CHAPTER 13

Clutch and Brake Systems

Systems Versus Components

Most of the mechanisms that have been discussed up to this point produce intermittent motion without any assistance from other components. A Geneva, for example, converts the continuously rotating motion of an input shaft into intermittent motion to drive a load. No external controls, or the like, are needed for the Geneva to perform its designed task. On the other hand, clutches and brakes, are components which, taken alone, usually cannot produce intermittent motion. They are used instead as building blocks of larger systems involving control components, etc.; without these additional components the clutch-brake combination will produce either continuous motion or no motion.

A clutch is a device used to connect one shaft to another, usually connecting a load to a driver on command. A brake is a device used to connect a shaft to ground for stopping or holding that shaft. Usually it is the load shaft which is provided with the brake. Clutches and brakes are very similar devices and, in many cases, are identical to each other in construction. They can be obtained as separate components and provided with separate and independent controls by the system designer. Since they are so frequently used together, however, they can also be purchased as combined clutch-brake components and often with predesigned control packages. Examples of these various products will be seen in this chapter.

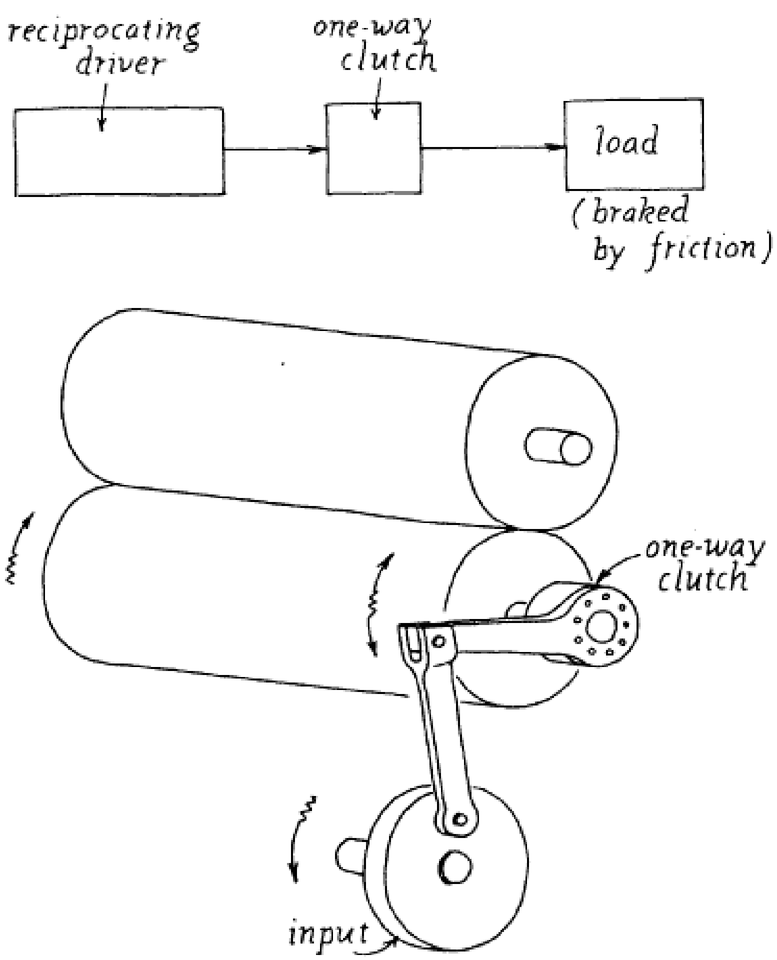
Types

There are many different types of clutches and brakes. It would be possible, in fact, to write a separate book on this subject alone. I hope it will be sufficient for our purposes to say that some clutches and brakes have toothed mating surfaces; some rely on friction (disc or spring clutches and brakes); some make use of wedging or toggle forces (and friction) to grip the output member (sprag, roller, or cam clutches and brakes); and some rely on magnetic or electrical forces to produce the drive or braking torque (hysteresis, eddy current, magnetic powder and magnetic fluid clutches). Most of these various types can be actuated by either mechanical, electrical, pneumatic, or hydraulic means, depending on the system in which they are used.

Systems

Clutch-brake combinations are used in two basically different ways in intermittent motion drives. They are used alone (with suitable control means) to produce intermittent motion where high-precision positioning is not required. When high precision is required, they are used with precision mechanical indexers; Genevas, ratchets, star wheels, gears, etc. Their main function in this second case is to extend dwell periods while permitting fast and precise indexing during drive periods.

Figures 13–1 through 13–8 will describe and illustrate next, a number of different basic clutch-brake



Drawing courtesy of The Lowell Corporation

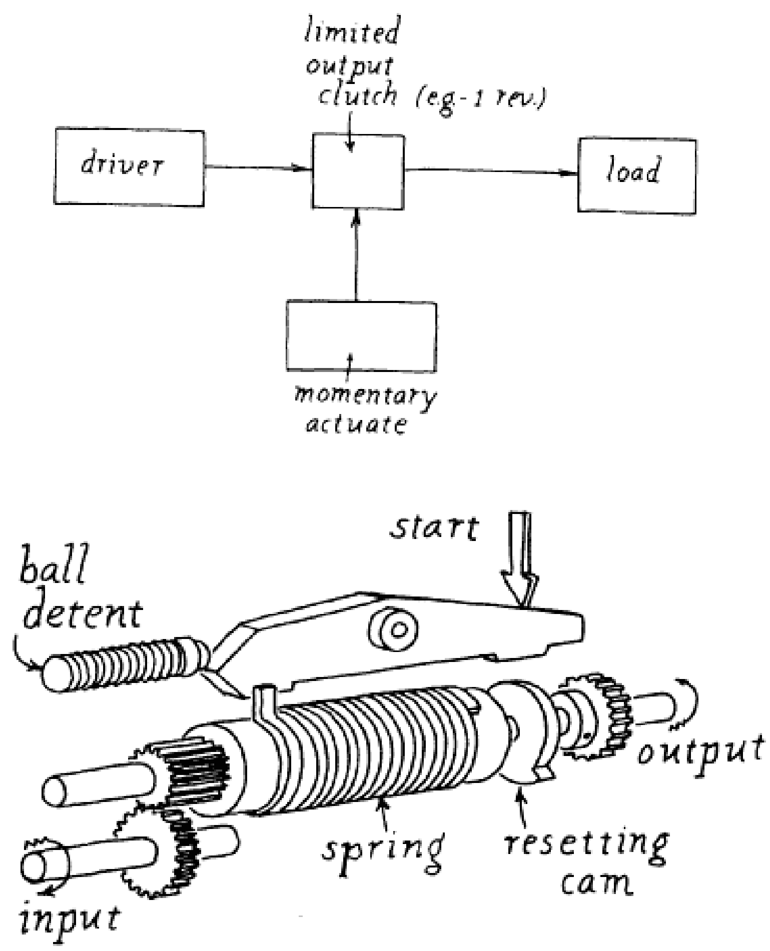
Fig. 13–1. Simple intermittent motion system employing a one-way clutch.

systems for producing intermittent motion. Some of these produce fixed-length steps at a fixed repetition rate. Others produce controllable steps at a controllable rate, while the rest produce fixed steps at a variable rate or vice versa.

Figure 13–1 shows a block diagram and illustration of a simple intermittent motion system employing a one-way clutch. This system produces fixed steps at a fixed rate and no brake is involved since the load is braked by its own friction.

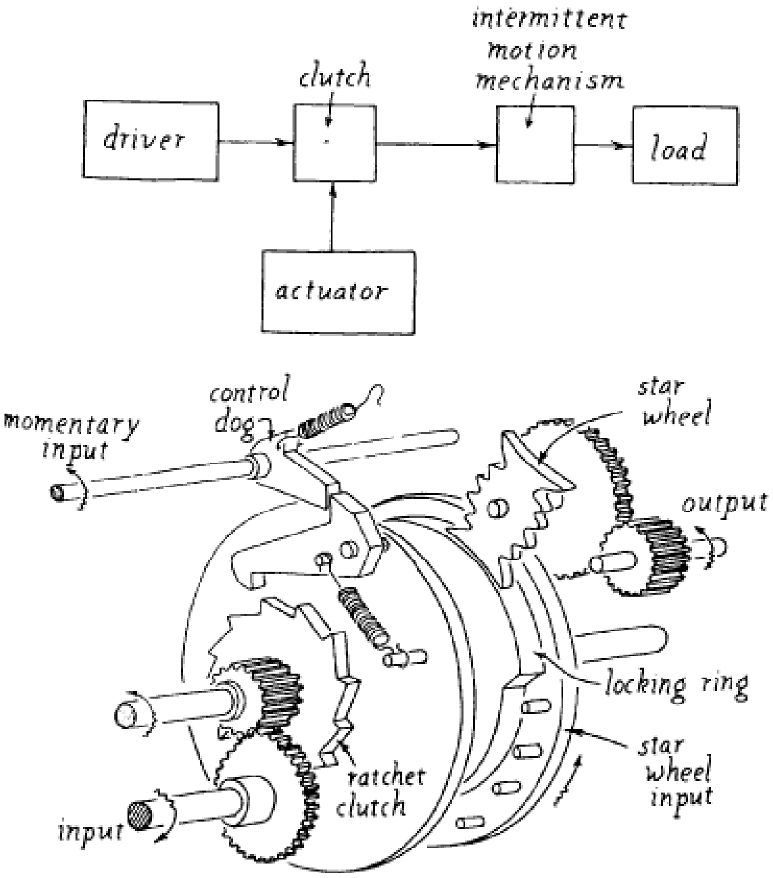
The block diagram and schematic illustration in Fig. 13–2 explain a system in which a momentary control action (pushing on the control lever in the direction shown by the "start" arrow) actuates a clutch. As the control lever is pushed, the left end of the spring is released allowing the spring to grab the input shaft and transmit torque to the output shaft at the other end of the spring. (The barrel-shaft on which the spring is mounted is in two pieces and the spring is fastened to the right-hand end.) As the output shaft turns, it carries with it the resetting cam which brings the starting lever back into its original position (remember, the starting push was only momentary). When the left end of the spring strikes the control lever again, the output motion ceases. And, again, a brake is not necessary in some systems where friction in the load will bring the output to rest in a reasonable time; but it is necessary if load inertia exceeds load friction. This system produces fixed steps with variable dwells.

In the clutch and intermittent motion mechanism system illustrated in Fig. 13–3, a ratchet pawl engages the input ratchet wheel after the momentary rotation of the control input shaft releases the pawl. This produces approximately one turn in the ratchet clutch, which moves until the control dog lifts the ratchet pawl out of engagement with the input ratchet wheel. The ratchet clutch, in turn, drives the star-wheel input, producing precisely 180 degrees of motion in the output shaft each time the system is actuated. This system produces a fixed-length step, but with a variable dwell time (depending on the control system). The brake on the output consists of the locking ring on the star wheel. Other than friction, there is no brake on the ratchet clutch.



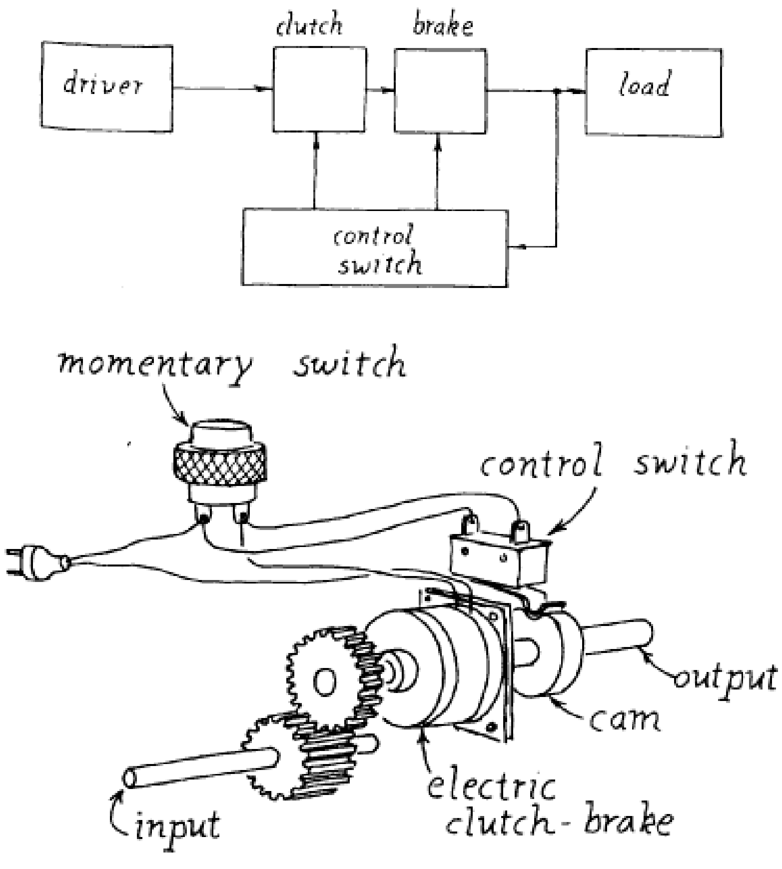
Drawing courtesy of MACHINE DESIGN Magazine; Nov. 21, 1968

Fig. 13–2. System producing fixed steps with variable dwells.



Drawings courtesy of MACHINE DESIGN Magazine; Nov. 21, 1968

Fig. 13–3. Intermittent motion system with clutch, producing fixed-length step with variable dwell—depending on the control system.



Drawings courtesy of MACHINE DESIGN Magazine; Nov. 21, 1968

Fig. 13–4. Electric clutch-brake system with simple control means.

A block diagram and illustration of an electric clutch-brake system and simple control means are shown in Fig. 13–4. The push-button switch is actuated momentarily, energizing the clutch and de-energizing the brake. The output shaft starts to move. As soon as the output shaft has moved a few degrees, the cam has closed the control switch which overrides the momentary starting switch and keeps the clutch energized and the brake de-energized. After the output shaft has moved one revolution the control switch is opened. If, by this time, the momentary switch has been released by the operator the clutch will de-energize and the brake will stop the output motion. This system produces fixed steps with variable dwell.

The block diagram in Fig. 13–5 shows a self-controlling clutch-brake system. A rotating driver

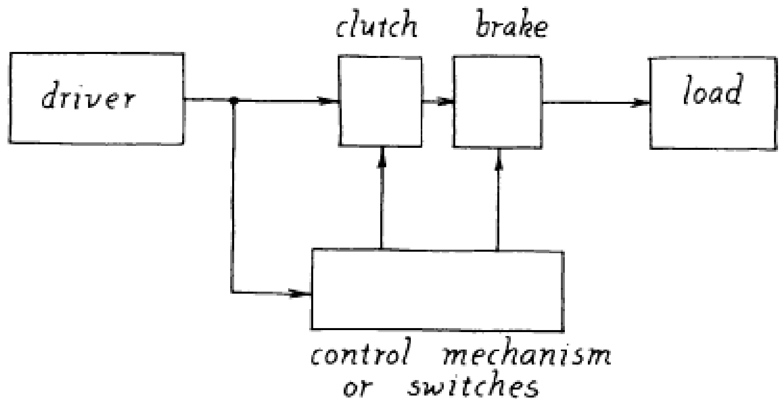


Fig. 13–5. Block diagram of a self-controlling clutch-brake system.

periodically actuates a clutch and de-actuates a brake (and vice versa) to move a load intermittently. This system is very similar to that of Fig. 13–4 except that it will run continuously, producing fixed steps with a fixed dwell period and does not depend upon operator actuation.

Figure 13–6 shows a block diagram (left) of a programmable clutch-brake system. The programmer might be a computer, a bank of switches, a punched card reader, a limit switch and cam system, or the like. The sensor connected to the load could be a shaft encoder, limit switch, pulse generator, etc. The control system might be used to drive a clutch-brake system such as that shown in the illustration at the right. It will produce a fixed or variable step and a fixed or variable dwell, as programmed.

The switch bank in the counter of the programmable clutch-brake system of Fig. 13–7 (in which a predetermining counter is used as the program and