

The IBM SELECTRIC Composer

Carbon Ribbon Feed Mechanism

Abstract: High quality impact printing requires that a sufficient supply of printer ink be presented to the print element for each character. It is also required that this supply of ink last for a reasonable length of time. To enable the IBM SELECTRIC Composer to meet the standards considered necessary under these criteria, it was necessary to increase the character yield per ribbon by a factor of two over that which was provided by the IBM SELECTRIC Typewriter. To do this a new constant ribbon tension control device had to be designed to eliminate the inertia and geometry effects associated with the larger composer ribbon spools. It was also necessary to eliminate ribbon feeding on no-print or spacebar operations and to provide various load controls.

Introduction

High quality impact printing can be realized only through the use of a total-release or single-pass ribbon. This precludes the use of a high-yield fabric or wet-ink ribbon and requires the use of a carbon ribbon with a much lower character-per-ribbon yield. It was the authors' purpose to design and develop a carbon ribbon feed mechanism for the IBM SELECTRIC Composer that was both reliable and convenient for use when character yield was maximized. The mechanism design as discussed herein is based very much on an earlier design, the IBM SELECTRIC Typewriter carbon ribbon feed mechanism which moves with the printing element along the stationary writing line as described by O'Daniel and Palmer.¹ The Composer had certain unique requirements, however, and its ribbon feed mechanism differs appreciably from that of the SELECTRIC Typewriter. These new requirements, and their effects on the design of the ribbon feed mechanism, will be discussed in this paper.

Design specifications

The configuration in which the ribbon feed mechanism moves with the carrier was decided upon because the basic technology was already inherent in the IBM SELECTRIC Typewriter and the development time would almost certainly be less than that required for a completely new design. With a knowledge of the mechanism then existing, the following specifications were set:

1. The ribbon must be fed in such a manner as to allow no character overlap with subsequent characters.

2. The ribbon must be fed in such a manner as to allow maximum use of existing ribbon.
3. There must be no waste during a no-print or spacebar operation.
4. The mechanism must accommodate the maximum ribbon footage consistent with space requirements as dictated by the covers and the other mechanisms in its vicinity.
5. The motion of the ribbon associated with feeding must not occur at time of print.
6. The ribbon must not be presented to the typehead when an uninked character impression is to be struck.
7. The changing from a used to a new ribbon must be as convenient and as clean as possible.
8. The mechanism must be reliable in that unused ribbon must be presented to the print element for each character impression for the life of the machine.

Early in the Composer development program a carbon ribbon feed mechanism for a single element printer was nonexistent. Two separate efforts were then in effect—one for the SELECTRIC Typewriter and one for the Composer. At that time the Composer program called for a proportional feed on a one-track ribbon that utilized the over-under supply-take up spool arrangement, while the SELECTRIC Typewriter program was proceeding on a two-track, fixed-increment feed with a side-by-side supply-take up spool arrangement. Since the SELECTRIC Typewriter mechanism seemed to be compatible with the Composer requirements, work on

the proportional mechanism was discontinued. This decision did not result in any loss of character yield because the two-track arrangement required a feed increment equal to half the maximum character width or four and one-half units, whereas the average character used on the proportional feed was six units. However, this mechanism became less and less compatible as the Composer program grew to a full composing machine, with justification ability and its own print requirements.

At the time the present development program was begun it was evident that the existing ribbon mechanism would not meet the minimum requirements of the Composer:

1. Loading a new ribbon was difficult, and probably impossible, because the justifier mechanism would not permit access to the front load bail on the mechanism.
2. The character yield per ribbon was very low because of the large feed increment and small spool arrangement.
3. The ribbon mechanism was designed for a nonrotating print shaft spacebar whereas the Composer had a no-print or rotating print shaft spacebar, resulting in ribbon feed whenever the spacebar was operated.
4. The ribbon mechanism was quite sensitive to change in type of ribbon and was unreliable with the Composer ribbon at higher temperature and humidity conditions.
5. The use of an inertia-sensitive tensioning device did not permit any increase in spool diameter.
6. It was impossible to obtain an uninked character because the justifier mechanism would not permit access to the ribbon lift lockout lever.

Since the ribbon mechanism failed to meet so many of the design objectives, it was decided to retain those parts of the mechanism that were considered reliable and completely redesign other areas for reliability and operator convenience. The feed and lift mechanisms were considered reliable and were not modified functionally, except for a change in spring bias that resulted in a more consistent lift pattern. It was evident that the complete tensioning and tracking philosophy would have to be changed if the maximum footage of ribbon consistent with the available-space objective were to be realized. It was also evident that the ribbon feed would have to be locked out during a no-print or spacebar operation and that the lift mechanism would have to be locked out to obtain an uninked character impression. The final modification was a completely redesigned ribbon loading area. This modification made loading convenient and clean, even though access to the carrier area was blocked from the front by the justifier.

The final design was to be judged on the basis of a minimum yield per ribbon of 60,000 characters, based on a maximum character width of 0.125 in. The mechanism had

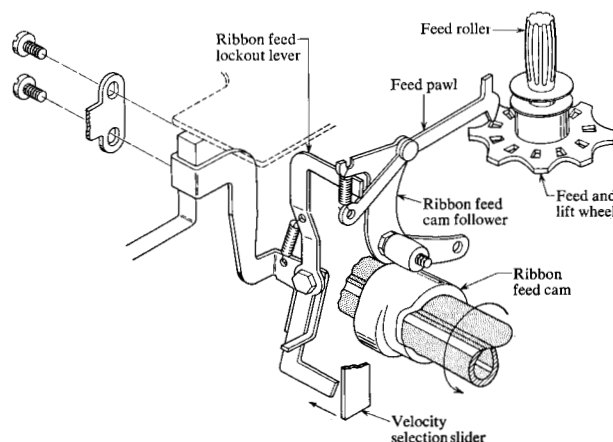


Figure 1 Spacebar lockout.

to meet the normal reliability and life criteria and, being operator oriented, would also be judged from a human factors standpoint.

Final design

At the time it was decided the standard SELECTRIC Typewriter carbon ribbon feed mechanism would not meet the Composer's objectives, a machine improvement program had already begun on the ribbon feed mechanism for the SELECTRIC Typewriter. The SELECTRIC Typewriter configuration consisted of a new ribbon-tracking circuit and a new loading mechanism; however, the loading, being frontal in operation, was not compatible with the Composer. But this work proved to be a great step forward in that it eliminated tracking and feeding sensitivity to character impression on the used ribbon, to small changes in ribbon tension, to take-up spool tension on the feed increment, and supply spool ribbon coning. (Coning is a condition in which the outside ribbon wraps slip relative to adjacent wraps to form an upright cone with the vertex at the supply spool pivot.) These improvements (except for coning, which is covered later) were realized by replacing the crowned feed roller by crowned-gear rollers (see illustration of final mechanism, Figure 3). This resulted in less sensitivity because of the greater effective wrap angle realized as the ribbon conforms to the gear teeth of this capstan type feed. However, the design did not lend itself to an increase in spool size, because the tensioning device was dependent both upon the changing inertia of the supply spool and the invariant cycle time of the supply spool brake. Therefore, it was evident that the ribbon footage could be increased sufficiently only if the ribbon tension were independent of the inertial and geometrical changes associated with the supply spool as it travels from full to empty.

The following discussion will be concerned with a brief description of the complete ribbon feed mechanism and a

more detailed discussion of the developmental work associated with the constant ribbon tension device, ribbon feed lockout during a no-print or spacebar operation, and various operator-oriented loading functions. This development program was started with an obvious ribbon loss due to feeding during no-print and spacebar operations. To better understand the design philosophy of the solution it is necessary to understand how the ribbon feed is actuated.

◆ *Spacebar lockout*

At the beginning of each ribbon feed operation, Fig. 1, the ribbon feed cam follower rests on the high point of the ribbon feed cam, and the feed pawl rests in its forward position, engaged with one of the feed windows in the feed and lift wheel. As the feed cam rotates counterclockwise to its low point, the feed pawl moves to the rear and engages the next feed window. As the cam continues to rotate back to its high point, the feed pawl rotates the feed and lift wheel, which results in a ribbon feed operation. It is at once obvious that the best way to lock out the feed is to prevent the feed pawl from entering the next feed window of the feed and lift wheel. The problem, then, was to find an input motion in the carrier area that was different for a spacebar or no-print than it was for a normal print operation. After a study of the timing diagrams, two possible motions were found that take place before the ribbon feed cycle starts. One of the possible inputs was the rocker motion during print and the other was the velocity selection slider which provided a different motion for no-print or spacebar than for a character selection. The two motions were different in that the rocker motion was greater during print and the velocity slider motion was greater during no-print.

The rocker motion was found unsuitable because it required a negative lockout system—negative in that the motion for a print cycle was greater than for a no-print or spacebar operation. The result of this was that the feed had to be locked out at the start of each cycle, with a print cycle releasing the lockout mechanism. The velocity slider motion, on the other hand, provided a fail-safe system in that the feed would only be affected during a no-print or spacebar operation. With this in mind, the velocity slider motion was selected as an input to the ribbon feed lockout. With a small increase in the dwell on the ribbon feed cam, the follower motion was such that the velocity slider could be used as the input to a ribbon feed lockout lever that would catch the ribbon feed follower and pawl before the pawl engaged the next window of the feed and lift wheel, thus locking out the ribbon feed. Although this solution worked in practice, it created another problem that was later identified in testing: The ribbon lift operation was not locked out. This, in itself, was no problem, but the supply spool brake was actuated by the ribbon lift mechanism which allowed the tensioning device to pay out ribbon without the feed rollers taking up the slack, with the result that the ribbon lost all

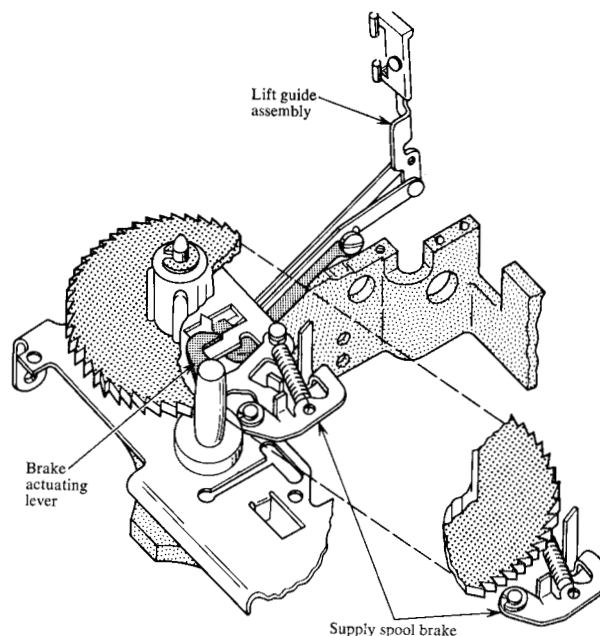


Figure 2 Old braking system.

tension under a repeat spacebar operation. This could have made the design unworkable, but it was felt that the tensioning device then in use could be modified to control the tension and, at the same time, eliminate this problem.

◆ *Constant tension device*

To fully understand the constant tension device and the nature of the problem caused by the spacebar lockout mechanism, it is necessary to describe the original braking system (Fig. 2). This mechanism consisted of a supply spool brake that engaged the supply spool ratchet on the right-hand side. The brake was actuated to disengage every other cycle by the ribbon lift guide assembly through the intermediate brake actuating lever. The brake was not disengaged during a low lift cycle but was during a high lift cycle. A static tension was maintained in the ribbon circuit by means of a lever spring loaded against the ribbon in a manner similar to that of the sensing arm in Fig. 3. The brake was disengaged for a fixed time every other cycle, allowing ribbon to be paid out during this time. As the supply spool decreases in size, the inertia of the spool decreases; but the acceleration needed to pay out the same amount of ribbon at this small radius increases, and the available torque decreases due to the decrease in radius of the spool. The net effect of this was that the ribbon tension continued to increase as the supply spool went from full to empty. When this braking arrangement was used with the spacebar lockout as described above, the ribbon lost all tension during a repeat spacebar operation, because the feed rollers were locked out and thus were not taking up the ribbon paid out

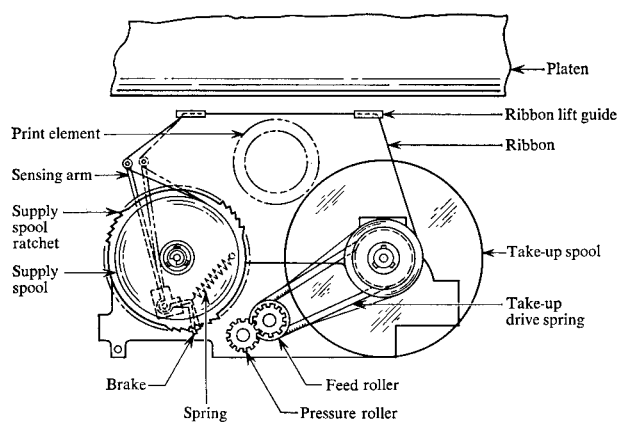


Figure 3 Constant tension braking device.

at the supply spool by the ribbon tension. This type of braking system also limited the spool size because of the increase in tension as the spool went from full to empty and the need to maintain a sufficient amount of tension at the start of a ribbon for good tracking at the feed roller.

Because of the problem created by the spacebar lockout mechanism and the requirement of larger spools, another tensioning and braking device was needed. With the wide variation in geometry and inertia associated with the changing supply spool diameter, it became evident that the fixed time interval for paying out ribbon would have to be eliminated. The following is a discussion of the tensioning device that allowed the spool size to be increased to allow for 60,000 characters per ribbon.

The tension control, Fig. 3, consists of a one-piece brake and ribbon tension sensing arm. When the brake is engaged with the supply spool ratchet, ribbon cannot be paid out and the ribbon control arm is held in static equilibrium by an extension spring, the supply spool ratchet, and the ribbon tension. When the ribbon is fed through the feed rollers at the start of a ribbon feed cycle, the ribbon tension increases to the point at which the brake is rotated out of engagement with the supply spool ratchet. At this point in the cycle the ribbon tension is essentially controlled by the inertial force associated with the acceleration of the supply spool. This is better seen by looking at an equivalent one-degree-of-freedom spring-mass system where the excitation is applied to the base, Fig. 4. The inertia force due to the mass of the supply spool is $M\ddot{x}$ where $\ddot{x}$ is the absolute acceleration of the supply spool and M is the equivalent linear mass of the supply spool. The ribbon tension is due to the deformation of the ribbon web and is equal to $k(x - y)$ where k is the spring constant of the ribbon and x and y are the displacements of the mass and the feed roller, respectively. If we assume no damping, the equation of motion becomes

$$M\ddot{x} + k(x - y) = 0.$$

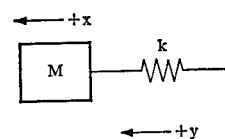


Figure 4 Equivalent representation of braking system.

The displacement y is a function of time that allows the ribbon tension to decrease before the feed cycle is completed. At the point at which the tension has decreased sufficiently, the brake engages the ratchet, cutting off feed at the supply spool. Minimum tension is restored as ribbon is fed, while the supply spool is held by the brake. Therefore, the ribbon tension is always at this constant value (within predetermined limits) at the time print and lift take place. There are, of course, transient deviations from this constant tension which do not adversely affect ribbon feed or print quality. These deviations are brought about by the feeding of the ribbon and controlled by the equation of motion as the supply spool inertia and acceleration vary over a wide range as the supply spool travels from full to empty. This ribbon tension control device made larger spools possible and eliminated the ribbon feed mechanism's sensitivity to ribbon type and operating conditions of temperature and humidity.

• Ribbon loading

The constant tension braking device made possible the 60,000-character-per-ribbon objective. The increased character yield was realized through an increase in ribbon length, but consequently the diameter of the supply and the take-up spools had to be increased. To allow for the larger spools, a number of changes in geometry were made to the base mechanism. A self-detenting load lever was placed between the spools to facilitate loading. This loading mechanism consists of several bellcranks that elevate the ribbon lift guides above the print element and disengage the pressure roller from the feed roller for ribbon loading. To further facilitate loading, a threading arm that places the ribbon around the feed roller is supplied with each new ribbon.

• Coning

During the testing program for the ribbon feed mechanism a supply spool coning problem became evident. This condition was found to be caused by the vibratory motion of the carrier during escapement. The vibration of the carrier was such as to thrust the supply spool ratchet and ribbon upward. The supply spool ratchet motion was stopped by a high spring-rate retainer clip (Fig. 5) on the supply spool pivot stud. The supply spool core was, likewise, stopped by the supply spool ratchet, but since the supply of ribbon consists of many wraps of ribbon, the kinetic energy associated with its motion was dissipated through slippage between

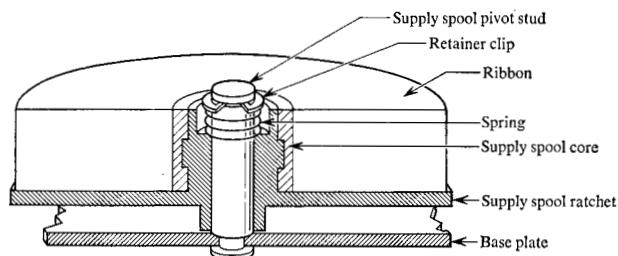


Figure 5 Supply spool.

adjacent wraps. The initial slip plane usually occurred at a radius half the maximum. The problem was solved by placing a low-rate compression spring (Fig. 5) between the retainer clip and supply spool ratchet. The result was a smaller slip force, because the spring provided a more gradual change in momentum during the upward motion of the mass. The solution is further enhanced by the reverse coning effect realized on the downward motion of the spool as it is stopped by the solid base plate. In this case the ribbon motion is arrested by the supply spool ratchet.

Conclusions

The final design of the ribbon feed mechanism proved to be most effective in practice. Feeding and tracking were made reliable under various environmental conditions of temperature and humidity by the new tension control and the

gear-type feed rollers. The constant tension device also made possible the increase in spool size which resulted in a greater character-per-ribbon yield by eliminating the effects of inertia on ribbon tension. The spacebar lockout mechanism provided for a 20% increase in character yield, which, along with the increase in ribbon footage, achieved the 60,000-character-per-ribbon objective.

A loading mechanism and a threading arm, which helps the ribbon through part of the ribbon circuit, made loading of a new ribbon clean and convenient for the operator. The solution to the coning problem allowed ribbon loading to remain simple; without it a bail would have to have been provided to hold the ribbon down. The presence of this bail almost certainly would have made loading less convenient.

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Reference

1. J. B. O'Daniel and L. E. Palmer, "Typewriter Ribbon Feed," *IBM Technical Disclosure Bulletin* 6, No. 4, 17 (1963).

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