Systems and methods for handling sheet material, for example, signatures or inserts, are provided. Individual systems and methods for loading and jogging stacks of sheet material are combined with systems and methods for transferring sheet material whereby the mishandling or misfeeding of sheet material is minimized or reduced. The loading and jogging aspects are characterized by pivotally mounted receptacles or bins that facilitate introducing sheet material to a conveyor. The transferring aspects include automated transfer devices adapted to grip and position stacks of sheet material, for example, into a hopper feeding a disk feeder. These automated systems and their combination minimizes or prevents the mishandling of sheet material whereby the processing of sheet material is enhanced compared to conventional systems and methods.
METHODS AND SYSTEMS FOR TRANSFERRING STACKED SHEET MATERIAL

TECHNICAL FIELD

[0001] The present invention generally relates to systems and methods for handling sheet material. More particularly, the present invention relates to hopper loaders adapted to introducing sheet material to collating conveyor feeding devices and the like.

BACKGROUND OF THE INVENTION

[0002] The binding and printing industries often rely on high-speed sheet material handling systems for printing, collating, binding, and otherwise handling sheet material, for example, sheets of paper. This sheet material, for example, individual sheets, newspapers, magazines, inserts and “onserts” (that is, sheet material used when collating newspapers), books, brochures, and the like, is typically, fed to and accumulated in containers or “magazines” or “hoppers” and withdrawn from the magazines or hoppers for further processing.

[0003] One particular sheet material that is handled in the binding and printing industry is what is known in the art as a “signature.” A signature typically comprises two or more sheets of paper that may be folded to form a spine, that is a “spine fold.” Signatures may contain four or more pages of text or graphics, for example, 30 or more pages of text or graphics.

[0004] In the manufacture of books, it is common to assemble the book on a collecting conveyor by sequentially withdrawing signatures from magazines, or hoppers, containing stacks of signatures. In producing a book, typically, a plurality of serially-arranged hoppers, separating devices, and feeders are employed for gathering and collating the printed sheets of, for example, signatures. Typically, the separating devices separate and withdraw the sheet material from the hoppers and feed the sheet material to a rotating drum. The rotating drum then feeds the sheet material to a conveyor that collects and transfers the separated printed sheets for collation, binding, or other handling. The separation of the sheet material from the stacked sheet material is typically effected by a rotating disk separator. The separation of the sheet material by the disk separator is typically aided by a suction device, for example, a device known in the art as a “sucker”. One typical disk-type separator is disclosed in U.S. Pat. No. 6,193,229 B1, the disclosure of which is incorporated by reference herein in its entirety. The disk separator separates and feeds the sheet material to a rotating drum that accepts and retains the sheet material and conveys it to the conveyor. The disk separator, typically with the aid of the suction device, deflects the edge of the lower-most article of sheet material in the hopper stack. When the sheets to be withdrawn from the hopper are in the form of signatures, the deflected edge is typically the spine fold portion of the signature. The rotating drum positioned below the disk separator typically includes some means of retaining the sheet material as it rotates, for example, devices known in the art as “grippers”. The conveyor that receives the sheet material is typically a horizontal conveyor. This horizontal conveyor may also receive sheet material from other, typically serially-positioned, feeding drums. A common drive mechanism typically drives and synchronizes the operation of the separator, suckers, feed drum, grippers, and the conveyor.

[0005] The throughput of such systems is dependent upon how closely together the sheet material is spaced, and on how fast the sheet material is moved. Accordingly, the throughput of such systems may be optimized by spacing the sheet material as closely together as possible and by maximizing the speed of operation of each of the components. One important factor in the operation of disk-type separators is the alignment of the sheet material with the separator disk. Since the disk separators of such devices rotate at high speed and typically “bite into” the stack of sheet material in the hopper, misalignment of the sheet material and the disk can cause misfeeds, jamming, or even damage to the equipment.

[0006] According to prior art methods, sheet material typically fed to the hopper that feeds the disk separate by means of some form of conveyor. Typically, the conveyor feeds the sheet material to the hopper such that the sheet material forms a uniform stack in the hopper. Forming a uniform stack of sheet material in the hopper helps to ensure that the sheet material is uniformly stacked so that the sheet material can be engaged and separated by the rotating disk separator. The formation of a non-uniform or misaligned stack of sheet material in the hopper can interfere with the uniform separation of the sheet material by the disk separator and, in the worst case, cause jamming of the sheet material and disruption of the production facility. Thus, the uniform alignment of the stacked sheet material is highly desired by the operator.

[0007] In prior art sheet material handling systems, the sheet material or signatures is typically fed to the hopper from which the sheet material is with drawn by the drum conveyor by means of belt conveyor system, often referred to as a “hopper loader.” For example, the 750 hopper loader provided by Prim Hall Enterprises of Plattsburgh, N.Y. In the prior art, hopper loaders typically include a loading station where sheet material or signatures are introduced to the hopper loader for transfer by the hopper loader to the hopper. During loading, for example, manual loading, the stacks of signatures are typically aligned with each other to minimize misfeeding and ensure proper operation of the hopper loader and drum feeder. This alignment of signatures is typically practiced by agitating or “jogging” a set of signatures within a bin or receptacle to align the signatures along a common surface of the bin. This jogging is typically performed manually during loading. Though prior art loading and jogging mechanisms have been effective in inbreeding signatures to hopper loaders, there exists a need in the art to improve the efficiency of loading and jogging, for example, to remove the human operator from the jogging process and improving the alignment of the signatures being transferred by the hopper loader. Aspects of the present invention provide improved signature loading and jogging devices.

[0008] Signature feeding by a hopper loader is typically characterized by the feeding and discharging of overlapping material in the form of a “shingle” in which each signature is conveyed with adjacent signatures with their leading edges displaced a relatively uniform amount. These over-lapping, shingle-fed signatures are typically accumulated and aligned, for example, against a “backguide,” for example, the backguide disclosed in U.S. Pat. No. 7,014,184 (the disclosure of which is incorporated by reference herein), prior to being withdrawn from the hopper by the disk feeder and drum feeder. Though the hopper loader feeder has proven to be an effective means of introducing sheet material or signatures to
hoppers, any improvement in the feeding efficiency and alignment of signatures in the hopper would be welcome in the art. Aspects of the present invention provide such an improvement.

SUMMARY OF THE INVENTION

[0009] The present invention provides various systems and methods for handling stacked sheet material; for example, for introducing sheet material, such as, signatures, to drum feeder and a collating conveyor. One aspect of the invention is a method for transferring stacked sheet material to an individual sheet material conveyor, the method including positioning a stack of sheet material in a first position, the first position having a first surface at a first elevation; gripping the stack of sheet material in the first position with a translatable gripping device; transferring the gripping device and gripped stack of sheet material from the first position to a second position laterally disposed from the first position, the second position having a second surface at a second elevation, lower than the first elevation; and introducing individual sheet material from the stack of sheet material to the individual sheet material conveyor. In one aspect, gripping the stack of sheet material comprises compressing the stack of sheeting material between two opposing surfaces, for example, by means of a hydraulic or pneumatic cylinder.

[0010] Another aspect of the invention is a system for transferring stacked sheet material to an individual sheet material conveyor, the system including a first position having a first surface at a first elevation adapted to receive a stack of sheet material; a second position laterally disposed from the first position and having a second surface at a second elevation, the second position located to introduce individual sheet material to the individual sheet material conveyor; a transfer device including means for grasping the stack of sheet material in the first position; and means for transferring the stack of sheet material from the first position to the second position whereby the individual sheets in the stack of sheet material can be introduced to the individual sheet material conveyor. In one aspect, the means for grasping the stack of sheet material comprises two opposing surfaces adapted to engage the stack of sheet material; for example, the system may include at least one fluid cylinder assembly adapted to translate at least one of the two opposing surfaces.

[0011] Another aspect of the invention is a system for transferring individual sheet material to a rotatable drum conveyor, the drum conveyor having a rotatable disk feeder, the system including a conveyor adapted to transfer stacked sheet material to a first position having a first surface at a first elevation; a transfer device including two opposing surfaces adapted to engage the stack of sheet material in the first position; means for translating at least one of the two opposing surfaces whereby the stack of sheet material is grasped by the two opposing surfaces; and a translatable assembly supporting the two opposing surfaces; and means for transferring the transfer device whereby the stack of sheet material is transferred from the first position to a second position laterally disposed from the first position wherein the individual sheets in the stack of sheet material can be introduced to the drum conveyor by the disk feeder. In one aspect, the second position may be at a second elevation lower than the first elevation. In another aspect, the transfer device may be adapted to lower the stack of sheet material onto the second position.

[0012] A further aspect of the invention is a system for handling sheet material including a receptacle adapted to receive a plurality of pieces of sheet material, the receptacle pivotally mounted above a conveyor; an agitating device mounted to the receptacle, the agitating device adapted to agitate the receptacle whereby at least some of the pieces of sheet material become aligned along an inside surface of the receptacle; and means for pivoting the receptacle from a first position where the pieces of sheet material can be received to a second position where the pieces of sheet material can be displaced from the receptacle by the conveyor. In one aspect, the means for pivoting the receptacle comprises at least one fluid driven cylinder having a first end mounted to a rigid support and a second end mounted to the receptacle. In another aspect, the conveyor comprises a plurality of translating guides adapted to contact and transfer the pieces of sheet material, and wherein the receptacle comprises at least one slot adapted to receive the plurality of translating guides. In one aspect, the system includes at least two agitating devices, for example, one driven electrically and one driven by a fluid.

[0013] A still further aspect of the invention is a method for handling sheet material including introducing a plurality of pieces of sheet material to a receptacle, the receptacle pivotally mounted above a conveyor; agitating the receptacle whereby at least some of the pieces of sheet material become aligned along an inside surface of the receptacle; and pivoting the receptacle from a first position where the pieces of sheet material can be introduced, to a second position, where the pieces of sheet material can be removed from the receptacle by the conveyor. In one aspect, pivoting the receptacle comprises actuating at least one fluid driven cylinder having a first end mounted to a rigid support and a second end mounted to the receptacle. In another aspect, the the conveyor comprises a plurality of translating guides adapted to contact and translate the pieces of sheet material, and wherein the method further comprises removing the pieces of material from the receptacle by contacting the pieces of material with the translating guides.

[0014] An even further aspect of the invention is a hopper loader system adapted to load individual sheet material to a rotatable drum conveyor, the drum conveyor having a rotatable disk feeder, the system including a pivotsaly mounted receptacle adapted to receive a stack of sheet material; an agitating device mounted to the receptacle, the agitating device adapted to agitate the receptacle whereby at least some of the pieces of sheet material in the stack of sheet material become aligned along an inside surface of the receptacle; means for pivoting the receptacle from a first position where the stack of sheet material can be received to a second position where the stack of sheet material can be displaced from the receptacle; a conveyor adapted to displace the stack of sheet material from the receptacle and transfer the stack of sheet material to a third position; and a transfer device adapted to transfer the stack of sheet material from the third position to a fourth position laterally disposed from the first position wherein the pieces of the stack of sheet material can be introduced to the drum conveyor by the disk feeder.

[0015] And finally, a further aspect of the invention is a method of introducing sheet material to a disk feeder, the method including introducing a stack of pieces of sheet material to a pivotsaly mounted receptacle; agitating the receptacle whereby at least some of the pieces of sheet material in the stack of sheet material become aligned along an inside surface of the receptacle; pivoting the receptacle from a first position, where the stack of sheet material can be introduced,
to a second position, where the stack of sheet material can be removed from the receptacle; transferring the stack of sheet material from the receptacle to a third position; gripping the stack of sheet material in the third position with a translatable gripping device; transferring the gripping device and gripped stack of sheet material from the first position to a second position laterally disposed from the first position, the second position; and introducing individual sheet material from the stack of sheet material to the disk feeder.

These and other aspects, features, and advantages of this invention will become apparent from the following detailed description of the various aspects of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other objects, features, and advantages of the invention will be readily understood from the following detailed description of aspects of the invention taken in conjunction with the accompanying drawings in which:

[0018] FIG. 1 is a perspective view of a stacked sheet material handling system according to one aspect of the invention.

[0019] FIG. 2 is a detailed perspective view of a sheet material transfer system used in the handling system shown in FIG. 1 according to one aspect of the invention.

[0020] FIG. 3 is a front elevation view of the sheet material transfer system shown in FIG. 2.

[0021] FIG. 4 is a top plan view of the sheet material transfer system shown in FIG. 2.

[0022] FIGS. 5A through 5K are schematic front elevation views of the transfer system shown in FIG. 2 illustrating sequential operation according to an aspect of the invention.

[0023] FIG. 6 is a front perspective view of a sheet material loading and jogging system that may be used in the handling system shown in FIG. 1 according to one aspect of the invention.

[0024] FIG. 7 is a front elevation view of the sheet material loading and jogging system shown in FIG. 6.

[0025] FIG. 8 is a top plan view of the sheet material loading and jogging system shown in FIG. 6.

[0026] FIG. 9 is a rear perspective view of the sheet material loading and jogging system shown in FIG. 6.

DETAILED DESCRIPTION OF THE INVENTION

[0027] FIG. 1 is a perspective view of a stacked sheet material handling system, or hopper loader system, 10, according to one aspect of the invention. Handling system 10 is adapted to feed stacks 26 of sheet material 24 to a sheet material conveying system, for example, to hopper associated with a conveying system having a disk feeder and a drum conveyor (not shown), for example, a drum feeder and conveyor similar to those disclosed in U.S. Pat. No. 6,623,000, the disclosure of which is included by reference herein. Handling system 10 may include at least three subsystems: a sheet material loading and jogging system 12, a sheet material conveying system 14, and a sheet material transfer system 16. As shown in FIG. 1, systems 12, 14, and 16 may be mounted to a common support structure 18, for example, a portable structure having a support frame 20, made from conventional structural elements and mechanical fasteners, which may have a plurality of wheels or casters 22.

[0028] Sheet material loading and jogging system 12 may be any loading and jogging system adapted to receive stacks 26 of sheet material 24, jog or otherwise vibrate or agitate sheet material 24 to align at least some of the sheet material 24, and transfer sheet material 24 to conveying system 14. Sheet material 24 may include, but is not limited to, individual sheets, signatures, newspapers, magazines, books, booklets, brochures, inserts, or onserts, among other types of sheet material. As shown in FIG. 1, according one aspect, sheet material loading and jogging system 12 may include a plurality of jogging or agitation and articulating bins 25 adapted to receive stacks or reams 26 of sheet material 24, jog sheet material 24, and transfer stacks 26 to conveying system 14. Bins 25 may be adapted to be positioned in a somewhat upright position as shown, for example, for receiving stacks 26 of sheet material 24, and then bins 25 may be adapted to rotate to position the stacks 26 so that stacks 26 can be transferred to conveying system 14. Stacks 26 of sheet material 24 may be mounted in bins 25 either manually by an operator or automatically, for example, by means of a stack handler or conveyor, for instance, an automated robotic arm-type stack handler (not shown). Loading and jogging system 12 may typically include at least one, but typically, two, protective panels 27 that protect human operators from contacting the moving components of systems 12 and 14. Panels 27 may be opaque or transparent, and typically are made from transparent plastic, such as, a polycarbonate or its equivalent.

[0029] Loading and jogging system 12 typically introduces stacks 26 to conveying system 14 having a conveyor 29 (discussed below) having a plurality of translating guides 30 that transfer the stacks 26 of sheet material 24 to transfer system 16. Details of one transfer system 16 according to one aspect of the invention are illustrated and described below with respect to FIGS. 2 through 5K. Details of one loading and jogging system 12 according to one aspect of the invention are illustrated and described below with respect to FIGS. 6-9.

[0030] Sheet material transfer system 14 may be any system adapted to receive stacks 26 of sheet material 24 from jogging system 12 and transfer stacks 26 to sheet material handling system 16. As shown in FIG. 1, transfer system 14 may comprise an inclined ramp assembly 34 and a conveyor 29 having guides 30 (See FIGS. 5A-5K) adapted to transfer stacks 26 along ramp assembly 34.

[0031] FIG. 2 is a detailed perspective view of the stacked sheet material transfer system 16 used, for example, in the handling system 10 shown in FIG. 1. FIG. 3 is a front elevation view of the system 16; FIG. 4 is a top plan view of system 16. As shown in FIG. 2, handling system 16 is adapted to receive stacks 26 of sheet material 24, for example, from conveying system 14, in a first position 36 and transfer the stack 26 to a second position 38, laterally disposed from the first position 36, whereby the individual sheets 24 may be received and transferred by, for example, a sheet material conveying system, such as, a disk and drum conveyor (not shown). First position 36 may be located at a first elevation and second position 38 may be located at a second elevation, for example, different from the first elevation, for instance, at a lower elevation, as shown in FIG. 3. First position 36 may comprise a surface or plate 37 upon which stack 26 is positioned, for example, by conveying system 14. Second position 38 may comprise a surface or plate 39 upon which stack 26 is positioned, for example, by a transfer device 40, as discussed below. One or more guide surfaces or barriers 43 and 53 may be provided for first position 36 and second
position 38. For example, system 16 may include one or more side guide plates, guide bars, or barriers 43 to assist in guiding stack 26 while it is being transferred, and second position 38 may include one or more guide plates, guide bars, or barriers 53 against which stacks 26 may impinge when the stacks 26 are placed in second position 38.

[0032] Transfer system 16 includes a sheet material transfer device 40. Transfer device 40 includes a means for grasping stack 26 in first position 36 and a means for transferring stack 26 from first position 36 to second position 38 whereby the individual sheets 24 in stack 26 may be introduced to an individual sheet material conveyor, for example, to a drum conveyor (not shown). In FIGS. 2-5K, transfer device 40 is illustrated in two different locations for illustration only; however, typically only a single transfer device 40 is provided with system 16. (Though in one aspect, two or more transfer devices 40 may act in tandem to transfer stacks 26.) In the first, right-hand location (as viewed in FIGS. 2-4), transfer device 40 is illustrated and positioned to engage a stack 26 in first position 36. In the second, left-hand location, transfer device 40 is illustrated and positioned after depositing a stack 26 in second position 38. Though shown as two different assemblies, the two illustrated transfer devices 40 represent the same assembly having the same components and functions.

[0033] As shown in FIGS. 2 through 5K, transfer device 40 is adapted to grasp or engage stack 26 in position 36 and transfer stack 26 to second position 38. Preferably, when transferring stack 26, the misalignment or loss of individual sheets 24 in stack 26 is minimized or prevented. Transfer device 40 may include at least two opposing surfaces, a first surface 42 and a second surface 44, adapted to engage stack 26 of sheet material 24. Surface 37 of first position 36 may include an opening or gap 41 that permits transfer device 40 to access and engage both surfaces of stack 26.

[0034] In one aspect, at least one of the opposing surfaces 42, 44 is translatable, that is, translatable in the direction toward the opposing surface whereby stack 26 can be grasped between opposing surfaces 42, 44. Though the translation of at least one surface 42, 44, may be effected by many different means, according to one aspect of the invention, at least one of surfaces 42, 44 is translatable by means of at least one fluid cylinder, for example, a pneumatic or hydraulic cylinder.

[0035] As shown in FIGS. 2-5K, transfer device 40 may include two sets of fluid cylinders. A first set of fluid cylinders 45 and 46 is mounted in a cylinder block 47 and adapted to translate a block 48 and a plate 49 having first surface 42 via rods 50 and 51, and a second set of fluid cylinders 55 and 56 mounted in a cylinder block 57 adapted to translate a block 58 and a plate 59 having second surface 44 via rods 60 and 61. Fluid cylinders 45, 46, 55, and 56 are fed by fluid hoses 62, 63, 64, and 65, respectively, for example, hydraulic or pneumatic hoses. As shown in FIGS. 2-5K, cylinder blocks 47 and 48 may be mounted to the cylinder block 47 and 48 may comprise a single cylinder block and have a plurality of cylinders.

[0036] According to aspects of the invention, at least one of first surface 42 and second surface 44 are translatable whereby stack 26 grasped there between may be transferred from first position 36 to second position 38. In one aspect, cylinder blocks 47 and 57 may be translatable. In another aspect, as shown in FIGS. 2-4, cylinder blocks 47 and 57 may be mounted to a translatable support structure 66. Support structure 66 may be translatable by any conventional means, for example, pneumatically, hydraulically, or mechanically, among others means. As shown in FIGS. 2, 3, and 4, support structure 66 may be mounted to a conveyor system 68 adapted to transport support structure 66 and its associated parts from first position 36 to second position 38 and then return. In the aspect shown in FIGS. 2, 3, and 4, conveyor system 68 may be a belt conveyor system having translatable cart 69 mounted to a belt 70, a driven sheave 72, and an idler sheave 74. Belt 70 may be a toothed belt having teeth that engage complementary toothed sheaves 72 and 74. Sheaves 72 and 74 may be mounted to an appropriate structure, such as a channel 75 or like structural element, and may include appropriate antifric tion bearings, such as roller or journal bearings. Driven sheave 72 may be driven by a conventional electric motor 97 and gear reducer 99 (see FIG. 4), as is conventional. In another aspect, conveyor system 68 may be a chain conveyor having a roller chain and sprockets corresponding to belt 70 and sheaves 72 and 74, respectively. Channel 75 may typically be mounted to support structure 20, as shown in FIGS. 3 and 4, for example, by means of a plurality of rods or bars 87 and 88 and collars 89. Collars 89 may be adjustable collar clamps that may be used to adjust the mechanical alignment, for example, of rods or bars 87 and 88. In one aspect, channel 75 may be adjustably mounted to support structure 20 whereby collars 89 may permit rods 87 and 88 to telescope within collars 89.

[0037] As shown in FIGS. 2-4, support structure 66 of transfer device 40 may comprise a support gusset 76 to which cylinder blocks 47 and 57 are mounted, for example, by mechanical fasteners, and a main plate 78. Support gusset 76 may be mounted to main plate 78, for example, by mechanical fasteners. Main plate 78 may also include a plurality of wheels or rollers 80 and 82 adapted to support cart 66 during translation by conveyor system 68. As shown in FIG. 3, main plate 78 may include two sets of upper wheels 80 and lower wheels 82. Wheels 80 and 82 may be positioned to engage an appropriate support structure permitting translation of main plate 78 and providing appropriate support for main plate 78, for example, wheels 80 and 82 may engage the opposite surfaces of channel 75, or like structural element. Channel 75 may include one or more guide rails 77 and 79 mounted to the top and bottom of channel 75, respectively, to provide a channel 75 and may be translatable against which wheels 80 and 82 may bear during translation of translatable cart 66. Rails 77 and 79 may be mounted to channel 75 by conventional means, for example, a plurality of mechanical fasteners as shown.

[0038] Handling system 16 may include one or more guide plates or bars 84 positioned to guide stacks 26, for example, from above, as stacks 26 are introduced to system 16 and as stacks 26 are translated from first position 36 to second position 38. As shown in FIGS. 2, 3, and 4, the ski-shaped guide bars 84 may comprise a sheet metal or plastic strip mounted above the path of travel of stacks 26 and extend from first position 36 to second position 38. Guide bars 84 may be mounted to rods 85 by means of collars 95. Collars 95 may be adjustable collar clamps, for example, for adjusting the position of bars 84. Rods 85 may be mounted to support frame 20, for example, by means of mechanical fasteners.

[0039] As shown in FIGS. 2, 3, and 4, system 16 may include a support 100 for hoses 62, 63, 64, and 65. Support 100 may include a support arm 102, to which hoses 62-65 may be mounted, which is adjustably mounted to a support post 104 mounted to channel 75, for example, by mechanical
fasteners. The pivotal mounting of arm 102 to post 104 allows hoses 62-65 to deflect with the movement back and forth of translatable cart 66, without causing damage to or interference from hoses 62-65. Hoses 62-65 are typically in fluid communication with a pressurized fluid supply (not shown), for example, a compressor or hydraulic pump.

Handling system 16 may include sensors, actuators, and motors to effectively control the operation of handling system 16. The sensors, motors, and actuators may be monitored and controlled by a central processing unit (not shown) or distributed processing units (not shown). In one aspect, handling system 16 may include at least one, but typically, a plurality of optical detectors or “photo-eyes.” Among other things, these optical detectors may be located to sense the presence or absence of stacks 26 as stacks 26 are introduced to first position 36, transferred, and introduced to second position 38. For example, as shown in FIG. 3, system 16 may include an optical detector 90 positioned to detect the presence or absence of a stack 26 in first position 36 and an optical detector 92 positioned to detect the presence or absence of a stack 26 in second position 38. Detectors 90 and 92 may be thru-beam, retro-reflective, or diffuse photo-detectors or their equivalent.

FIGS. 5A through 5K are schematic front elevation views of system 16 shown in FIGS. 2, 3, and 4 illustrating the sequential operation of system 16 according to an aspect of the invention. FIGS. 5A-5K include representative schematic illustrations of transfer system 14 having a conveyor 29 having guides 30 mounted for translation on conveyor 29 to convey stacks 26 to first position 36 of handling system 16. FIGS. 5A-5K also illustrate guide bars 84, transfer device 40 having opposing surfaces 42 and 44, and second position 38 having support plate 39 and guide bars 43 and 53. A representive stack 26 of sheet material 24 is shown located in second position 38. Photo-detectors 90 and 92 are also illustrated in FIGS. 5A-5K.

FIG. 5A illustrates a representative stack 26 of sheet material 24 mounted on transfer system 14 and a representative stack 26 positioned in first position 36 of system 16. Guide bars 84 retain or hold down the individual sheets 24 of stack 26. One or more photoelectric sensors 90 may be used to detect the presence or absence of stack 26 in first position 36 as shown in FIG. 5A. In the first step of this sequence, transfer device 40 is positioned adjacent to stack 26 in first position 36 whereby opposing surfaces 42 and 44 straddle stack 26. FIG. 5B illustrates the engagement of surfaces 42 and 44 with stack 26, for example, under the influence of cylinders 47 and 57 of transfer device 40.

As shown in FIG. 5C, stack 26 is transferred by transfer device 40 from first position 36 as indicated by arrow 106. As stack 26 is transferred from first position 36, the next stack 26 is transferred by conveyor 29 to first position 36 as indicated by rotational arrow 108 and translation arrow 110. In FIG. 5D, transfer device 40 draws stack 26 into second position 38 while conveyor 29 introduces the next stack 26 to first position 36. As shown, one or more photoelectric sensors 92 may be used to detect the presence or absence of stack 26 in second position 38, for example, by detecting the height of the assembled stacks 24 in second position 38.

In FIG. 5E, stack 26 is positioned over second position 38 whereby the trailing edge of stack 26 passes bar 43 and falls into second position 38. FIG. 5F illustrates transfer device 40 lowering the leading edge of stack 26 into second position 38 to complete the transfer of stack 26 to second position 38, as indicated by arrow 112. As also shown in FIG. 5F, at approximately the same time that transfer device 40 lowers stack 26, photo-detector 90 may detect that the next stack 26 is positioned in first position 36 and awaits transfer by transfer device 40. In addition, conveyor 29 may stop to prevent further stacks 26 from being introduced to first position 36.

As shown in FIG. 5G, after stack 26 is lowered into second position 38 by transfer device 40, transfer device 40 disengages stack 26 by separating opposing surfaces 42, 44, and translating out of engagement with stack 26, as indicated by arrow 114. Then, as shown in FIGS. 5H and 5I, transfer device 40 raises above the recently placed stack 26, as indicated by arrow 116, typically, while also closing the gap between surfaces 42 and 43, and then translates back toward first position 36 as indicated by arrow 118. As shown in FIG. 5J, the opposing surfaces 42, 44 of transfer device 40 are separated in preparation for engaging the next stack 26 and, as shown in FIG. 5K, the opposing surfaces 42, 44 are positioned to engage stack 24, as indicated by arrow 120, and then engage stack 24. After engagement, the sequence returns to the steps illustrated in FIG. 5A and repeats, for example, substantially continuously or intermittently.

FIG. 6 is a front perspective view of a sheet material loading and jogging system 12 that may be used in the handling system 10 shown in FIG. 1 according to another aspect of the invention. FIG. 7 is a front elevation view, FIG. 8 is a top plan view, and FIG. 9 is a rear perspective view of the sheet material jogging system 12 shown in FIG. 6. Though in FIG. 1 loading and jogging system 12 includes at least one protective panel 27, in FIGS. 6-9, at least one of the protective panels 27 is removed to better illustrate aspects of the invention.

As shown in FIGS. 6-9, loading and jogging system 12 comprises a system for handling sheet material that includes at least one receptacle 25 adapted to receive a plurality of pieces of sheet material 24 as a stack 26 of sheet material. As discussed above, the sheet material 24 in stack 26 may comprise individual sheets, signatures, newspapers, magazines, books, booklets, brochures, inserts, or onserts, among other types of sheet material. As shown, receptacles 25 typically comprise a rectangular receptacle, for example, a receptacle sized to receive the stacks 26 of sheet material 24. Receptacles 25 include an open top 133 for receiving stacks 26 and a substantially closed bottom 135, a front 137, a back 139, and sides 141. Receptacle 25 is typically pivotally mounted above a conveyor 29, for example, the same conveyor 29 discussed above. As shown most clearly in FIGS. 6 and 7, receptacle 25 may be mounted to a plurality of, typically, at least two, bars 125. Bars 125 may be pivotally mounted at a distal end to a rigid structure, for example, mounted to a shaft 126 that is operatively mounted to rigid structure, for example, to the housing of conveyor 29. One or more reinforcing bars 124 may be mounted between bars 125 to provide stiffness or structural integrity. Shaft 126 may be pivotally mounted to bars 127, for example, by means of journal bearings 129. Bars 127 may be mounted to conveyor 29, for example, by means of rods 131 and mechanical fasteners.

As shown most clearly in FIGS. 7 and 8, conveyor 29 may be a conventional chain driven conveyor having a chain 130 (shown in phantom in FIG. 7) driven by a driven sprocket 132 and a drive motor (not shown). Chain 130 may typically include a plurality of pusher plates 134 adapted to be
translated by chain 130, to contact stacks 26, and convey stacks 26. In one aspect, pusher plates 134 may be profiled, that is, provided with a specific shape or geometry, to provide little or no interference with the placement and conveying of stacks 26. As shown, jogging and loading system 10 may also include safety features, for example, a one or more protective plates or barriers 147, to prevent an operator from access to a pinch point between pusher plates 134 and receptacle 25. In addition, one or more detectors, for example, photo-eyes, may be provided to prevent bodily harm, for example, a photo-eye 151 having beam 153 positioned before barrier 147 to detect the presence of an operator or an obstruction. The control system (discussed below) may be adapted to shut down hopper loader 10, or at least loading and jogging device 12 should beam 153 be broken.

As shown, conveyor 29 may be oriented at an angle Θ to the horizontal, for example, whereby conveyor 29 transfers stacks 26 from a lower elevation, for example, where the stacks 26 are loaded, to an upper elevation, where stacks 26 are discharged from conveyor 29, for example, to transfer system 14 shown in FIGS. 2-5K. The angle Θ may range form about 1 to about 10 degrees. In one aspect, conveyor 29 may be substantially horizontal, that is, angle Θ may be substantially zero.

According to aspects of the invention, receptacles 25 include an agitating device 136 mounted to each receptacle 25. Agitating device 136 is adapted to agitate receptacle 25 wherein at least some of pieces of sheet material 24 are agitated whereby they become aligned along an inside surface of receptacle 25, for example, alignment along an inside lateral surface of one of sides 141 of receptacle 25. Though many types of agitating devices may be provided, in the aspect shown in FIGS. 6-8, agitating device 136 may, for example, include an electric motor 138, which drives a shaft 140 having an eccentric weight. Electric motor 138 may be an AC or DC motor provided by Electric Speed Controls, having a horsepower rating of between about 1/2 to about 1/5 Hp, or its equivalent. As shown in FIGS. 6-9, shaft 140 may extend beneath protective a cover 144, for example, to shield an operator from the rotating components in agitating device 136. Cover 144 may be removably mounted, for example, by means of mechanical fasteners 146.

In FIG. 8, cover 144 is at least partially removed to display the components of agitating device 136. As shown, motor 138 via shaft 140 may rotate an eccentric rotor 142 via a coupling 143 and a bearing 148, for example, a pillow-block rolling bearing. The rotation of eccentric rotor 142 causes agitating device 136 to agitate receptacle 25 whereby at least some of pieces of sheet material 24 become aligned along an inside surface of receptacle 25. Since receptacle 25 is typically exposed to repeated agitation, receptacle 25 may be mounted to bars 125 by vibration damping devices, for example, one or more elastomeric vibration isolators 149.

Loading and jogging system 12 also includes means 150 for pivoting receptacle 25 from a first position (indicated by arrow 152 in FIGS. 6-9), for example, a somewhat elevated vertical position, where the stacks 26 of sheet material 24 can be received, to a second position (indicated by arrow 154) where the stacks 26 of sheet material 24 can be removed from receptacle 25 by conveyor 29. The means for pivoting 150 may comprise any conventional mechanism, for example, a mechanism employing one or more motive devices, cams, linkages, bearings, and the like. However, as shown most clearly in FIG. 9, means for pivoting 150 may typically comprise one or more fluid driven cylinders 156, for example, a hydraulic or pneumatic cylinder. Cylinders 156 may typically have a first end 158 mounted to a rigid support and a second end 160 operatively mounted to receptacle 25. As shown in FIG. 9, first end 158 of cylinders 156 may be pivotally mounted to vertical bar 127 be means of bracket 164 and mounting block 166. Vertical bar 127 may be mounted to conveyor 29, for example, by means of rods 131 and mechanical fasteners. Second end 160 of cylinders 156 may be pivotally mounted to a lever arm 167 that is operatively connected to receptacle 25, for example, second end 160 may include a conventional tie-rod end 168 that is pivotally mounted to lever arm 167. As shown, lever arm 167 may be mounted to shaft 126, to which receptacle 25 is operatively mounted, whereby deflection of lever arm 167 deflects receptacle 25. Cylinders 156 typically include at least two ports 171, 172 for introducing a fluid, for example, a gas or a liquid, to cylinders 156 to effect the desired deflection of second end 160 of cylinder 156.

As discussed above, chain 130 may typically include a plurality of translating guides or pusher plates 134 adapted to be translated by chain 130, to contact stacks 26, and convey stacks 26 along conveyor 29. In one aspect, receptacles 25 may include at least one slot 170 adapted to receive the plurality of translating guides 134. When the receptacles 25 are in second position 154, translating guides 134 are adapted to contact and transfer stacks 26 pass through slots 170, and avoid contact with receptacle 25. In this aspect, the translating guides 134 driven by chain 130 displace or remove the stacks 26 of sheet material 24 from receptacle 25 and translate the stacks 26 along conveyor 29, for example, along the surface 178 of conveyor 29.

As shown in FIG. 9, loading and jogging system 12 may also include a second agitating or jogging means 180 mounted to receptacle 25. According to one aspect, jogging means 180 may be provided to agitate or jog receptacle 25 to provide some alignment of sheets 24 in stacks 26, for example, when receptacle 25 is in the first position 152 or the second position 154. In one aspect, jogging mechanism 180 agitates receptacle 25 when receptacle 25 is raised into second position 152 prior to lowering into second position 154. Second jogging means 180 may comprise any conventional mechanism, for example, employing one or more motive devices, cans, linkages, bearings, and the like. However, as shown most clearly in FIG. 9, second jogging means 180 may typically comprise one or more fluid driven cylinders 182, for example, a hydraulic or pneumatic cylinder, having a tie rod 183. Cylinders 182 may typically have a first free end 184 and a second end 186 operatively mounted to lever arm 167. For example, second end 186 may be mounted to lever arm 167 by means of plate 188 and mounting block 190, and appropriate mechanical fasteners. Tie rod 183 may typically be pivotally mounted to receptacle 25 by means of mounting block 194 which may be mounted to receptacle 25. Cylinders 182 typically include at least two ports 196, 197 for introducing a fluid, for example, a gas or a liquid, to cylinders 182 to effect the desired agitation or jogging of receptacle 25.

According to aspects of the present invention, hopper loader 10 shown in FIG. 1 includes a loading and jogging device 12 having at least one bin or receptacle 25 having means 150 for pivoting receptacle 25 and two jogging devices 136 and 180; a conveying system 14 having a conveyor 29; and a transfer system 16 having a transfer device 40 adapted to position stacks 26 of sheet material 24 in a hopper associ-
ated with a feeding device (not shown), for example, disc and drum feeder. According to aspects of the invention, hopper loader 10 may generally operate as follows. Stacks 26 of sheet material 24 are loaded, for example, manually or automatically, into receptacles 25 while receptacles 25 are positioned by means 150 to a elevated position 152. Prior to, during, or after one or more stacks 26 are introduced to receptacle 25, receptacle 25 is agitated by jogging device 136 to provide at least some alignment to sheet material 24 in receptacle 25. In one aspect, receptacle 25 may be further agitated by jogging device 180.

[0056] Prior to, during, or after the loading of a stack 26 in to receptacle 25, conveyor 29 having conveying belt 130 and pusher plates 30, 134 may be energized wherein conveyor 29 and pusher plates 30, 134 begin moving. During or after agitation of receptacle 25 by at least one of jogging devices 136 and 180, means 150 for pivoting receptacle 25 lowers receptacle 25 onto conveyor 29 where pusher plates 30, 134 contact stack 26 and displace stack 26 from receptacle 25. Pusher plates 30, 134 pass through slots 170 in receptacle 25 while displacing stack 26. According to one aspect of the invention, when a plurality of receptacles 25 are provided, the positioning of receptacles 25 by means 150 may typically be timed to prevent stacks 26 from contact other receptacles 25 when stacks 26 are being transferred by conveyor 29. After stack 26 has been displaced from receptacle 25, for example, as determined by a sensor; for instance, a photo-eye, the means 150 for pivoting receptacle 25 may elevate receptacle 25 into position 152 to await further loading of a stack 26 and the process is repeated.

[0057] As shown most clearly in FIG. 1, stack 26 is then transferred by conveying system 14 and conveyor 29 to transfer system 16. As illustrated and described with respect to FIGS. 5A-5K, earlier, stacks 26 are received by conveyor system 14 in position 36 and transferred to position 38 by transfer device 40. The location of position 38 is such that a disc separator (not shown) may contact individual pieces of sheet material 24 whereby the material 24 may be grasped by a drum feeder (also not shown).

[0058] The operation and timing of the individual components of hopper loader 10 may be controlled, monitored, and regulated by a conventional control system (not shown). For example, a control system may be provided to monitor and detect the presence of stacks 26 in a plurality of locations in hopper loader 10. The control system may include numerous sensors, for example, speed sensors, position sensors, load sensors, and the like, to assist in monitoring and controlling the operation of hopper loader 10. The control system may typically include a user interface, for example, a touch screen, and means for outputting operation or performance data, for example, a video screen or a printer. In one aspect, the control system may include numerous alarms, such as, lights, sirens, or bells, to advise the operator of unsafe or off-spec conditions.

[0059] It will be apparent to those in the art that aspects of the invention provide an improved hopper loading device having enhanced material handling capability that can minimize or prevent misfeeds and interruptions in process throughput. Aspects of the invention provide automated jogging and loading systems that can minimize or prevent the mishandling of sheet material as it is introduced to the hopper loader, and a material transfer system that minimizes or prevents mishandling of sheet material as it is introduced to the hopper. Thus, aspects of the present invention can provide a marked improvement in prior art methods of handling sheet material that can dramatically improve the throughput and efficiency of sheet material handling systems such as collators and feeders.

[0060] While several aspects of the present invention have been described and depicted herein, alternative aspects may be effected by those skilled in the art to accomplish the same objectives. Accordingly, it is intended by the appended claims to cover all such alternative aspects as fall within the true spirit and scope of the invention.

1. A method for transferring stacked sheet material to an individual sheet material conveyor, the method comprising: positioning a stack of sheet material in a first position, the first position having a first surface at a first elevation; gripping the stack of sheet material in the first position with a translatable gripping device; transferring the gripping device and gripped stack of sheet material from the first position to a second position laterally disposed from the first position, the second position having a second surface at a second elevation, lower than the first elevation; and introducing individual sheet material from the stack of sheet material to the individual sheet material conveyor.

2. The method as recited in claim 1, further comprising conveying the stack of sheet material to the first position.

3. The method as recited in claim 1, wherein gripping the stack of sheet material comprises compressing the stack of sheet material between two opposing surfaces.

4. The method as recited in claim 3, wherein gripping the stack of sheet material further comprises translating at least one of the two opposing surfaces toward the stack of sheet material.

5. The method as recited in claim 1, wherein transferring the gripping device and gripped stack of sheet material comprises transferring the translatable gripping device.

6. The method as recited in claim 1, wherein introducing individual sheet material from the stack of sheet material to the individual sheet material conveyor comprises positioning the stack of sheet material whereby individual sheet material is enganged by a rotatable disk conveyor.

7. The method as recited in claim 1, wherein the individual sheet material conveyor comprises a rotatable drum conveyor.

8. A system for transferring stacked sheet material to an individual sheet material conveyor, the system comprising: a first position having a first surface at a first elevation adapted to receive a stack of sheet material; a second position laterally disposed from the first position and having a second surface at a second elevation, the second position located to introduce individual sheet material to the individual sheet material conveyor; a transfer device comprising: means for grasping the stack of sheet material in the first position; and means for transferring the stack of sheet material from the first position to the second position whereby the individual sheets in the stack of sheet material can be introduced to the individual sheet material conveyor.

9. The system as recited in claim 8, wherein the means for grasping the stack of sheet material comprises two opposing surfaces adapted to engage the stack of sheet material.

10. The system as recited in claim 9, wherein the means for grasping the stack of sheet material further comprises at least one fluid cylinder assembly adapted to translate at least one of the two opposing surfaces.
11. The system as recited in claim 10, wherein the at least one fluid cylinder assembly comprises at least one of a hydraulic cylinder assembly and a pneumatic cylinder assembly.

12. The system as recited in claim 8, wherein the means for transferring the stack of sheet material comprises a translatable support structure adapted to support the means for grasping the stack of sheet material, the translatable support structure comprising a plurality of wheels adapted to engage a wheel rail.

13. The system as recited in claim 12, wherein the means for transferring comprises means for translating the translatable support structure.

14. The system as recited in claim 13, wherein the means for translating the translatable support structure comprises a chain conveyor adapted to engage the support structure.

15. A system for transferring individual sheet material to a rotatable drum conveyor, the drum conveyor having a rotatable disk feeder, the system comprising:
   a conveyor adapted to transfer stacked sheet material to a first position having a first surface at a first elevation; a transfer device comprising:
   two opposing surfaces adapted to engage the stack of sheet material in the first position;
   means for translating at least one of the two opposing surfaces whereby the stack of sheet material is grasped by the two opposing surfaces; and
   a translatable assembly supporting the two opposing surfaces; and
   means for transferring the transfer device whereby the stack of sheet material is transferred from the first position to a second position laterally disposed from the first position wherein the individual sheets in the stack of sheet material can be introduced to the drum conveyor by the disk feeder.

16. The system as recited in claim 15, wherein the second position comprises a second elevation lower than the first elevation.

17. The system as recited in claim 16, wherein the transfer device is adapted to lower the stack of sheet material onto the second position.

18. The system as recited in claim 15, wherein the translatable assembly comprises a plurality of wheels adapted to support the translatable assembly.

19. The system as recited in claim 15, wherein the means for translating at least one of the two opposing surfaces comprises at least one fluid-driven cylinder.

20. The system as recited in claim 15, wherein the means for transferring the transfer device comprises one of a drive belt and a drive chain.

21. A system for handling sheet material comprising:
   a receptacle adapted to receive a plurality of pieces of sheet material, the receptacle pivotally mounted above a conveyor;
   an agitating device mounted to the receptacle, the agitating device adapted to agitate the receptacle whereby at least some of the pieces of sheet material become aligned along an inside surface of the receptacle; and
   means for pivoting the receptacle from a first position where the pieces of sheet material can be received to a second position where the pieces of sheet material can be displaced from the receptacle by the conveyor.

22. The system as recited in claim 21, wherein the means for pivoting the receptacle comprises at least one fluid driven cylinder having a first end mounted to a rigid support and a second end mounted to the receptacle.

23. The system as recited in claim 21, wherein the conveyor comprises a plurality of translating guides adapted to contact and transfer the pieces of sheet material, and wherein the receptacle comprises at least one slot adapted to receive the plurality of translating guides.

24. The system as recited in claim 21, wherein the conveyor comprises a plurality of translating guides adapted to contact and displace the pieces of sheet material, and wherein the second position comprises a position where at least one of the plurality of translating guides contacts and displaces the pieces of sheet material from the receptacle.

25. The system as recited in claim 21, wherein the receptacle comprises a rectangular receptacle having an open top for receiving pieces of sheet material and a closed bottom.

26. The system as recited in claim 25, wherein the system further comprises a plurality of bars mounted to the receptacle, the bars having a distal end pivotally mounted to a rigid structure.

27. The system as recited in claim 25, wherein the inside surface of the receptacle comprises an inside lateral surface of the rectangular receptacle.

28. The system as recited in claim 21, wherein the agitating device comprises an electric motor.

29. The system as recited in claim 21, wherein the system comprises a plurality of receptacles adapted to receive a plurality of pieces of sheet material, each of the plurality of receptacles pivotally mounted above the conveyor.

30. The system as recited in claim 21, wherein the agitating device comprises a first agitating device, and wherein the system further comprises a second agitating device, different from the first agitating device, the second agitating device adapted to agitate the receptacle.

31. A method for handling sheet material comprising:
   introducing a plurality of pieces of sheet material to a receptacle, the receptacle pivotally mounted above a conveyor;
   agitating the receptacle whereby at least some of the pieces of sheet material become aligned along an inside surface of the receptacle; and
   pivoting the receptacle from a first position, where the pieces of sheet material can be introduced, to a second position, where the pieces of sheet material can be removed from the receptacle by the conveyor.

32. The method as recited in claim 31, pivoting the receptacle comprises actuating at least one fluid driven cylinder having a first end mounted to a rigid support and a second end mounted to the receptacle.

33. The method as recited in claim 31, wherein the conveyor comprises a plurality of translating guides adapted to contact and translate the pieces of sheet material, and wherein the method further comprises removing the pieces of material from the receptacle by contacting the pieces of material with the translating guides.

34. The method as recited in claim 31, wherein the receptacle comprises a rectangular receptacle having an open top, and wherein introducing the plurality of pieces of sheet material to the receptacle comprises introducing the plurality of pieces of sheet material to the open top of the rectangular receptacle.

35. The method as recited in claim 34, wherein the rectangular receptacle comprises at least one inside lateral surface, and wherein agitating the receptacle comprises agitating the
rectangular receptacle wherein at least some of the pieces of sheet material become aligned along the inside lateral surface of the rectangular receptacle.

36. The method as recited in claim 31, wherein agitating the receptacle comprises agitating the receptacle with an electric motor mounted to the receptacle.

37. The method as recited in claim 31, wherein introducing the plurality of pieces of sheet material to a receptacle comprises introducing the plurality of pieces of sheet material to a plurality of receptacles, each pivotally mounted above the conveyor;

wherein agitating the receptacle comprises agitating the plurality of receptacles; and

wherein pivoting the receptacle comprises pivoting a plurality of the receptacles from a first position to a second position.

38. The method as recited in claim 31, wherein agitating the receptacle comprises agitating the receptacle with an electric motor mounted to the receptacle, and wherein the method further comprises agitating the receptacle with a fluid-driven cylinder.

39. A hopper loader system adapted to load individual sheet material to a rotatable drum conveyor, the drum conveyor having a rotatable disk feeder, the system comprising:

a pivotally mounted receptacle adapted to receive a stack of sheet material;

an agitating device mounted to the receptacle, the agitating device adapted to agitate the receptacle whereby at least some of the pieces of sheet material in the stack of sheet material become aligned along an inside surface of the receptacle;

means for pivoting the receptacle from a first position where the stack of sheet material can be received to a second position where the stack of sheet material can be displaced from the receptacle;

a conveyor adapted to displace the stack of sheet material from the receptacle and transfer the stack of sheet material to a third position; and

a transfer device adapted to transfer the stack of sheet material from the third position to a fourth position laterally disposed from the first position where the pieces of the stack of sheet material can be introduced to the drum conveyor by the disk feeder.

40. A method of introducing sheet material to a disk feeder, the method comprising:

introducing a stack of pieces of sheet material to a pivotally mounted receptacle;

agitating the receptacle whereby at least some of the pieces of sheet material in the stack of sheet material become aligned along an inside surface of the receptacle;

pivoting the receptacle from a first position, where the stack of sheet material can be introduced, to a second position, where the stack of sheet material can be removed from the receptacle;

transferring the stack of sheet material from the receptacle to a third position;

gripping the stack of sheet material in the third position with a translatable gripping device;

transferring the gripping device and gripped stack of sheet material from the first position to a second position laterally disposed from the first position, the second position; and

introducing individual sheet material from the stack of sheet material to the disk feeder.

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