United States Patent

[11] 3,595,159

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[54] GRAPHIC ARTS FILM PROCESSOR
16 Claims, 6 Drawing Figs.

[52] U.S. Cl. 95/94, 95/89
[51] Int. Cl. G03d 3/04
[50] Field of Search ..... 95/89 M, 89 R, 93, 94

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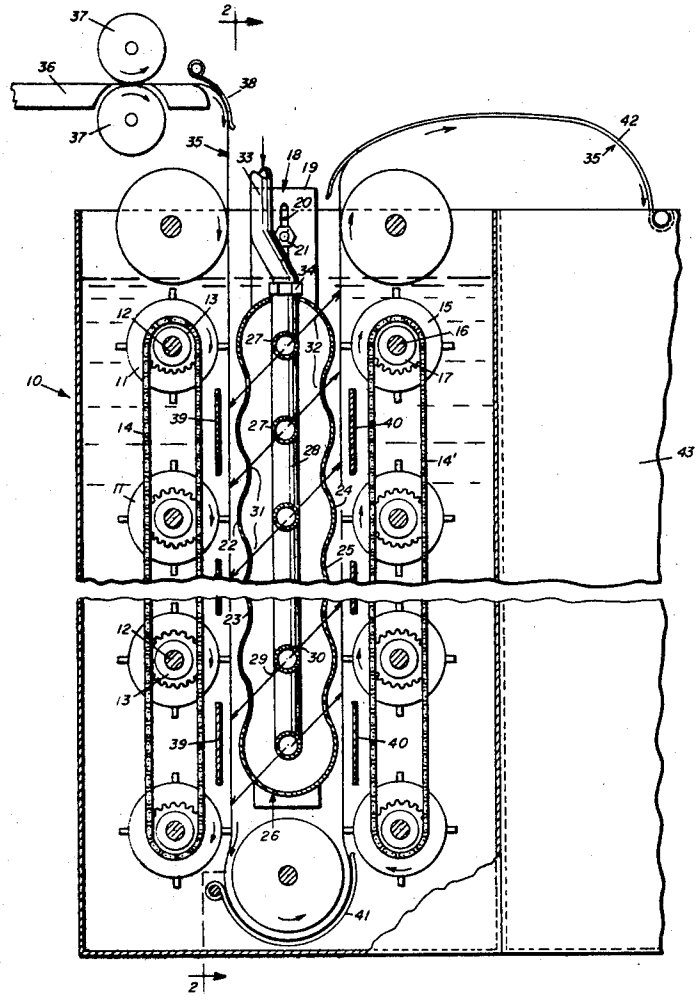
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Assistant Examiner—Fred L. Braun
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ABSTRACT: An apparatus for processing graphic arts sheets including an enclosure for the processing fluid, a fluid circulating system, and a series of rollers within the enclosure. The rollers have ridged portions on their periphery which establish a continuously moving point of contact with the sheet as it is being processed. The fluid circulating system directs streams of processing fluid against both sides of the sheet in the direction of movement of the sheet through the enclosure.



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SHEET 1 OF 3

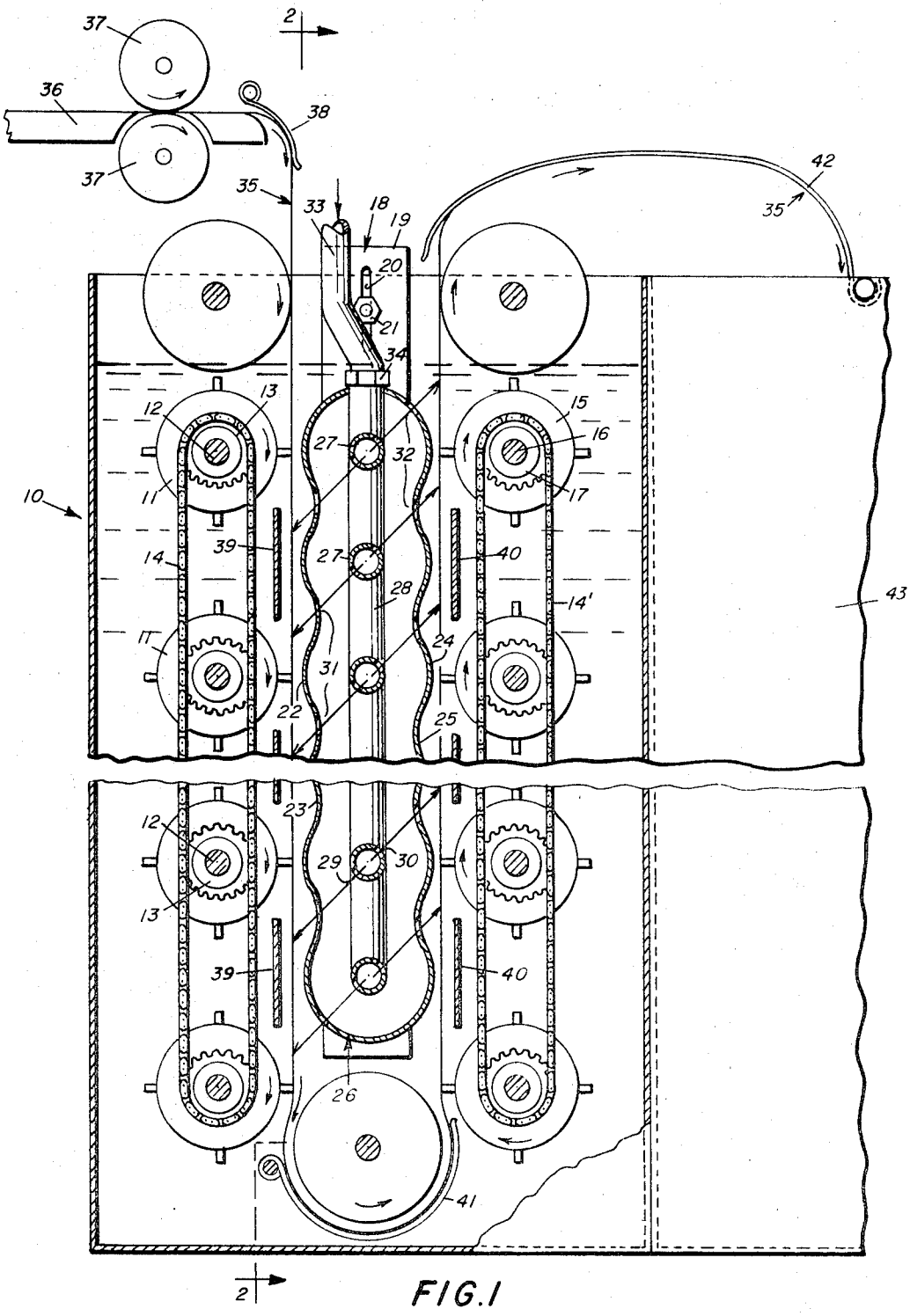


FIG. 1

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FIG. 2

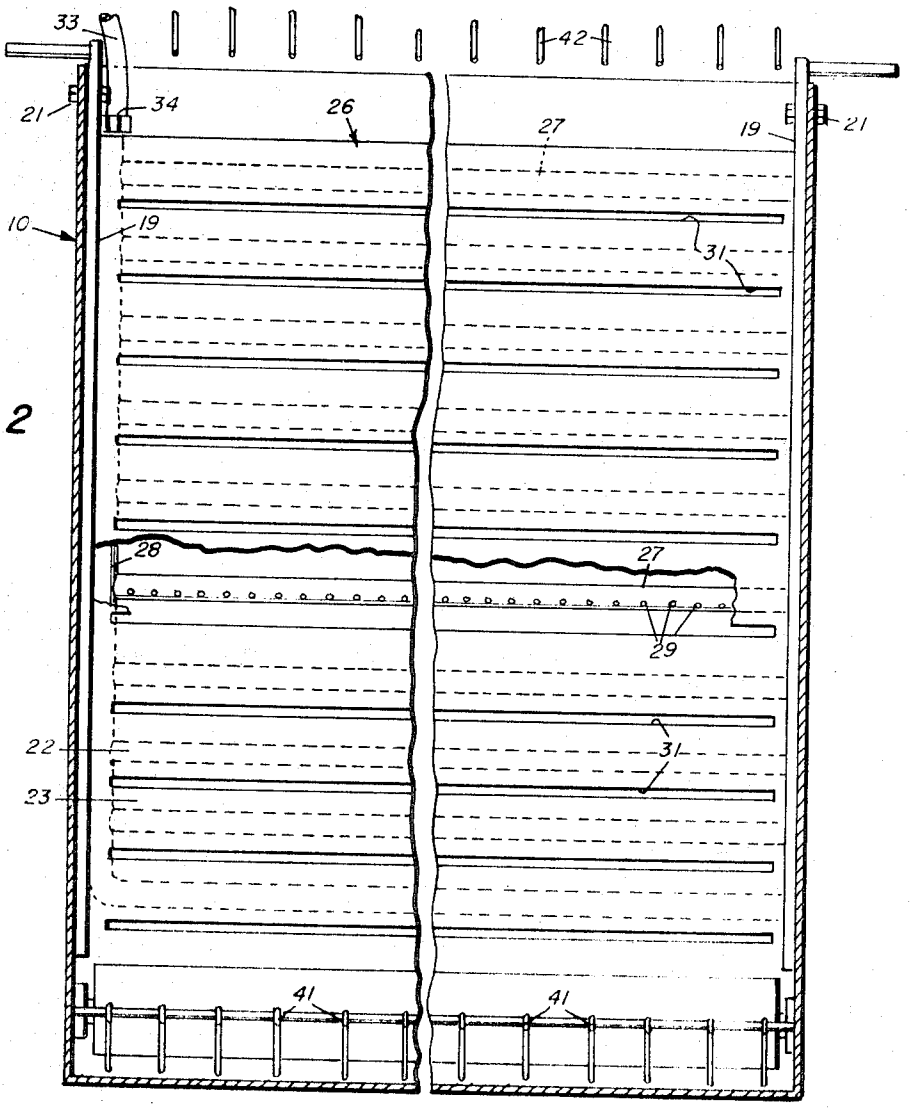


FIG. 3

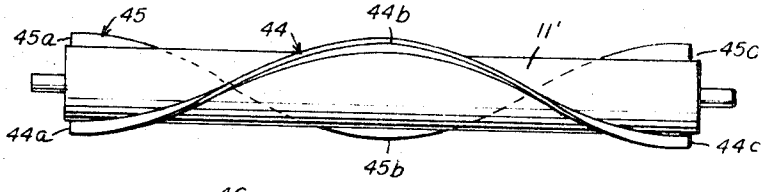
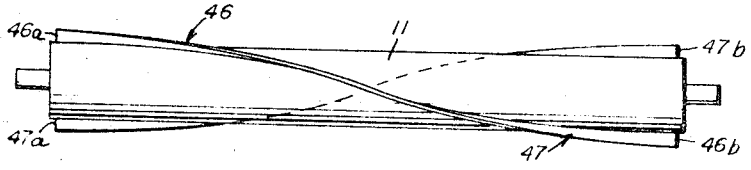


FIG. 4



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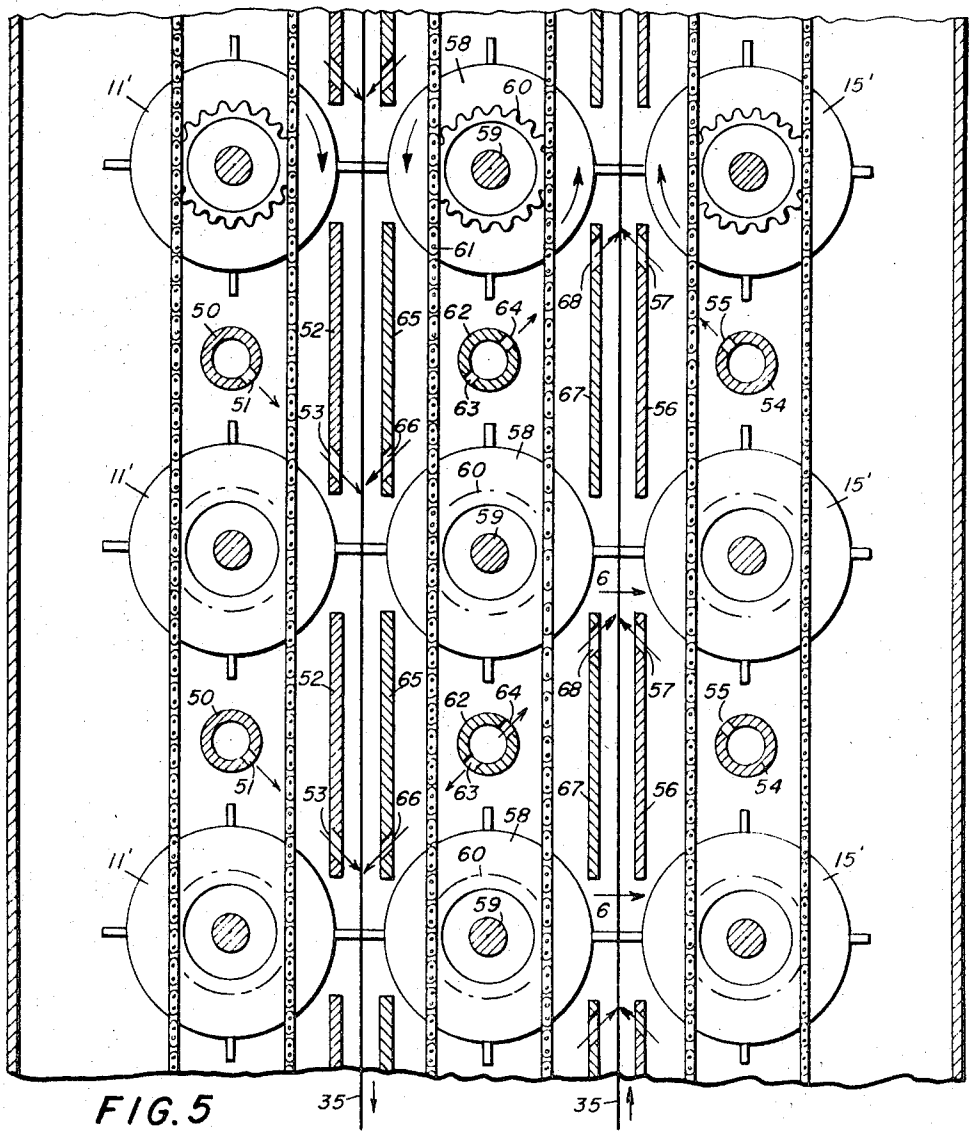


FIG. 5

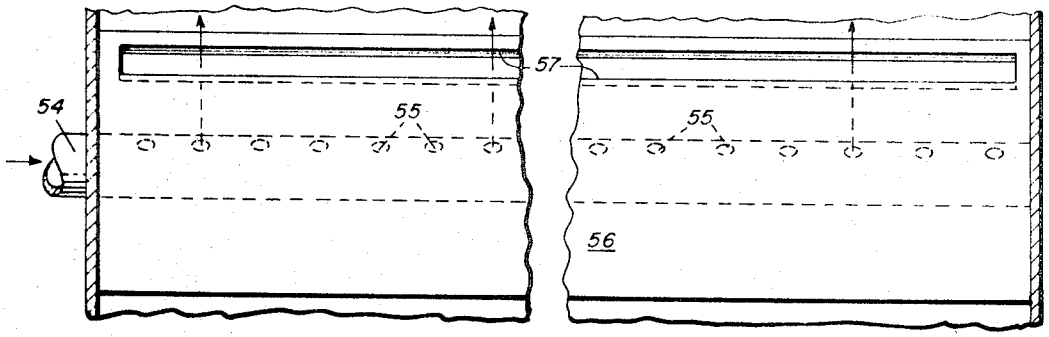


FIG. 6

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GRAPHIC ARTS FILM PROCESSOR

This invention relates to graphic film processing apparatus, and more particularly to apparatus for treating a sheet of film material with a processing fluid, either liquid or gaseous, in such a way as to minimize physical contact between the processing apparatus and the emulsion coated on a sheet or film. This apparatus is an improvement over the apparatus disclosed in U.S. Pat. No. 2,913,973, granted to Glen C. Bull, et al. on Nov. 24, 1959.

In the apparatus disclosed in the above named patent, the film is transported through a processing fluid between a series of smooth rollers which contact the emulsion side of a sheet of film, the other side of the film being in contact with a series of belts having tensioning means for urging the belts towards the rollers. This type of machine had the advantage of limiting the impression of the fabrics of the belts which resulted when film was treated by machines wherein the belts came into contact with the emulsion.

However, in the present invention it has been found possible to transport film through a body of processing fluid substantially without physical contact between any of the elements of the transporting mechanism and the emulsions side of the film. In one form of the invention this is accomplished by providing a series of rotating or idler rollers for supporting the untreated sides of a photographic, or other graphic arts type, of film and urging frictional contact between the film and the rollers by directing a fluid stream or current of the treating liquid against the emulsion side of the film.

In addition, while the driving rollers may be provided with smooth surfaces, as in said above mentioned patent, it has also been found possible to provide these rollers with one or more series of axially extending ridged portions, these ridges being arranged in helical fashion to provide substantially point contact between the film and a roller at any given instant of travel of the film through the processing fluid.

In a further embodiment of the present invention, it has been found possible to almost entirely eliminate contact between the surface of a film being processed and any of the elements of the apparatus by directing streams of the treating fluid against both sides of the sheet and in the desired direction of travel in a manner such as to not only move the film forwardly but to agitate the treating material. In this form of the invention a series of guiding rollers may be provided on both sides of the moving sheet material but arranged in such a manner that their surfaces act only occasionally on the film to compensate for unexpected inequalities in the force of the streams of liquid acting against the opposite sides of the film as it moves through the processor.

Further objects and advantages will be apparent to those skilled in the art after reading the following specification in connection with the annexed drawing in which;

FIG. 1 is a cross-sectional elevation of a preferred form of film transport apparatus constructed in accordance with the present invention;

FIG. 2 is a cross section taken on the line 2–2 of FIG. 1;

FIG. 3 is a side elevation of one form of roller used in the film transport apparatus, and;

FIG. 4 is a side elevation of a modified form of roller.

FIG. 5 is a cross-sectional elevation of a modified form of film transport apparatus;

FIG. 6 is a cross section taken on the line 6–6 of FIG. 5.

In the drawings the numeral 10 indicates generally an enclosure for the particular fluid with which the film strip or web is to be treated, and in the case of liquid processing system this may comprise a tank. Several of these tanks may be used, in accordance with the processing method involved; for example, one intended to contain a developing liquid, another for the fixing liquid and another for a washing liquid but since all of these enclosures may be substantially identical in construction it will be necessary only to describe one of them.

Within the enclosure 10 there are provided a series of horizontally extending vertically aligned rollers indicated generally by numeral 11, supported on shafts 12 which, for ease of disassembly for cleaning may in turn be mounted on a pair of side frames (not shown) to permit the entire assembly of rollers to be removed from the enclosure as a unit. Attached at one end of each shaft is a sprocket wheel 13 to enable all of the rollers to be rotated in unison by means of an endless chain 14. Another set of horizontally positioned vertically aligned rollers, indicated generally by numeral 15, supported on shafts 16 and having sprocket wheels 17 at their one end, are driven in unison by another chain 14'. This second set of rollers 15 may also have their shafts supported on a removable frame similar to the arrangement provided for the rollers 11. As in the case of the prior patent, No. 2,913,973, the topmost shafts 12 and 16 of each set of rollers may also include a driving gear (not shown) for connection with a horizontal driving shaft having cooperating worm gears (not shown). In this respect the general arrangement just described is similar to that shown in the prior patent.

Also removably positioned between the first set of rollers 11 and a second set of rollers 15 is a vertically extending fluid distribution mechanism, indicated generally by numeral 18. This system may comprise a shell 19 mounted at each side on a pair of frame members 19', each of which is provided with slotted openings 20 to permit the frame to be vertically adjustably attached to the enclosure 10 as by means of the bolts 21. The opposite sides of the shell are corrugated in a vertical direction, as can be seen in the cross section of FIG. 1, to provide a series of horizontal ridges 22 and valleys 23 on one side and a corresponding series of valleys 24 and ridges 25 on the opposite side.

Within the shell 26 are positioned a series of horizontally extending conduits 27 which may be connected at one end with a supply line 28. Each of the conduits is provided on one side with a series of horizontally aligned downwardly directed nozzles, which may comprise a series of small openings 29 for directing a series of streams of fluid angularly in the direction of travel of the film being processed or, as seen in FIG. 1, in an angularly downward direction on the left-hand side of the conduit. Another series of openings 30 are provided on the other side of each of the conduits to direct streams of fluid also in the direction of travel of the film or towards the right-hand side and in an upward direction. These streams of fluid are intended to impinge against one side of the film sheets and for this purpose a series of horizontally extending slots 31 are provided in the shell 26 on one side positioned in alignment with the stream of fluid projected from the openings therein. Similarly, on the other side of the shell another series of slots 32 are provided in the shell positioned in alignment with the stream coming from each of the openings 30 in the horizontal conduits. Fluid under pressure is supplied to the conduits 27 through the supply 28 from a pipe 33 connected with a pump (not shown) and detachably joined to the supply 28 by means of a coupling 34.

A strip of film, indicated generally by numeral 35, may be fed into the machine manually by inserting its leading edge downwardly between the uppermost of the rollers 11 and the fluid distribution shell 26, but it is preferable from a commercial standpoint to provide a horizontal feed table 36 having at its forward end a pair of feed rollers 37 driven at the same peripheral speed as the rollers in the remainder of the mechanism, which rollers move the film forwardly into engagement with a set of curved wires 38 which turn the film downwardly into the enclosure 10.

As soon as the film enters the enclosure the force of the fluid passing outwardly and downwardly from the nozzle openings 29 through the slots 31 urges the film against the rollers 11 with sufficient force that the clockwise rotation of these rollers will begin to move the film downwardly in this section of the enclosure. In this connection it should be noted that even if the rollers are closely spaced there would be some tendency for the film to bend or buckle between rollers. How-

ever, in order to employ as few rollers as necessary a series of backup plates **39** may be placed between the rollers substantially in a plane tangent to the surfaces of the rollers which contact the moving film. A similar set of plates **40** may be placed between the rollers **15**.

When the film reaches the lowermost of the rollers **11**, it encounters a turnaround device comprising a series of wire **41** curved in a 180° arc causing the film to bend around and reverse its direction so as to come in contact with the lowermost of the other set of rollers **15** which are also turning in a clockwise direction. Since the force of the fluid discharging in an upward direction from the nozzles **30** through the slots **32** urges the film against the surfaces of these rollers, the film thus travels upwardly until it reaches the top of the enclosure at which point a series of guide wires **42** changes the direction of the film to feed it downwardly into the following tank (indicated fragmentarily by numeral **43** in FIG. **1**), or to a discharge table if desired.

While the direction of flow of fluid from the nozzles **29** and **30** is such that it produces a component of force urging the film into contact with the rotating surfaces of the rollers **11** and **15** respectively, the fact that the nozzles are angularly directed in the direction of travel of the film also creates another component of force tending to urge a film forwardly so that movement of the film is induced not only by contact with the rollers but also by the fluid movement itself. Furthermore, the rotation of the rollers themselves assist in the creation of a flow of fluid on the side of the film away from the nozzles which is in the direction of its movement through the enclosure, or tank.

In other words, the positioning of the nozzles and the rotation of the rollers is such as to create currents of flow in the body of fluid contained within the enclosure **10**, which currents move in a downward direction on both sides of the film on the left-hand side of the enclosure, as viewed in FIG. !, and in an upward direction on both sides of the film on the right-hand side of the enclosure. Thus, movement of the film will take place even if the surfaces of the rollers are smooth.

However, in order to insure more positive movement of the film, as well as to reduce to a minimum the amount of contact between the film and any mechanical surface within the enclosure, it may be desirable to provide a series of helically disposed ribs, or ridges, on the rollers, one arrangement of which is shown in FIG. 3. In this form of the invention a roller **11** is shown having a series of helical ribs **44** and **45** sinuously arranged on, and projecting outwardly from, the surface of the roller. In this instance, the helix begins at one end and at the midpoint **44*b*** reverses its direction and continues to its other end **44*c*** at approximately the same angular position as the first end **44*a***. Similarly, one end **45*a*** of the other rib starts at one end and curves in one direction towards its midpoint **45*d*** then reverses direction to return at its other end **45*c*** at approximately the same angular position as end **45*a***. It should also be noted that the angular position and the pitch of the two ridges is such that at least one portion of a ridge will always be in contact with the film; that is to say the midpoint **45*b*** of rib **45** is positioned substantially in angular alignment with the ends **44*a*** and **44*c*** of rib **44** and the midpoint **44*b*** of rib **44** is substantially in alignment with the end **45*a*** and **45*c*** of rib **45**. As a further aid in ensuring movement of the film these ribs may be fabricated of some resilient synthetic material having a relatively high coefficient of friction with the film surface. It should further be noted that while two ribs are shown in the roll of FIG. **3**, any convenient number of ribs may be provided so long as the pitch of each helix is such that there will be an overlap between two or more of the helixes.

In the modified form of roll shown in FIG. **4** the roll **11** is provided with two ribs **46** and **47** running only in a single direction. Thus, rib **46** begins at **46*a*** with its other end **46*b*** being displaced angular 180°. Again, it should be noted that the beginning end **47*a*** starts at an angular position approximately in alignment with end **46*b*** of the first rib and the other end **47*b*** of the second rib is in substantial angular alignment with the end **46*a*** of the first rib. As in the previously described modification, a single rib could be provided, in which case the pitch of the single rib would be such that it would make a complete turn of 360° from one end of the rib to the other. More than two ribs could also be employed, the criterion being that the pitch of these ribs is sufficient such that at least a portion of one rib would always be in contact with the film.

In the modified form of the invention shown in FIGS. **5** and **6** the film strips are conveyed, or transported, substantially entirely by movement of streams of fluid so that contact with physical apparatus within the tank is reduced to an absolute minimum. This modified form of the invention is particularly adaptable to the processing of X-ray film which characteristically is provided with an emulsion on both sides. In this modified form the rollers **11′** are driven by the chain **14′** to rotate in a clockwise direction so that if there should happen to be any contact between the film strip, indicated by numeral **35′**, the film will be carried downwardly in this section of the tank. Similarly the rollers **15′** are driven by a chain so that they also are driven in a clockwise direction to urge the film strip upwardly out of the tank after it has made its turnaround (not shown) at the bottom thereof. Therefore, in this respect the arrangement for rollers **11′** and **15′** is the same as that for the rollers **11** and **15** in the previously described form of the invention.

Positioned between the rollers **11′** there may be a series of fluid distribution conduits **50**, each of these having a series of angularly downwardly directed openings **51** so that fluid supplied under pressure to these conduits is directed outwardly and downwardly toward the moving film. Positioned between these nozzles and the film is a series of flat backup plates **52** substantially in alignment with the peripheral surfaces of the rollers **11′**, each of these plates having a horizontally slotted portion **53** positioned slightly below the level of the nozzles **51** so as to permit the fluid to pass through the plates and into contact with the moving film. Horizontally positioned between the rollers **15′** are another set of conduits **54** having a series of angularly upwardly directed nozzles **55** and positioned between these rollers are the backup plates **56** having horizontally slotted portions **57** arranged to allow upwardly directed fluid under pressure from the nozzle **55** to impinge against one side of the upwardly moving film **35′** in an angularly upwardly directed direction.

This arrangement of forced fluid circulation could be used with the centrally arranged fluid system **18** shown in FIG. **1** but it is also possible to employ a third set of rollers **58** mounted on horizontally arranged shafts **59** on a vertically removable framework (not shown) similar to the frame **19** of FIG. **1**. These rollers are provided with sprocket **60** and may be driven by a chain **61** connected with the common drive system (not shown) for driving the other rollers **11′** and **15′**. The removable framework may also include a series of horizontal conduits **62** each of which is provided with a series of angularly downwardly directed horizontally arranged openings or nozzles **63** on the left-hand side, as shown in FIG. **5**, so as to direct fluid generally in the same direction as the nozzles **51**. On the other side of the conduits **62** there are also provided another series of horizontally arranged openings or nozzles **64** arranged to direct fluid in an angularly upward direction in conjunction with the fluid issuing from nozzles **55**. The removable framework may also be provided with a series of flat backup plates **65** having their surfaces generally in alignment with the left-hand periphery of each of the rollers **58**, these plates having horizontally arranged slots **66** to permit the passage of fluid from the nozzle **58**. On the other side of the removable frame another series of backup plates **67** are provided in alignment with the right hand periphery of the rollers **58**, each of these plates being provided with horizontally arranged slots **68** arranged to facilitate the flow of fluid from the upwardly directed nozzles **64**.

It will be obvious that when fluid, such as a liquid or gas suitable for processing a sheet of film **35′** is supplied to the conduits **50**, **52** and **54** through suitable means (not shown)

the pressure supplied to these conduits may be controlled or the design and placement of the nozzles may be chosen such that the force of the downwardly directed fluid from nozzles **51** on the one side and nozzles **63** on the other side of the film will be equalized so as to carry the film strip downwardly substantially out of contact with any of the rotating rollers and, similarly, the force of the fluid leaving the nozzles **55** and **64** may also be equalized so that the films strip is carried upwardly substantially without contacting any of the rollers. At the same time it will also be realized that in the event the force become momentarily unbalanced so that the film should come in contact with the surface of any of the rollers no substantial damage will be done because the surfaces of the rollers will carry the film strip in the same direction as that urged upon it by the fluid stream.

What I claim is:

1. Apparatus for processing graphic arts sheet or roll material of varying sizes with a processing fluid comprising an enclosure for confining said fluid therein, sheet feeding mechanism within said enclosure, said feeding mechanism comprising a series of closely spaced generally cylindrical rollers mounted in generally vertically superposed relation on parallel axes, each having a peripheral surface tangent to a common generally vertical plane, means for driving all of said rollers together in the same direction at the same peripheral velocity, means for guiding the leading edge of a sheet into contact with the peripheral surface of one of said rollers in said common plane while said rollers are rotating together, fluid jet means spaced from said series of rollers for directing a stream of processing fluid toward the side of said sheet away from said rollers and across the length thereof to urge the sheet into operative contact with the rollers, and means for supplying processing fluid under pressure to said jet means for urging movement of said sheet in the direction of peripheral movement of said rollers in said common plane and in frictional contact therewith, the peripheral surfaces of said rollers being provided with at least one sinuously disposed ridged portion extending across the length thereof whereby said sheet contacts the peripheries of said rollers substantially only at a series of axially moving points.

2. The invention as defined in claim **1**, wherein said fluid is a liquid and said liquid supplied to said jet means is recycled through said enclosure.

3. The invention as defined in claim **1**, wherein a flat backup plate is positioned between pairs of said rollers for supporting said sheet substantially in said common plane during movement thereof.

4. The invention as defined in claim **1**, wherein said sheet feeding means comprises an elongated strip of rigid material spaced generally from said common plane having a plurality of transverse openings therein, and said jet means includes means for directing fluid under pressure through said openings from the side away from said common plane.

5. The invention as defined in claim **4**, wherein said jet means includes a plurality of transversely arranged nozzle means arranged to direct fluid angularly through said transverse openings.

6. The invention as defined in claim **5**, wherein said elongated rigid strip is of undulating cross-sectional configuration in a plane normal to said common plane and extending in the direction of movement of said sheet.

7. The invention as defined in claim **6**, wherein a flat backup plate is positioned between pairs of rollers for supporting said sheet substantially in said common plane during movement thereof.

8. The invention as defined in claim **1**, wherein each of said rollers are provided with a plurality of said sinuously disposed peripherally spaced ridges.

9. The invention as defined in claim **9**, wherein said ridged portions extended progressively from one end in a first peripheral direction along a portion of the length of a roller and continue progressively in the reverse peripheral direction along a further portion of the length of said roller.

10. Apparatus for processing sheet material with a processing fluid comprising an elongated enclosure for confining said fluid therein, one end of said enclosure being open, two sets of spaced roller guide means comprising a first set of closely spaced rollers and a second set of closely spaced rollers positioned in said enclosure, means for rotating rollers of both sets at substantially the same peripheral speed for defining a first path between said two sets of rollers for sheet to be processed, a respective roller of each of said sets having a sinuously arranged resilient ridge portion extending transversely over the width of the roller and peripherally over the entire circumference thereof, whereby during rotation of the rollers a continuously moving point of contact is established between a sheet of material and said resilient ridge, means for feeding one end of a sheet of material into said enclosure through said open end and into said first path between said spaced sets of roller guide means, fluid circulating means in said enclosure, said circulating means including means for continuously directing two streams of said processing fluid within the enclosure against the respective opposite surfaces of said sheet angularly in the direction of movement of the sheet, said two streams being of substantially equal force in a direction normal to the plane of the sheet, whereby said sheet is moved through said enclosure between said two sets of roller guide means with a minimum of physical contact therewith.

11. The invention as defined in claim **10**, wherein a third set of roller guide means is provided in said enclosure defining with one of said first two sets a second path for sheet to be processed generally parallel with first path, guide means for turning said sheet from said first-mentioned path into said second path and reversing the direction of movement thereof, said fluid circulating means including means for directing two additional streams of said processing fluid of substantially equal force against the respective opposite surfaces of said sheet while in said second path and angularly in the direction of said reverse movement.

12. The invention as defined in claim **11**, wherein said means for directing said streams of treating fluid include a series of horizontally disposed superposed conduits positioned between said rollers and in generally parallel relation thereto, and nozzle means consisting of a series of openings in said conduits.

13. The invention as defined in claim **10**, wherein the peripheral surface of each of said rollers is provided with more than one axially extending ridged portion.

14. The invention as defined in claim **13**, wherein said ridged portion is helically arranged.

15. The invention as defined in claim **13**, wherein flat backup plates are disposed between said rollers for supporting the outer surfaces of said film.

16. The invention as defined in claim **10**, wherein a backup plate is mounted adjacent the path of said film and between certain of said rollers.