CLUTCH MECHANISMS

It is not always desirable to have feeding, punching, or other mechanisms operative on every machine cycle. Therefore, it is necessary to provide some means of control so that these mechanisms can be given instructions to operate. This control is generally provided by means of a clutch, many types and sizes of which are in use throughout IBM machines. A clutch is a form of connection between a driving and a driven member on the same axis. The connection must be designed so that the two members may be engaged or disengaged at any desired time. However, they may be controlled either by a manually operated device or automatically by the action of some power-driven device.

Clutch Types

The clutches used in IBM machines vary in size, shape, and principle depending on requirements of speed, load, available space, and the method of control. They can, however, be classified into one of the two general categories shown below.

1. Friction drive clutches.
2. Positive drive clutches.

Each of these classifications may use various electrical or mechanical systems for achieving their objective. This may be used to further classify clutches into the following subdivisions:

Friction drive clutches

1. Clutches where frictional contact is made by engaging two discs having facings made of metal, woven, or molded material.

2. Clutches where frictional contact is made by engaging two members by means of a helical spring.

Positive drive clutches

1. Pawl and square tooth ratchet (teeth are around the periphery of the ratchet).
   a. Single-tooth ratchet.
   b. Multi-tooth ratchet.

2. Pawl and saw-tooth ratchet (teeth are around the periphery of the ratchet).

3. Face type ratchet (teeth on the face of a disc).

FRICTION-DRIVE CLUTCHES

Friction Discs

The first type of clutch to be discussed is the friction drive clutch using friction discs for the two clutch members. Figure 76 shows a very simple, manually controlled, friction clutch. The lever is moved to the right to cause this clutch to perform its function. As the lever is moved to the right, the rotating pulley operates against the friction disc. If sufficient pressure is applied to the operating lever, it will cause the friction between the driving pulley and the friction disc to rotate the driven member. During the time necessary for sufficient friction to be created between the members, slippage will occur. This is an important factor that should be considered when using this type of clutch.

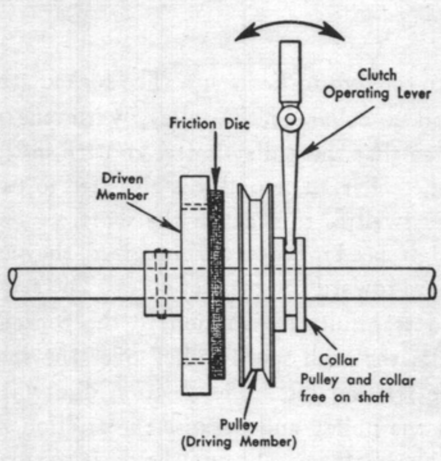

Figure 76. Basic Friction Clutch

Two Speed Clutch

The two speed clutch, which is used on the Type 402-403 Accounting Machine, is very similar in principle to the simple clutch shown above. In Figure 77 there are two pulleys which are a part of the clutch. The two pulleys are being driven at different speeds and the speed of the machine depends upon which of the two pulleys is engaged with and driving the friction disc.

The engaging of the clutch is controlled by four magnets, an armature and two forked arms. The armature, situated between the two sets of magnets, is

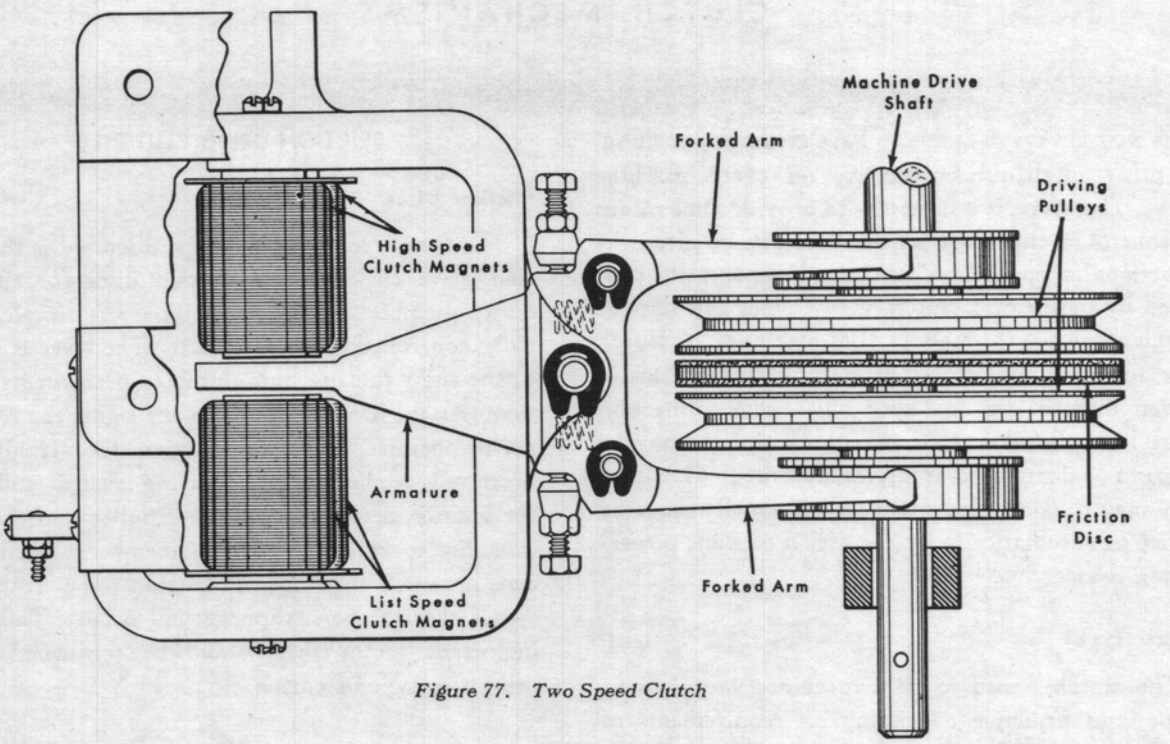

Figure 77. Two Speed Clutch

attached to the two forked arms. The forked arms are engaged in a collar on a pulley, with the collar mounted, so that the pulley is free to turn independently of the collar. The pulley is also free to turn on the shaft as well as to slide on the shaft.

If the high speed magnets are energized, they attract the armature toward the magnet cores. The armature pivots and transmits the motion to the forked arm which slides the high speed pulley over the shaft to engage the friction disc. The friction disc will then turn with the pulley and because the friction disc is pinned to the shaft it will cause the shaft to turn and drive the machine. If the list, or slow speed magnets had been energized, the other pulley would have engaged the friction disc driving the machine at list speed.

This type of clutch has two main advantages: first, the load is applied gradually without shock; second, in the case of extreme overload, slippage will occur, preventing damage to the mechanism. It is not possible, however, to obtain absolute synchronism with this clutch which limits its use in IBM machines.

Helical Spring Drive and Clutch

Another type of friction clutch used in IBM machines is the helical spring drive clutch device. Figure 78 illustrates the principle; the clutch is shown disengaged. The shaft rotates continuously and the gear is free to rotate on the shaft. A helical spring with a normal diameter slightly less than the diameter of the shaft is attached to the gear and wound about the shaft. With the armature engaging one end of the helical spring, as in the figure, if the gear is turned in the direction of the arrow the unwinding effect increases the diameter of the spring. In the figure, the spring is held unwound by the detent. Because the diameter of the spring is now larger than the shaft diameter, the spring does not grip the shaft.

To engage the clutch, the magnets are energized to pull the armature away from the end of the spring. The spring immediately tightens on the shaft. The

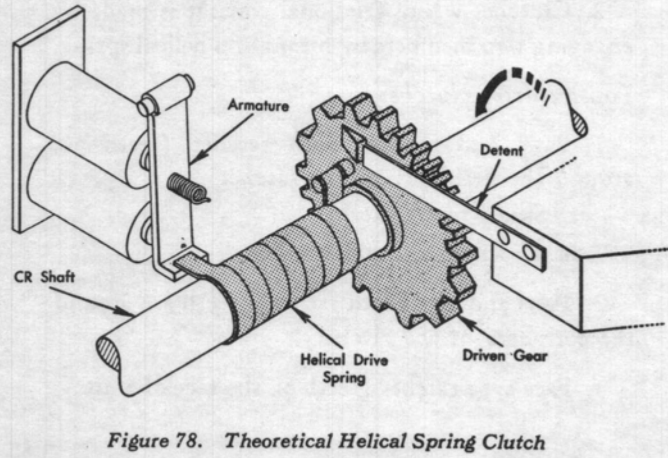

Figure 78. Theoretical Helical Spring Clutch

shaft is turning in the direction that will cause the friction between the spring and shaft to further tighten the spring. The spring is wound so tightly on the shaft that no slippage can occur between the members. Thus the shaft drives the gear to operate the mechanism which is under the control of the clutch. When the shaft, spring, and gear have made one revolution, the armature again engages and stops the left end of the spring. The momentum of the gear and the mechanism it operates causes the gear to continue to rotate far enough for the detent to drop in behind the detent stud. This increases the diameter of the spring so that it no longer grips the shaft, and the clutch is disengaged.

Type 24 Helical Spring Clutch

The principles of the helical spring clutch used on the Type 24, 26 and 56 machines are the same as those of the hypothetical clutch used for purposes of explanation. The parts of the actual clutch may be seen in Figure 79. The drive pulley and sleeve is the constantly rotating driving member and is comparable to the shaft in the figure used for illustration. However, the pulley is not attached to the shaft, but is free to rotate on it. The clutch sleeve and clutch spring operate together to provide a control and are comparable to the spring alone in the previous discussion. The remaining mechanisms, i. e. the spring collar, detent, and shaft, are connected to act as one piece and are comparable to the gear in the hypothetical clutch. The left end of the spring is on a step of the inside surface of the clutch sleeve. The sleeve also has a step in its outer periphery which will be engaged by the armature. In effect the armature is going to engage and stop the left end of the spring as in the hypothetical case (Figure 80). The right end of the spring is held by the spring collar which is clamped to the shaft and provides a means of increasing the spring diameter when the left end has been stopped by the armature. The spring permits the pulley to turn freely when the clutch is inoperative. However, when the magnet is energized and the spring is released, it clamps the pulley sleeve and the sleeve which is pinned to the shaft together. Note that the turned up ear on the right end of the spring does not drive the mechanism. It is merely the means by which the detent is able to hold the spring open when the clutch is latched.

Shoe-Type Clutch

The shoe-type clutch is a friction clutch used for high-speed, random-engaging applications, such as in the carriage. The clutch consists of a driving member called the drum, a latch wheel, a detent wheel, friction shoes and a prybar (Figure 81). The clutch is considered latched when it is disengaged; that is, the clutch latch is engaged in a tooth of the latch wheel and the detent is fully seated in the detent wheel (Figure 81).

The clutch shoes are held away from the drum, when the clutch is latched. The engaging shoe rests on the turned over ear on the prybar. This ear projects through an opening in the latch wheel. The prybar pivots on the eccentric stud on the prybar adjusting plate. The following shoe is held between the shoe stops which also project through the opening in the latch wheel.

The clutch is operated by changing the position of the prybar. The position of the prybar is controlled by the relative position of the latch wheel and detent wheel. When the clutch is unlatched, the clutch-engaging spring pulls on the bottom of the prybar. The prybar pivots around the prybar pivots stud.

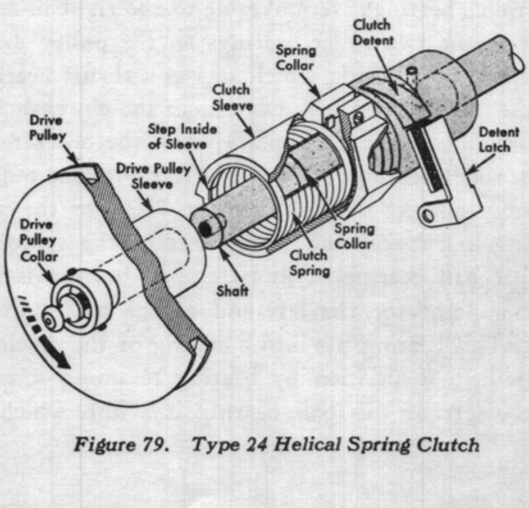

Figure 79. Type 24 Helical Spring Clutch

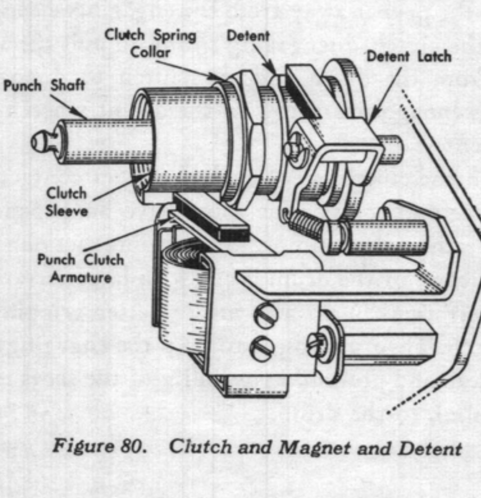

Figure 80. Clutch and Magnet and Detent

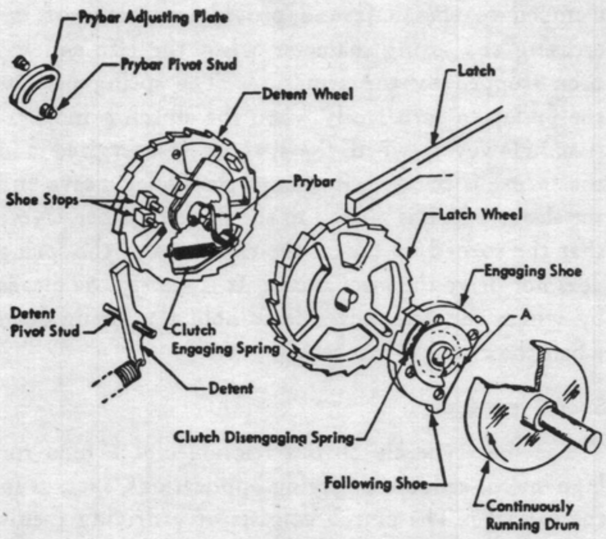

Figure 81. Shoe Type Clutch

This causes:

1. the latch wheel to move clockwise relative to the detent wheel
2. the ear on the top to move the engaging shoe outward to the right, causing it to contact the drum.

The prybar's action is transmitted to the following shoe at point A, Figure 81. Thus, the shoes are firmly engaged with the drum. The shoes operate against the shoe stops and thus transmit the motion to the detent wheel. Therefore, the detent wheel is the output member, or the driven part of the clutch.

To disengage the clutch, the magnet is de-energized and the latch is allowed to catch a tooth of the latch wheel. By stopping the latch wheel, it turns counterclockwise with respect to the detent wheel. This rotates the prybar counterclockwise about its pivot causing the clutch-engaging spring to stretch and also pulling the prybar away from the engaging shoe. This allows the clutch-disengaging spring to pull the shoes away from the drum and the clutch to disengage. There is enough overthrow in the detent wheel to let the detent seat.

When the clutch is engaged, the shoes contact the drum at four points. The shoes have an expanding action rather than simply an opening action. The inner surface of the drum is cut with large serrations. These serrations in no way insure better gripping of the clutch. Their purpose is to keep the engaging surfaces clean and prevent a possibility of the shoes tending to stick to the drum.

Figure 82 shows another view of the shoe-type clutch.

Magnetic Clutch

The next few paragraphs describe the construction and operation of the magnetic clutch. The clutch coil housing contains the coil and commutator assemblies and is pinned to the pulley drive shaft.

Clutch Construction

The coil assembly is a coil wound on a bobbin similar to a spool of thread. The terminals of the coil are connected to commutator rings which are located on the right side of the housing. The commutator rings are part of an assembly attached to the coil housing by the same screws which hold the coil assembly to the housing (Figure 83, upper right section). Insulation is placed between the commutator rings and the coil housing. Contact is made to the commutator rings and thus to the magnet coil by stationary carbon brushes similar to a motor brush.

With the commutator ring and brush arrangement, the circuit can be completed to the magnet coil regardless of the position of the idling clutch coil housing. The circuit through the magnet coil is completed from the line side through the necessary cam and relay points, to one carbon brush, through the commutator ring, magnet coil, other commutator ring, other carbon brush, and to the fuse side of the line. Depression of the start key will initially energize the magnet coil, after which a continuous hold circuit is established.

The construction of the clutch pulley assembly is shown in Figure 83, upper center section. The pulley is free to revolve about the pulley drive shaft and is fitted to two roller bearings which are placed side by side on the pulley drive shaft. The outer races of these two roller bearings are moveable to the right or left. Next to the two roller bearings on the pulley drive shaft is a ball bearing which acts as a thrust bearing for the pulley when it is away from the clutch housing assembly. This takes place when the outer races of the roller bearings move to the left with the pulley assembly against the ball bearing. Next to the ball bearing is a spacer and to the left of the spacer is another ball bearing. This latter ball bearing is the bearing point for the left end of the pulley drive shaft. This bearing fits into a casting of the machine and is held in position by bearing retaining screws. At the left of this ball bearing is a hub which is

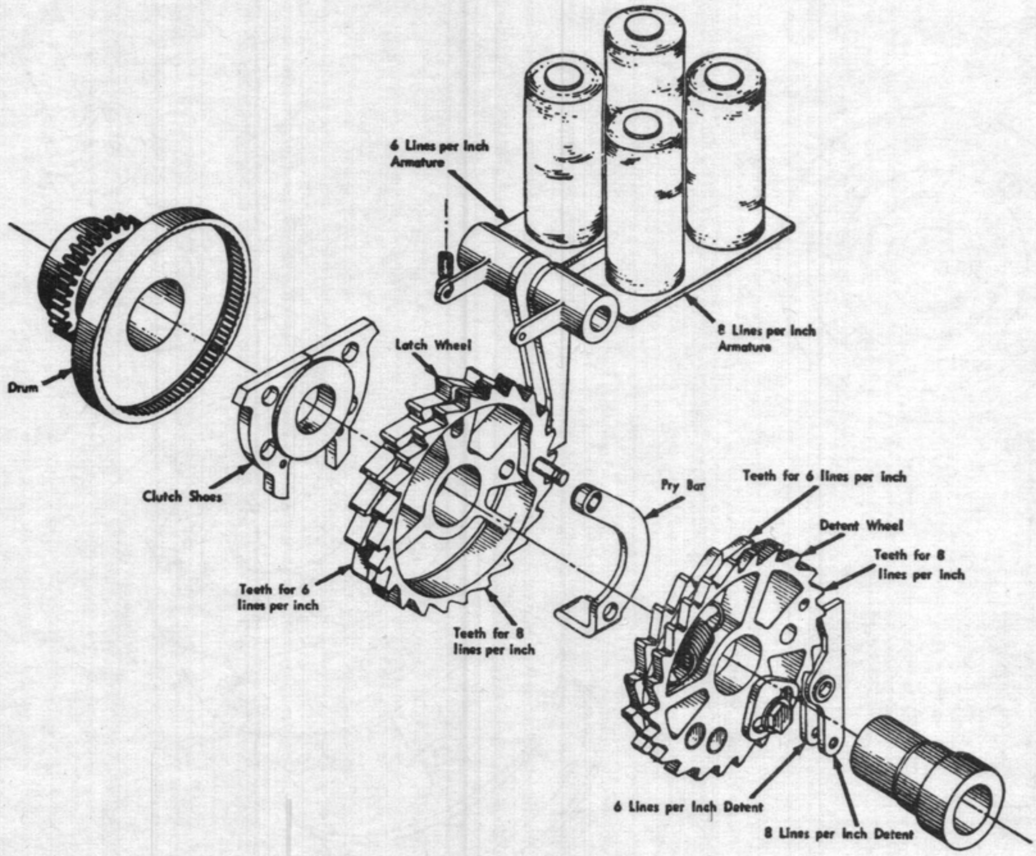

Figure 82. Shoe Type Clutch

pinned to the pulley drive shaft. This hub keeps the four bearings and spacer snugly against a shoulder of the pulley drive shaft, thus preventing any lateral movement of the bearings.

The clutch pulley of the drive clutch has a slight sliding motion because the separable roller bearings allow the pulley to move away from the clutch coil housing which is pinned to the pulley drive shaft. This makes it possible to keep the pulley drive shaft from turning by separating the clutch pulley from the clutch coil housing.

Attached to this clutch pulley by screws is the clutch armature with the same diameter as the outer diameter of the pulley. Separating the armature and pulley is a narrow gasket which prevents grease from escaping as explained in a later paragraph. This armature is attracted to the magnet when the magnet becomes energized. When the armature is attracted to the magnet core, the entire pulley assembly is moved to the right, together with the outer races of the roller bearings. This causes the clutch armature to be brought against the outer rim of the clutch housing assembly. The movement of the pulley toward the magnet core is not stopped by the magnet core but is stopped by the full circumference of the outer rim of the clutch coil housing before the armature strikes the core. When the armature is against the outer rim of the housing, there is still clearance between the magnet core and armature to keep a steady pull on the armature during machine operation. The force of the magnet is sufficient to hold the armature rigidly against the outer rim of the housing without slippage after full contact is made by the armature and housing. With the pulley firmly against the clutch housing both units will operate as one. This, in turn, causes the pulley drive shaft to turn with the pulley.

POSITIVE DRIVE CLUTCHES

Pawl and Square-Tooth Ratchet

There are two general types of clutches that fall into this category: those whose ratchet has a single tooth, and those whose ratchet has more than one tooth.

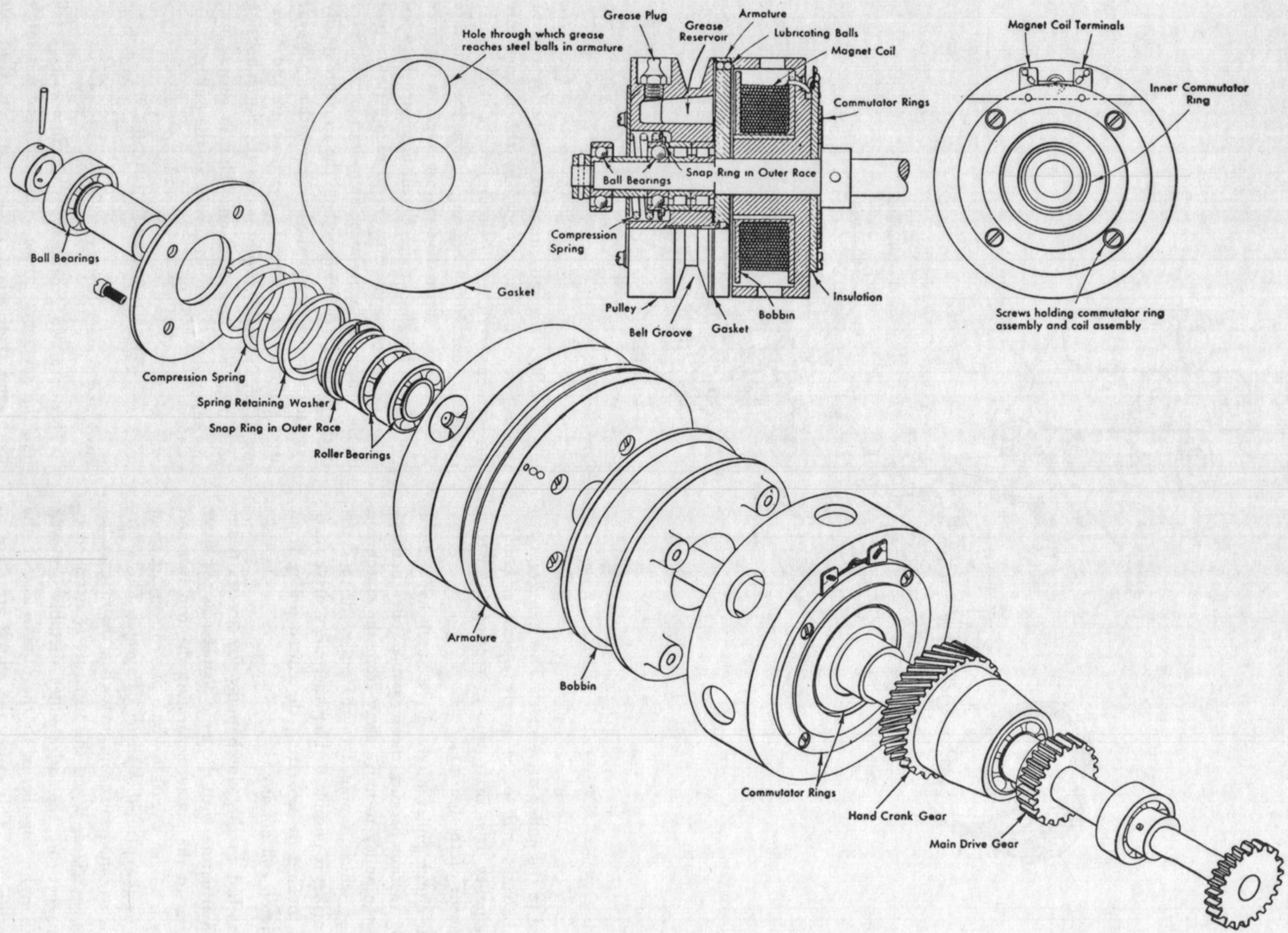

Figure 83. Magnetic Clutch

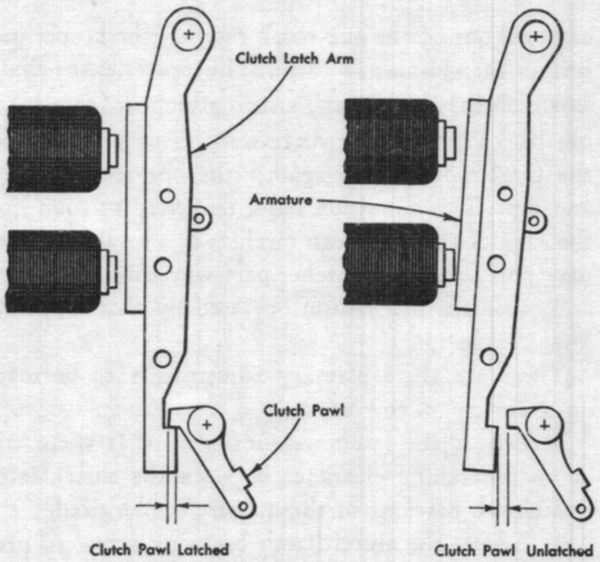

Figure 84. Clutch Pawl and Latch Relationships

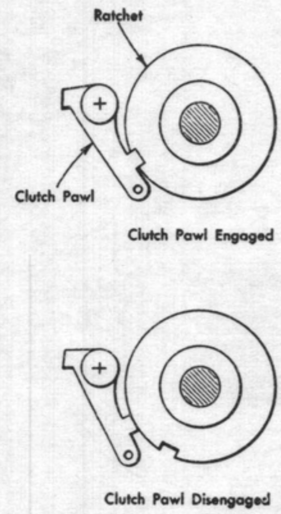

Figure 85. Clutch Pawl and Ratchet Relationships

To prevent misunderstanding of the use of terms such as latched, unlatched, engaged, and disengaged, the following explanation serves as a guide. First, it should be clear that the terms latched and unlatched refer only to the relationship of the clutch pawl to the clutch latch. Figure 84 shows the two conditions of the pawl in relation to the latch.

Latched — The clutch pawl and clutch pawl arm are held in position by the clutch latch arm.

Unlatched — The clutch pawl and clutch pawl arm are released because the armature has been attracted by the clutch magnet.

It is obvious that one of these two conditions must exist at all times.

It should also be clearly understood that the terms engaged and disengaged refer only to the relationship of the clutch pawl to the ratchet. Figure 85 shows the two conditions of the pawl in relation to the ratchet.

Engaged — The clutch pawl is engaged in the tooth of the driving ratchet.

Disengaged — The clutch pawl is not engaged in the tooth of the driving ratchet.

It is also obvious that one of these two conditions must exist at all times. It can now be concluded that at all times two conditions must exist with respect

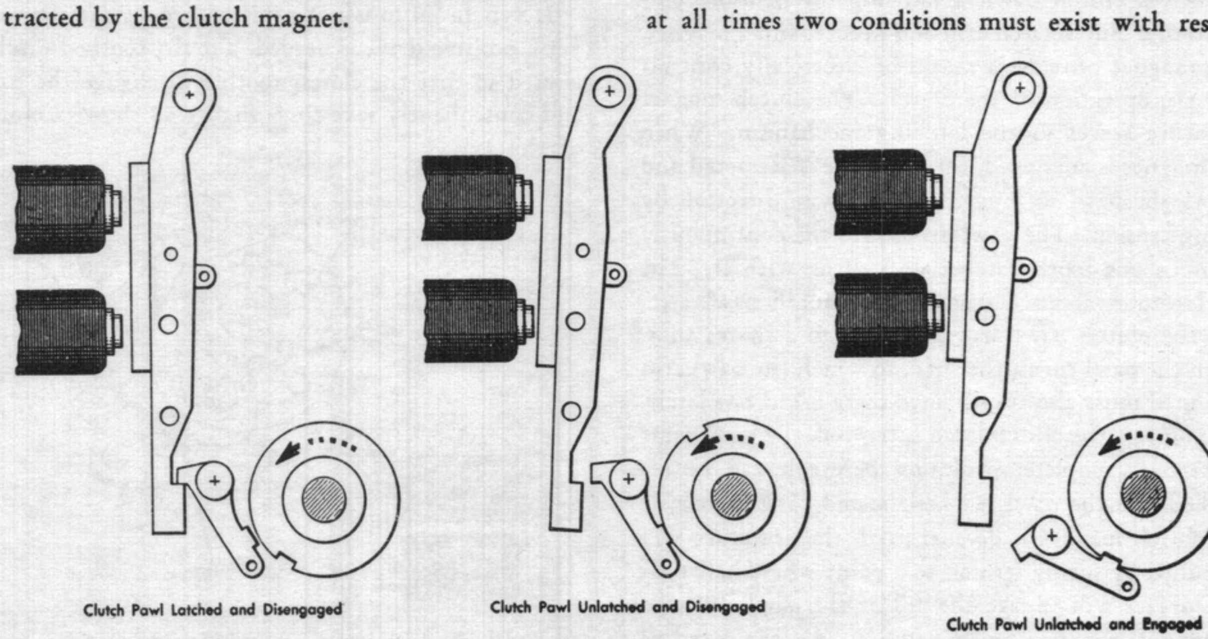

Figure 86. Combined Clutch Conditions

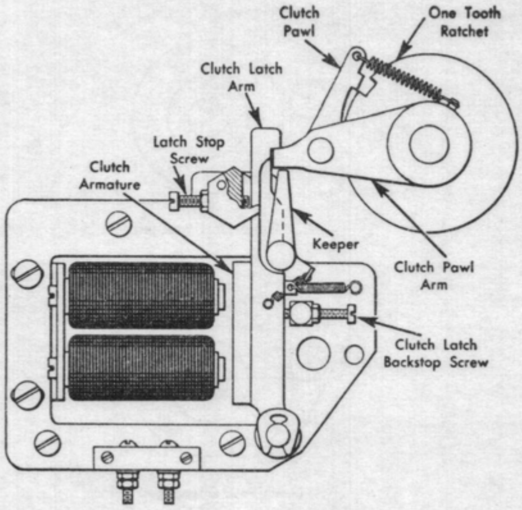

Figure 87. Pawl and Ratchet Clutch

to the clutch pawl. It is either latched or unlatched and, at the same time, it is either engaged or disengaged. If the clutch pawl is latched the pawl must be disengaged as it is impossible for the clutch to be both latched and engaged. If the clutch is unlatched, it may be either engaged or disengaged. Figure 86 shows the three possible combinations.

Single Tooth Ratchet

Figure 87 shows a typical single-tooth ratchet type clutch and the nomenclature. The principle parts of the clutch are a continuously running one-tooth ratchet, a clutch pawl, a latching mechanism composed of a clutch latch arm and keeper, 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. When the magnet is energized, the armature is attracted and allows the pawl to pivot in a clockwise direction by spring tension. The pawl drops into the continuously running one-tooth ratchet and turns with it. The pawl rotates about a stud on the clutch pawl arm, and the clutch pawl arm is pinned to a shaft; thus, when the pawl turns, the shaft to which the pawl arm is pinned must also turn. Since there is but one latching point, if the clutch latch is tripped, the pawl must make one complete revolution before it can be relatched. As the pawl reaches the end of the cycle, if the clutch magnet is de-energized, the armature will be pulled by spring tension to a point where its latching surface will engage the tail of the pawl and cam it out of the one-tooth ratchet. As the pawl is cammed out of the one-tooth ratchet, the keeper gets behind the clutch pawl arm. This prevents the shaft, to which the clutch pawl arm is attached, from turning backward. If the shaft were to turn backward, the pawl would drop against the one-tooth ratchet and nip. This condition has a tendency to round off the edge of the one-tooth ratchet; as a result the pawl may pull out of the ratchet part way through a cycle and cause the mechanism operated by that clutch to lose a cycle.

There are three primary adjustments to be made on a clutch of this type.

1. Adjust the latch stop screw so that there will be an unlatching clearance between the clutch latch and clutch pawl when the magnet is energized.
2. Adjust the clutch latch backstop screw to provide an overlap for latching up when the magnet is de-energized.
3. Shift the magnets and cores to provide a minimum clearance between the cores and the armature when energized.

This type of clutch has two main advantages; perfect synchronism can be obtained, and it has a positive drive with no slippage. It can be engaged or disengaged at only one point in a cycle and is consequently easily synchronized with other mechanisms. For this reason it is used extensively throughout IBM machines.

Multi-Tooth Ratchet Clutch

If synchronism is not a primary consideration and yet a positive drive is needed, a multi-toothed ratchet is used so that the closest tooth will engage the pawl and consequently save time. Figure 88 shows a clutch of this type.

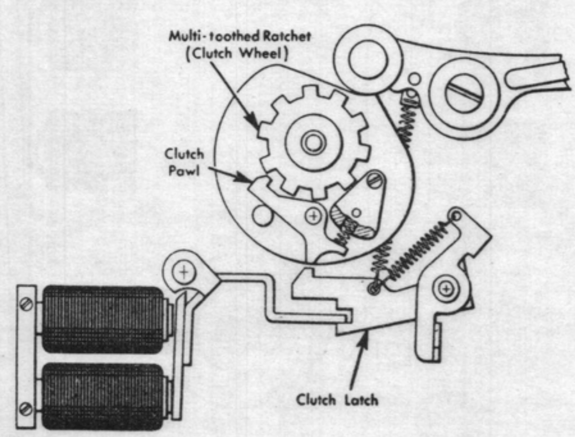

Figure 88. Multi-Tooth Ratchet Clutch

Saw-Tooth Ratchet

It may be desirable to have positive-drive where the time of engagement is not important and a square tooth ratchet is not necessary. This is true when the ratchet is not moving or is moving slowly at the time the pawl is engaged. The ratchet is then started or accelerated. This type of engagement will reduce the tendency for the driven member to lead the driving member which eliminates the need for a square tooth. Figure 89 shows a clutch of this type. Here the operation is slightly different from that of the square-tooth ratchet. The energization of the trip magnet begins a train of events that leads to the operation of the clutch. The trip magnet armature bracket operates against an ear on the feed pawl latch causing the feed pawl latch to rotate in a counter-clockwise direction. An ear on the latch is actually supporting the feed pawl and it moves under the cut-out portion of the feed pawl. The feed pawl then moves down under spring tension so that it engages a tooth on the ratchet.

At the same time that the armature bracket operates against the pawl latch, it also operates a contact that completes a circuit to the motor. The motor drives the ratchet so that when the feed pawl is engaged in the ratchet, the feed rack drive gear is operated. As the feed pawl latch, feed pawl, and drive gear revolve together in a counter-clockwise direction, the tail of the feed pawl will strike the feed pawl stop bracket before it makes a complete revolution. This action causes the feed pawl to pull out of the ratchet and, because the drive gear is under spring tension, it will now revolve in a clockwise direction to a normal rest position. Note that the drive gear is actually two pieces, which are held together by two springs. These springs are safety trip springs and are operative if some obstruction should cause the outer portion of the drive gear assembly to stop. In that event the ratchet continues to drive the pawl and the inner section of the drive gear assembly. The safety trip springs will be extended until the tail of the pawl strikes the safety trip pin. The safety trip pin, which is mounted on the outer section, disengages the pawl from the ratchet and the drive gear assembly will return to a normal position.

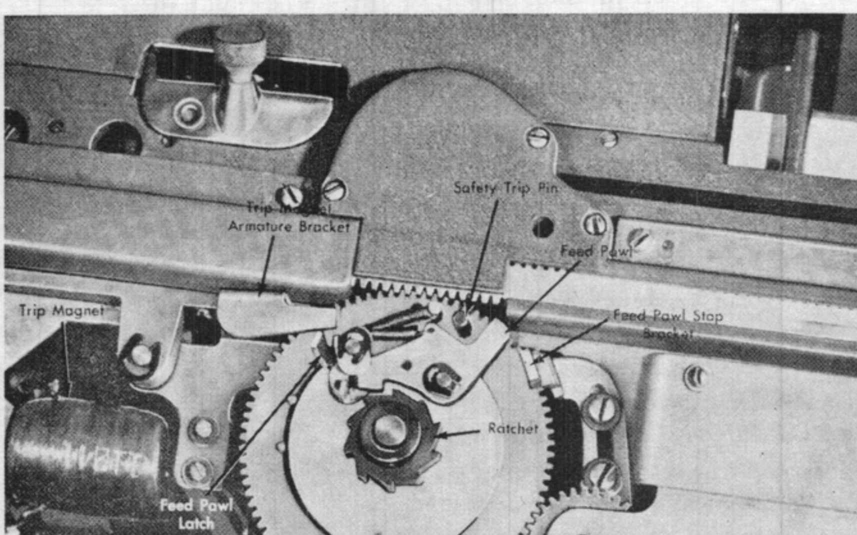

Figure 89. Saw-Tooth Ratchet Clutch

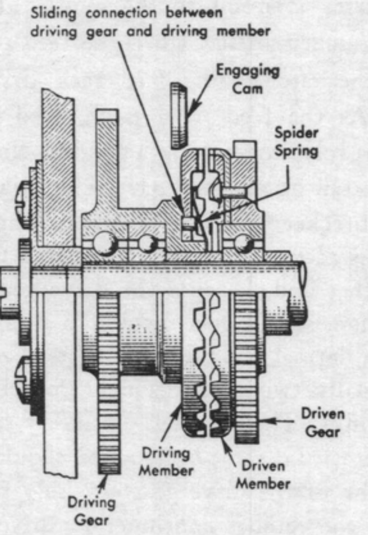

Figure 90. Face Type Ratchet Clutch

Face Ratchet Clutch

Another type of clutch in use in IBM equipment is the face ratchet clutch (Figure 90).

It can be assumed that the driving gear is a continuously running gear and, because the driving member is turning with the driving gear, it will also be continuously running. The driving member is connected to the driving gear by means of three pins which engage three holes in the driving member. However, the driving member is free to slide to the left or right along the shaft and the three connecting pins. A spider spring is used to hold the driving member to the left, against the shoulder on the driving gear, and away from the driven member. This is the normally inoperative position (Figure 90).

When the engaging cam is moved down, the sloping surface of the engaging cam strikes the top portion of the driving member. Thus, the top portion of the driving member is moved to the right and its teeth engage the teeth of the driven member. Figure 91 shows how the clutch is engaged. The clutch teeth are fully meshed at the point where the engaging cam is operating. The driven member, connected to the driven gear, transmits motion to the gear train controlled by the driven gear.

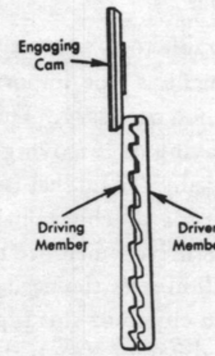

Figure 91. Face Type Ratchet Clutch — Engaged

One means of controlling the time that the clutch will be engaged is shown in Figure 92. When the magnet is energized, the armature releases the engaging cam arm and the spring causes the engaging cam to move in a counter-clockwise direction. This action permits the cam to move in against the driving member and engage the clutch.

The clutch can be disengaged by means of a cam as shown in Figure 92. The lobe on the knockoff cam which makes one revolution per cycle, disengages the clutch at the same time in the cycle regardless of the time the clutch was engaged. The clutch engaging arm is rotated clockwise far enough for the armature to relatch the clutch engaging arm.

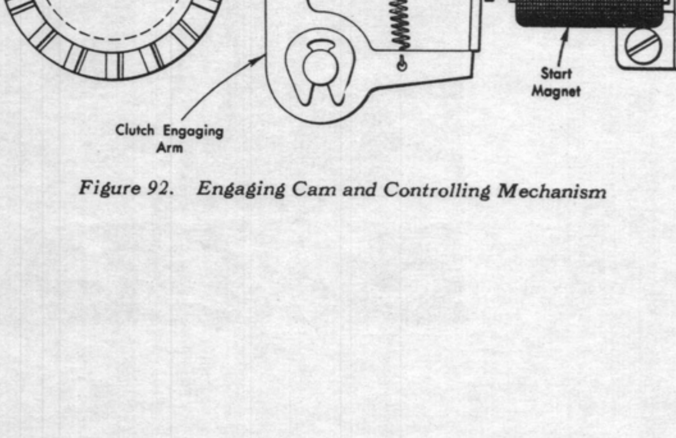

Figure 92. Engaging Cam and Controlling Mechanism