United States Patent [19]

Guy

[11] **3,897,053**

[45] **July 29, 1975**

[54] **SHEET FEEDING APPARATUS AND METHOD**

[75] Inventor: **George Victor Guy,** London, England

[73] Assignee: **Metal Box Limited,** Reading, England

[22] Filed: **Apr. 25, 1973**

[21] Appl. No.: **354,343**

[30] **Foreign Application Priority Data**

Apr. 25, 1972 United Kingdom 19158/72

[52] **U.S. Cl.** **271/238;** 271/240; 271/243; 271/250; 271/271

[51] **Int. Cl.** **B65h 9/10**

[58] **Field of Search** 271/48, 49, 50, 58, 59, 271/60, 236, 238, 240, 250, 269, 271, 243

[56] **References Cited**

UNITED STATES PATENTS

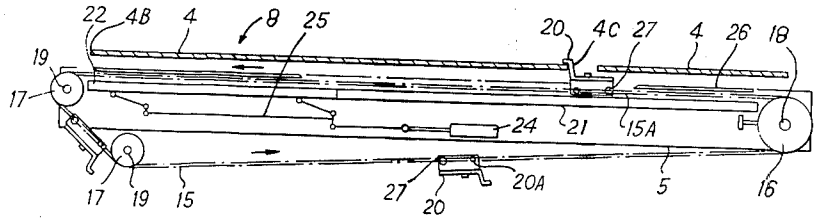
1,136,562	4/1915	Stokes et al.	271/49 X
2,052,829	9/1936	Johnston	271/59
2,488,551	11/1949	Nordquist et al.	271/49
2,699,940	1/1955	Huck et al.	271/49
2,986,393	5/1961	Brigham	271/49 X
3,650,526	3/1972	Schultz	271/48

Primary Examiner—Richard A. Schacher
Assistant Examiner—Bruce H. Stoner, Jr.
Attorney, Agent, or Firm—Diller, Brown, Ramik & Wight

[57] **ABSTRACT**

The invention relates to the feeding of a succession of sheets of rigid or semi-rigid material to associated equipment such as a printing press, and provides an infeed conveyor which receives the sheets one at a time and delivers them to the said equipment in predetermined orientation and correct register which is obtained by use of moving side lays which travel along the conveyor with the sheets, at the same time adjusting the register of the sheets.

6 Claims, 9 Drawing Figures



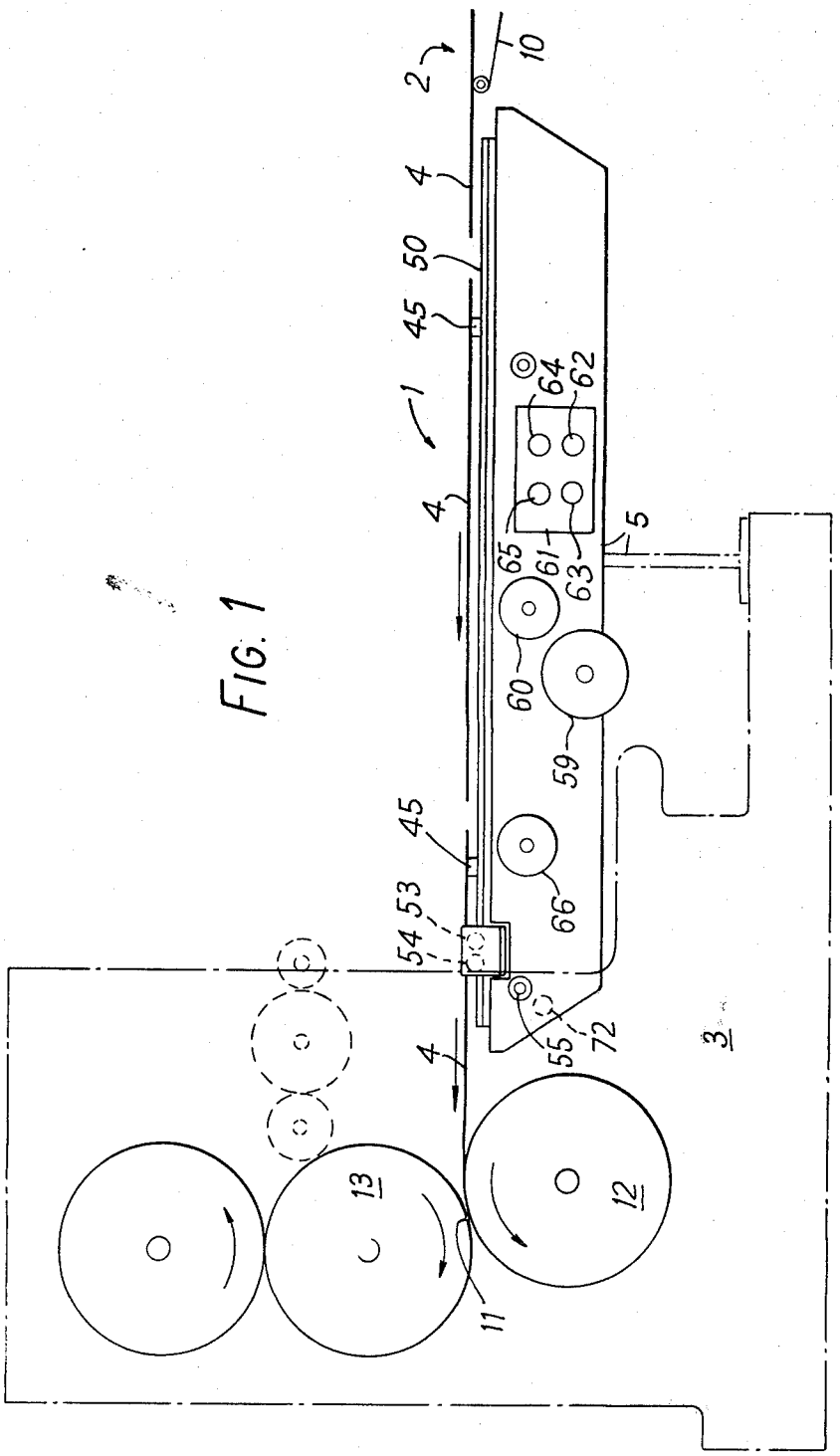


FIG. 1

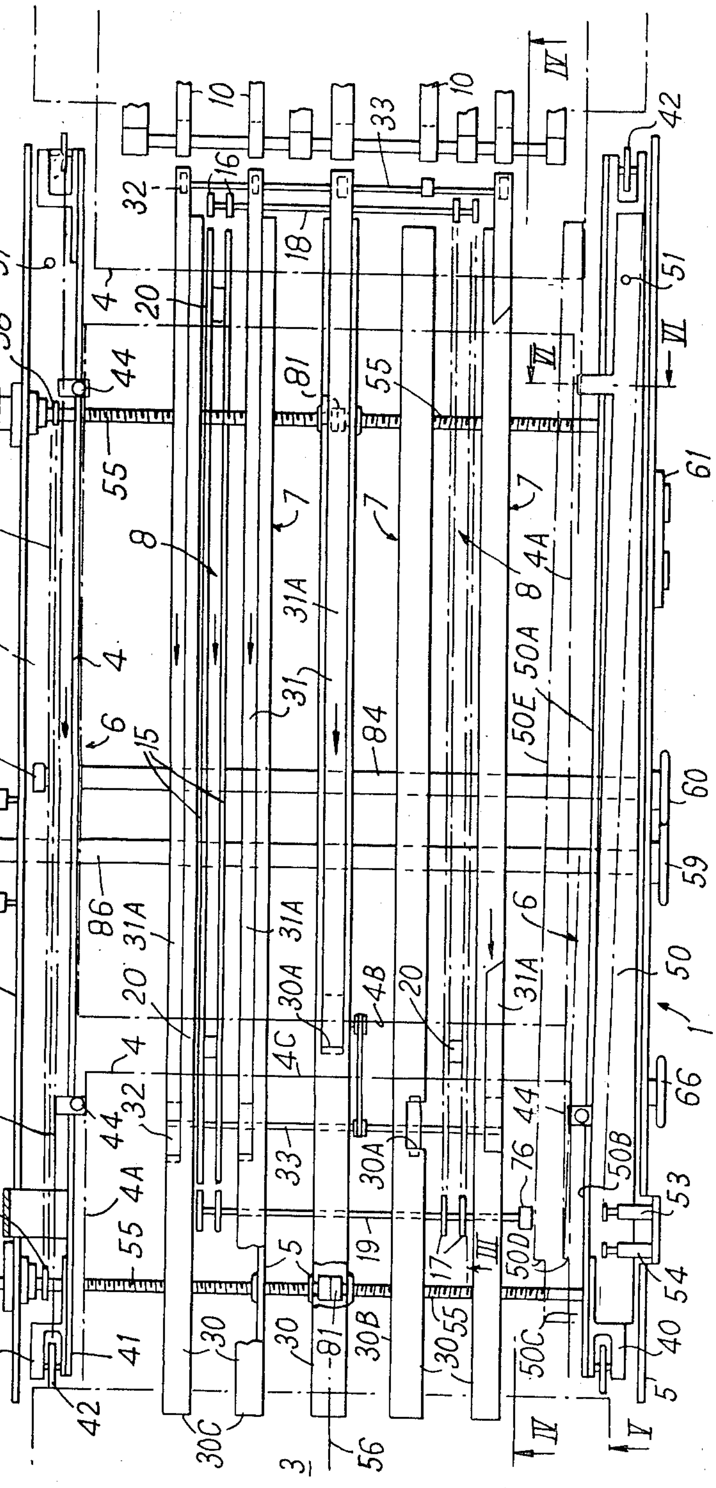


FIG. 2

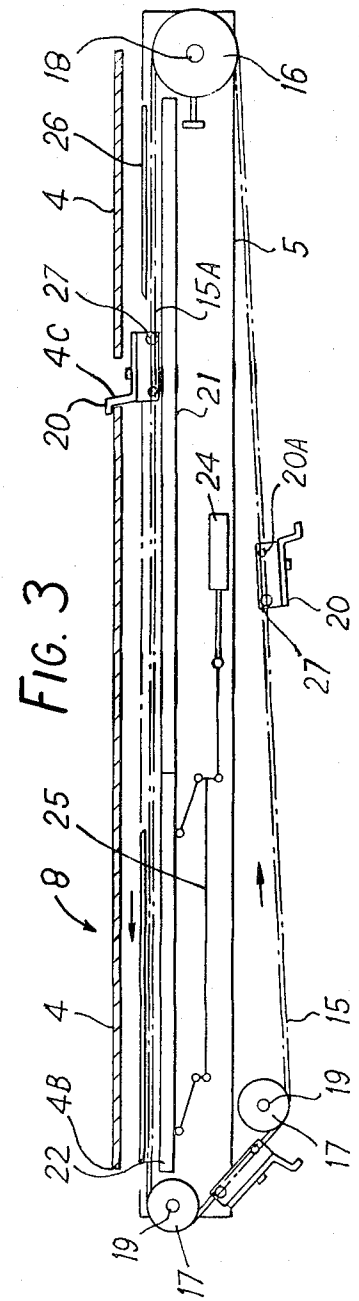

18
16
26
4
5
27
15A
4C
21
20
24
20A
20
27
25
8
4
15
4B
19
22
17
19
17

FIG. 3

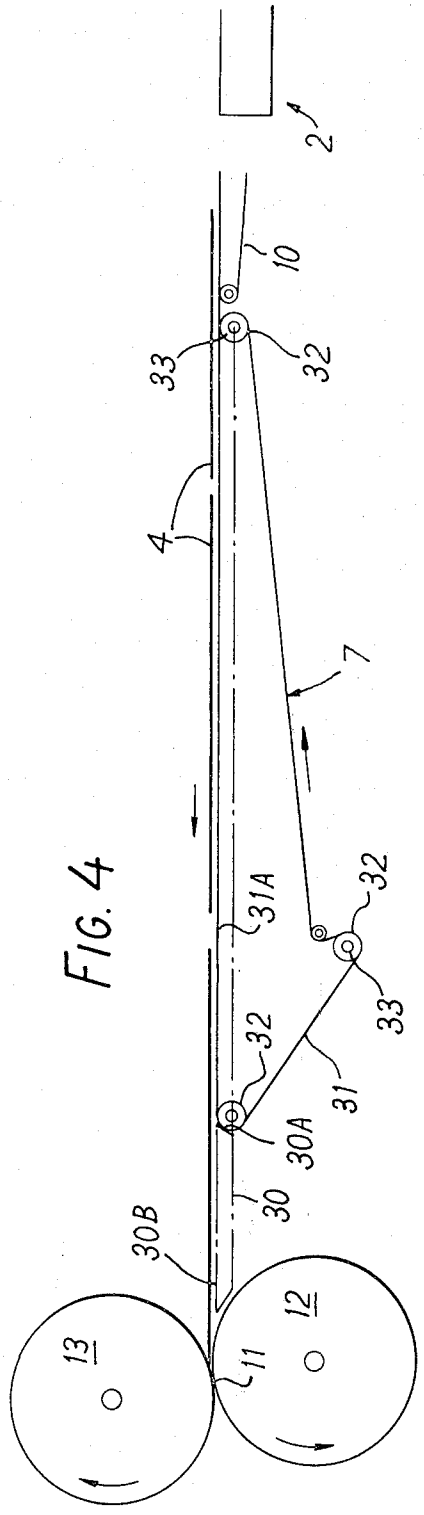

2
10
33
32
4
7
31A
32
33
32
31
30A
30
30B
13
12
11

FIG. 4

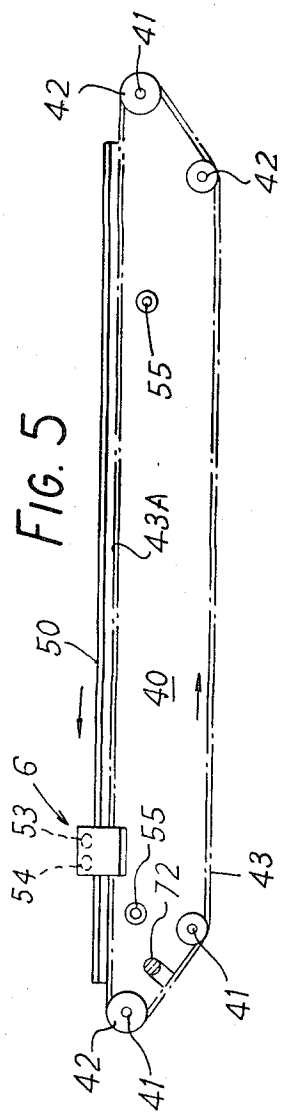


FIG. 5

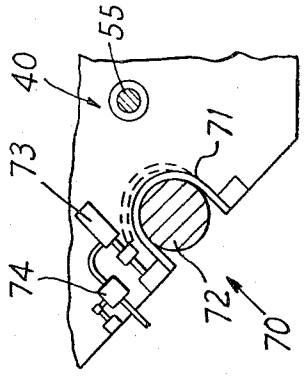


FIG. 7

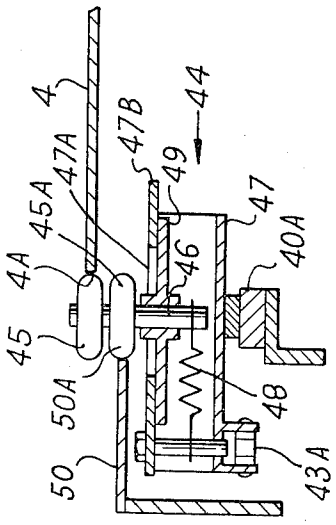


FIG. 6

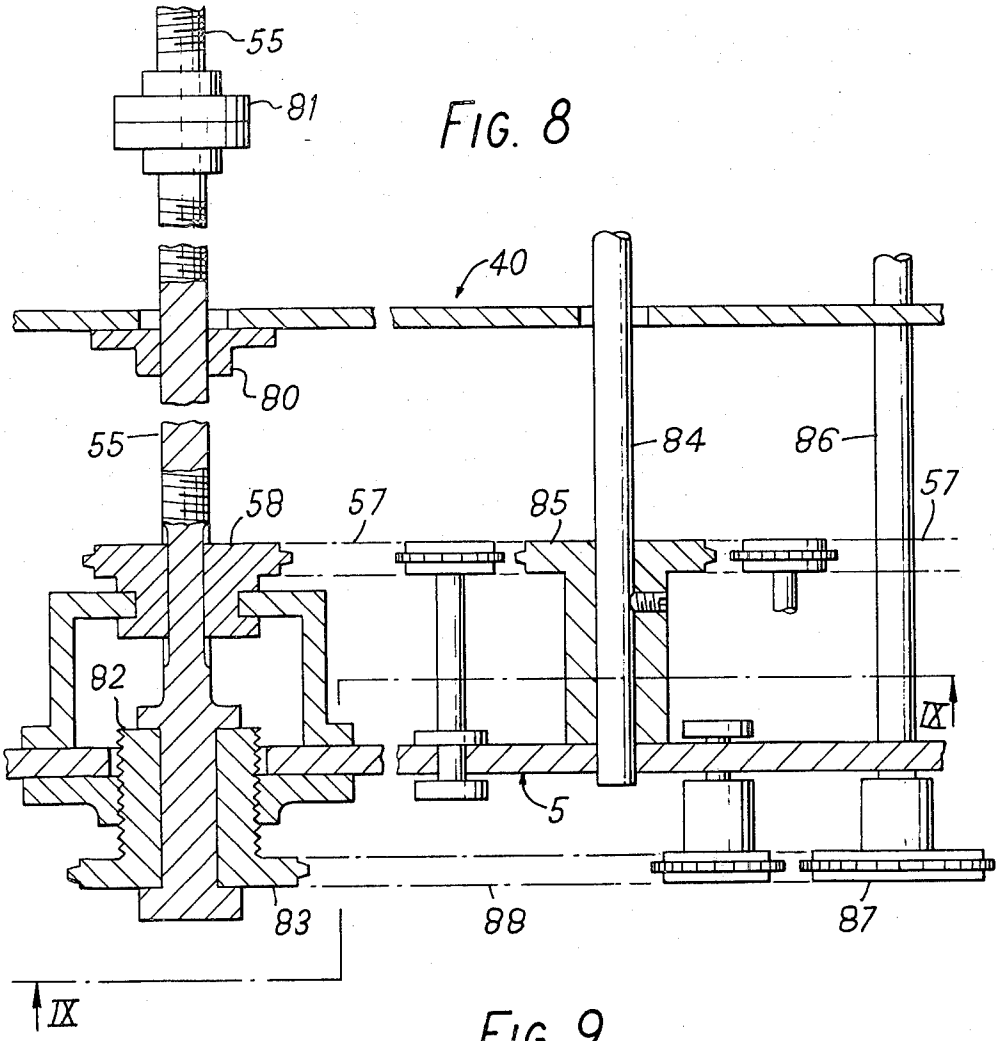

55
81
40
80
55
84
86
57
58
57
85
82
IX
5
83
88
87
IX

FIG. 8

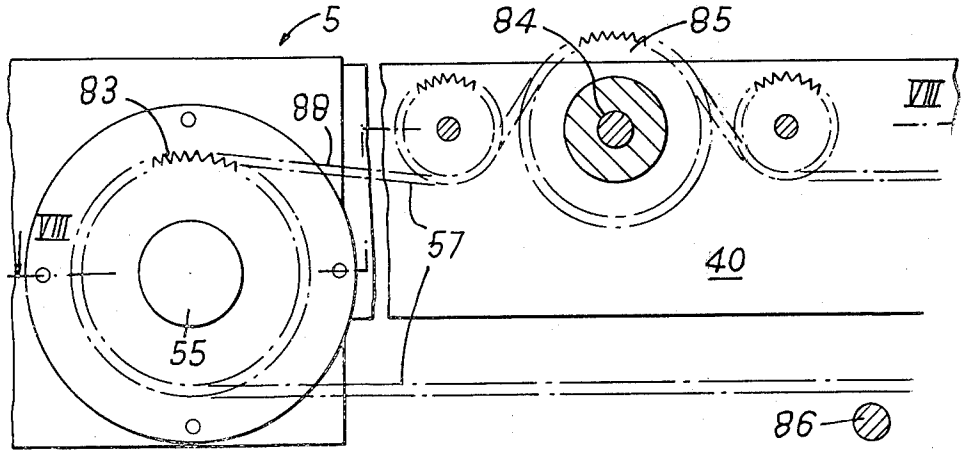

5
84
85
83
88
VIII
VIII
57
40
55
86

FIG. 9

SHEET FEEDING APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

This invention relates to the feeding of sheets to apparatus.

The term "sheet" as used herein embraces articles, components or material in rigid or semi-rigid sheet or plate-like form.

More particularly, the invention relates to apparatus and methods for feeding a succession of sheets to associated sheet-receiving equipment in predetermined orientation and alignment. Such an apparatus and method will be referred to herein as, respectively, an apparatus or a method of the kind hereinbefore specified.

Apparatus of the kind hereinbefore specified is employed in many different types of industrial process. Examples include printing, or coating with protective material, of metal or paperboard sheet destined to be subsequently cut and formed to make packaging containers, such as cans or cartons, or components therefor. It is well known, for example, to provide a printing pres with an associated device, usually known as a feeder, press picks up sheets one at a time from a stack and advances them successively, and in synchronism with the operation of the press, directly into the press where the sheets are printed in succession.

The feeder mechanism usually delivers the sheets in a manner that may result in successive sheets being slightly out of register with each other, and it is necessary, for printing and other industrial processes, that the sheets be delivered into the equipment for effecting such process, e.g. the sheet-engaging cylinders of a printing press, in very accurate register therewith, that is to say accurately orientated longitudinally and transversely and with the side edges of the sheet correctly aligned, or positioned in the correct longitudinal planes with respect to the said equipment.

A usual way of achieving this is to provide guiding means synchronised with the press or other said equipment, including dogs or pawls which are arranged to rise up from below each sheet in turn to engage the rear edge of the sheet and push it into the equipment, ensuring that the sheet enters at the correct moment (and therefore in correct longitudinal register) and ensuring that the sheet is properly orientated with respect to the said equipment. Such guiding means also typically includes side lays or gauges, that is to say a pair of members, one each side of the press or other apparatus to which the sheets are being fed, the side lays being mounted for limited spring-biased movement in a transverse plane but in a fixed position considered longitudinally of said apparatus, and arranged to engage the side edges of each sheet, as it is advanced by the pushers to a position between the side lays, so as to centre the sheet in correct transverse register with the said equipment, e.g. the printing cylinders. This results in impingement occurring between each sheet and the side lays in succession, and this impingement is more violent if the speed of advance of the sheets is increased. Furthermore, the thinner the sheets of any given material are, the more will this impingement cause flexural instability of the sheet immediately before entry into the said equipment.

These and other causes can result in mis-register of the sheets, which may therefore be printed in the wrong position on the sheets and may in extreme cases cause jamming or damage to the apparatus. For these reasons

such known apparatus is limited both as to speed and as to the thickness of sheet that can be handled. It is found that these limitations in many cases prevent full advantage, in apparatus such as printing or coating machines and feeders, being taken of the speeds of which they are capable and of their capability of handling thin material. For example, while certain conventional printing presses of the kind generally discussed above, having side lays at a fixed distance from, and close to, the blanket and impression cylinders of the press, can with conventional feeders handle tinplate sheet 0.01 inch thick quite satisfactorily (though at a speed no more than 80 percent of the maximum speed of which they are capable), even at this reduced speed it has been found that instability of the sheets as discussed above has made it impossible or difficult to use tinplate sheet only 0.006 inch thick.

A further disadvantage of conventional apparatus such as that discussed above is that when the sheet size is to be changed, the apparatus must be stopped for the necessary adjustments to be made to the pushers, side lays and any other components requiring re-setting. This drawback is particularly serious where sheets of several different sizes may need to be handled by the apparatus during the course of 1 day.

OBJECTS OF THE INVENTION

A main object of the present invention is to enable sheets to be fed in succession at higher speeds than has hitherto been found possible without sacrificing accuracy of positioning.

Another object is to improve the accuracy of register of sheets being fed.

A further object is to eliminate or reduce flexual instability in sheets being fed to equipment.

More particularly, this invention aims to eliminate the chance of sheets being presented to a conventional printing press or other equipment out of register, while realising speeds of operation potentially available from such presses or other equipment.

Yet another object is to provide means whereby sheet infeed equipment can be adjusted while running to take different sizes of sheets.

Still a further object is to provide means whereby sheet infeed equipment can be adjusted while running as to the parameters affecting sheet register and orientation.

SUMMARY OF THE INVENTION

According to the invention there is provided a precision infeed conveyor, aligned with sheet-receiving equipment such as a printing press, this conveyor being arranged to receive the sheets one at a time and delivers them to the said equipment in predetermined orientation and correct register which is obtained by use of moving side lays which travel along the conveyor with the sheets, at the same time adjusting the register of the sheets.

More specifically, the invention proposes interposing an infeed conveyor between a feeder (which may be of conventional construction) and the printing press or other receiving equipment; substitutes for the fixed transversely operating side lays of conventional equipment a system of side lays travelling along with the sheet so as to effect a gradual correction of the transverse register of the sheets while maintaining correct longitudinal register; and provides a system whereby

adjustments of appropriate parameters, for example to obtain correct register or to re-set the conveyor for different sheet sizes, can be made while the conveyor and equipment associated therewith are running.

The above and other objects and features of the invention will be more readily apparent from the description which follows, of one embodiment of the invention, given with reference to the accompanying drawings, by way of example only, and not intended to be limiting as to the scope of the invention, which is defined by the appendant claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic side elevation showing a sheet feed conveyor, incorporating features of the invention and arranged to transfer sheets from a feeder to a printing machine for printing the sheets in succession;

FIG. 2 is a simplified plan view of the same sheet feed conveyor;

FIG. 3 is a simplified sectional elevation of one of two pusher assemblies of the conveyor, taken substantially on the line III—III in FIG. 2;

FIG. 4 is a simplified sectional elevation showing one of several travelling-belt assemblies of the conveyor, taken substantially on the line IV—IV in FIG. 2;

FIG. 5 is a simplified sectional elevation of one of two side lay assemblies of the conveyor, taken substantially on the line V—V in FIG. 2;

FIG. 6 is a sectional elevation showing a side lay, taken on the line VI—VI in FIG. 2 but drawn to a much larger scale;

FIG. 7 is a simplified elevation, amplifying FIG. 5 but drawn to a much larger scale, and showing a detail associated with a side lay assembly;

FIG. 8 is a diagrammatic part-sectional plan view taken on the line VIII—VIII in FIG. 9 and showing how the side lay assemblies are adjusted for transverse spacing and transverse position; and

FIG. 9 is a diagrammatic part-sectional elevation taken on the line IX—IX in FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The sheet infeed conveyor shown in the drawings, and indicated at 1 in FIG. 1, is mounted between a conventional feeder 2 and a conventional printing press 3. Large flat sheets 4 of a thin but relatively rigid material such as tinplate, aluminum or paperboard, are fed by the feeder 2 successively from a stack (not shown) of the sheets, by means of belts 10 of the feeder, on to the conveyor 1, which in turn feeds the sheets successively into the nip 11 between an impression cylinder 12 and a blanket cylinder 13 of the printing press 3.

Each sheet 4 must be fed into the printing press at an accurately controlled speed and with its side edges 4A accurately registered transversely with respect to the impression (referred to herein as the printing plate image) on the blanket cylinder 13. In addition, the front edge 4B of each sheet must be accurately registered with respect to the printing plate image. The sheet feed conveyor 1 is adapted, as will become evident hereinafter, to present each sheet 4 to the printing press 3 with its edges correctly aligned and orientated with respect to the printing plate image, and at a high speed, the velocity at which the sheet advances being kept constant, and closely controlled by virtue of the fact that no free movement of the sheet on the conveyor is possible.

The sheet feed conveyor 1 has a rigid main frame, various parts of which are indicated by the numeral 5 in the drawings, and which is mounted rigidly with respect to the printing press 3. The main frame 5 carries, at each side thereof, a side lay assembly 6 (FIGS. 2 and 5). Between the two side assemblies, and extending longitudinally of the conveyor, there are sheet-advancing means comprising a plurality (in this example four) of what will be referred to herein, for convenience, as travelling-belt assemblies 7 (FIGS. 2 and 4), and two pusher assemblies 8 (FIGS. 2 and 3).

In the example shown, the travelling-belt assemblies 7 are arranged in two pairs, with a pusher assembly 8 between and closely adjacent to the two travelling-belt assemblies of each pair.

Each of the pusher assemblies 8, as seen in FIGS. 2 and 3, includes a pair of sprocket chains 15 spaced apart transversely and parallel to each other, passing over sprocket wheels 16, 17 carried on transverse shafts 18, 19 respectively, which are rotatable in the main frame 5 of the conveyor. The shaft 19 is driven conventionally through a differential gear unit indicated at 76, FIG. 2, by a main drive unit (not shown), synchronised with the operation of the cylinders 12, 13 of the press by any suitable known means.

This main drive unit may be made so that its speed can be changed to give any desired constant speed of advance of the sheets 4. It may be a separate unit mounted in the main frame 5; alternatively the main drive unit may be that of the press 3 or of the feeder 2, being coupled with the gear unit 76 through a suitable transmission, preferably a belt drive, to give the required predetermined speed ratio or ratios. Preferably the main drive unit includes a synchronous electric motor.

Coupled between the two chains 15 of each pusher assembly 8 are a number of equally spaced pushers 20. Each pusher 20 is arranged so as always to lie at the same longitudinal section of the conveyor as the corresponding pusher 20 of the other pusher assembly 8, so that the two pushers co-operate to engage the rear edge of a sheet 4 being conveyed by the conveyor. Each pusher 20 is attached to the associated chains 15 by means only of a pivot 20A near the leading end of the pusher 20, and has rollers 27 near the rear end of the pusher, the rollers 27 running in engagement with the support bars 21, 22.

Below the top run 15A of each pusher chain 15, and extending along part of the length of the said run, is a fixed support bar 21 to keep the run 15A substantially horizontal. An adjustable support bar 22 extends below the top run 15A of each chain 15 along substantially the remainder of the length of the run, and is arranged end to end with the corresponding fixed support bar 21. Each adjustable support bar 22 is arranged to be moved up and down by suitable operating means, so as to bring it into or out of engagement with the pushers 20 as they move over the top of the bar 22.

Each adjustable support bar 22 is coupled through suitable means such as the linkage 25 with a piston-and-cylinder type pneumatic actuator 24 fixed with respect to the main frame 5. The operation of the adjustable support bars is as follows. As the leading edge 4B of each sheet 4 enters the nip between the press cylinders 12, 13, FIG. 1, it is subjected to a reaction force

tending to retard its movement and tilting the pushers **20,** engaging the rear edge 4C of the sheet, backwards. Each pusher tilts about its pivot **20A.** Air pressure in the actuator **24** is set to a predetermined level so as to exert a force on the piston of the actuator, this force being transmitted through the linkage **25,** support bar **22,** and rollers **27** to the pusher **20** and thence to the sheet **4.** The value of the actuator air pressure is set so that this force, which is a compressive force acting on the sheet **4,** shall be substantially equal to the reaction force abovementioned, so as to counteract the reaction force and ensure that the sheet **4** enters between the cylinders **12** and **13** substantially without retardation or jerking. It will be seen that the tilting movement of the pushers **20,** and the ability of the linkages **25** and support bars **22** to move, are inherent in the function of the actuators **24** to act as a source of the compressive force or thrust substantially eliminating the effects of sudden entry of the leading edge **4B** of the sheet between the cylinders **12** and **13** of the press.

The actuators **24,** associated with or forming part of the pusher assemblies, are preferably arranged to be operated simultaneously, for example by being supplied from a common source of compressed air, so that the compressive thrusts applied to the pushers **20** of each pair engaging the rear edge 4C of a sheet **4** may be adjusted simultaneously, even when the conveyor is operating. These thrusts will hereinafter be called "pusher thrusts."

Fixed guide bars **26** may be arranged over the top of the top run **15A** of each pusher chain.

Each of the travelling-belt assemblies **7,** as seen in FIGS. **2** and **4,** comprises a flat bar or slat **30** fixed to the main frame **5** and extending along substantially the full length of the conveyor, and an endless travelling belt **31** passing around rollers **32,** which are carried on transverse shafts **33** rotatable in the main frame **5** of the conveyor. Each belt **31** has a top run **31A** extending over a substantial part of the length of the associated slat **30,** by which the top run **31A** of the belt is supported. In the arrangement shown, each slat **30** is of constant width throughout its length, the associated travelling belt **31** being narrower than the slat and passing at the downstream end of its top run **31A** through a transverse slot **30A** formed in the slat.

The slats **30** are mounted rigidly on the main frame **5** at such a height that sheets **4** can pass from the belts **10** of the feeder **2** on to the travelling belts **31** of the conveyor **1** without changing level, and at such a height that the sheets **4** sliding on the portions **30B** of the slats downstream of the travelling belts **31,** are conveyed directly into the nip **11** between the blanket and impression cylinders **13, 12** respectively of the press **3.** To this end, at least some of the slats **30** extend to a free end **30C** closely adjacent the impression cylinder **12.**

Further slats **30,** not associated with travelling belts, may if desired be provided to give additional support to the sheets **4.** There may be any convenient number of travelling belts **31,** but there should be at least two. In the present example there are five.

One or more of the belts **31** may be unsupported by a slat such as the slats **30,** one or more of the slats **30** then being separate from the travelling-belt assemblies.

The shaft **33,** carrying the rollers **32** at the upstream end of the top runs of the travelling belts **31,** is arranged to be driven by the main drive unit hereinbefore mentioned, but at a speed such that the speed of advance of the belts **31** is always slower than that of the pusher chains **15** and their pushers **20.** The travelling belts thus provide a retarding effect to the sheets **4** supported thereon, so ensuring that the rear edge **4C** of each sheet is maintained in engagement with the appropriate pusher dogs **20** on the top runs **15A** of the pusher chains **15** while being pushed by the dogs along the conveyor.

Each of the two side lay assemblies **6** (FIGS. **2** and **5**) includes a sub-frame **40** extending longitudinally of the conveyor and carried by the main frame **5.** The sub-frame **40** carries shafts **41** on which sprocket wheels **42** are mounted for rotation with respect to the sub-frame. An endless chain **43** extends around the sprocket wheels **41,** and carries a number of equally-spaced travelling side lays **44.** One of the side lays **44** is shown in FIG. **6,** and consists essentially of a pair of rollers **45** 45A, each freely and independently rotatable on an upstanding pin **46** which extends through a slot **47A** extending generally transversely with respect to the conveyor and formed in a body member **47** of the side lay. The body member **47** is slidable along a horizontal fixed guide **40A** of the sub-frame **40,** to maintain the side lay **44** at a constant level while on the top run **43A,** FIG. **5,** of the chain **43.** The pin **46** is biased by a tension spring **48** towards an outboard position, and is maintained in its upstanding attitude by any suitable means, for example by a plate **49** fixed to the pin **46** and sliding under a top plate **47B** of the body member **47,** ,the slot **47A** being formed in this top plate.

Each side lay assembly includes a horizontal side lay cam plate **50,** which is mounted on the sub-frame **40** at a level such that, on the top run **43A** of the chain **43,** the rollers **45A,** arranged inboard of the cam plate, engage the inner or side lay guiding edge **50A** of the cam plate, being urged into engagement therewith by the springs **48.** The cam plates **50** are tapered so that their inner edges **50A** are mutually convergent over most of the length of the cam plates so that, as the side lays move along the conveyor as indicated by the arrows in FIG. **1,** the rollers **45** and **45A** are steadily urged inwards against the action of the springs **48,** that is to say towards the right hand end of the slot **47A** as seen in FIG. **6.**

Over a section, which may be for example **12** inches long, indicated at **50B** in FIG. **2,** the inner edges of the cam plates **50** are substantially parallel, terminating in a cutaway or release portion **50C** to enable the springs **48** to release the side lays transversely from engagement with the sheets **4.**

The side lays **44** of each assembly **6** are so positioned that the axis of the roller **45** of each side lay lies at all times, when on the top run **43A** of its chain, in the same transverse plane of the conveyor as the roller axis of the corresponding side lay **44** of the other assembly **6.** One of the shafts **41** of each side lay assembly **6** is arranged to be driven through a suitable transmission (not shown) from the main drive unit, at a constant speed which is preferably such that the side lays **44** travel at the same speed as the pushers **20.**

At least one of the cam plates **50** (each of them, in this example) is pivoted, as indicated at **51** in FIG. **2,** near its upstream end, upon the corresponding sub-frame **40.** The other or downstream end of the pivoted cam plate is connected with its sub-frame **40** by means of two pneumatic piston-and-cylinder type actuators **53, 54,** which are mounted on the sub-frame **40** as

shown diagrammatically in FIGS. 1 and 2, to engage each cam plate 50 near the downstream end thereof and move it through a limited arc pivotally about the mounting 51. The effect of this pivotal movement is to increase or decrease the pressure exerted transversely by the side lays 44 on a sheet 4 the side edges 4A of which are engaged by the rollers 45 of the side lays. One of the actuators 53 is a high-pressure actuator capable of moving the cam plate only through the full stroke of the actuator and the other, 54, is a low pressure actuator arranged, by conventional means not shown, to make movements to a very high degree of accuracy so as closely to control the side lay pressure exerted on the side of a sheet 4.

If only one of the cam plates 50 is pivoted (the other being fixed with respect to its sub-frame), the other, fixed, cam plate may not be provided with actuators such as 53 and 54; and the pivoted cam plate need not be provided with a high-pressure actuator 53. In place of the actuators 53, 54, one or both cam plates may be connected at its downstream end with its sub-frame 40 by means of a simple tension spring, the effect of which is to urge the cam plate towards the "fully open" position shown by full lines for the lower cam plate 50 as seen in FIG. 2.

Operation of the actuators 53, 54 controls the position of the associated cam plate 50 between the open position (full lines, FIG. 2) and a position, indicated by chain-dotted lines at 50D in FIG. 2, wherein the transverse pressure exerted by the side lays on the sheet 4 is greatest. The distance between these two positions is exaggerated in FIG. 2, for clarity.

Each side lay assembly 6 is arranged for transverse movement of the whole side lay assembly with respect to the main frame 5, whereby the effective width of the conveyor is adjustable to accommodate different widths of sheet 4. Thus, for example, one position to which a side lay assembly can be adjusted is indicated by chain-dotted lines at 50E in FIG. 2. In this position the cam plate 50 is represented in its "open" position relative to the associated sub-frame 40. The transverse adjustment of the side lay assemblies is achieved by any suitable means; in this example transverse threaded shafts or leadscrews 55 are mounted in the main frame 5, the sub-frame 40 of each side lay assembly 6 on that side of the conveyor being provided with threaded bushes 80, FIG. 8, engaging the leadscrews 55 and the arrangement being such that, by relative rotation between the bushes 80 and the leadscrews 55, the side lay assembly is moved towards or away from the longitudinal centre line 56 of the conveyor.

In the embodiment shown, each side lay assembly engages two leadscrews 55, one near each end of the sub-frame 40. There are four such leadscrews, arranged in two pairs, each of which consist of a leadscrew 55 having a right-hand thread coupled end to end by means of a coupling 81 to a leadscrew 55 having a left-hand thread. The free end of one of the leadscrews of each such pair is rotatable and freely movable axially in a suitable bearing, not shown, in the main frame 5. The free end of the other leadscrew of each pair, at the opposite side of the machine, is mounted freely rotatably in a bush 82, FIG. 8 which is itself threaded externally and mounted for rotation in the main frame 5, as shown in FIGS. 8 and 9, the thread of the bush 82 engaging a corresponding thread of the frame 5. The leadscrews 55 are constrained against axial movement with respect to the rotatable bushes 82 and each bush 82 includes a sprocket 83.

One leadscrew 55 of each said pair carries a further sprocket 58 which is arranged for relative axial, but not rotating, movement between the leadscrew 55 and sprocket 58. The sprockets 58 are constrained against transverse movement relative to the main frame 5.

A first handwheel 60 (FIGS. 1 and 2), or other suitable control device, is coupled to the shafts 55 through a shaft 84, a driving sprocket 85 on the shaft 84, and an endless sprocket chain 57 engaging the driving sprocket 85 and both the sprockets 58.

A second handwheel 59 (FIGS. 1 and 2), or other suitable control device, is coupled with the rotatable bushes 82 through a shaft 86, a driving sprocket 87 on the shaft 86, and an endless sprocket chain 88 engaging the driving sprocket 87 and both the sprockets 83 of the rotatable bushes 82.

Rotation of the handwheel 60 causes all four leadscrews 55 to rotate.

The leadscrews do not move axially during this rotation, being constrained by the bushes 82.

Rotation of the leadscrews 55 causes the bushes 80, and therefore the side lay assemblies 6, to travel along them. Since the threads on the leadscrews 55 of each pair are of opposite hands, the side lay assemblies move either towards or away from each other, depending on the direction of rotation of the handwheel 60. In this way the side lay cam plates 50 are set to the required distance apart for handling sheets 4 of any desired width.

Rotation of the handwheel 59, with the handwheel 60 kept stationary by suitable means (not shown) so that the laedscrews 55 do not rotate, causes the bushes 82 to rotate and so move the leadscrews 55 transversely of the apparatus, thus enabling the side lay cam plates 50 to be set accurately without changing the distance between them. In this way the sheets 4 can be brought into accurate register transversely with the printing plate image in the press 3.

It is to be understood that FIGS. 8 and 9 are only diagrammatic and intended to illustrate the principle of operation of this particular embodiment of means for adjusting the spacing between the side lay cam plates and the register of the sheets 4 with the printing plate image.

The sprockets 58 and 85 and their associated parts need not be on the same side of the apparatus as the rotatable bushes 82, sprockets 87 and parts associated therewith.

The main frame 5 includes a plurality of transverse stretchers or stay bars, of which the only one indicated in the drawings is indicated at 72 in FIGS. 1 and 7. To ensure that the side lay assemblies 6 do not move once the abovementioned adjustments have been effected, they are clamped to the stay bar 72 by simple pneumatically-operated clamps 70 one of which is shown in FIG. 7.

With reference to FIG. 7, each clamp 70 comprises a flexible band 71, mounted on the side plate of the corresponding side lay frame 40 and movable into and out of clamping engagement with the stretcher 72 by means of an air-operated piston-and-cylinder actuator 73 actuated by a control valve 74. The control valves 74 of the two clamps 70 are controlled by further valves, not shown, which may conveniently be arranged to be actuated by operation of the handwheels 59 and

60 so as to release the clamps 70 when either handwheel is operated, and to engage the clamps when the handwheels cease to be operated.

Other controls of the apparatus include the following: A pneumatic control panel 61 carries a pusher thrust control 62 which operates the adjusting means 23, FIG. 3 to control the pusher thrust as described hereinbefore, and a side lay tension control 63 which operates the actuators 53, 54, FIG. 2, to adjust the pivotal position of one or other of the side lay cam plates 50. Indicators 64, 65 respectively, may be provided to indicate the pusher thrust and the pressure exerted by the side lays 44 on the sheets 4. A handwheel 66 is coupled to the differential gear unit 76 to effect a forward or backward adjusting movement of the pushers 20. This adjusts the position of the pushers 20 longitudinally with respect to the press 3, so that they can engage the rear edge 4C of each sheet at a longitudinal position such that the front edge 4B of the sheet will enter the press 3, in the correct relationship with the printing plate image, whereby the image printed on the sheet is correctly positioned longitudinally thereon.

In operation, the conveyor 1 is first adjusted to handle a succession of sheets 4 of a particular size as follows. The clamps 70 are released and the handwheel 60 is operated to move the side lay assemblies 6 until the side lay rollers 45 of one side lay assembly, when engaging the portion 50B of the corresponding side lay cam plate 50, are spaced transversely from those of the other side lay assembly 6 by approximately the width of a sheet 4. The handwheel 59 is operated to move both side lay assemblies in the same direction as each other, so as to align the sheet 4 transversely in the desired position with respect to the printing plate image in the press 3. The clamps 70 are engaged to lock the side lay assemblies 6 in position. The handwheel 66 is operated to set the pushers 20 correctly so as to position the sheets 4 longitudinally with respect to the said image.

The main drive is then energised, the press 3, conveyor 1 and feeder 2 being started, preferably at a slow speed initially. The feeder begins to feed sheets 4 on to the conveyor 1, the rear edge 4C of each sheet being engaged by the pushers 20, against which the sheet is urged by virtue of the travelling belts 31 engaging the underside of the sheet and moving at a slower speed than the pushers 20. Each sheet is maintained correctly orientated by the two pushers 20 engaging its rear edge.

As each sheet 4 travels along the conveyor, its two side edges 4A, not necessarily simultaneously, are engaged by the rollers 45 of the side lays 44 which, by virtue of engagement of the rollers 45A with the convergent inner edges 50A of the side lay cam plates 50, centre the sheet into a final transverse alignment in which it is held by the side lays 44 along the portion 50B of the cam plates 50. The cam plates are so spaced from the press cylinders that the leading edge of each sheet enters the nip 11 between the blanket cylinder 13 and impression cylinder 12 before the side lays 44 engaging it reach the release portions 50C of the respective cam plates 50.

The directions of motion of the side lays 44, pushers 20 and belts 31 are indicated by arrows in the drawings.

As the first sheet 4 passes along the conveyor, the side lay pressure, indicated on the indicator 65, can be adjusted by means of the control 63. To this end, one of the side lay cam plates 50 is pre-set to a fixed position with respect to its sub-frame 40 by operation of its high-pressure actuator 53, the other cam plate 50 being adjusted accurately by operation of its low-pressure actuator 54 until the required side pressure on the sheet 4 is indicated on the indicator 65. This adjustment may if desired be carried out with the sheet 4 stationary and engaged by side lays 44 on the portions 50B of the cam plates 50.

Also as the first sheet passes along the conveyor, the pusher thrust indicated by the indicator 64 can be adjusted by means of the control 62.

Side lay pressure and pusher thrust may also be adjusted as described, at any time during subsequent operation of the conveyor while it is running.

It will be seen also from the foregoing that, should the image printed on the first sheet or sheets be found to be slightly off its correct position on the sheet, small transverse errors can be adjusted to a certain extent for subsequent sheets by operation of the handwheel 59 to produce a correcting shift in the transverse alignment of the sheets with respect to the printing plate image. This adjustment may be carried out while the conveyor is running.

It will furthermore be apparent that major changes in the sheet size settings may also be made while the machine is running. Thus the conveyor can be adjusted to take longer or shorter sheets as required, without stopping any of the equipment, merely by appropriate adjustment of the handwheel 66. Similarly, the side lay assemblies 6 can be adjusted for narrower or wider sheets or for transverse register while the equipment is running, by releasing the clamp 70 and operating the handwheels 60 and/or 59 as appropriate, the clamp 70 then being re-engaged.

Some possible variations on the arrangements shown in the drawings have already been mentioned herein, but it will be understood that others are possible within the scope of the invention. For example, the side lays may take any convenient form having sheet-engaging means, such as the rollers 45, such as to urge the sheet into correct transverse register by co-operation between side lays on opposite sides of the conveyor and side edges of the sheet, the sheet-engaging means being to this end arranged for movement having a component transverse of the conveyor in response to movement of the side lays longitudinally of the conveyor with respect to side lay guide means such as the cam plates 50.

It will be understood that conveyors according to the invention are not confined to use in association with printing processes, but may be used to feed material or components, in semi-rigid or rigid sheet or plate-like form, to any kind of apparatus requiring accurate feeding.

I claim:

1. Apparatus for feeding a succession of sheets of rigid or semirigid material to associated sheet-receiving equipment in predetermined orientation and alignment, said apparatus comprising a conveyor which comprises a main frame; sheet advancing means disposed longitudinally on said main frame for moving a succession of said sheets along a path on the conveyor in predetermined orientation; at least one pair of side lays, each side lay being disposed transversely opposite the other side lay of the same pair with the sheet advancing means disposed intermediately between the side lays of each pair; means, carrying said side lays and mounted on said main frame, for advancing the side

lays along the conveyor simultaneously with said sheet advancing means; and side lay guide means carried on said main frame for gradually converging the appropriate side lays towards and into engagement with opposite side edges of each sheet when the side lays are so advancing, whereby each sheet may be brought by the side lays gradually into a predetermined transverse register, the sheet advancing means including pusher means for engaging rear edges of the sheets, a plurality of endless flexible carrying members engageable with the undersides of the sheets, first means for advancing the pusher means, and second means for advancing said flexible carrying members, said second means being movable at a speed less than that of said first means whereby the flexible carrying members urge the sheets continuously backwards against the pusher means, said first means for advancing the pusher means comprising a plurality of flexible drive members of the pusher means, said pusher means also comprising pusher dogs carried by said flexible drive members and arranged to engage the rear edges of said sheets, said apparatus comprising tension-adjusting means mounted on the main frame for adjusting the tension in the said flexible drive members during operation, the flexible drive members being endless and arranged to define a longitudinal top run thereof supported from below by longitudinal guides, the said tension-adjusting means comprising a movable said guide extending along at least part of the length of said top run of each flexible drive member, and actuating means for moving said movable guides into and out of frictional engagement with the pusher means of said flexible drive members so as to control the tension in said flexible drive members.

2. Apparatus for feeding a succession of sheets to associated sheet receiving apparatus, said apparatus comprising sheet advancing means for advancing sheets along a sheet path, said sheet advancing means including a flexible drive member and a plurality of pusher members for engaging rear edges of sheets, connecting means connecting said pusher members to said flexible drive member at spaced intervals for movement along a predetermined path a portion of which generally corresponds to a portion of the sheet path, said connecting means being of the pivotal mounting type and mounting said pusher members for pivotal movement generally normal to the sheet path, guide means underlying a part of said predetermined path portion for engagement by said pusher members to control the tilting thereof and support means resistingly supporting said guide means for limited movement in response to pivoting of said pusher members in response to the resistance of a pushed sheet engaging sheet receiving apparatus to absorb the shock thereof.

3. The apparatus of claim 2 wherein said support means includes a deflectable support member.

4. The apparatus of claim 2 wherein said support means includes a deflectable support member in the form of a piston and cylinder type fluid actuator.

5. The apparatus of claim 2 wherein said support means includes a deflectable support member of the type having a settable resistance to the deflection thereof.

6. Apparatus for feeding a succession of sheets of rigid or semirigid material to associated sheet-receiving equipment in predetermined orientation and alignment, said apparatus comprising a conveyor which comprises a main frame; sheet advancing means disposed longitudinally on said main frame for moving a succession of said sheets along a path on the conveyor in predetermined orientation; at least one pair of side lays, each side lay being disposed transversely opposite the other side lay of the same pair with the sheet advancing means disposed intermediately between the side lays of each pair; means, carrying said side lays and mounted on said main frame, for advancing the side lays along the conveyor simultaneously with said sheet advancing means; said side lay guide means carried on said main frame for gradually converging the appropriate side lays towards and into engagement with opposite side edges of each sheet when the side lays are so advancing, whereby each sheet may be brought by the side lays gradually into a predetermined transverse register, each side lay including a body member, a support element, means mounting said support element for movement with said body member and for transverse movement relative to said body member, first roller means carried by said support element for engagement with a respective one of said side lay guide means for transversely shifting and positioning said support element, and second roller means carried by said support element for engaging a side edge of a sheet, said sheet advancing means including a flexible drive member and a plurality of pusher members for engaging rear edges of sheets, connecting means connecting said pusher members to said flexible drive member at spaced intervals for movement along a predetermined path a portion of which generally corresponds to a portion of the sheet path, said connecting means being of the pivotal mounting type and mounting said pusher members for pivotal movement generally normal to the sheet path, guide means underlying a part of said predetermined path portion for engagement by said pusher members to control the tilting thereof, and support means resistingly supporting said guide means for limited movement in response to pivoting of said pusher members in response to the resistance of a pushed sheet engaging sheet receiving apparatus to absorb the shock thereof.

* * * * *