Sheet feeding apparatus comprises travelling feed grippers which grip a sheet and carries it over a feed table. The travelling feed grippers are mounted on carrier means which is moved back and forth across the feed table by a drive mechanism disposed underneath the feed table. The travelling feed grippers which transfer the sheets protrude through slots in the feed table during the sheet transfer operation but are lowered below the top surface of the feed table for most of the return travel of the feed grippers to their initial position.
SHEET FEEDING APPARATUS HAVING TRAVELLING FEED GRIPPERS

The present invention relates to sheet-feeding apparatus having travelling feed grippers wherein there is provided a carrier which is moved back and forth by a drive mechanism disposed underneath a feed table plate. The travelling feed grippers which transfer the sheets protract through slots in the feed table plate during the transfer operation but are lowered below the sheet guiding surface of the feed table plate for most of the return travel of the feed grippers to their initial sheet transfer position.

Sheet-feeding apparatus is known in which at least two travelling feed grippers grip a sheet and transport it under positive control over a straight or curved feed table plate up to the front stops. The drive for the carrier of the travelling feed grippers is arranged underneath the feed table plate and may, by way of example, consist of a chain drive, a guide linkage, or a Cardan crank drive.

The positively controlled feeding of individual sheets by means of grippers over the feed table has advantages particularly for small-format printing machines, in that it is possible to obtain simple operation and sheet transport without smearing in cases where the printing ink is not yet dry. However, the drives for the carrier of the travelling feed grippers used up to now, are unable to permit an increase in the rate of output. Moreover, because of the large number of drive elements required, the apparatus is complicated and expensive.

Accordingly, it is an object of the present invention to increase the printing rate capacity of a sheet feeding apparatus of the type heretofore mentioned and to simplify substantially the design of the travelling feed gripper guides as well as of the travelling feed gripper drive.

According to the present invention, the aforesaid object is achieved by providing an oscillating lever as part of the carrier of the travelling feed grippers which oscillating lever is linked via a connecting rod to a crank wheel. The fulcrum of the oscillating lever is moved in synchronism with the operating cycle of the machine in relationship to the lowering stroke of the travelling feed grippers by means of a control device. The apparatus of the present invention requires very few drive elements compared to known devices. Accordingly, applicants invention provides for simple and inexpensive production and assembly of the sheet feeding means. Furthermore, most of the few moving parts are easily controlled so that an increase in the number of prints per hour can be obtained.

An embodiment of the present invention will now be described with reference to the accompanying drawings wherein:

FIG. 1 is a side elevational view of a sheet feeding apparatus according to one embodiment of the invention with the travelling feed grippers being shown in the sheet transfer position;
FIG. 2 is a view of the sheet feeding apparatus shown in FIG. 1 but with the travelling feed grippers shown in a lowered position;
FIG. 3 is a front view of the sheet feeding apparatus shown in FIGS. 1 and 2 with the travelling feed grippers in the sheet transfer position;

FIG. 4 is a side elevational view showing the travelling feed grippers after the latter have gripped a sheet;

FIG. 5 is a top view of the travelling feed grippers;
FIG. 6 is a functional diagram of the sheet feeding apparatus shown in FIGS. 1 to 5 provided to facilitate description of the operation of the apparatus and
FIG. 7 is a velocity-time diagram of the sheet feeding apparatus shown in FIGS. 1 to 5.

Referring to the drawings the sheet feeding apparatus of the present invention comprises a suction bar 1 which lifts the top sheet off of a supply stack 2 and passes it on to two travelling feed grippers 3. The travelling feed grippers 3 are mounted on a gripper bridge 4 which is best shown in FIGS. 4 and 5. The gripper bridge 4 is pivoted on a shaft 5 which is biased by torsion springs 6. During rotation of the gripper bridge 4 each of the two travelling feed grippers 3 are lifted off of a gripper rest 7 which is arranged in fixed position on the shaft 5. The shaft 5 in turn is secured in gripper bridge bearing 8 by means of pins.

The travelling feed grippers 3 and the gripper rests 7 protrude upwardly through slots 9 in the curved feed table plate 10. Control of the opening and closing movements of the travelling feed grippers 3 is effected by a lever 11 which is arranged underneath the feed table plate 10 and which is pivoted for movement in a vertical plane about bearing 12. An upper arm 13 of the lever 11 controls the opening and closing movements of the travelling feed grippers 3 when the latter are in the sheet transfer position as shown in FIG. 1. The lower arm 14 of the lever 11 opens the travelling feed grippers 3 when the sheet is placed against front stops 15. A roller 16 which is mounted on the gripper bridge 4 cooperates with the lever 11 for the purpose of opening and closing the travelling feed grippers 3.

The lever 11 is pivoted about bearing 12 by a cam 17 via a cam follower 18 mounted on the arm 13. The arm 13 is urged and maintained against the cam 17 by a tension spring 19. The cam 17 is secured to a single-revolution shaft 20 having a drive gear 21 mounted thereon.

The previously described gripper bridge bearing 8 is attached to the free end of an oscillating lever 22 which oscillates about an axis of rotation 23 of a fulcrum bearing 24. The axis 23 extends horizontally and transversely to the direction of feed of the sheets. The design details of the fulcrum bearing 24 can best be seen in FIG. 3. The fulcrum bearing 24 is equipped with ball bearings 25 which are secured laterally by a ring 25'. The fulcrum bearing 24 is disposed on the free, offset end 26 of an eccentric shaft 27 which is rotatably supported in a bearing sleeve 28 about the axis 29.

The bearing sleeve 28 is secured in a side wall 30 of the sheet-feeding apparatus. The eccentric shaft 27 protrudes from the bearing sleeve 28 through an opening in the side wall 30 and the protruding section forms a bearing pin 31 for a positioning lever 32 mounted on the bearing pin 31. The positioning lever 32 is movably attached to a cam lever 34 via a link 33. The cam lever 34 has a roller 35, mounted thereon which is urged against a cam 37 by a tension spring 36 acting on the link 33.

A shaft 38 carries the cam 37 as well as a spur gear 39 which meshes with the previously mentioned drive gear 21. The shaft 38 rotates in a bearing sleeve 40...
A connecting rod 41 is attached to the oscillating lever 22 at about halfway along the length of the latter. The other end of the connecting rod 41 is movably connected to the crank wheel 42 via a crank pin 61 (FIG. 3). The crank wheel 42 is secured to a shaft 43 which is rotatably supported in a bearing sleeve 44 (FIG. 3) mounted and supported on the sidewall 30. The free end of the shaft 43 which protrudes through the sidewall 30 carries a spur gear 45 which meshes with the previously mentioned spur gear 39. Thus, all drive and control elements are mounted to the sidewall 30. Only the shaft 20 for the drive gear 21 extends transversely through the sheet feeding apparatus. The shaft 20 is also supported in a second sidewall 46.

The sheet fed to the front stops 15 by the oscillating lever 22 is gripped, after being aligned, by an auxiliary gripper 47 and passed on to a printing cylinder 48. The oscillating parts such as the oscillating lever 22, connecting rod 41, bearing 8, and gripper bridge 4 are made preferably of magnesium or an aluminum alloy.

The operation of the above apparatus will now be set forth with reference to FIG. 6. When the suction bar 1 transfers a sheet from the stack 2 to the travelling feed grippers 3, the oscillating lever 22 is disposed in the sheet transfer position 60 shown by solid lines in FIG. 6. The connecting rod 41 then also occupies the position shown by solid lines in FIG. 6 so that at this time, the crank pin 61 of the connecting rod 41 is located on that part of the crank wheel 42 which faces the oscillating lever 22, that is, on the line connecting the axis of rotation 43' of crank wheel 42 and the attachment point 41 where the rod 41 is attached to the lever 22. After the closing of the travelling feed grippers 3 the crank wheel 42 pivots the oscillating lever 22 via the connecting rod 41 about the axis 23 counterclockwise as shown in FIG. 6. In this operation the travelling feed grippers 3 move along a path of travel represented by the arc-shaped line 62 having a radius 63. The feed table plate 10 has an arcuate configuration which is matched to this curvature.

In the sheet deposition position 64, the travelling feed grippers 3 have reached the front stops 15 and have released the transported sheet. In this position the oscillating lever 22 and connecting rod 41 are shown with dash-dotted lines and the crank pin 61 occupies the position 61'. Immediately after the travelling feed grippers 3 are opened, the cam lever drive 32 to 37 becomes operative and rotates the eccentric shaft 27 about its axis 29. When this occurs the axis of rotation 23 of the fulcrum bearing 24 is displaced and turned through an angle 65. As a result the travelling feed grippers 3 are lowered below the feed table plate 10. During this lowering operation the travelling feed grippers 3 are moved along a path represented by the dash-dotted line 66. At the end of the lowering operation, which is denoted by 66', the oscillating lever 22 and the connecting rod 41 occupy the dashed position shown in FIG. 6. Thus, the crank pin 61 has travelled on in the meantime into the position denoted by 61''.

During the return motion of the oscillating lever 22 which follows, the travelling feed grippers 3 are guided underneath the feed table plate 10 and follow the path represented by the dashed line 67. In the final phase of the return movement the travelling feed grippers 3 again protrude through the slots 9 in the feed table plate 10. After reaching the sheet transfer position 60, the operating cycle is ready to be repeated.

The velocity-time diagram in FIG. 7 illustrates the events relative to the time and velocity change of the travelling feed grippers 3. The dimension 68 indicates the time for one revolution of the machine, that is for 360°. The dimension 69 corresponds to the time required for the feed grippers 3 to receive and pass on one of the sheet to the sheet deposition position 64 and is about 183° of one machine revolution. The dimension 70 indicates the lowering period corresponding to the curve 66 in FIG. 6. The dimension 71 extends over about 30° of one machine revolution. The dimension 71, finally represents the time of return of the feed grippers 3 corresponding to the curve 67 in FIG. 6 and amounts to about 147° of one machine revolution.

The travelling feed grippers 3 therefore start in the sheet transfer position 60 with a velocity of zero. The velocity increases rapidly and finally drops almost to zero in the sheet deposition position 64, where the travelling feed grippers open. The return of the travelling feed grippers 3 consists of the lowering time and the return time proper. The velocity curve rises again from the sheet deposition position 64 with the exception of a slight dip at the point 66' and finally drops again to zero in the sheet transfer position 60.

The velocity-time diagram of the sheet-feeding apparatus according to the invention is similar to a sine curve. This slope of the curve lends itself for use in connection with the crank drive for the oscillating lever and is extremely well suited for the present purpose because in spite of the high average velocity of the travelling feed grippers, the velocity at the reversal points, where the sheet is to be gripped or placed against the front stops, reaches a value of zero or approximately zero.

I claim:

1. Sheet feeding apparatus comprising a feed table, feed grippers having gripper heads movable back and forth to transfer sheets on said feed table, said feed table having slots through which said feed grippers are adapted to extend, operable means operable to move said feed grippers from a first to a second position while said gripper heads are disposed above said feed table to transfer a sheet, said operable means also being operable to displace said feed grippers to lower the latter so that said feed grippers are disposed below the top surface of said feed table for the major portion of the return movement of said feed grippers to said first position, said operable means comprising a lever on which said feed grippers are mounted, a fulcrum bearing about which said lever is pivoted, a shaft having an end portion which is eccentrically offset relative to the axis of the shaft, said offset end portion defining said fulcrum bearing on which said lever is pivotally mounted, drive means for rotating said shaft back and forth in synchronism with the operating cycle of the apparatus to displace said fulcrum bearing over a predetermined angle, a crank wheel, a connecting rod between said crank wheel and said lever, whereby rotation of said crank wheel oscillates said lever, said crank wheel being rotationally displaced upon rotation of said shaft and displacement of said fulcrum bearing.

2. Sheet feeding apparatus according to claim 1 including a lateral wall, bearing means rotatably mounting said shaft on said lateral wall.
3. Sheet feeding apparatus according to claim 2 including bearing means for rotatably supporting said crank wheel, said drive means including a first cam, bearing means rotatably supporting said first cam, means for opening and closing said gripper heads, the last said means including a second cam, and bearing means rotatably supporting said second cam, all of said bearing means being mounted on said lateral wall.