Jan. 26, 1960 A. BÜTTNER 2,922,646

SHEET FEED APPARATUS DRIVING MECHANISMS

Filed March 25, 1958 11 Sheets-Sheet 1

Fig. 1

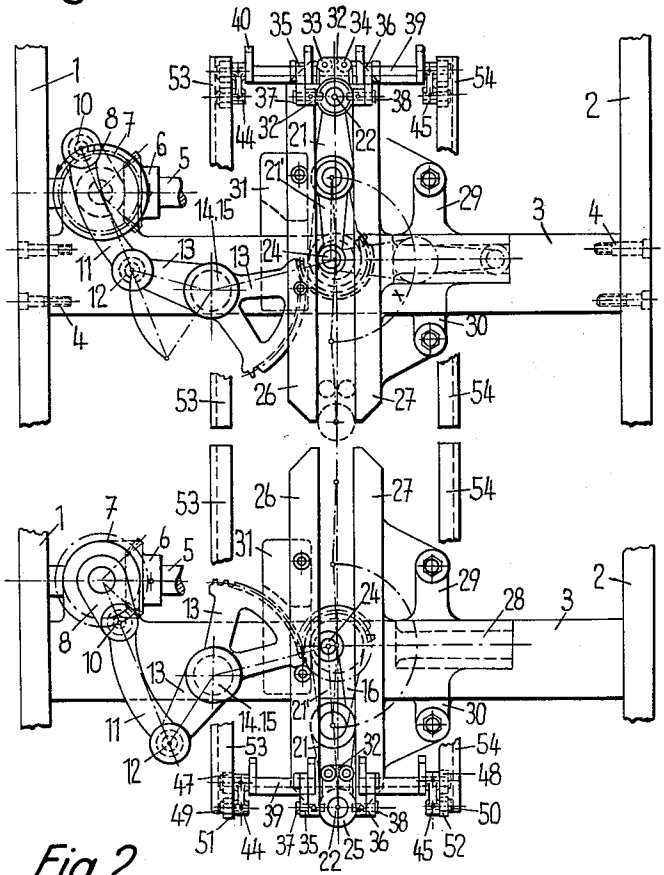


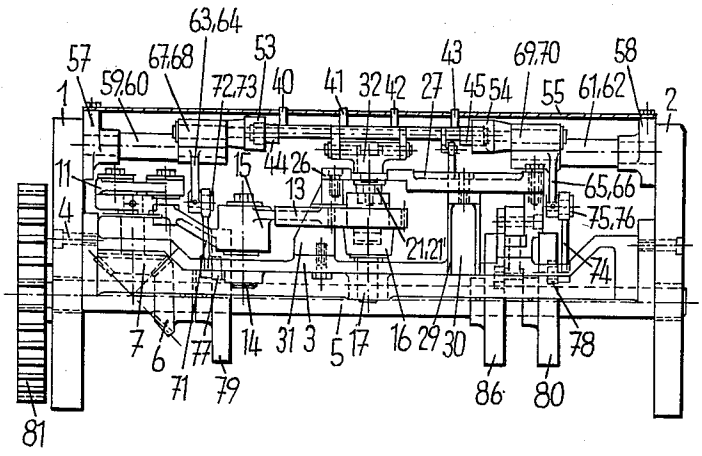
Fig. 2

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SHEET FEED APPARATUS DRIVING MECHANISMS

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Fig. 3



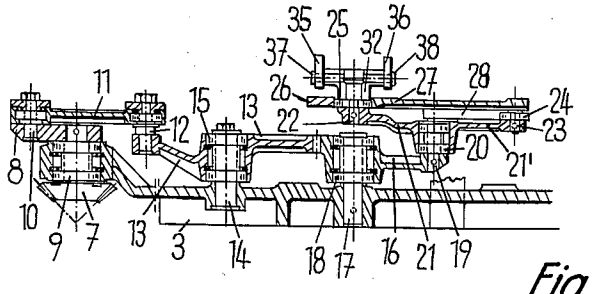


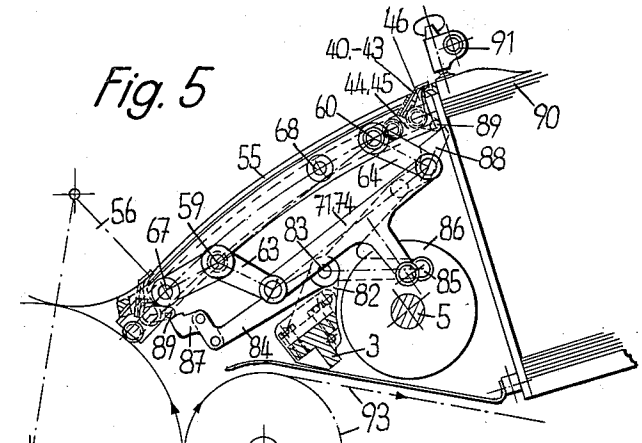
Fig. 4

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SHEET FEED APPARATUS DRIVING MECHANISMS

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Fig. 5



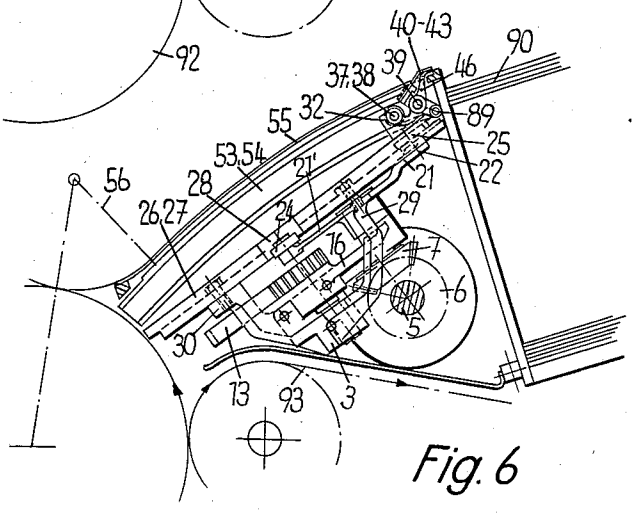


Fig. 6

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SHEET FEED APPARATUS DRIVING MECHANISMS

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Fig. 7

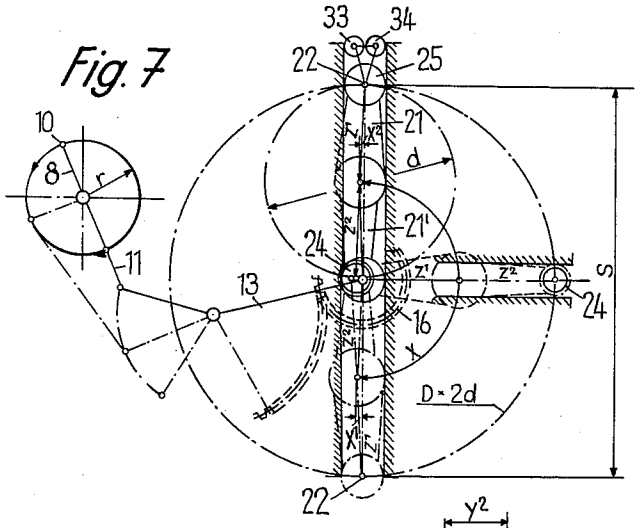
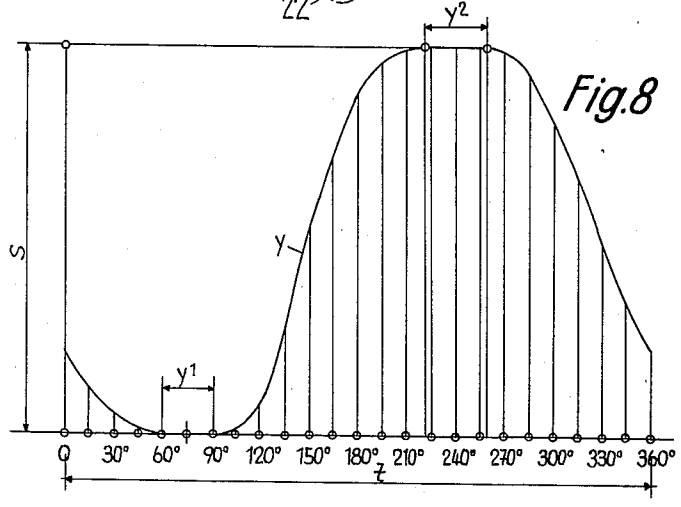


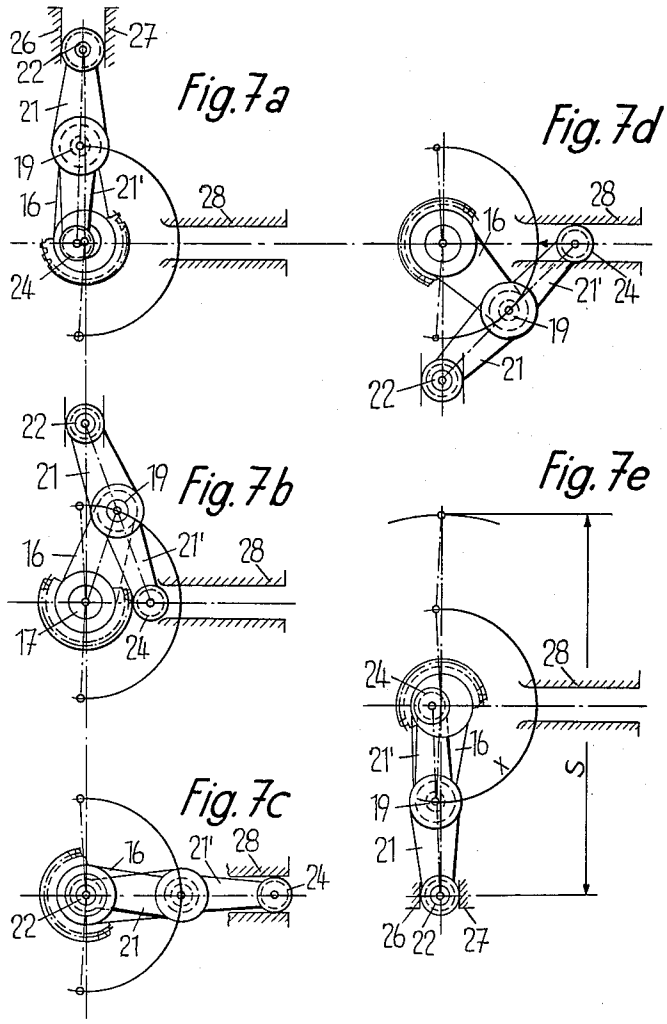
Fig. 8



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SHEET FEED APPARATUS DRIVING MECHANISMS

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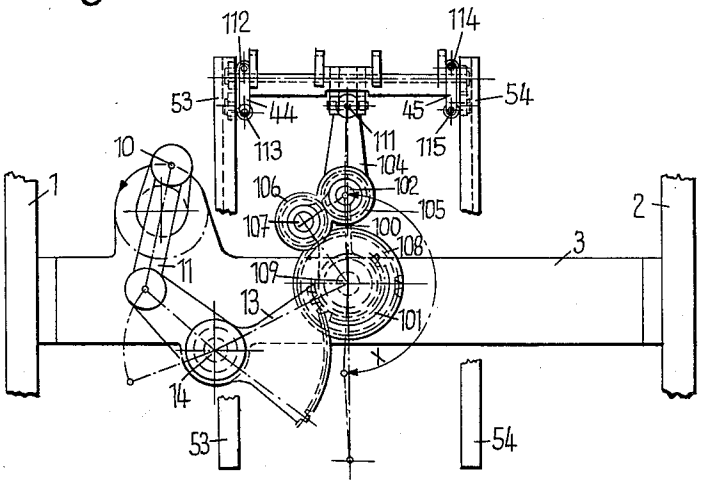


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SHEET FEED APPARATUS DRIVING MECHANISMS

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Fig. 9



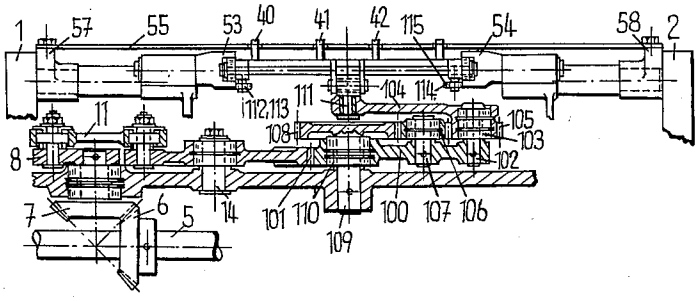


Fig. 10

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Fig. 11

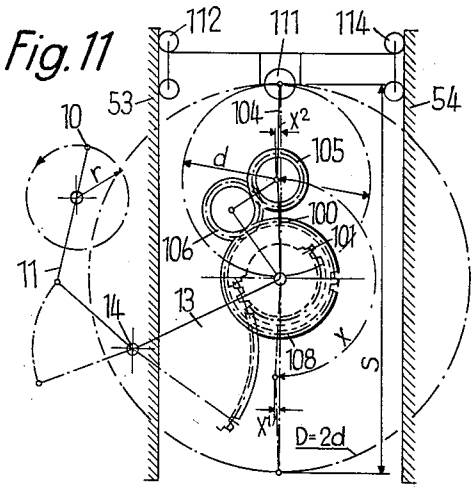
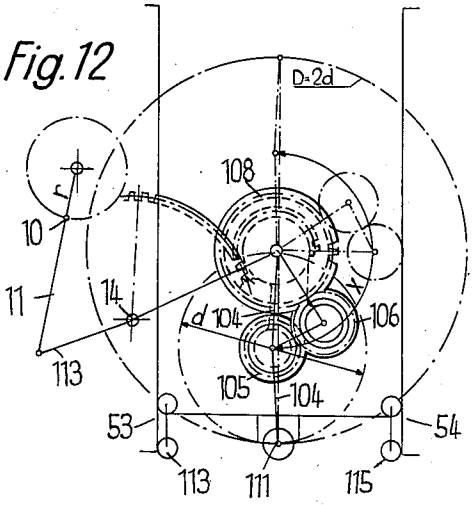


Fig. 12

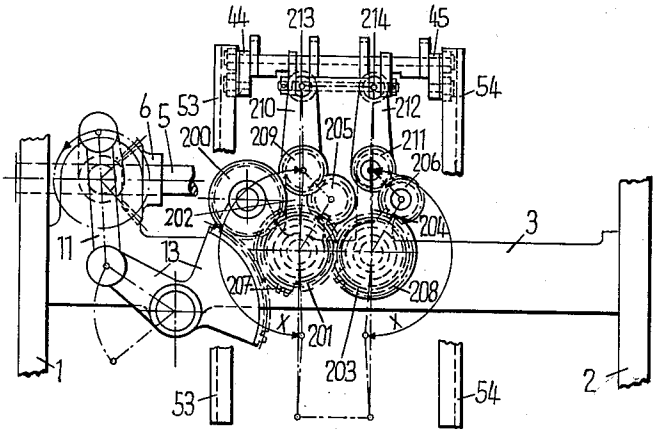


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SHEET FEED APPARATUS DRIVING MECHANISMS

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Fig. 13



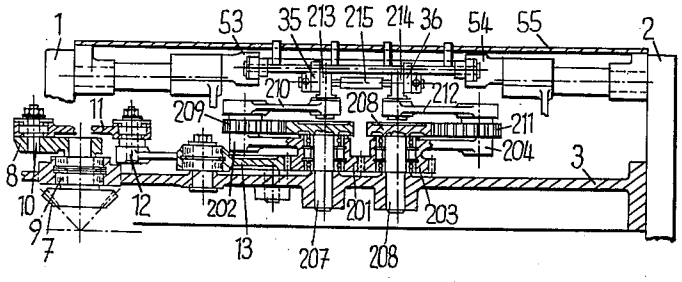


Fig. 14

SHEET FEED APPARATUS DRIVING MECHANISMS

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Fig. 15

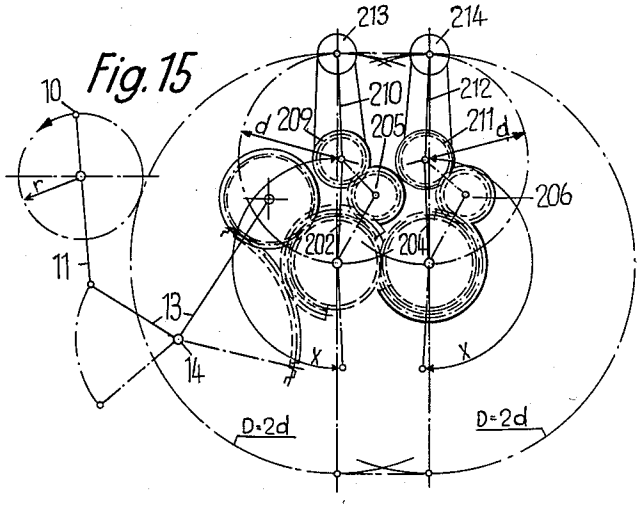


Fig. 16

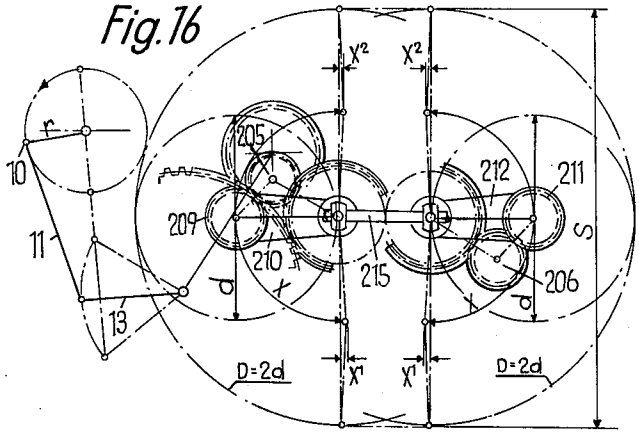


Fig. 17

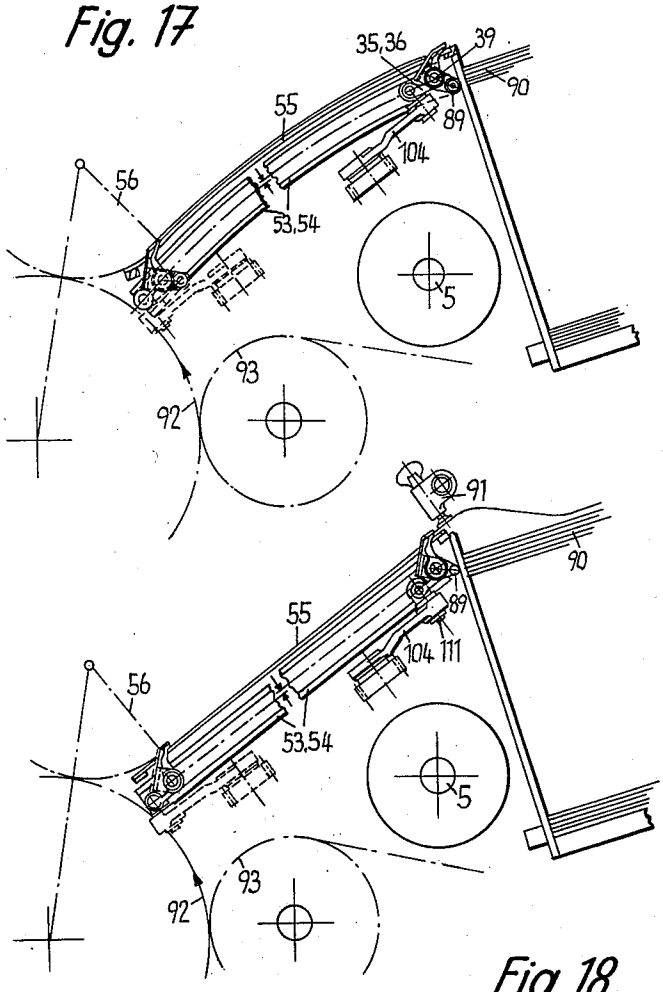

35,36
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Fig. 18

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Fig. 20

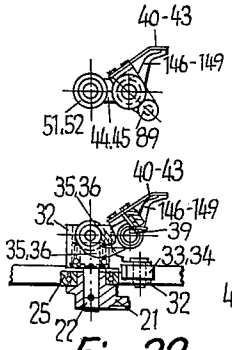


Fig. 22

Fig. 19

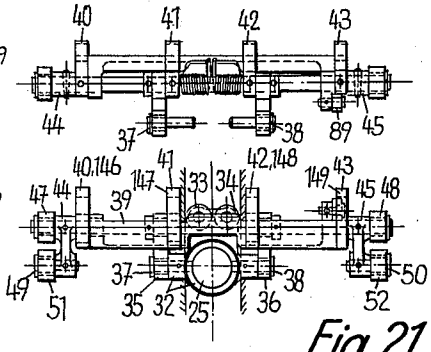


Fig. 21

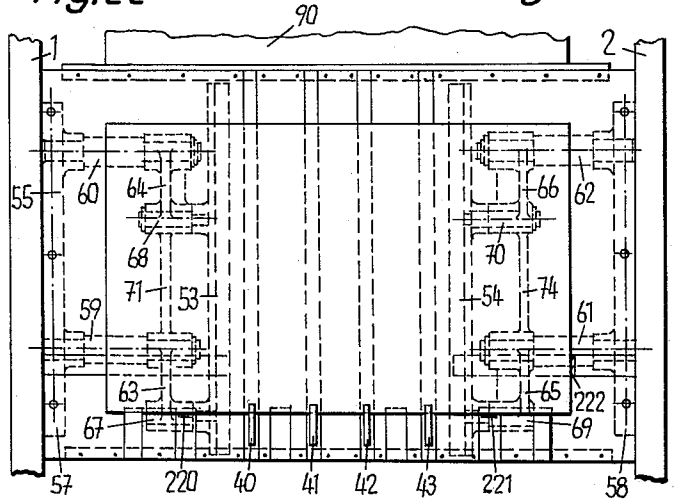


Fig. 23

United States Patent Office 2,922,646
Patented Jan. 26, 1960

2,922,646

SHEET FEED APPARATUS DRIVING MECHANISMS

Artur Büttner, Heidelberg, Germany, assignor to Schnellpressenfabrik Aktiengesellschaft Heidelberg, Heidelberg, Germany, a corporation of Germany

Application March 25, 1958, Serial No. 723,771

Claims priority, application Germany April 20, 1957

12 Claims. (Cl. 271—54)

The invention relates to sheet feed mechanisms and particularly to a driving device or mechanism for effecting the reciprocating movement of the gripper carriage of a sheet feed device for printing or other kinds of sheet converting machines, in which the individual sheets are conveyed over the feed table to the front stops by means of grippers which seize the sheet at the front edge.

According to the invention grippers receive the sheet lifted from the stack by a forwarding suction means and convey it subsequently over the feed table up against the feed stops. The feed grippers are then lowered beneath the feed table so as to allow them to carry out the return movement without hindrance to the sheet.

In known sheet feeding devices of the type using grippers the reciprocating movement of the gripper carriage is effected by means of gears, actuated in alternate directions of rotation which engage racks to which the gripper carriage is secured. The racks are guided rectilinearly in the side walls of the printing machine. The long racks and the guides required therefor are often a hindrance to the arrangement and impede mechnical operations. For this purpose there have also been proposed the use of short racks which are actuated by means of two gear shafts.

In a different known apparatus of this kind which operates without racks, the rectilinear reciprocating movement of the feed grippers is effected underneath the feed table by means of rocker arms moved in a parallelogram-like manner. A disadvantage of this arrangement consists in the fact that, due to the long rocker arms, the drive must be effected from outside the machine frame. Moreover, due to the inertia of the levers which actuate the feed grippers the opposite end operative positions of the gripper carriage are not precisely defined and therefore separate locking devices are required for both dead center positions of the gripper carriage.

Finally, arrangements are also known in which the gripper carriage is moved beneath the feed table by means of chains which may either be rotatively driven or may execute reciprocating movement. Chain gears, however, are no longer sufficiently precise for the precision required today in the movements carried out in connection with the feeding of sheets.

The above mentioned disadvantages are not only removed by means of the sheet feed device of the present invention, but over and above that the reciprocating movement of the gripper carriage is carried out by means of comparatively simple mechanical parts which are inexpensive to manufacture.

This is attained in accordance with the invention in that a connecting rod is used as drive for the gripper carriage, connected at one of its ends to the gripper carriage and at its other end to a crank which is oscillated through about 180°; the length of the connecting rod is preferably identical with that of the crank. The crank is thus moved through approximately 180° by means of a crank pinion. All operational parts are located within the walls of the frame and the two end operative positions

of the gripper carriage at high speeds are exactly the same as at low speed without need of using separate arresting stops and without need of corresponding rest positions.

The reciprocating movement of the gripper carriage is effected below the feed table by means of a so-called cardan crank swinging through about 180° around a center, i.e. a crank with a connecting rod of equal length connected thereto describe a rectilinear gnomonic curve, when producing the double stroke peculiar to that of the cardan crank, corresponding to the travelling distance of the gripper carriage. By connection of a revolving crank for diverting the swinging movement of the cardan crank, there is attained an overlapping of the dead centers of the operational members, which assure accurate end positions to the gripper carriage with longer periods without reciprocation at the end positions of the cycle. These periods of non-travel between the pick-up and delivery positions are utilized for carrying out the various control operations, e.g. the opening and closing movement of the feed grippers, and also the lifting and lowering thereof.

The rectilinear movement of the cardan crank may be effected with or also without a pair of cardan gears. According to one embodiment, the connecting rod is combined with a second connecting rod of identical length to form an extended jointed lever at the center of which the drive crank is pivotally connected and the two ends of this lever are guided rectilinearly in two guides arranged at right angles to one another.

According to another embodiment, it is also possible for the crank to have mounted on the extreme end thereof a planetary wheel or gear fixedly connected with the connecting rod engaging, by way of an intermediate gear mounted on the crank, a fixed sun wheel having twice the number of teeth than the planetary gear. The use of separate guides is unnecessary in this case, as the end point of a cardan crank constructed in this manner forcibly executes a substantially linear movement. It is merely necessary to provide a guide for the gripper carriage itself.

The use of guides for the gripper carriage may be dispensed with if in place of the cardan crank having a planetary gear and sun gear, two such cardan cranks are arranged parallel in juxtaposition and connected with one another. The guiding of the gripper carriage results automatically from the multiple connection with the driving cardan cranks.

If guide rails for guiding the gripper carriage are used, they are adapted to be raised and lowered and actuated by means of a cam controlled parallelogram-like constructed lever mechanism, which engages at the ends of the guide rail, so that they and together therewith the gripper carriage are raised during the sheet feed movement and lowered during the return movement.

The invention will be described further by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a plan view showing the operational members of the oscillatable cardan crank for effecting the reciprocating movement of the feed gripper carriage which conveys the sheets over the feed table. The feed table itself has been removed for the purpose of showing more clearly the operational members. The gripper carriage is in the upper position for receiving the sheet;

Fig. 2 is an elevation view corresponding to Fig. 1 with the gripper carriage in the lower position for delivery of the sheet to the feed gauges;

Fig. 3 is a front elevation view of the driving device;

Fig. 4 is a partial cross section view of the driving device according to Fig. 3;

Fig. 5 is a side elevation view of the sheet feed mechanism showing the means for raising and lowering the

feed grippers, and also for opening and closing the grippers;

Fig. 6 is a side elevation view of the sheet feeding mechanism with the guides of the feed grippers shown as straight guides;

Fig. 7 is a diagram of the operational members shown in Figs. 1 to 6;

Fig. 7*a* to Fig. 7*e* are operation diagrams with the cardan crank shown in five different phases of movement;

Fig. 8 is a movement and time diagram of the gearing shown in Figs. 1 to 7;

Fig. 9 is a plan view showing the operational members for the substantially rectilinear reciprocating movement of the gripper carriage in a second example of the invention. The rectilinear movement of the gnomonic curve for leading off the movement of the gripper carriage is herewith effected by means of a cardan crank having a pair of gears meshing with one another and having an external gearing with a ratio of 1:2;

Fig. 10 is a partial cross-section view of the driving device shown in Fig. 9;

Fig. 11 is a diagrammatic view of the operational members according to Figs. 9 and 10 with the gripper carriage in the upper end position;

Fig. 12 is a diagrammatic view of the operational members shown in Figs. 9 and 10 with the gripper carriage in the lower end position;

Fig. 13 is a plan view showing a third embodiment of the operational elements according to the invention, in which two pairs of cardan gears meshing with one another are connected in parallel. In this embodiment lateral guides for the gripper carriage are not necessary, as is the case in the embodiment shown in Figs. 9–12;

Fig. 14 is a cross-section view of the driving mechanism shown in Fig. 13;

Fig. 15 is a diagrammatic view of the operational elements shown in Figs. 13 and 14 with the gripper carriage in the upper end position;

Fig. 16 is a diagrammatic view of the operational elements shown in Figs. 13 and 14, with the gripper carriage in the lower end position (the cycle of movement corresponds with the movement time graph shown in Fig. 8);

Fig. 17 is a partial side elevation view of the sheet feed device with a curved feed table;

Fig. 18 is a partial side elevation view of the sheet feed device with a flat feed table;

Figs. 19 and 20 are front and side elevation views respectively of the gripper carriage;

Fig. 21 is a plan view of the gripper carriage;

Fig. 22 is a fragmentary detail view of part of the gripper carriage with the guide rollers; and

Fig. 23 is a plan view of the feed table of the sheet feed mechanism for aligning the sheet which has been fed.

The sheet feeding apparatus (Figs. 1–6) is received by two side walls **1**, **2**, of a printing machine or the like between which there is disposed a cross-member **3** by means of screws **4**. The member **3** supports all operational parts necessary for the reciprocating movement of the gripper carriage. This movement is imparted by a revolvable shaft **5**, which is driven by known means of the feeding apparatus. A bevel gear **6** on shaft **5** meshes with a bevel gear **7** to rotate the crank **8** in a counterclockwise direction as indicated (Fig. 7). The crank driving gear **7** is provided with a pin which is rotatably mounted in a bearing **9** of an arm (Fig. 4) of the cross-member **3**. The crank **8** is secured at one end by pinning to the bevel gear **7** and at the other end it carries a crank pin **10** to which one end of a link **11** is rotatably connected. The link **11** has its opposite end connected by means of a pin **12**, with a toothed segment lever or gear sector **13**. The latter is mounted with a bearing **15** on a bolt **14** firmly secured in the member **3** and is oscillated by the crank **8** and the link **11**. A crank **16** having a toothed sector engages sector **13** and this movement is transmitted to the crank which is also rotatably mounted in a bearing **18** on a pin **17** also secured to the member **3**. Due to the gear ratio between the toothed segments on the parts **13** and **16**, the crank **16** carries out cyclically a reciprocating or oscillating movement through the arc *x*. The arc *x* amounts to approximately 180°. The crank **16** carries at the end thereof a pin **19** firmly secured therein on which there is pivotally mounted by means of the bearing **20** a connecting rod **21**; the crank **16** and connecting rod **21** together form a so-called cardan crank. On the free end of the connecting rod **21** there is secured a pin **22** for the reciprocating movement of a gripper carriage later herein described. The connecting rod **21** is in addition connected to a connecting rod **21'** of identical length to form an extended lever, in the center of which the drive crank **16** is pivotally connected by means of the pin **19**. The extended lever has its opposite two ends guided rectilinearly in guides **26**, **27** and **28** disposed at right angles to one another. The two guide members **26**, **27** parallel to one another on the one hand and **28** at right angles thereto intersect at the pivotal axis of the crank **16**. Mounted on the pin **22** of the connecting rod **21** there is a roller **25**, which slides between the guides **26** and **27**. On the free end of the connecting rod **21'** there is disposed a pin **23** for mounting a guide roller **24** which slides in the guide **28**.

In Figs. 7 to 7*e* the cardan crank **16**, **21** with its additional guide arm **21'** is shown in the various phases of movement. Fig. 7*a* shows one end position of the cardan crank and Fig. 7*e* the other end position or one-half the cycle of the operation thereof.

In the end position shown in Fig. 7*a* the connecting rod **21** and the crank **16** are approximately at an angle of 180° relative to one another, so that the distance of the free end of the connecting arm **21** from the pivotal axis of the crank **16**, approximately corresponds to twice the length of the connecting rod **21**. The additional connecting rod **21'** at the same time assumes a position with its free end approximately above the pivot of the crank **16**.

As shown in Fig. 7*b* the crank has been rotated through about 30°, whereby the free end of the guide arm **21** with its roller bearing **22** has approached the crank axis **17** by a small amount, while the free end of the auxiliary connecting rod **21'** with its roller **24** has moved away from the crank axis **17** to the right and has moved into the guide **28**.

As shown in Fig. 7*c* the crank **16** has executed a pivotal movement of approximately 90°, whereby the free end of the connecting rod **21** with the roller **22** has been displaced to a position above the pivot **17** of the crank **16**, while the auxiliary connecting rod **21'** has reached the end position in its guide **28**. This dead center position of the cardan crank **16**, **21** is overcome when the crank is rotated further by means of the auxiliary connecting rod **21'**, which is in an opposite position to the dead center and opposite relative to the crank **16**, and due to its movement also continues to move the connecting rod **21** rigidly connected thereto. Fig. 7*d* shows a further movement phase of the cardan crank, wherein the crank **16** has been moved approximately through 135° relative to the starting position as seen, whereby the free end of the auxiliary connecting rod **21'** disposed in its guide **28** has moved closer to the pivot of the lever **16**. At the same time, the free end of the connecting rod **21** with the roller **22** has moved by a multiple of the path of the roller **24** in the direction towards the other position.

Fig. 7*e* shows the cardan crank **16**, **21** in its position opposite to the position shown in Fig. 7*a*. The overall path *s* which the free end of the cardan crank **16**, **21** with its roller **22** travels during one swinging movement of the crank **16** approximately through 180°, corresponds to four times the length of the crank **16**, the stroke of which is thus doubled by means of the connecting rod **21**.

The guides **26**, **27** and **28** are mounted on the member

3 on correspondingly constructed supporting arms 29 and 30 or a pedestal bearing 31. On the portion of the pin 22 projecting from the guides 26 and 27 there is pivotally mounted a guide element 32. This part 32 is provided with two rollers 33 and 34, which are reciprocated or travel back and forth adjacent to a roller 25 also between the two guides 26 and 27. Connected to the guide part 32 by means of pins 37 and 38 are connecting straps 35 and 36, which engage on a spindle 39 of a gripper carriage. The gripper carriage consists of the gripper spindle 39, supporting spaced grippers 40, 41, 42 and 43 projecting through the feed table. At the ends of the gripper spindle 39 there are firmly mounted levers 44 and 45, by means of which the grippers 40—43 or a gripper support 46 pinned on the gripper spindle 39 respectively, are retained accurately in the correct position. For this purpose, there are also mounted on either side of the spindle 39 rollers 47 and 48 and on the levers 44 and 45 by means of the pins 49 and 50 a roller 51 and 52 each. These four rollers run in guide rails 53 and 54, which, as shown in Fig. 5 have circular or arcuate guide grooves for the rollers, in order to guide the gripper carriage in accordance with the curved shape of the feed table 55.

As shown in Fig. 5 it is necessary for the grippers of the gripper carriage to project slightly through slots in the feed table, when conveying a sheet over the feed table, while during the return movement after the sheet has been fed they are returned past the swinging grippers or feed gauges 56 in a lowered position, hence beneath the sheet that has been fed. In order to return the carriage in a lowered position the curved guide rails 53 and 54 are displaceably mounted and controlled by means of cams hereinafter described. The control is effected on both sides separately. Firmly screwed to the side walls 1 and 2 are disposed supports 57 and 58 for supporting the feed table. Into the table supports 57 and 58 are pressed two pins 59 and 60 on the one side and 61 and 62 on the other side, on which there are pivotally mounted parallelogram levers 63, 64 or 65, 66 respectively (Fig. 3–6 and 23). By means of pins 67 and 68 and 69 and 70 the curved guide rails 53 and 54 are pivotally connected with the parallelogram levers. The parallelogram levers 63, 64 in addition are connected with one another on one side by means of a connecting strap 71 by means of pins 72 and 73, and the levers 65, 66 on the opposite side by the connecting strap 74 by means of the pins 75 and 76 (Figs. 3 and 5).

The connecting straps 71 and 74 have extensions cast thereon, which each support a roller 77 and 78 (Fig. 3), which each slide in an associated disc 79 and 80. These two cam discs 79, 80 are mounted on the one-revolution shaft 5 of the feeding apparatus, which in known manner is mounted on either side in the walls 1 and 2 and which is driven by means of a gear wheel 81.

The parallelogram-like mounting of the curved guide rails 53 and 54 on either side serves the purpose of enabling the gripper carriage to carry out an additional movement in the upwards direction independent of its being driven rectilinearly. The feed grippers when conveying a sheet (feeding) are moved by this control means over the feed table 55 with suitable clearance, while after the sheet has been delivered to the sheet aligning means, are lowered below the feed table. For opening the grippers at the delivery point, there is displaceably mounted on the member 3 a pedestal bearing 82 (Fig. 5), in which by means of a pin 83 movement is transmitted to a long double lever 84. Mounted on a cast-on arm of the double-lever 84 is a disposed roller 85 which runs in a closed cam disc 86. The latter imparts to the double lever a slight swinging movement, which in the lower position of the gripper carriage by way of a stop 87, and at the other end for the upper position by means of a stop 88, both firmly secured by means of screws to the double lever 84, is used for the opening and closing movement of the feed gripper. In the upper of the lower position respectively, the roller 89 of the gripper system is located over the stops 87 and 88 for carrying out the opening and closing movement. In Fig. 5 there is also shown the feed stack 90, from which the suckers 91 in known manner lift by means of suction air and individually deliver to the feed grippers 40—43. The latter are opened shortly before receiving the sheet and then closed. Figs. 5 and 6 also show the impression cylinder 92 and the sheet delivery chains 93. During the take-over of a sheet from the sucker and also when the sheet is delivered to the feed gauges it is necessary for carrying out the control operations—such as opening and closing of the feed grippers, and also the lifting or lowering thereof—to introduce longer stopping periods in the cycle of operation. Although all the operational members are continually in motion, these necessary stationary positions of the operational members are produced by the double dead center movement, as shown diagrammatically in Fig. 7.

The large cardan circle shown in the drawing conforms accurately with the reciprocating movement of the gripper carriage, and its path is denoted by s. The diameter of the large cardan circle D is twice the size of the diameter d of the small cardan circle. During the circular swinging movement of the cardan crank through the arc x, the center of the cardan crank with the pin 19 swings slightly beyond 180°. This path is inserted in the upper reversing position by the reference x^2 and in the lower reversing position by x^1. Further, the lever sections of the cardan crank denoted by the references Z^1 and Z^2, and it is evident that they are of equal length. Besides the two opposite end positions Fig. 7 also shows the position of the cardan crank 21 after travelling half the distance. The roller 24 on the cardan crank 21 or 21′ respectively describes a rectilinear movement which is effected exactly at right angles to the reciprocating movement of the gripper carriage. The object of this is, similar to the principle of the cross loop, to overcome the dead center position of the cardan crank 21 in this central position, arising when the bearing pin 22 executes the rectilinear reciprocating movement.

Fig. 8 is a movement-time diagram which illustrates the course of the reciprocating movement of the gripper carriage through 360°, thus one revolution of the machine. The travel-time curve is denoted by y, while the stationary positions arising when carrying out the movement in the upper and lower position of the gripper carriage are denoted by y^1 and y^2. The stationary position y^1 serves for the sheet delivery to the feed gauges in the lower position of the feed grippers, and the stationary position y^2 for the sheet take-over in the upper position of the feed grippers.

In a second example shown in Figs. 9 to 12, the cardan crank is caused to carry out the rectilinear reciprocating movement of the center connecting rod by means of a planetary gear having peripheral teeth. Only the differing operational members are discussed below in order to avoid repetition, it being understood that similar parts are similarly numbered in the drawings. The lifting and lowering of the curved guide rails 53 and 54 is effected in the same manner as described in Figs. 1 to 8. Also the control operations for opening and closing the feed grippers in the two end positions are effected as described above, and the introduction of the movement by means of a crank gear, which acts on a swinging toothed segment, corresponds to those shown in Figs. 1–7.

As shown in Figs. 9 to 12, the crank 100 is caused to cyclically oscillate on its pivotal axis in an arc x by means of the toothed segment 13. This swinging or oscillating movement of the crank 100 is caused by the meshing of the segment 13 with a gear wheel 101, which is firmly connected with a crank 100. Mounted on the crank 100 is a pin 102 on which a bearing 103 supports a cardan crank 104 rotatably mounted thereon. A cardan crank 104 is firmly connected with a planetary gear

105 meshing with a gear wheel 106, which is pivotally mounted on the crank 100 by means of a pin 107. The gear wheel 106 meshes with a fixed sun wheel 108, which forms an integral part with a bearing pin 109. The bearing pin 109 is secured firmly in the member 3 and by means of the bearing 110 carries the crank 100, which thus carries out a circular oscillating or swinging movement around the pin 109. With the oscillating movement of the toothed segment 13 and the circular movement of the crank 100 the intermediate planetary gear 106 is in a rolling engagement with the stationary sun wheel 108. This rotary movement is also transmitted by the gear wheel 105 to the planetary crank 104, a pin 111 thereon thus describes a rectilinear reciprocating movement. This rectilinear movement of the pin 111— as shown in Figs. 11 and 12—is attained because the lengths of the lever of the crank 100, and the cardan crank 104, are exactly equal, the pitch-circle diameter of the planetary wheel 105 and the sun wheel 108 are at the ratio 2:1, and the transmission of the rolling engagement movement to the cardan crank 104 is effected by an intermediate planetary gear 106. The pin 111 is rotatably mounted in the cardan crank 104 and connected with the gripper carriage by the straps 35, 36. The lateral guiding of the gripper carriage is effected as shown in Figs. 9–12 by means of rollers 112 and 113 on the one side, and rollers 114 and 115 on the other side. These rollers run laterally along the guides 53 and 54 in the groove guide of which in turn, as described in Fig. 1, two rollers run on either side. The rollers 112 and 113 are mounted in the strap 44, and the rollers 114 and 115 in the strap 45, which, exactly as in Fig. 1, are connected with the complete gripper carriage. While in Fig. 1 the guide is close to the machine center, the necessary guide as shown in Figs. 9–12 has been transferred to the outside and for this purpose the guide levers 53 and 54 are employed.

In Figs. 11 and 12, the operational members are shown diagrammatically in the opposite positions of the gripper carriage, whereby the rectilinear reciprocating movement of the gripper carriage is again denoted by *s*. The diameters and designations of the large and the small cardan circle correspond with those according to Fig. 7.

The movement time diagram shown in Fig. 8 also applies to the construction as shown in Figs. 9 to 12.

As a further example in Fig. 13 there is shown two cardan-circle cranks arranged in parallel. The operational members correspond in principle with the members shown and described in Figs. 9 to 12. The difference consists in that by connecting in parallel two swinging cardan-circle cranks, there are described two adjacent rectilinear gnomonic paths, which allow the gripper carriage to be reciprocated rectilinearly connected at two points, thus rendering unnecessary the lateral guides of the gripper carriage required in the two previously described embodiments. The gripper carriage is guided in the guides 53 and 54 merely for the lifting and lowering movement, but not in the lateral direction. The toothed segment lever 13 transmits its swinging movement to a gear wheel 200, which meshes with a gear wheel 201 of a crank 202. The gear wheel 203 of the second crank 204 meshes with a gear wheel 201, thus when transmitting the swinging movement by means of the toothed segment lever 13, the cranks 202, 204 are moved outwardly in a circle each swinging through an arc of approximately 180°.

The two cranks 202 and 204 each have mounted thereon an intermediate gear 205 and 206 respectively. The intermediate gear 205 meshes with a fixed sun wheel 207, and the gear wheel 206 with a fixed sun wheel 208. As described with respect to the embodiment in Figs. 9 and 10, in this case the sun wheels 207 and 208 form an integral part with the two bearing pins and both bearing pins are firmly mounted in the cross-member 3.

A gear wheel 209 which is firmly connected with a cardan crank 210 meshes with the intermediate gear 205. Similarly, a gear wheel 211, which is also firmly connected with a cardan crank 212 meshes with the intermediate gear 206. With the circular swinging movement of the two cranks 202, 204, the intermediate gears 205 and 206 are in rotary engagement around the fixed sun wheel associated thereto. This movement is transmitted to the gear wheels 209 and 211 and as these are firmly connected with the cardan cranks 210 and 212, the two connecting pins 213 and 214 describe an accurate rectilinear reciprocating movement. This condition is fulfilled in that—again as shown in Figs. 15 and 16 the cardan cranks 210 and 211 have the same length of lever as the two cranks 202 and 204, and further that the gear wheels 209 and 211 have half the pitch-circle diameter of the two fixed sun wheels 107 and 108. The gripper carriage moves with its four rollers in the grooves of the guide rails 53 and 54 for carrying out the lifting and lowering movement of the feeding apparatus. The means for the opening and closing movement of the feed grippers corresponds to that as shown in Fig. 5.

As the two adjacent pins 213 and 214 execute an absolutely rectilinear reciprocating movement, it is possible to connect them by means of a coupling element 215. The two straps 35 and 36 are mounted on the coupling member 215 forming the connection with the gripper carriage. The gripper carriage is constructed as in the previously described examples. Also, the references inserted in Figs. 15 and 16 for the diagrammatic illustration of the operational movement correspond to the references described and shown in Figs. 11 and 12.

Figs. 17 and 18 show that the described operating members are suitable for the reciprocal movement of the gripper carriage along an arcuate path corresponding to the curved construction of the feed table, as well as a straight path for a flat construction of the feed table as shown in Fig. 18. In both figures, the feed grippers are shown once in the upper position at the feed table receiving the sheet, and on the other hand in the lower position when feeding the sheet to the feeder gauges. In the upper position for receiving the sheet the feed grippers are projecting a few millimeters above the feed table. During the travel of the feed gripper over the feed table, the rails 53 and 54, which carry the complete gripper carriage, are gradually lowered to such an extent that the sheet lies in a plane with the upper edge of the feed table. After the grippers have been opened in the lower position, the rails 53 and 54 are lowered by a further small degree, so that the grippers disappear below the feed table. The return movement of the gripper system is thus effected in the lowered position below the sheet which has been fed to the guage.

The clearance of the rails 53, 54 from the feed table increase from the pile 90 towards the impression cylinder 92, i.e. the grippers 40—43 are lowered towards the feed table during their movement in a direction toward the impression cylinder.

As shown in Figs. 20 and 21, there is also associated with the grippers 40 to 43 a gripper support 146, 147, 148, 149, which are pinned to the shaft 39. The grippers are secured by pins on a stirrup 39′, which is rotatably mounted on the shaft 39. The closing movement of the grippers 40 to 43 against supports 146, 147, 148, 149 is effected by means of two torsion springs 39″, which are mounted between the grippers 41 and 42 on the shaft 39.

Fig. 23 shows in a plan view of the feed table the position of the sheet fed to the feed gauges. The sheet conveyed by the gripper carriage by means of the four grippers 40 to 43 up against the front feed gauges 220 and 221, is released by the feed grippers in this position, to allow the sheet to be aligned on the feed table 55. The lateral alignment is effected in known manner by the diagrammatically shown lateral or drawing gauge 222. The feed table 55 is provided with slots 223 for

the passage of the grippers 40 to 43 during the sheet feeding movement.

The mode of operation of the three described embodiments is identical in each case and is as follows:

Rotation of the crank 8 causes movement of the link 11 of the toothed segment lever 13. The toothed segment member provided on the crank 16 engages the sector 13 so that the crank 16 is caused to carry out a swinging movement through approximately 180°. The cardan crank 21 supported by the crank 16 herewith describes by means of the provided guides a double stroke in rectilinear movement. This rectilinear path is also followed by the gripper carriage coupled therewith, the object of which is to convey successively individual sheets, received from the vacuum cups or suction means, over the feed table up against the feed gauges. During this movement cycle of the gripper carriage, the grippers are moved by means of the parellelogram-like mounted guide rails, first over the feed table, and during the return movement of the grippers lowered below the feed table.

In place of the cardan gear wheels having peripheral teeth described in Figs. 9 to 16, it is, of course, also possible for the large cardan wheel to be constructed as an internally toothed gear wheel, in that a gear wheel of half the pitch-circle diameter thereof is caused to effect a rolling engagement swinging the crank in a semi-circle.

While preferred embodiments of the invention have been illustrated and described, it will be understood that the invention is in no way limited to these embodiments and that many changes may be made within the spirit and scope of the invention as defined by the following claims.

What I claim and desire to secure by Letters Patent is:

1. In a sheet feed apparatus for printing machines and the like having a feed table, a reciprocable gripper carriage, grippers on said carriage for receiving individual sheets successively at a first position substantially at one end of the feed table and for transporting them individually on to a second position on the table substantially at an opposite end thereof, an improved driving mechanism for cyclically reciprocating the carriage between said two positions comprising, crank means having at least one crank lever pivotally connected substantially at one end to the gripper carriage, means comprising at least one planetary gear system for cyclically reciprocating said end of the crank lever in substantially a rectilinear path thereby to reciprocate the carriage between said two positions and along a substantially rectilinear path at least when moving from the first to the second position, and means for causing the carriage to position the grippers in a selected position spaced above the table and corresponding to said first position and gradually lowering the carriage with respect to the table during its movement from the first to the second position thereby to position the sheets on the table in a selected position corresponding to said second position and for causing the carriage to transport the grippers beneath the sheets delivered successively on to the table while the carriage is returning the grippers to said first position.

2. In a sheet feed apparatus for printing machines and the like having a feed table, a reciprocable gripper carriage, grippers on said carriage for receiving individual sheets successively at a first position substantially at one end of the feed table and for transporting them individually on to a second position on the table substantially at an opposite end thereof, an improved driving mechanism for cyclically reciprocating the carriage between said two positions comprising, crank means having two similar crank levers each pivotally connected substantially at one end to the gripper carriage in spaced relationship, means comprising two parallel planetary gear systems for cyclically reciprocating said ends of the crank levers each in substantially a rectilinear path thereby to reciprocate the carriage between said two positions and along a substantially rectilinear path at least when moving from the first to the second position, and means for causing the carriage to position the grippers in a selected position spaced above the table and corresponding to said first position and gradually lowering the carriage with respect to the table during its movement from the first to the second position thereby to position the sheets on the table in a selected position corresponding to said second position and for causing the carriage to transport the grippers beneath the sheets delivered successively on to the table while the carriage is returning the grippers to said first position.

3. In a sheet feed apparatus for printing machines and the like having a feed table, a reciprocable gripper carriage, grippers on said carriage for receiving individual sheets successively at a first position substantially at one end of the feed table and for transporting them individually on to a second position on the table substantially at an opposite end thereof, an improved driving mechanism for cyclically reciprocating the carriage between said two positions comprising, means having a connecting rod pivotally connected substantially at one end to the gripper carriage, means comprising a cardan crank for cyclically reciprocating said end of the connecting rod in substantially a first rectilinear path thereby to reciprocate the carriage between said two positions and along a substantially rectilinear path at least when moving from the first to the second position, and means for causing the carriage to position the grippers in a selected position spaced above the table and corresponding to said first position and gradually lowering the carriage with respect to the table during its movement from the first to the second position thereby to position the sheets on the table in a selected position corresponding to said second position and for causing the carriage to transport the grippers beneath the sheets delivered successively on to the table while the carriage is returning the grippers to said first position.

4. A sheet feed apparatus according to claim 3, in which said means comprising the cardan crank comprises a pivotally mounted crank, a lever pivotally connected to said crank at the free end thereof and rigidly connected extending opposite to the connecting rod and having substantially the same effective length as the connecting rod, first guide means for guiding the end of the connecting rod connected to the carriage substantially along the first rectilinear path, second guide means for guiding the free end of the lever in substantially a second rectilinear path at 90° to the first rectilinear path, and means for cyclically rotatively oscillating the crank through substantially 180°.

5. A sheet feed apparatus according to claim 4, in which the crank of said cardan crank means is provided with teeth and the means for cyclically reciprocating the end of the connecting rod connected to the gripper carriage comprises an oscillatable gear sector engaging the teeth of said crank thereby to rotate it cyclically through an arc of 180°.

6. In a sheet feed apparatus for printing machines and the like having a feed table, a reciprocable gripper carriage, grippers on said carriage for receiving individual sheets successively at a first position substantially at one end of the feed table and for transporting them individually on to a second position on the table substantially at an opposite end thereof, an improved driving mechanism for cyclically reciprocating the carriage between said two positions comprising, means having at least one connecting rod pivotally connected substantially at one end to the gripper carriage, means for cyclically reciprocating said end of the connecting rod in substantially a first rectilinear path thereby to reciprocate the carriage between said two positions and along a substantially rectilinear path at least when moving from the first to the second position, and means for causing the carriage to position the grippers in

a selected position spaced above the table and corresponding to said first position and gradually lowering the carriage with respect to the table during its movement from the first to the second position thereby to position the sheets on the table in a selected position corresponding to said second position and for causing the carriage to transport the grippers beneath the sheets delivered successively on to the table while the carriage is returning the grippers to said first position.

7. In a sheet feed apparatus according to claim 6, in which said means for reciprocating the end of connecting rod along said first rectilinear path comprises, a pivotally mounted crank, a planetary gear system operatively connected to said crank, gear means for operatively connecting the connecting rod and the planetary gear system, means for rotatively oscillating the crank through an arc of substantially 180°, whereby the rotary motion of the crank is translated to the reciprocatory motion of the end of the reciprocating rod connected to the gripper carriage.

8. In a sheet apparatus according to claim 6, including a second connecting rod having one end pivotally connected to the gripper carriage, and in which the means for reciprocating the ends of the first mentioned rod along said first path includes means for reciprocating the end of the second rod along a second rectilinear path parallel to the first path, the means for reciprocating said ends of both connecting rods comprising two pivotally mounted cranks, means for rotatively oscillating each of the cranks through arcs of substantially 180°, and two parallel planetary gear systems for translating the rotary motion of the two cranks to the reciprocatory motion of said ends of both connecting rods.

9. In a sheet feed apparatus for printing machines and the like having a feed table, gauges for properly positioning sheets on the table at a delivery position to which the sheets are delivered successively, a reciprocable gripper carriage, grippers mounted in spaced relationship on said carriage and being operable to an open position for receiving individual sheets successively and a closed position for gripping the individual sheets, and a suction device for picking-up individual sheets successively from a stack of sheets at a pick-up position and delivering them to the grippers while in an open operative position, an improved driving mechanism for cyclically reciprocating the gripper carriage between said pick-up and deliver positions comprising, at least a first connecting rod pivotally connected at one end to the gripper carriage, at least one crank device having a crank pivotally mounted and means connected to the first connecting rod for cyclically reciprocating the end of the connecting rod connected to the carriage along a rectilinear path lying substantially in a given plane and between two positions substantially 180° apart thereby to reciprocate the carriage between the sheet pick-up and delivery positions, means to oscillate the crank through an arc of substantially 180°, and means for causing the carriage to position the grippers in spaced relationship from and above the table in a position for receiving the individual sheets and corresponding to the pick-up position and to gradually lower the grippers to the level of the table thereby to deliver the sheets to the table at said delivery position and for causing the carriage to transport the grippers beneath the sheets delivered successively on to the table while the carriage is returning the grippers to said position for receiving the individual sheets from the suction device.

10. A sheet feed apparatus according to claim 9, including guide means for guiding the carriage, and in which the means for causing the carriage to lower the grippers from the position above the table to the delivery position and beneath the sheet delivered to the table comprises means for progressively lowering said guide means while the carriage is moving from the pick-up position and gradually raising the carriage guide means while the carriage is returning to the pick-up position.

11. In a sheet feed apparatus for printing machines and the like having a feed table, a reciprocable gripper carriage, grippers on said carriage for receiving individual sheets successively at a first position and for transporting them individually on to a second position on the table, an improved driving mechanism for cyclically reciprocating the carriage between said two positions comprising, cardan crank means having at least one crank lever pivotally connected substantially at one end to the gripper carriage, means cooperative with said cardan crank means for cyclically reciprocating said end of the crank lever in substantially a rectilinear path thereby to reciprocate the carriage between said two positions and along a substantially rectilinear path at least when moving from the first to the second position, and means cooperative with said cardan crank means for causing the carriage to transport the grippers beneath the sheets delivered successively on to the table while the carriage is returning the grippers to said first position.

12. In a sheet feed apparatus for printing machines and the like having a feed table, a reciprocable gripper carriage, grippers on said carriage for receiving individual sheets successively at a first position substantially at one end of the feed table and for transporting them individually on to a second position on the table substantially at an opposite end thereof, an improved driving mechanism for cyclically reciprocating the carriage between said two positions comprising, crank means having at least one crank lever pivotally connected substantially at one end to the gripper carriage, means for cyclically reciprocating said end of the crank lever in substantially a rectilinear path thereby to reciprocate the carriage between said two positions and along a substantially rectilinear path at least when moving from the first to the second position, and means cooperative with said cardan crank means for causing the carriage to position the grippers in a selected position spaced above the table and corresponding to said first position and gradually lowering the carriage with respect to the table during its movement from the first to the second position thereby to position the sheets on the table in a selected position corresponding to said second position including means for causing the carriage to transport the grippers beneath the sheets delivered successively on to the table while the carriage is returning the grippers to said first position.

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