A STUDY of the mechanical principles of this machine is limited to the read and punch unit, because the only mechanical units on the electronic unit are the blowers. Only the location of parts on the electronic unit will be given in this section. The read and punch unit is essentially the same as a gang summary punch, and covers are removed in exactly the same manner.

Location of Parts

The five general views of the read and punch unit in Figures 7 through 11 show the location of all parts and units which are visible at a glance. Certain other features not readily visible must be illustrated schematically.

The front view (Figure 7) shows the card lever contacts which are mounted on a plate at the front of the machine. The contacts have been placed outside for convenient access, although the card levers remain in the same relative location as in the gang summary punch. Also visible from the front is the cam contact unit located directly under the hopper and a portion of the tube power supply chassis located on the lower base. The tube power

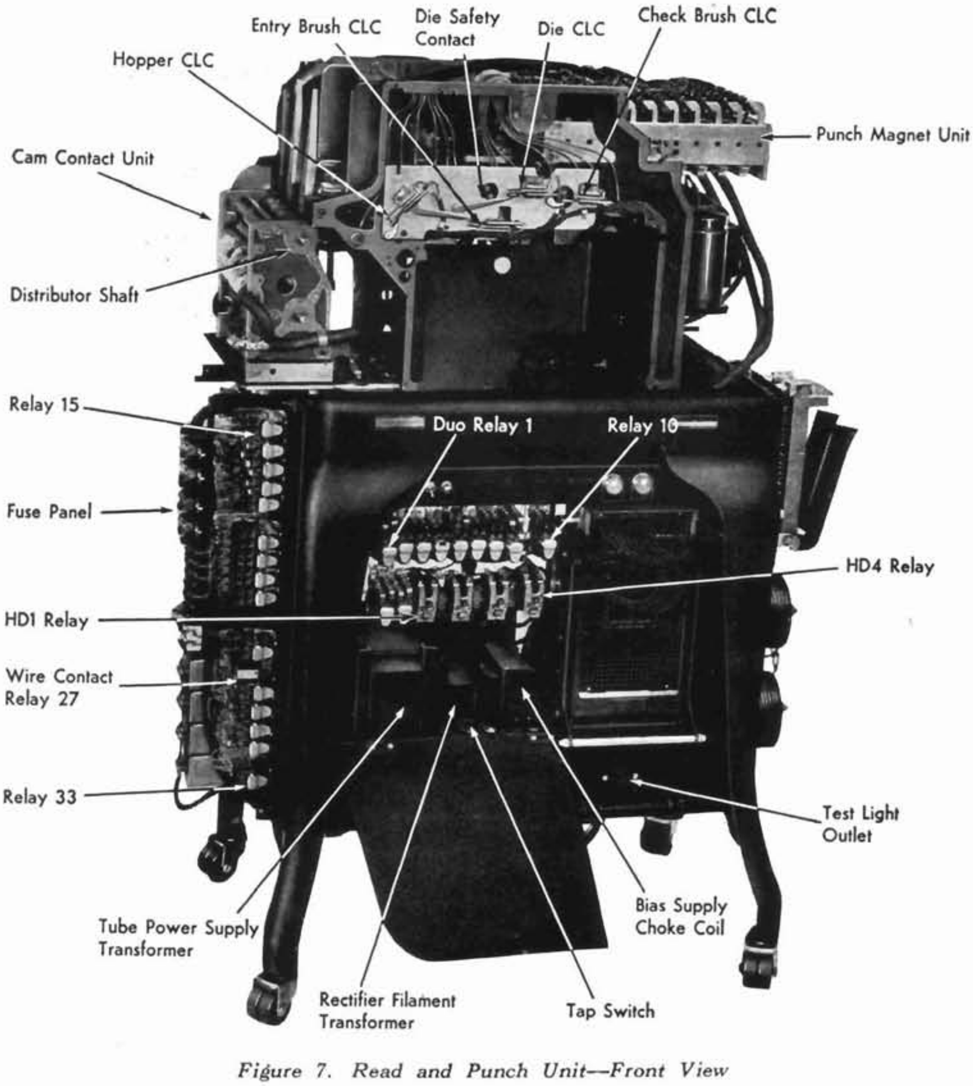

Figure 7. Read and Punch Unit—Front View

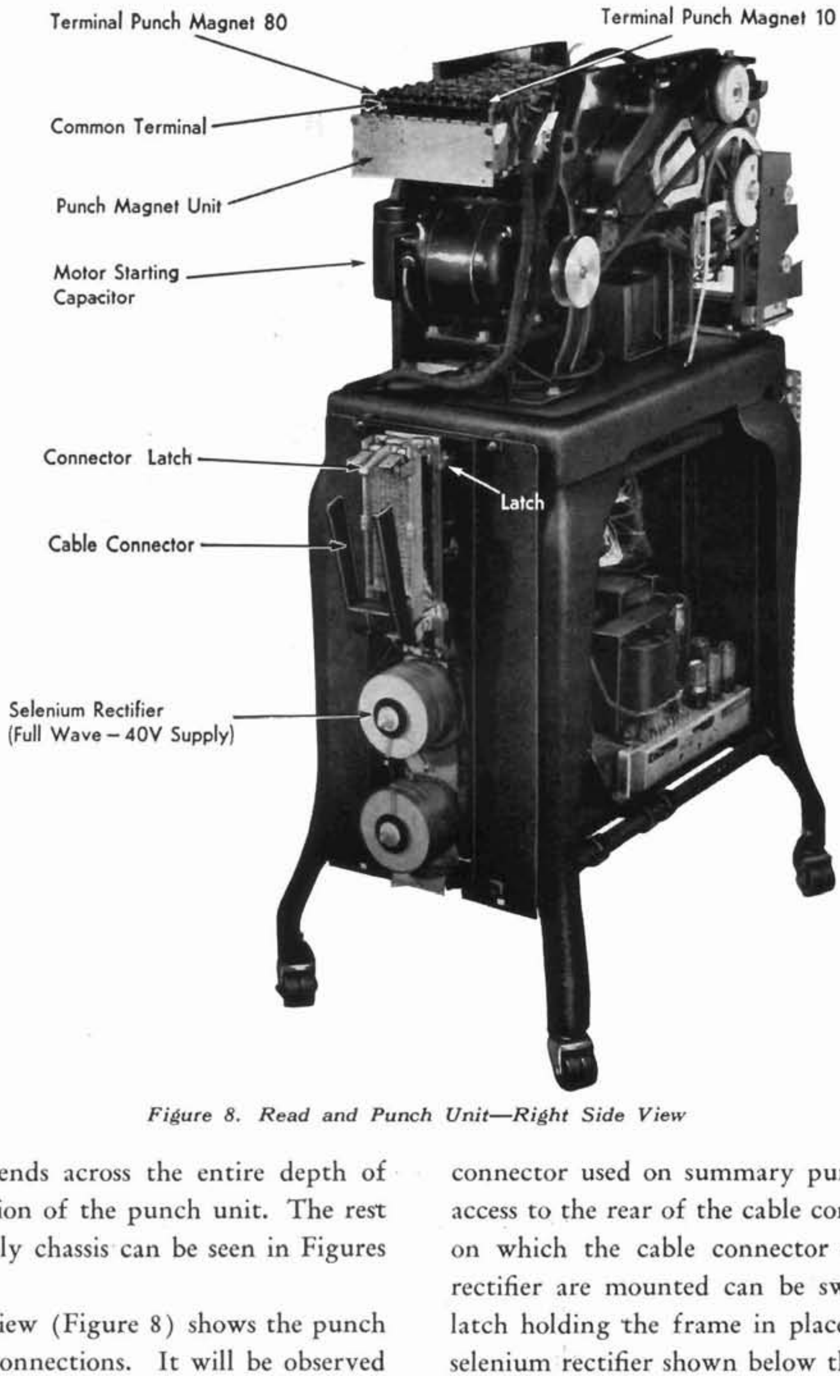

Figure 8. Read and Punch Unit—Right Side View

supply chassis extends across the entire depth of the lower left section of the punch unit. The rest of the power supply chassis can be seen in Figures 10 and 11.

The right side view (Figure 8) shows the punch magnet terminal connections. It will be observed that these connections are the reverse of standard gang punch connections. This is because the cards are fed into this machine face down, 9 edge first. Relays are mounted on the right side only if the class selectors and sign control features are installed. The cable connector which provides a convenient means of electrically connecting the read and punch unit to the electronic unit is a standard connector used on summary punches. To permit access to the rear of the cable connector, the frame on which the cable connector and the selenium rectifier are mounted can be swung down if the latch holding the frame in place is released. The selenium rectifier shown below the cable connector is a full-wave rectifier which supplies 40 volts D. C. in conjunction with the main transformer for the operation of the relays and punch magnets in the punch unit. The filter capacitors for this rectifier are mounted on the left side.

The left side view (Figure 9) shows the cam contact unit which is mounted under the card hopper. There is space for 52 cam contacts in this

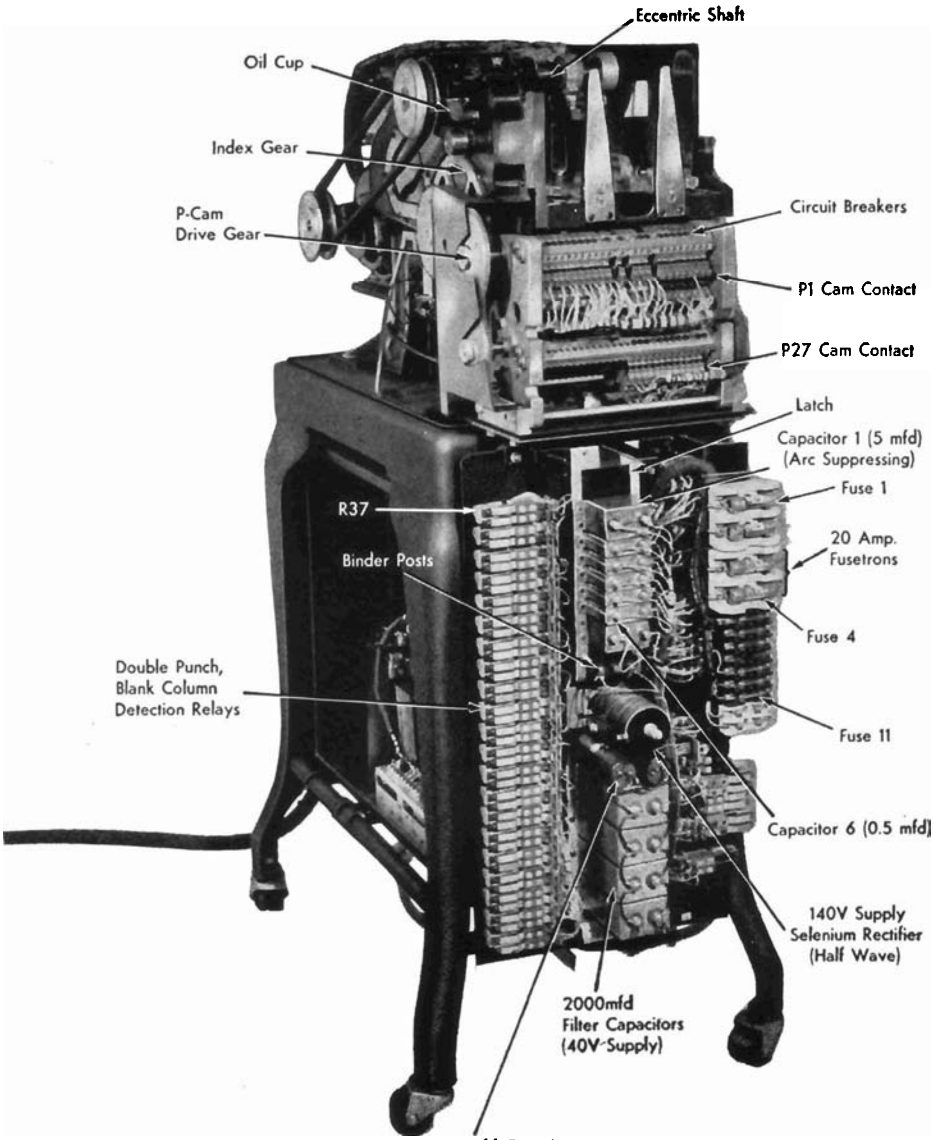

Figure 9. Read and Punch Unit—Left Side View

unit, numbered from front to rear, top to bottom. However, no cams beyond P41 are used, and although cams 9, 13, and 15 are not used, they retain their numbers. The 12 amp fuses and 20 amp fusetrons shown at the top of the fuse panel are in the main transformer circuit. The glass fuses are in the punch circuits and in the tube power supply circuits. The conventional arc-suppressing capacitors are mounted between the relay brackets and above the half-wave selenium rectifier. This selenium rectifier, together with its filter capacitors and bleeder resistor shown below the rectifier, supplies 140 volts D. C. for the read-out power tubes in the electronic unit. The four 2000 mfd. capacitors shown below the 140 volt D. C. selenium rectifier are the filter capacitors for the 40 volt D. C. supply. The double punch and blank column detection relays 37 through 57 are mounted on the left rear gate. If 10 additional positions of DPBC detection are installed, relays 58 through 77 are mounted just to the left of R37-R57.

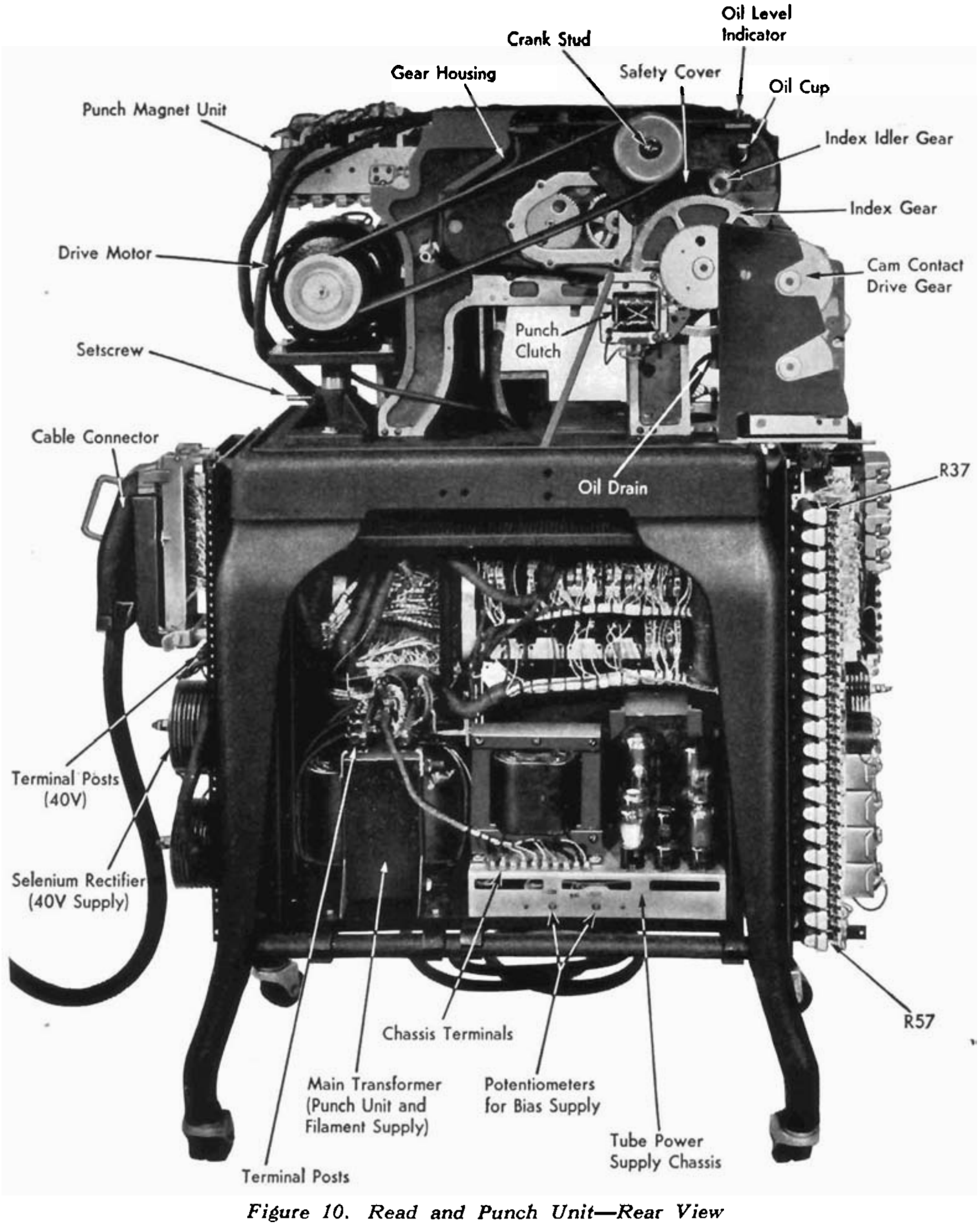

Figure 10. Read and Punch Unit—Rear View

The rear view in Figure 10 shows the mechanical features visible from the rear as well as the main transformer and the tube power supply chassis. The tube power supply furnishes D. C. voltages of 100 volts, 150 volts, and 250 volts for the operation of tubes in the electronic unit. The main transformer supplies A. C. of proper voltage to the 40 volt and 140 volt selenium rectifiers; it also supplies the filaments of all tubes except the gas-filled rectifier tubes.

In the close-up view of Figure 11, a better picture of the main transformer and tube power supply chassis is shown. Note particularly the system for numbering terminals on both the transformer and the power supply chassis. The EL-3C and EL-1C tubes are gas-filled full-wave rectifier tubes,

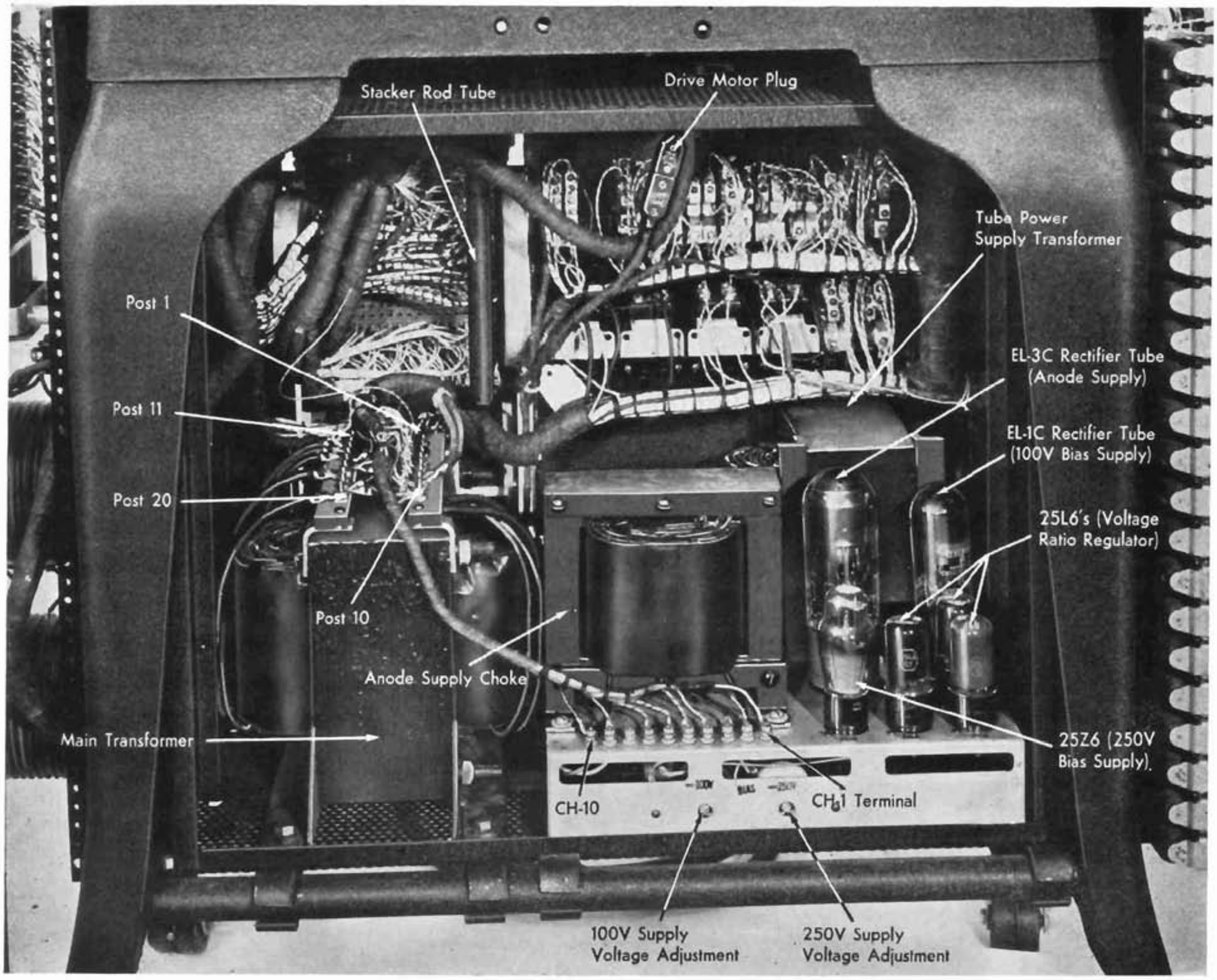

Figure 11. Closeup of Main Transformer and Tube Power Supply Chassis

while all other tubes on the chassis are vacuum tubes of the type indicated. All other components in the power supply circuit are mounted underneath the chassis.

Figure 12 shows schematically the location of the brush assemblies, die and stripper assembly, and the card levers. The hopper card lever is located directly under the hopper. The punch brush 1 and die card levers are mounted on the front side frame. The former is located directly under the punch brush 1 contact roll while the latter is located under the second set of feed rolls. The punch brush 2 card lever is mounted directly above the punch brush 2 contact roll. However, all card lever contacts are mounted on a plate at the front of the machine as shown in Figure 7.

Note from Figures 13, 14 and 15 that there are no relays in the electronic unit. Figure 15 shows the gates open with all connections accessible. The general function of each tube chassis is given, but no effort will be made to discuss these further until the section on *Electrical Principles.* The switch and push buttons shown in Figure 15 are not accessible unless the large gate is open; they are intended solely as an aid in servicing the unit. The blowers shown are provided to cool the tubes. Over 1200 watts of heat from the filaments alone must be dissipated. One blower is provided for each side of the electronic unit.

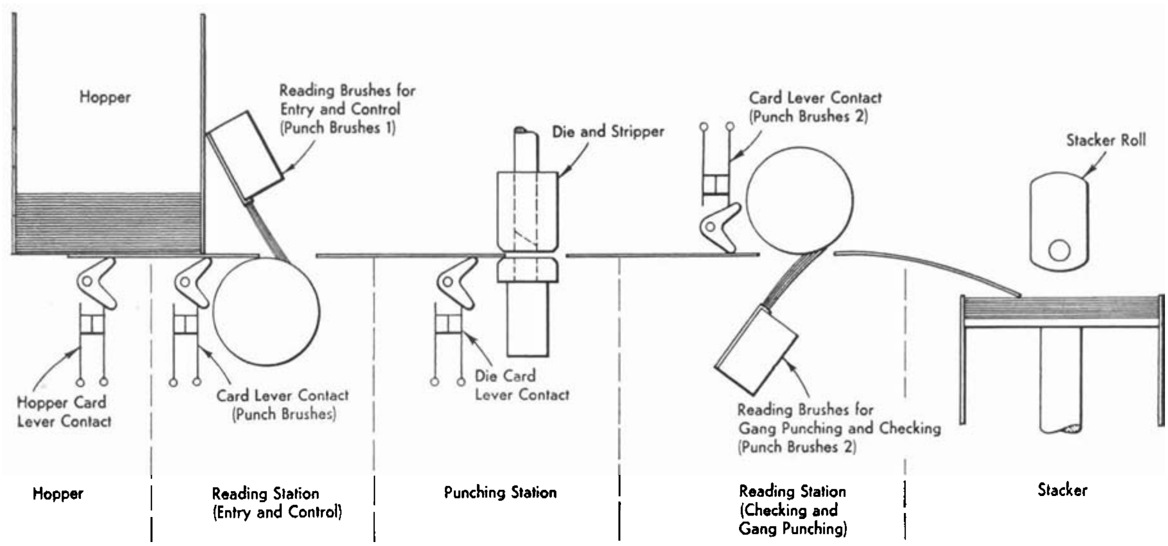

Figure 12. Schematic of Read and Punch Unit

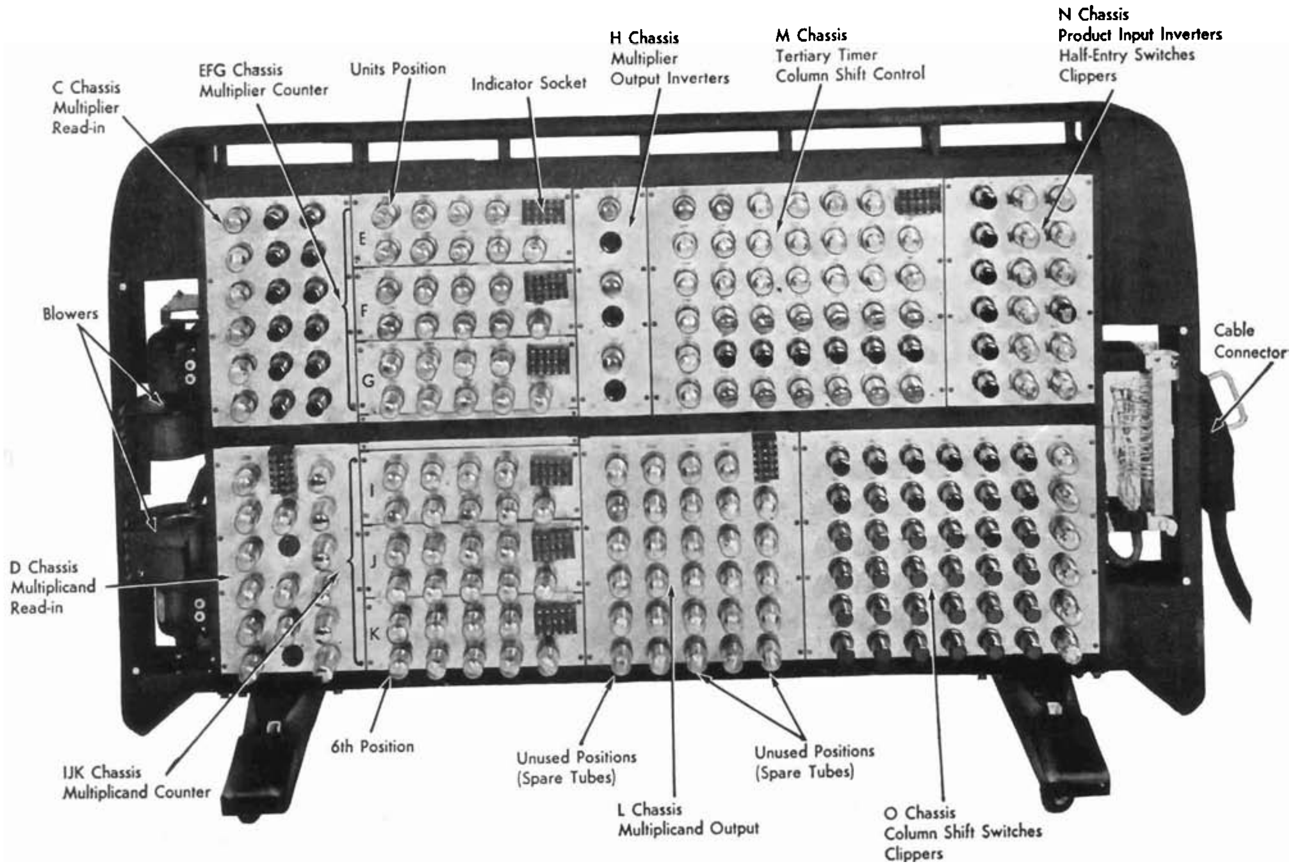

Figure 13. Electronic Computing Unit—Front View

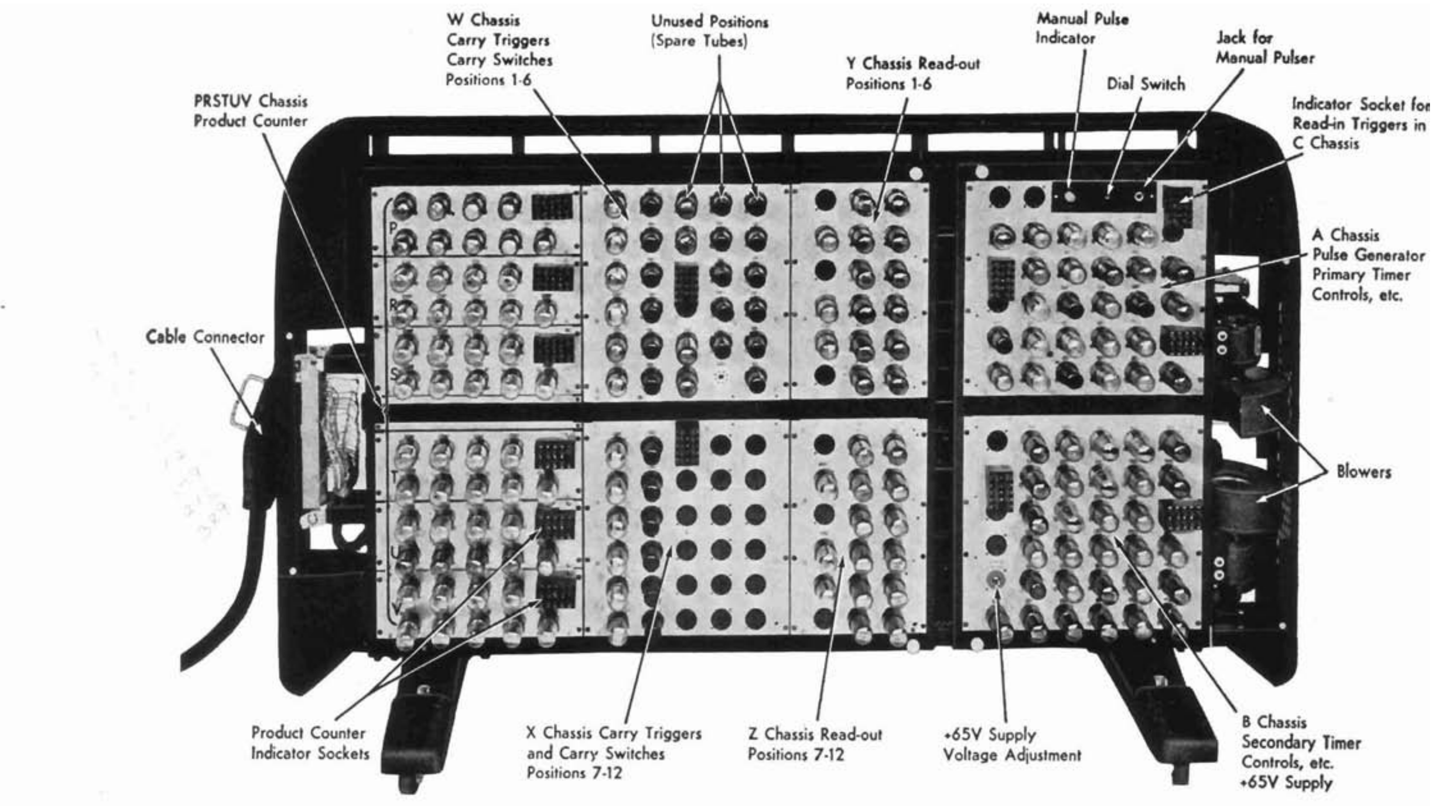

Figure 14. Electronic Computing Unit—Rear View

Drive Mechanism

Power to drive the read and punch unit is furnished by the drive motor which can be seen in Figure 8. The drive motor transmits power to the gear housing through a V belt and pulley. Practically all mechanisms are under control of the punch clutch. All feeding operations are under further control of the intermittent feed clutch (geneva clutch). Figure 16 shows schematically the various units under the control of the two clutches. When only the motor operates (with neither clutch engaged), the drive pulley rotates and drives the drive pulley shaft to which the pulley is keyed. Attached to this shaft inside the gear housing are two gears, the geneva drive gear and the eccentric shaft drive gear. The mechanisms and gear trains inside the gear housing may be seen by removing the top cover from the housing. (Caution: Do not operate the machine under power with this cover off because oil will be thrown out of the housing.) The eccentric shaft drive gear operates the eccentric shaft which in turn transmits motion to the punch bail. (The operation of this bail is discussed in connection with the principle of punching.) The geneva drive gear operates the geneva and geneva pawl and also the punch clutch idler gear and shaft. On the outside of the idler gear shaft is pinned a small gear which drives the index gear (Figure 10). The punch clutch one-tooth ratchet is a part of the index gear assembly and rotates continuously as long as the motor is in operation. The index gear and ratchet rotate on the punch clutch shaft but are not pinned to it.

In order to place the rest of the machine units in operation it is necessary to unlatch the punch clutch pawl from its armature and allow it to engage in the continuously running one-tooth ratchet, which is a part of the index gear assembly.

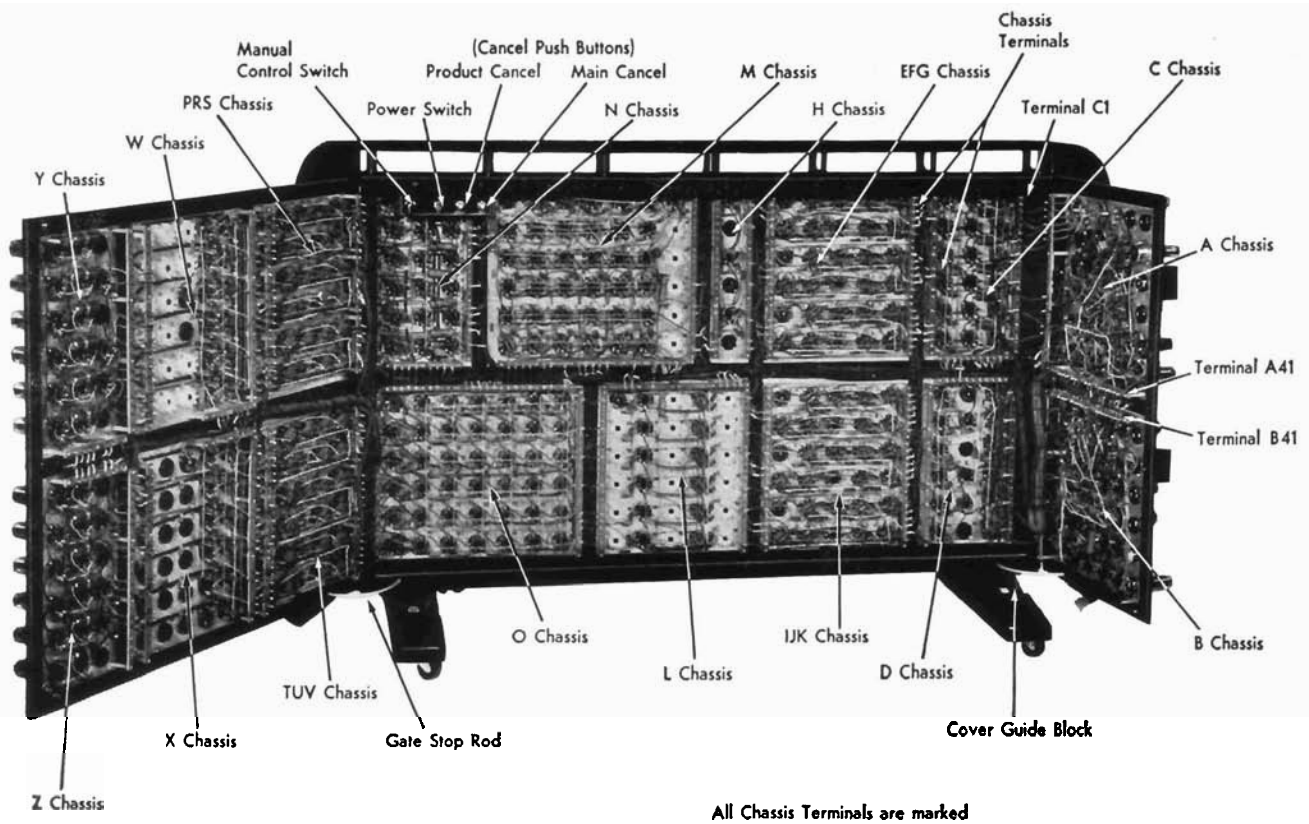

Figure 15. Electronic Computing Unit with Gates Open

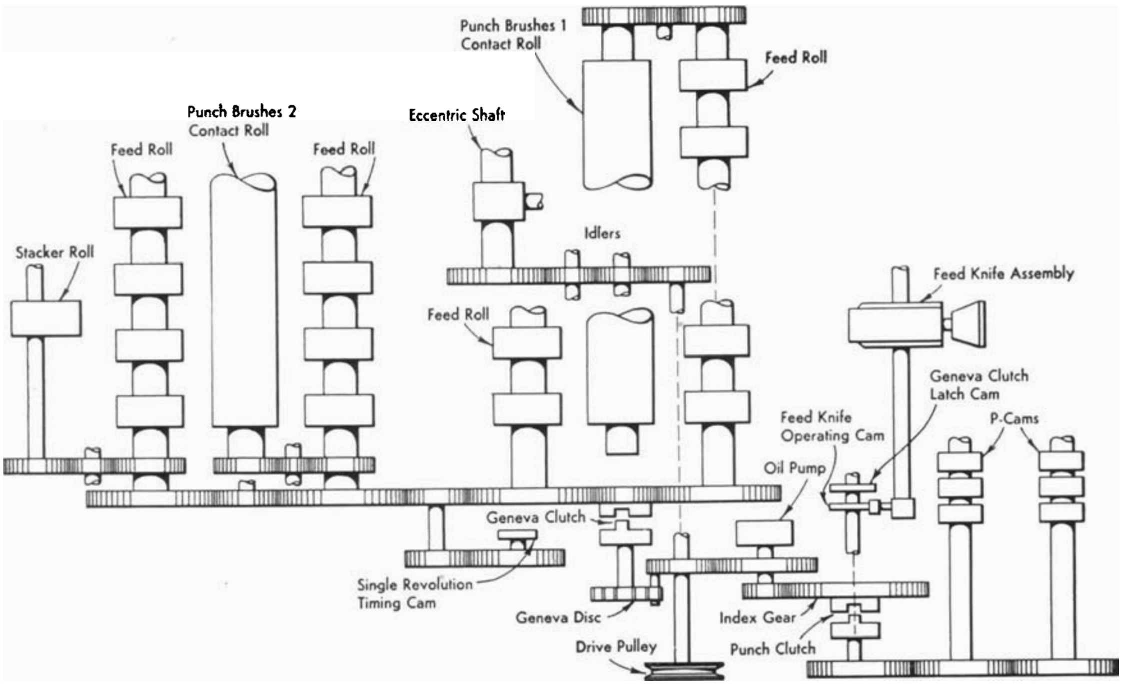

Figure 16. Schematic of Drive Mechanism

When the clutch pawl engages the one-tooth ratchet, the punch clutch shaft turns with the ratchet. The gear mounted on the outside end of the punch clutch shaft in turn drives the P-cam shaft, on which are mounted the P-cams. Within the gear housing there are two sets of complementary cams pinned to the punch clutch shaft. One set of cams operates the feed knives and the other set controls the engaging of the geneva clutch pawl with its ratchet. The geneva ratchet is normally stationary; but when the geneva pawl engages with it, the ratchet is driven by the geneva, which imparts an intermittent motion to this ratchet. Riveted to the geneva ratchet is the ratchet gear which serves as the drive gear for all feed rolls, contact rolls, and the stacker roll. Since all these rolls are driven from the geneva, they all turn intermittently. The intermittent movement is necessary to have the card in a stationary position while punching. (This is discussed in more detail in the section on the *Geneva Mechanism.*) Only the upper feed rolls and the punch brush 2 contact roll are driven from the gear train in the housing. The lower feed rolls are driven by their corresponding upper rolls through gears at the front of the machine. Also, the punch brush 1 contact roll is driven from the first upper feed roll. The stacker roll is driven by a gear train from the last feed roll.

Punch Clutch

The punch clutch shown in Figure 17 is of the one-tooth ratchet type commonly used on EAM equipment, and its operation should be thoroughly understood. The principal parts of the clutch are a continuously running one-tooth ratchet, a clutch pawl, a latching mechanism, and a magnet. The magnet provides a means of electrically controlling the operation of the clutch. The clutch magnet armature serves as the latching mechanism to latch the pawl and keep it from engaging in the ratchet.

When the magnet is energized, the armature is attracted and the pawl is released or unlatched. The

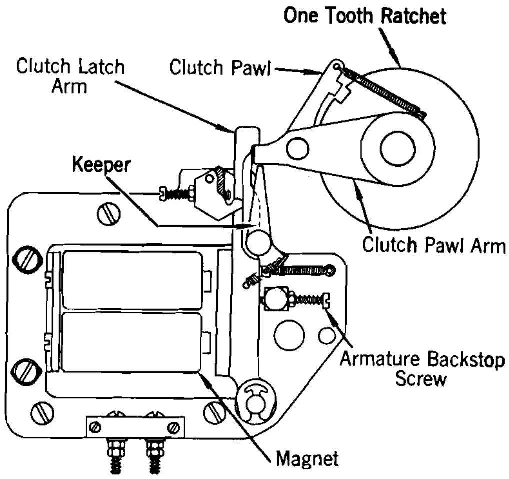

Figure 17. Clutch

pawl spring causes the pawl to pivot in a clockwise direction and engage the one-tooth ratchet when the ratchet tooth reaches the pawl. The pawl pivots on a stud riveted to the clutch pawl arm which is pinned to the punch clutch shaft. Thus, when the pawl turns with the ratchet, the shaft must also turn. Once the pawl is unlatched, it must make one complete revolution before it can be relatched since there is but one latching point. For this reason it is necessary to keep the armature attracted only long enough to allow the pawl to engage the ratchet. When the pawl reaches the end of its cycle, the armature has been returned to its normal position by the return spring and the tail of the pawl strikes the armature, causing the pawl to be cammed out of mesh with the one-tooth ratchet. When the pawl has been cammed out of mesh, the keeper drops behind the clutch pawl arm and prevents the clutch shaft from turning backward. Without the keeper, the shaft might turn backward because of the rebound; then the pawl would drop against the ratchet and catch on the tooth once each cycle. This nipping action has a tendency to round off the edge of the one-tooth ratchet. This is objectionable because a rounded edge on the ratchet tooth may cause the pawl to pull out of mesh under load.

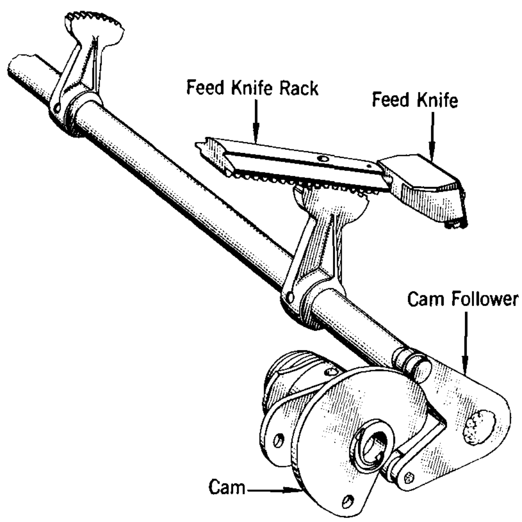

Figure 18. Punch Feed Knife Drive

Feeding Mechanisms

The purpose of the feed knives is to feed one card through the throat into the first set of feed rolls for each revolution of the punch clutch. The feed rolls then carry the card past the brush stations and punching station to the stacker. The knives are driven back and forth by gear sectors which mesh with the feed knife racks. The gear sectors are pinned to a shaft which oscillates under the control of a complementary cam and follower mounted on the punch clutch shaft (Figure 18).

When a card is fed from the magazine, it is fed between the first pair of feed rolls. The feed rolls operate intermittently, hence they will be stationary during a portion of the time a card is being fed between them. The feed knife carries a card up to the first feed rolls while the feed rolls are stationary. To insure that the first feed rolls will pick up the card, the knife buckles the card slightly just before the feed rolls start turning.

As indicated in Figure 16, the card passes through four sets of feed rolls on its way to the stacker. The upper feed rolls are mounted in fixed bearings while the lower feed rolls are provided with pivoted bearings to allow separation of the rolls when a card is fed between them. Feed roll tension is provided by a pressure bracket consisting of four bearing shoes held against the feed roll shaft by compression springs.

The card also passes two sets of brushes and contact rolls. The brush assemblies are identical except for minor constructional differences; each consists of 80 individual brushes mounted in a brush holder so that they are insulated from each other. The contact rolls are made of beryllium copper and are geared to turn at a higher speed than the feed rolls to provide a wiping action by the card.

Index and Cycles

In explaining machine operations it is necessary to make reference to one operation in terms of another. By using an index for a common reference point this becomes possible. The index gear serves as the common reference for all machine operations. One complete revolution of the index gear is called one cycle. If the punch clutch is engaged, a card would move from the first set of brushes to a corresponding position at the die (or from the die to the second set of brushes) during one revolution of the index. For convenience in measurement one cycle is divided into units called *cycle points*. The most logical unit of division is the distance between successive punching positions on the card. Therefore the distance from the *9* punching position to the *8* punching position in one card represents one cycle point, while the distance from the *9* punching position in one card to the *9* punching position in the following card is one cycle.

There are 12 punching positions on the card. Each punching position is $\frac{1}{4}$ inch from the next, therefore, for each cycle point the card moves $\frac{1}{4}$ inch on its path through the machine. Since the card is $3\frac{1}{4}$ inches wide, it requires 13 cycle points to advance a card past any given point. In this machine there is $\frac{1}{4}$ inch between cards, therefore, the cycle consists of 14 cycle points. The teeth on the index gear are used for further subdivisions. Thus a timing given as 14.1 indicates one tooth past the *14* index mark.

Geneva Mechanism

As indicated previously, the feed rolls in this machine operate intermittently to allow punching of the card. The card must not be in motion while the punches are being driven through the card and withdrawn. If the card is moving, the holes will not be clean cut, but ragged and torn. Since the card must be standing still while it is punched, then moved to a new punching position fourteen times each cycle, the motion is necessarily intermittent. This intermittent motion is obtained by means of a geneva mechanism.

The geneva drive gear is located just inside the gear housing and pinned to the pulley shaft. A stud and roller fastened to this gear operate in the slots of the driven member of the geneva gear (Figure 19).

The hub of the geneva drive gear is a cam surface for approximately two-thirds of its periphery. This cam surface holds the feed rolls in a stationary position during punching time by locking the geneva in position.

The geneva disc has seven deep slots and seven shallow cuts in it. The roller of the drive gear operates in the deep cuts in the geneva disc and the cam surface rides in the shallow cuts. As the drive roller leaves the deep cut of the geneva disc,

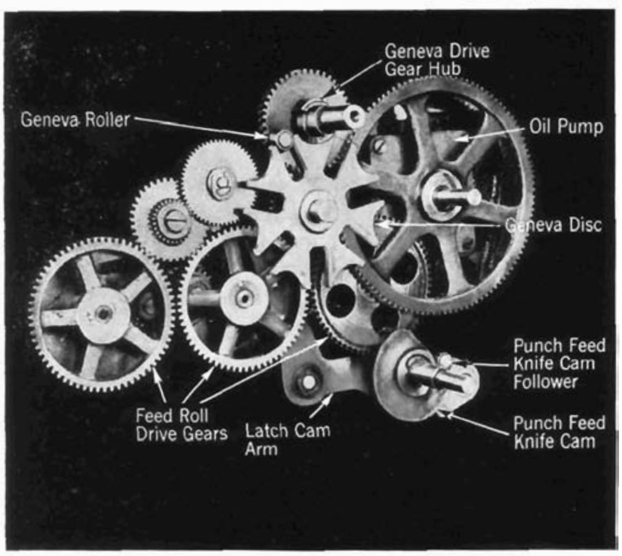

Figure 19. Geneva Mechanism

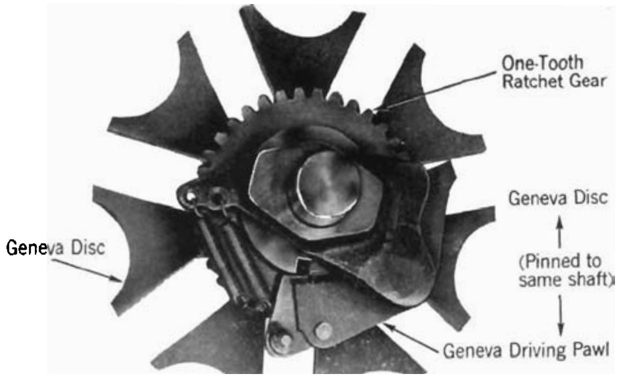

Figure 20. Geneva Pawl and Ratchet

the cam surface turns into the low cut and stops the geneva disc from turning and holding it until the drive gear has rotated to a point where the drive roller enters the next deep slot of the geneva disc and starts driving. Then the cam surface has turned to a point where it releases the disc and allows it to turn freely. The geneva disc turns continuously as long as the drive motor runs. However, no motion is transmitted to the feed rolls until the geneva pawl is engaged with its one-tooth ratchet. The geneva pawl is pinned to the same shaft as the geneva disc. This shaft runs through the hub of the one-tooth ratchet and gear. The one-tooth ratchet is free on the shaft and does not turn unless the geneva pawl is engaged. The one-tooth ratchet gear (Figure 20) is meshed with the feed roll drive gears.

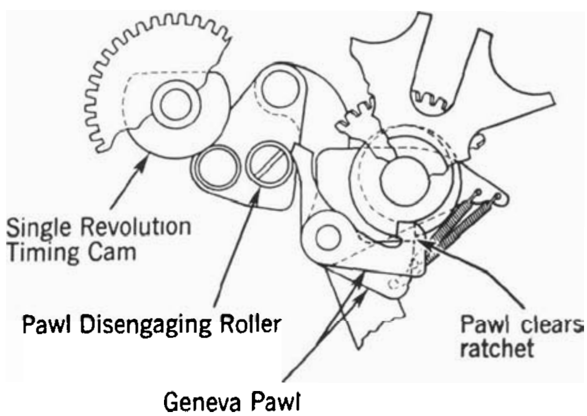

Figure 21. Pawl Disengaging Roller

When the punch clutch is not engaged, the geneva pawl rides on the surface of the one-tooth ratchet during the greater part of the cycle. When the pawl reaches a point opposite the single tooth, the tail of the pawl strikes the pawl disengaging roller (Figure 21) and is cammed away from the ratchet until it has moved past the point where it may engage in the single tooth of the ratchet. By cranking the machine by hand, it can be noted how the pawl disengaging roller prevents the geneva pawl from engaging. From the above, it is evident that the operation of the geneva pawl is controlled by the pawl disengaging roller. The pawl disengaging roller is mounted on a triangular plate (Figure 21) which is free to pivot on the latch cam roller arm. The latch cam roller arm (Figure 22) is operated by the latch cam which turns only when the punch clutch is engaged. When the punch clutch is engaged, the latch cam turns, causing the latch cam arm to rotate in a counterclockwise direction. As the latch cam arm rotates, the upper end moves to the left and down allowing the pawl disengaging roller to move past the single revolution timing cam and the geneva pawl to engage in the one-tooth ratchet. As the cycle is completed, the latch cam causes the latch

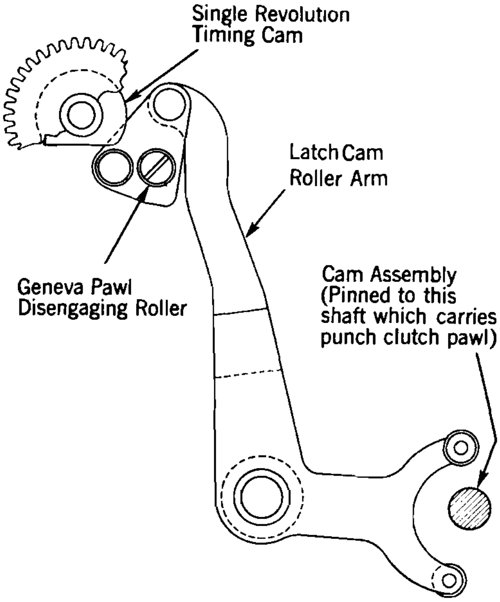

Figure 22. Single Revolution Timing Cam

cam arm to rotate in a clockwise direction carrying the pawl disengaging roller to the right. The roller strikes the tail of the geneva pawl and disengages the pawl from the one-tooth ratchet when the roller is backed by the single revolution timing cam.

Single Revolution Timing Cam

The geneva disc has 7 cuts in it and moves the card one cycle point for each cut. The machine is a fourteen point cycle machine; therefore, the geneva disc must make two revolutions per machine cycle, which means that the geneva pawl will pass the pawl disengaging roller twice during each cycle. The purpose of the single revolution timing cam is to prevent the feed rolls from stopping in a position half way through a cycle. At the end of the first revolution of the geneva pawl and disc, the flat side of the single revolution timing cam should be down (Figure 22). The pawl disengaging roller is free to swing away from the tail of the pawl. Therefore, in case the geneva pawl had become disengaged from the one-tooth ratchet, it would be free to drop into the one-tooth ratchet on the next revolution to complete the cycle. This assures that the pawl will not be disengaged by the pawl disengaging roller until the punch unit mechansim has reached its proper latching position and that the geneva makes two revolutions for each cycle.

Principle of Punching

The mechanism for punching holes consists of 80 individual punches, each controlled by an interposer, 80 punch magnets together with armatures and pull wires to control the 80 interposers, a punch bail to drive the punches through the card, and the eccentric drive shaft and links to operate the punch bail. There is a separate punch for each card column; any one punch may be required to punch any hole from *9* to *12*. The cards feed in *9* edge first, and every *9* to be punched is punched at the same time. The card then moves to the *8* position and every *8* is punched, and so on until

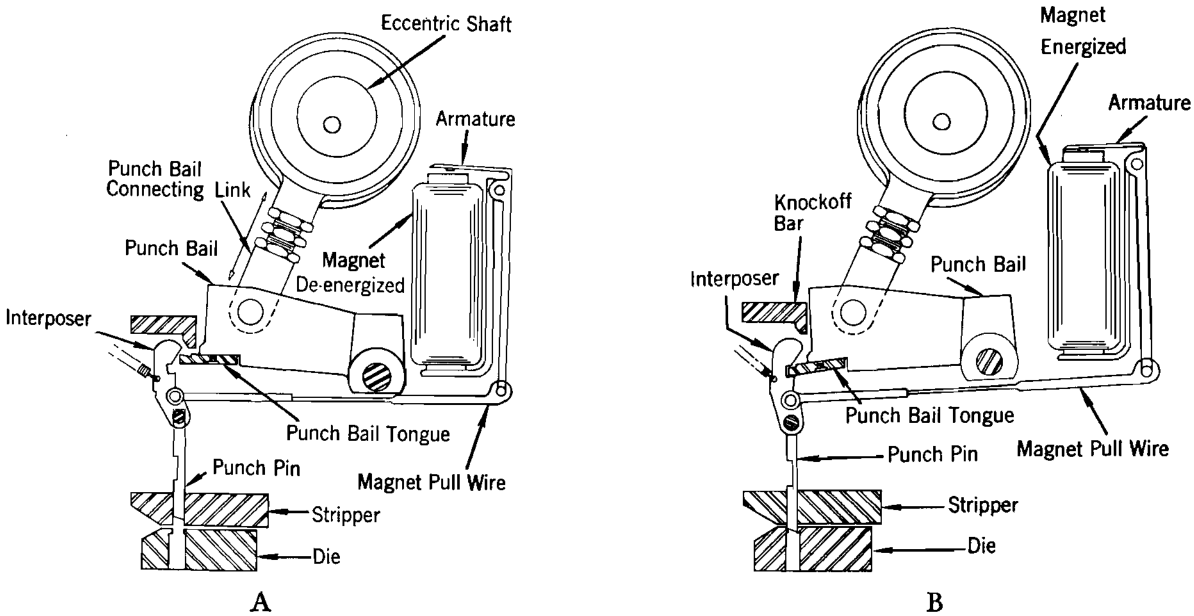

Figure 23. Principle of Punching

all positions have been punched. Thus, all possible punching is done in 12 cycle points.

As previously mentioned, the eccentric shaft operates continuously as long as the drive motor is in operation. The purpose of the eccentric shaft is to convert the rotary motion of the shaft to the reciprocating motion necessary to operate the punch bail. The punch bail operates up and down once for each cycle point. This up and down motion is imparted to the punch bail through the punch bail connecting links (Figure 23A). When the magnet is de-energized, the punch bail may move up and down without contacting the interposer; therefore no punching takes place. When the punch magnet is energized, its armature is attracted, and through the pull wire the corresponding punch interposer is pulled into engagement with the punch bail tongue. Since the punch bail tongue operates up and down, it carries the punch interposer and the punch connected to it down through the cards. On the return stroke, the punch is positively withdrawn from the card by the action of the punch bail. The purpose of the knockoff bar is to disengage the interposer from the punch bail tongue. As the interposer is returned to its normal position, the upper rounded edge strikes the knockoff bar and the interposer is cammed away from the punch bail tongue. The interposer spring then holds the interposer in normal position.

Figure 23A shows the bail in its upward position before the interposer is moved under it, while Figure 23B shows the bail driving the punch down through the die.

Magnet Unit

The punch magnet unit consists of 80 punch magnets along with their armatures and pull wires, 80 interposers and punches, the die and stripper assembly, and the punch bail assembly. Figure 24 shows a magnet unit with the punch bail and interposer knockoff bar removed. The insert shows a closeup of the interposers.

There are three types of interposer and punch assemblies. One type is used in the first column, another type in the 80th column, and yet another is used in all columns from 2 to 79 inclusive. The interposer used in the 1st column is provided with a long stud for the eye of the magnet pull wire to prevent it from slipping off the stud. The inter-

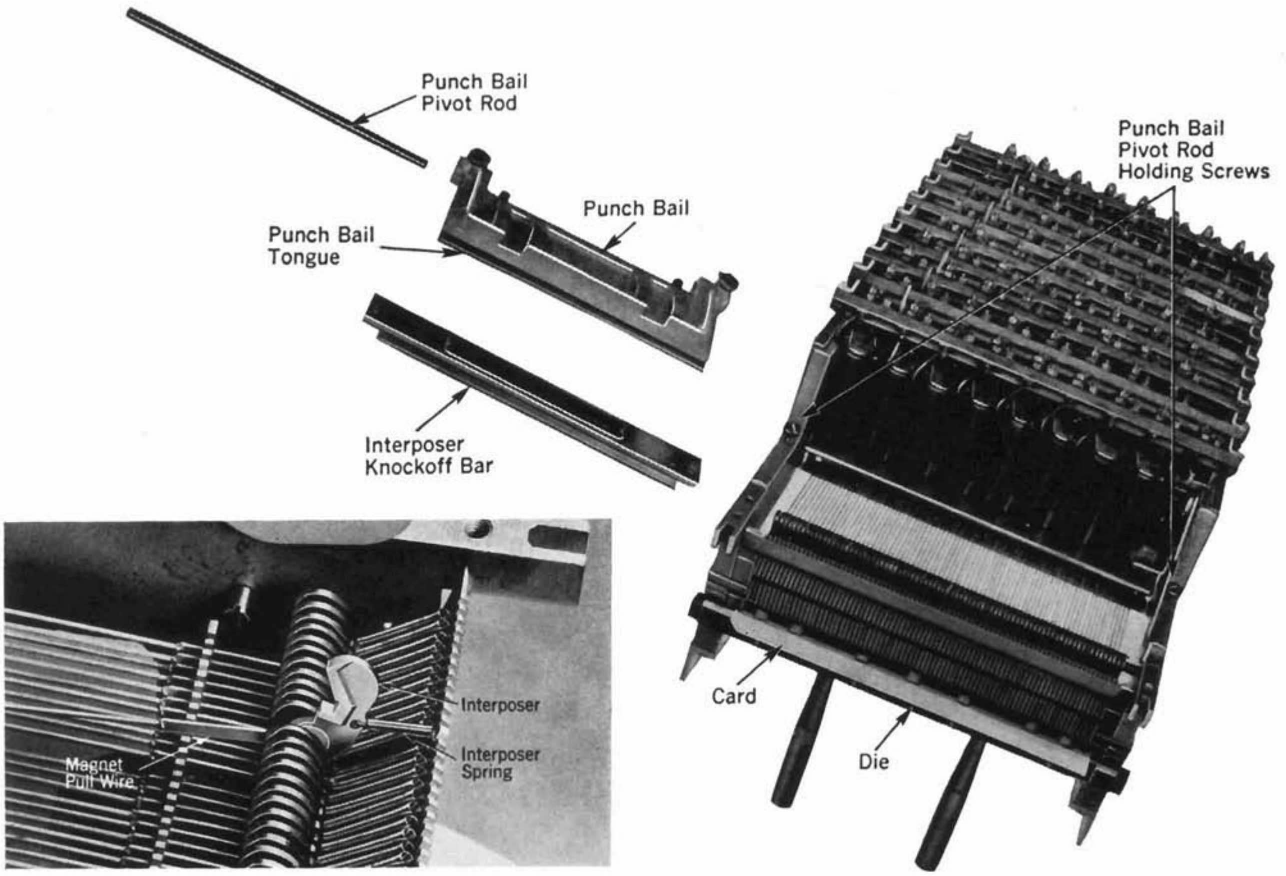

Figure 24. Magnet Unit

poser used in column 80 is attached to the punch to prevent the interposer from slipping off. The other interposers, being protected on both sides by other interposers, do not require any such precautionary design. The three types are shown in Figure 25. The interposers are being referred to as they are located in the Type 603 punch unit and not according to the column of the card as placed in the gang punches. It can be seen that the interposers have been relieved to provide a space between them. This space prevents the interposers from sticking together and causing extra holes to be punched. The interposers should be kept free of foreign particles and gumming oil.

The magnet unit is held in place by four mounting screws and located by two aligning screws (Figure 26). The adjusting screws at the left end locate the unit in a vertical position at the left end to permit proper fit of the die assembly. The

Figure 25. Three Types of Interposers

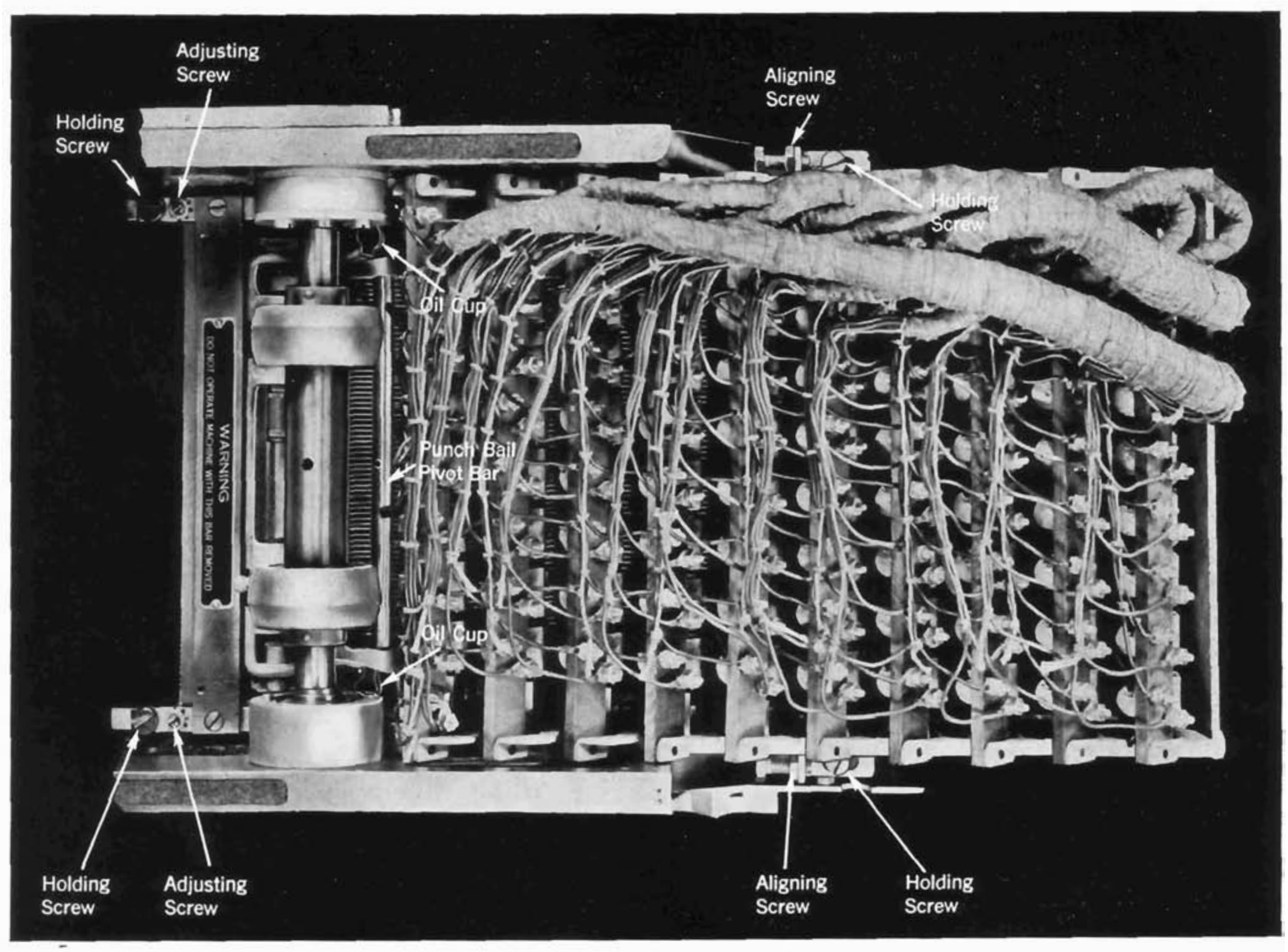

Figure 26. Magnet Unit—Top View

aligning screws locate the magnet unit laterally to permit adjustment of the vertical punching registration.

Oil Pump

The oil pump is a simple rotary-vane type pump. It is located inside the gear housing on the shaft of the small gear which drives the index. It pumps the oil from the bottom of the gear housing to the top where it is free to run down over the geneva and gears.

The rotor is pivoted off-center in the housing as shown in Figure 27. The expansion chamber at the inlet provides a vacuum and causes the oil to enter the pump from the well below. The compression chamber at the outlet causes oil to be forced out at the top.

Cam Contacts

The cam contact used on this machine makes it possible to obtain any desired duration of contact ranging from a fraction of a cycle point to a complete cycle.

This contact is available in two styles, latching and non-latching. The latching style (Figure 28) is used for all contacts that operate but once during a cycle; the non-latching style is used for contacts which must make more than once during a cycle, such as the circuit breakers which feed impulses to the brushes for reading the card.

All contacts are closed by a lobe on a bronze cam which operates against the contact plunger and carries it beyond the latching point so that the contact latch lever may support the contact

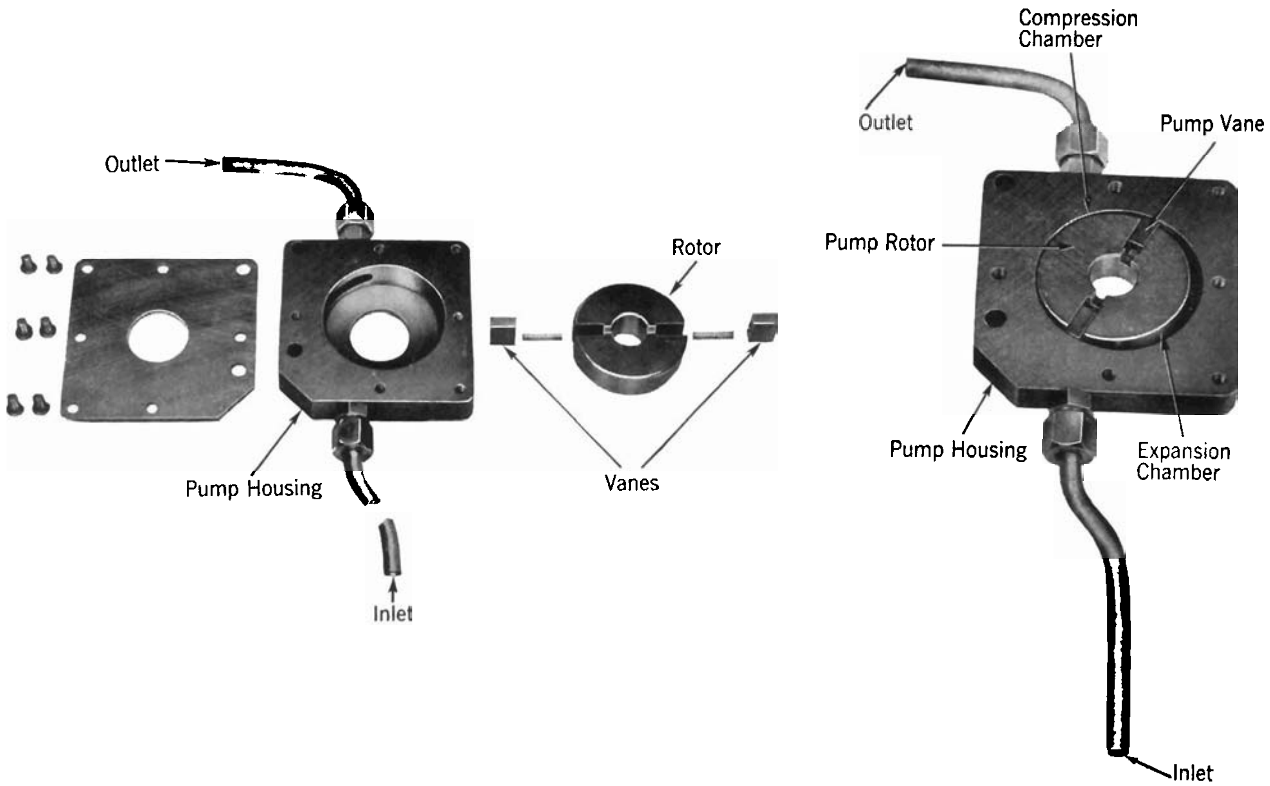

Figure 27. Oil Pump Dismantled

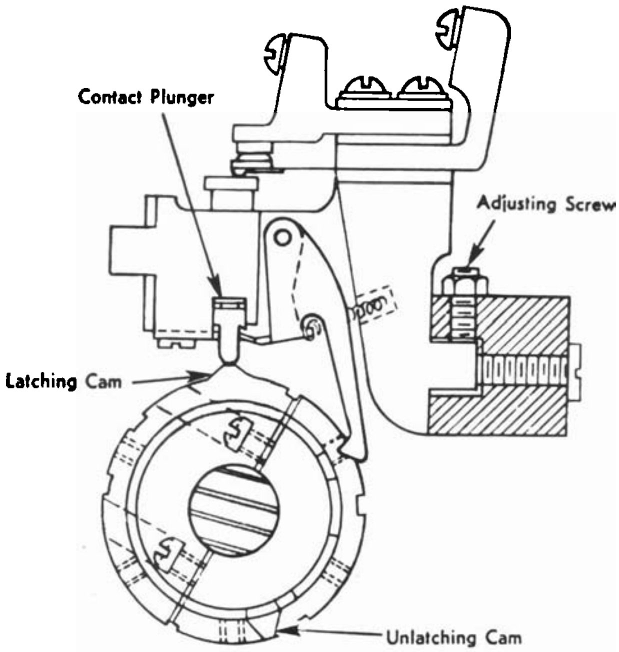

Figure 28. Contact Cam

plunger. The unlatching cam may be adjusted to any position with respect to the periphery of the bronze cam. This cam strikes the contact latch lever and unlatches the contact plunger. In this manner the contact duration may be adjusted.

There is a maximum of 41 cams and contacts mounted in the P-cam unit numbered from front to rear, top to bottom. Cams 9, 13, and 15 are not used but they retain their number. The P-cam unit is arranged so that it can be swung to the left to permit access to the underside of the cams and contacts. Care must be exercised when remeshing the unit to see that the unit is installed in time with the index.