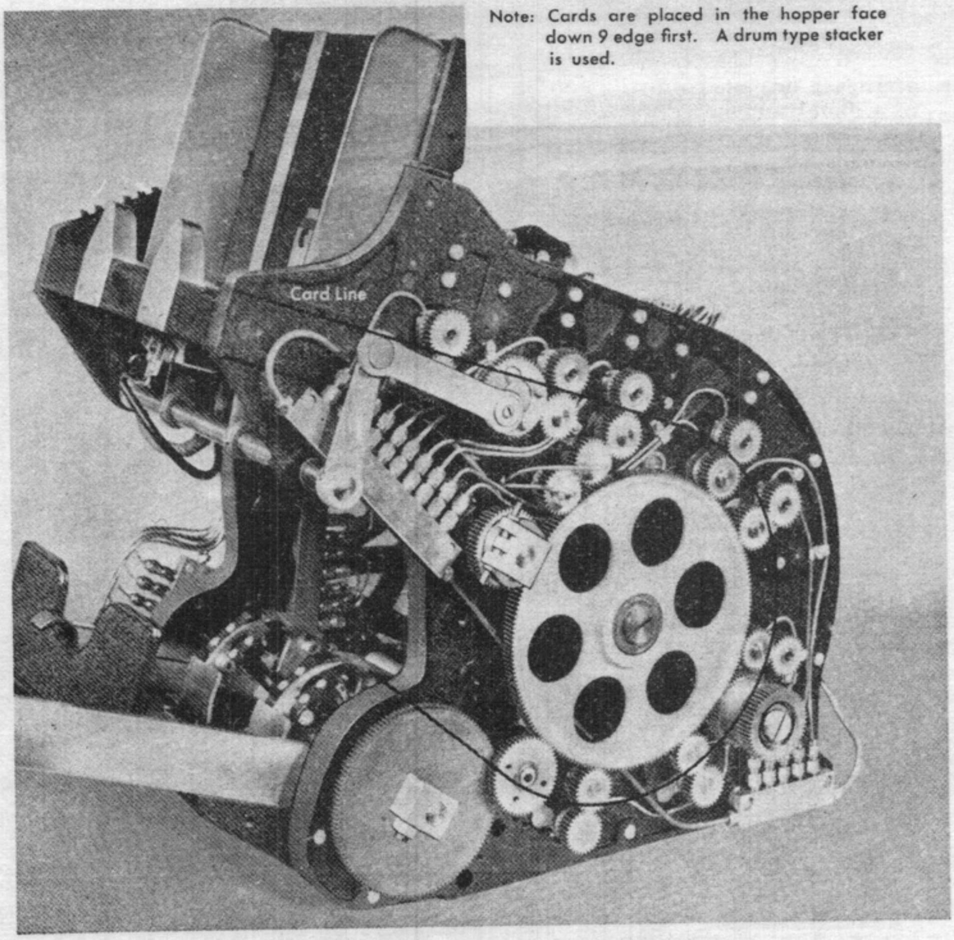
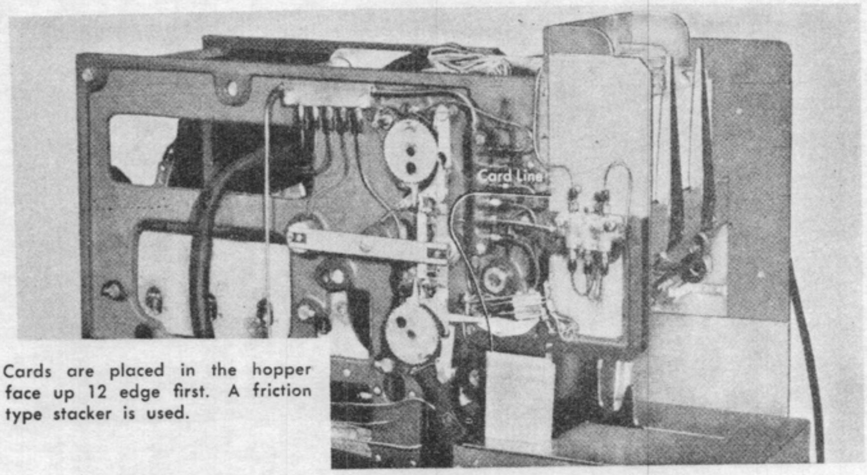


Figure 52. Card Feed Unit — Type 402 Accounting Machine



Note: Cards are placed in the hopper face up 12 edge first. A friction type stacker is used.

Figure 53. Card Feed Unit — Type 552 Card Interpreter

common method utilized in current types of IBM machines. There are two other sensing methods which, combined with the one studied, comprise the methods in common usage today. This does not imply, however, that other means are not used or will not be used; perhaps extensively, in the future. These two methods are:

1. Electrical sensing by means of pins or star wheels.
2. Electrical sensing of a mark by means of brushes.

PIN SENSING

ELECTRICAL sensing by means of pins is accomplished while the card is stationary, and is referred to as a method of static sensing. The card is sensed one column at a time with all twelve punching positions being sensed simultaneously. Since the card is to be moved intermittently column-by-column, a dog and escapement type movement is employed to control card movement.

Figure 54 shows a cross-section of a pin sensing unit which is in a normal position. The pin magnet is equal in width to a card, and it has twelve armatures, one for each punching position on the card. On the cross-section it can be seen that attached to the armature is a contact strap. A pin under spring tension is holding the armature and contact strap up away from the core of the magnet and the other side of the contact. When the pin magnet is energized, the armature is attracted to the magnet core. If there is a hole directly beneath the pin, there is no obstruction to the pin movement, and it moves down, permitting the contact to close as shown in Figure 55.

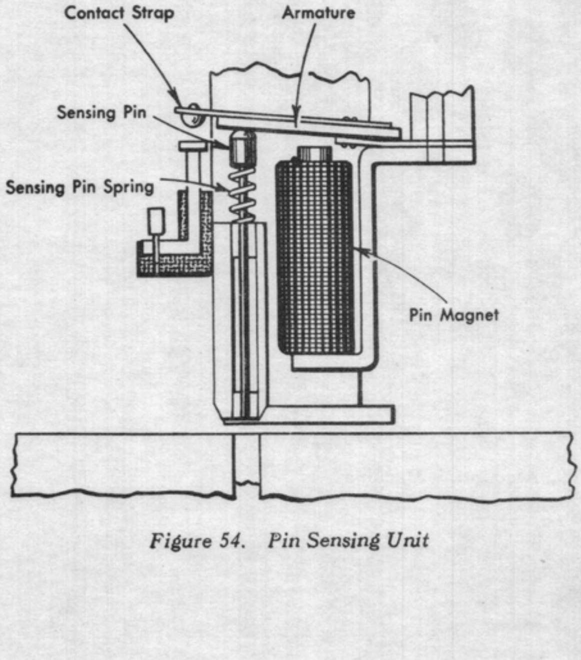


Figure 54. Pin Sensing Unit

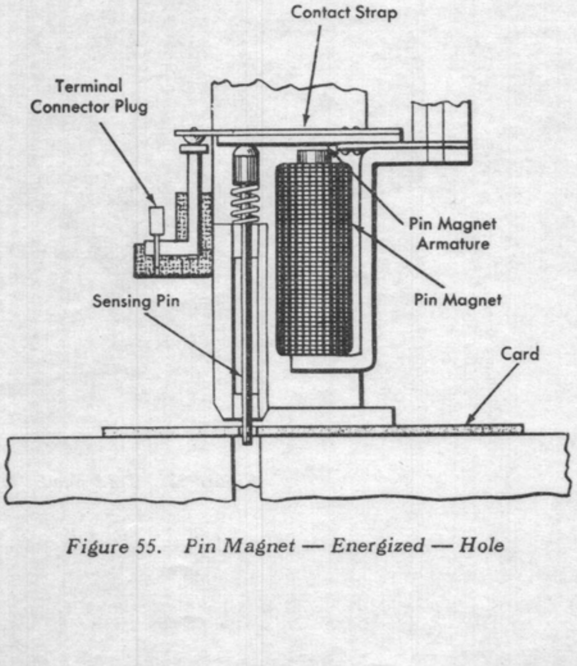


Figure 55. Pin Magnet — Energized — Hole

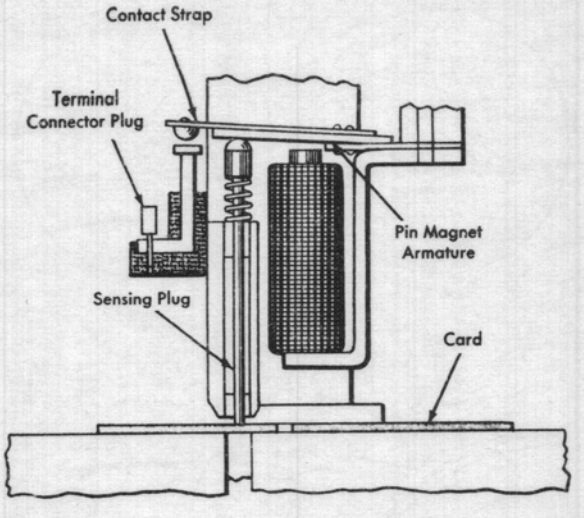


Figure 56. Pin Magnet — Energized — No Hole

When the contact closes, it indicates that a specific hole is punched in that column. Since all twelve armatures are attracted as a result of energizing the pin magnet, all holes in a column are sensed simultaneously and all contacts above the digits punched are closed.

In all positions where no hole is encountered, the pins strike the surface of the card as shown in Figure 56. This stops the downward travel of the pins before the contacts have closed. The strength of the magnet pull on the armature is not great enough to cause the pin to puncture the card or otherwise damage it.

If a hole is sensed and a contact closes it completes a circuit to energize a relay. The relay energized will assist in instructing the machine to the next operation to be performed.

Dual Pin Sensing

Figure 57 shows another type of pin sensing unit known as a dual pin sensing unit. It is so named because it has two pins which are used to sense one hole. This unit senses all twelve punching positions column by column and has two pins for each punching position. The pins are under the control of a bail which is cam operated. The shoulders on the pins are held against the bail by the tension of the contact straps. As the bail moves up, the pins follow and if a hole in a card is above the pins, they move up until they make contact against the common contact strip. If there is no hole, the pins strike the card

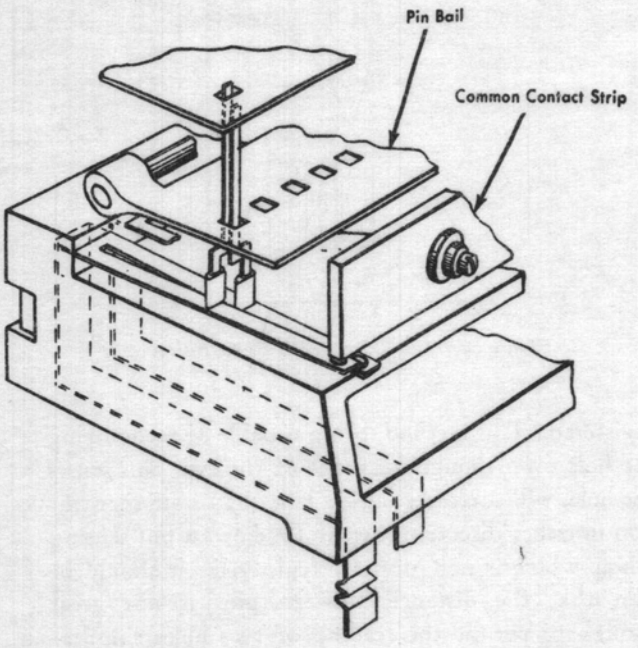


Figure 57. Dual Pin Sensing Unit

before the contacts have moved up far enough to make against the common contact strip. It should be noted that the contacts are constructed so that both of the contacts used to sense one hole are common and either one or both making contact will complete the circuit. Because each of the two contacts is operated by a separate pin if either one or both pins find a hole, the contact will be made. Figure 58 shows a hole being sensed by both pins.

The advantage of the dual pin sensing method is evidenced when either the holes are punched off-registration or the card being sensed is not properly

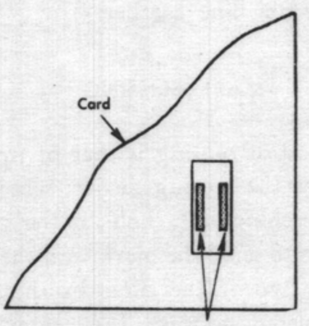


Figure 58. Dual Pin Registration

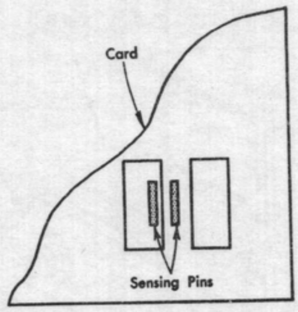


Figure 59. Dual Pins — Off Registration

registered. This method, being capable of recognizing the hole even though only one of the two pins senses the hole, will correctly sense a hole that is off-registration in either direction. Figure 59 shows a pin sensing a hole which is not properly registered. It should be seen that the distance between pins is not great enough to permit the reading of two holes simultaneously.

Star-Wheel Sensing

Another method of sensing which is similar to pin sensing is that of star-wheel sensing. This method also depends on mechanically sensing a hole and causing the closing of a contact. Star wheels may be used to sense a card in motion (flight sensing) or standing still (static sensing).

Figure 60 shows the principles involved in star-wheel sensing. During the time that the star wheel is sliding along the surface of the card the wire contacts are not making contact with the stationary contact. As soon as the star wheel encounters a hole the leading point of the star wheel glides into the hole permitting the left end of the sensing arm lever to move down. This action enables the contact wires to move up and make contact with the stationary contact. The completion of this circuit will assist in instructing the machine further.

MARK SENSING

A THIRD method of sensing is that of mark sensing. Brushes, used as the sensing device, sense a mark to initiate the punching of a hole in the card. Three brushes are used to sense the mark, and the mark must bridge at least two of the three brushes. A circuit must be completed between the center brush and either of the two outer brushes. The mark is required

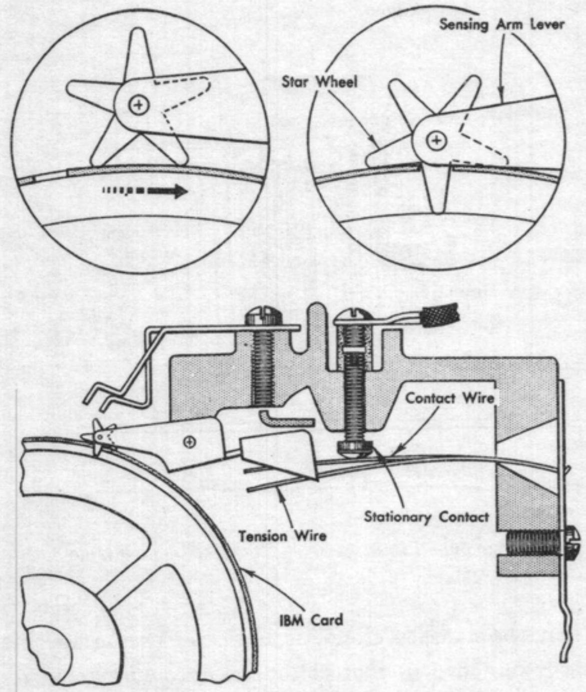


Figure 60. Star Wheel Sensing Unit

to complete a circuit which is primarily a voltage circuit and is not required to pass much current. The completion of this circuit is used to remove the negative voltage used to bias the grid of an electron tube.

Figure 61 is a schematic of a theoretical tube circuit. When a pencil mark shorts the mark sensing brushes, the control grid is driven less negative in relation to the cathode. The 40-volt negative bias is neutralized by the 110-volt positive potential. However, the 100,000 ohm resistor limits this opposing current so that the control grid is driven to zero po-

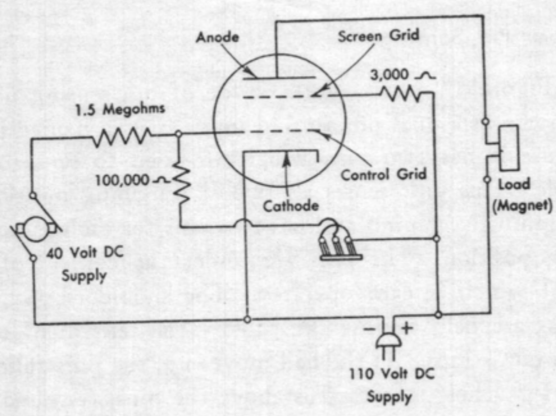


Figure 61. Theoretical Circuit for Mark Sensing

tential or only very slightly positive. When the grid reaches zero potential in relation to the cathode, maximum electron flow through the load from the 110-volt DC line will be obtained.

The 1.5 megohm resistor determines the maximum sensitivity of the tube.

The 100,000 ohm resistor becomes effective to limit the grid current when the brushes are shorted by the pencil mark.

The 3,000 ohm resistor limits the screen current to a safe operating value.

PREVENTIVE MAINTENANCE

PREVENTIVE maintenance, which includes cleaning, lubricating, and checking, is vital to good machine operation. This is especially true of units which are used a great deal such as the feed unit. The feed unit is used more than most other units and for that reason requires more attention. Particular care should be taken with preventive maintenance on the feed, since the satisfactory operation of all of the other units depends on how accurately the card is fed and read.

Cleaning

The first step in a preventive maintenance procedure is cleaning. The cleaning should start in the hopper and continue throughout the entire feed. Dirt and dust should be brushed out of the feed onto a card and put into a waste container. If a tank type vacuum cleaner, supplied to the local office with a plastic nozzle, is available, it may be used to remove dust and dirt from the feed mechanism.

Lubricating

The second step in the preventive maintenance procedure is lubricating. The automatic lubricating system should be checked; and all points which are not lubricated automatically, should be lubricated by hand. A drop of IBM 6 should be applied to each of the two roller throat bearings.

Checking

The third step in the preventive maintenance procedure is checking all parts of the feeding mechanism for wear and adjustment. The brushes in a feed require more attention than most other parts because they are subject to more wear. Therefore, the brushes should be the first item checked.

If the brushes are found to be badly worn, they should be replaced. If it is necessary to make up a new set of brushes, brush setup gage part 454090 should be used. If a brush set which was set up at the factory is to be used, tighten the individual clamps, as they may be loose due to shrinkage of the brush block.

Place the brush assembly in the holder, being very careful not to cross the brush strands or otherwise damage them.

Set the brushes to the scribed line. The brushes may now be aligned to the center of the space between the separators. If the entire set is out in the same direction, either the brush block or the separators should be shifted depending upon the provision of the machine. Individual brushes not centered between separators may be aligned by bending the ferrule with brush bending tool 450364. To facilitate observation of brush alignment, hold the brush assembly up to a light or back it up with white paper and sight along the brushes from the rear of the frame.

After the brushes have been checked, the contact roll and common brushes should also be checked. The other adjustments of the feed mechanism should be checked now in the order outlined in the machine reference manual under adjustments. This is desirable so that, where the sequence of adjustment is important, it will not be necessary to repeat an adjustment.

When checking timing, a dynamic timer should be used whenever possible. The CB's and brushes should be checked at the same time, using one dynamic timer circuit to check CB timing and the other to check brush timing. To do this, prepunch a group of cards 1-3-5-7-9 in the odd-numbered columns and 2-4-6-8 in the even-numbered columns and run all cards through the machine under power. Check brushes across the full set such as brushes 5-20-40-60-75.

If a dynamic timer is not available, time several brushes at each end and in the middle using an ohmeter and a 5 hole in the card. Run the cards through by hand.