# United States Patent

**Hope et al.**

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## [54] FILM TRANSPORT ROLLER SYSTEM


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[51] **Int. Cl.** .....**G03d 3/12**

[58] **Field of Search** .....95/93, 94; 226/189, 118, 119, 226/188, 92



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[57] **ABSTRACT**

A film transport roller system for conveying an elongate web of film through processing tanks including a plurality of juxtaposed rack assemblies, each having a plurality of pairs of rollers and film guides which cooperate to drive the film through the processing tanks without tensioning or otherwise stressing the film. The medial section of one roller of each pair of cooperating rollers is fabricated to a reduced diameter to form an annular film receiving area, wherein the film may be guided through the various processing tanks without stress. The transverse ends of the pairs of cooperating rollers tangentially coact to automatically thread the film through rack assemblies.


**10 Claims, 4 Drawing Figures**

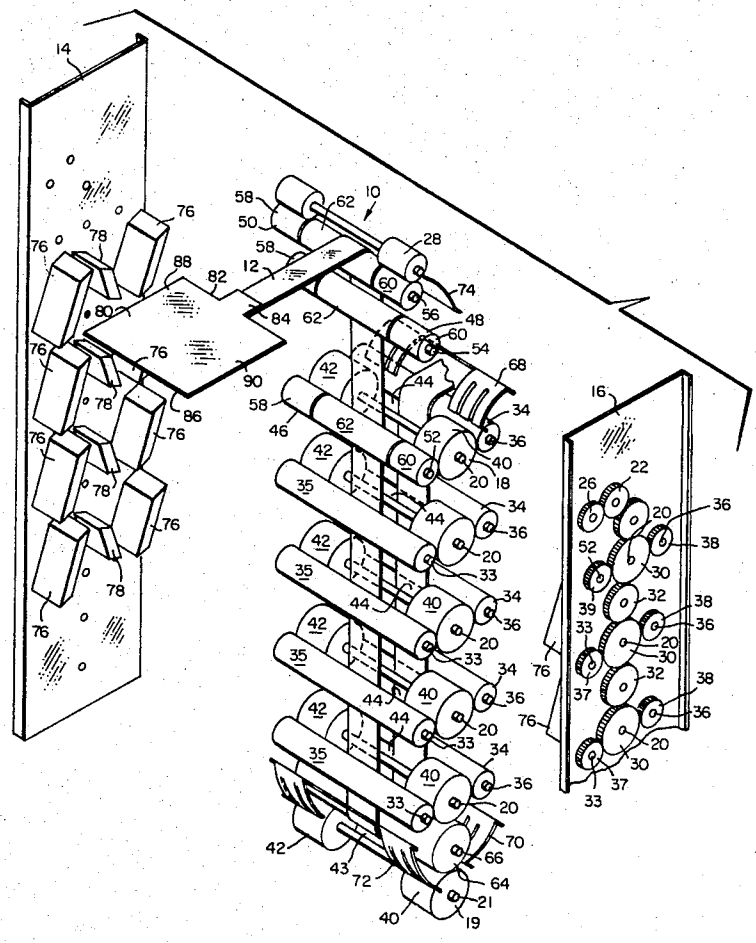
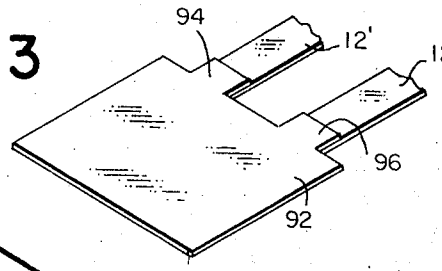


FIG. 3



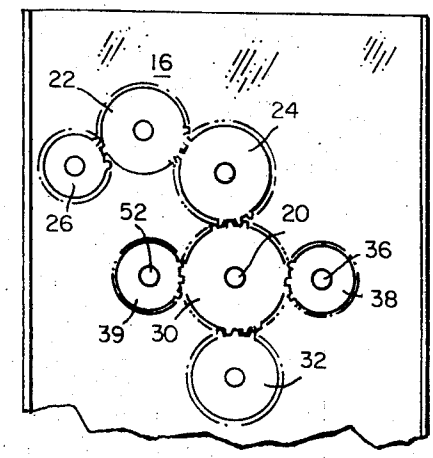




FIG. 2

FIG. 1




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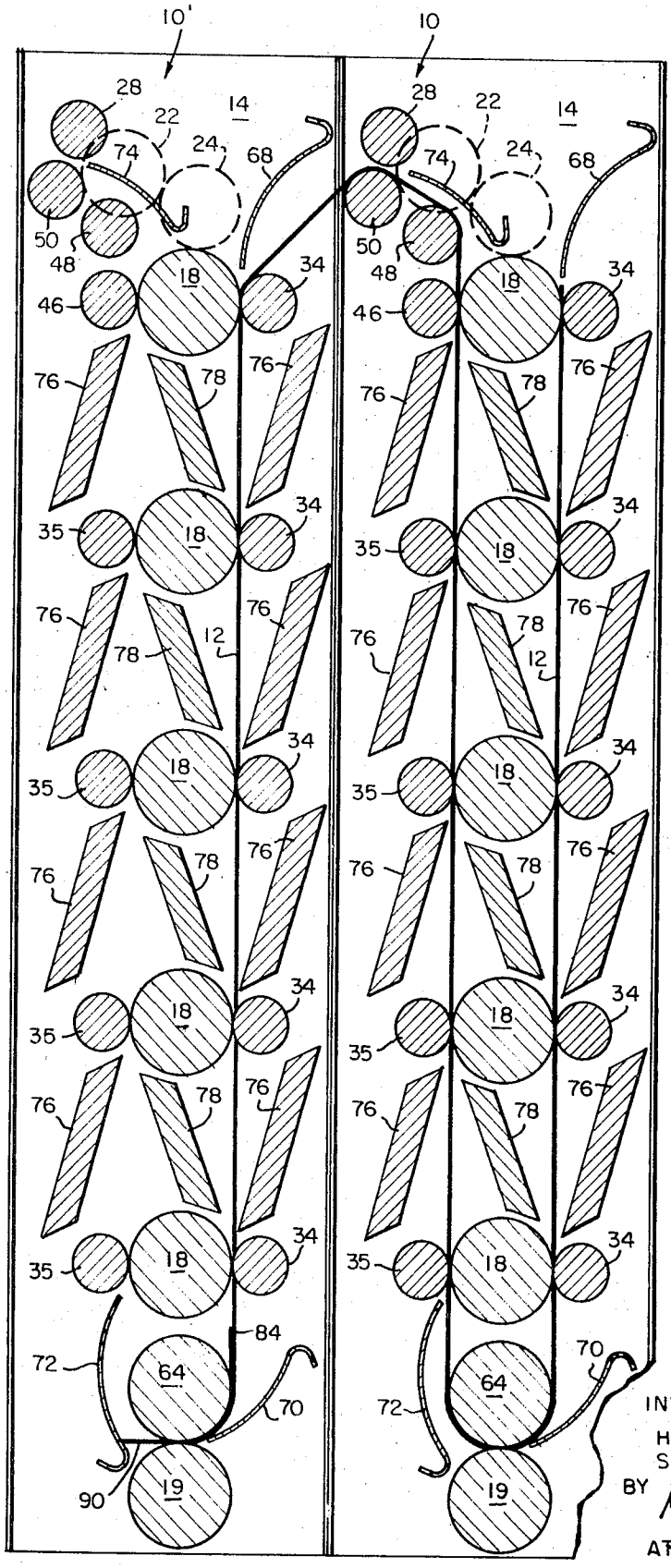



FIG. 4

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# FILM TRANSPORT ROLLER SYSTEM

## BACKGROUND OF THE INVENTION

The present invention relates generally to the field of photographic developing equipment, more particularly, is directed to a film transport roller system for use in developing film in elongate configuration.

It is the present practice to develop elongate film, such as 16 millimeter, 35 millimeter, and 70 millimeter film automatically by utilizing a plurality of side by side processing tanks and by employing film rack assemblies in conjunction with the processing tanks to direct the film through the various stages of the development process. The presently available rack assemblies all utilize pairs of cooperating driving and driven rollers to lead the film through the various development stages. Lengths of film extending 1,000 feet or more are common in present practice and accordingly, any small variation in the diameter of any of the film rollers will result in great inaccuracies over the length of the film. For instance, if one roller was manufactured one thousandth of an inch oversize with respect to the remaining rollers in the system, this inaccuracy when multiplied by a web 1,000 feet or more in length could result in a discrepancy of 1 inch or more over the length of the web. Accordingly, the rollers utilized in conjunction with prior art rack assemblies had to be carefully machined and fabricated with precision to keep the accumulated inaccuracy to a minimum. Even under careful manufacturing techniques and modern quality control procedures, this has proved to be a difficult and costly operation. The expenses required to produce rollers to such close tolerances has greatly increased the cost of prior art devices.

Additionally, all prior art rack assemblies of which we are familiar had built in operational difficulties in that it was both time consuming and tedious to thread the length of film through the rollers of the various rack assemblies located within the processing tanks. In order to thread the presently available equipment, one must attach each succeeding length of film to the trailing edge of the proceeding film to thereby utilize each length of film to pull the next succeeding length of film through the apparatus. In cases where continuous operation is not contemplated, it is now the practice to affix a trailing length of material to the trailing edge of the film so that this length of material will remain threaded within the apparatus for attachment of the film when it is desired to again use the apparatus. This would mean that a leader must be kept threaded through the apparatus at all times when the equipment was not being used.

Because of the difficulty of threading film through all prior art developing systems, the presently available rack assemblies include only top and bottom pairs of driving and driven rollers with no intermediate guiding apparatus of any kind. Accordingly, when the end of the film passes the top roller of a rack assembly, the end is then free and falls into the tank where it may become scratched, tangled, fouled, or otherwise harmed. Additionally, it is now the present practice to thread each rack assembly individually by lifting the rack assembly from its associated tank and then manually threading the film through the upper and lower rollers. This procedure is repeated from tank to tank and then until the entire system has been properly threaded. Of course, in precise developing techniques such as color developing, it is probable that chemicals from one tank will splash into the next adjacent tank to thereby present a source of contamination, all of which resulted in the need for frequent chemical changes in order to maintain satisfactory quality standards of development.

## SUMMARY OF THE INVENTION

The present invention relates generally to automatic film developing equipment and more particularly is directed to a novel film transport roller system for moving elongate lengths of exposed film through various developing tanks required in the developing process.



The film transport roller system of the present invention incorporates rack assemblies which include cooperating pairs of rollers in tangential rolling contact at the transverse ends. One of the pairs of rollers is medially fabricated to a reduced diameter to provide an annular film receiving area. A mule or leader of width sufficient to engage the nip of the tangentially touching areas of the cooperating pairs of rollers affixes to the leading edge of the film to pull the film automatically through the various cooperating pairs of rollers without requiring any manual threading of the rack assemblies. The cooperating rollers and mule eliminate the need to remove the rack assemblies from their associated processing tanks during the film threading operation.

The system further includes a plurality of discretely positioned guides which facilitate movement of the mule through the various pieces of apparatus within the processing equipment. The guides are fabricated to a width less than the overall width of the pairs of rollers, and generally position in vertical alignment with the tangentially touching portions of the rollers for guidance of the mule through the equipment. It will be noted that the film itself travels through the annular space between the rollers and does not contact the rollers or the guides during the course of travel through the equipment. By avoiding direct contact with either the rollers or the guides, any tendency to scratch or otherwise damage the film surface during the transportation through the equipment has been completely eliminated.

It is therefore an object of the present invention to provide a novel film transport roller system of the type set forth.

It is another object of the present invention to provide a novel film transport roller system including cooperating pairs of rollers functioning within rack assemblies, one of the rollers of the pair being medially fabricated to a decreased diameter.

It is a further object of the present invention to provide a novel film transport system which incorporates cooperating pairs of rollers which are fabricated to tangentially touch only at the lateral ends thereof for film directing purposes.

It is another object of the present invention to provide a novel film transport roller system incorporating roller means of width greater than the film and a carrying mule cooperating with the rollers to pull an elongate length of film automatically through the apparatus.

It is another object of the present invention to provide a novel film transport roller system, including cooperating pairs of rollers and intermediate film guides, both the roller and the guides defining a medial area to permit travel of the film therein without direct contact with the rollers.

It is another object of the present invention to provide a novel film transport roller system that is rugged in construction, inexpensive in manufacture, and trouble-free in operation.

Other objects and a fuller understanding of the invention will be had by referring to the following description and claims of a preferred embodiment thereof, taken in conjunction with the accompanying drawings, wherein like reference characters refer to similar parts throughout the several views and in which:

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded, perspective view of the invention showing a length of film travelling through a rack assembly.

FIG. 2 is an enlarged, partial, side elevational view showing a preferred gearing arrangement for driving the various rollers.

FIG. 3 is an enlarged perspective view showing a modified type of mule configuration.

FIG. 4 is a cross sectional view showing two rack assemblies in horizontal juxtaposed relationship and a length of film feeding through the rack assemblies.

## DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Although specific terms are used in the following description for the sake of clarity, these terms are intended to refer only to the particular structure of our invention selected for illustration in the drawings and are not intended to define or limit the scope of the invention.

Referring now to the drawings, we show in FIG. 1 a representation of a film transport rack assembly generally designated 10 which positions within a film processing tank (not shown) for developing exposed, elongate film webs 12 in accordance with well known principles of film developing. The rack assembly 10 includes a pair of vertical, spaced, side plates 14, 16 which journal a plurality of rollers in horizontal position between the side plates for film movement through the rack assembly 10.

A plurality of vertically spaced large diameter segmented rollers 18 and bottom segmented roller 19 medially position between the right and left side plates 14, 16 and have their respective shafts 20, 21 journalled through the side plates in well known manner. One end of each of the respective shafts 20, 21 extends through the side plate 16 a sufficient distance to receive a driving gear 30 for roller rotation purposes. As best seen in FIG. 2, a power gear 24 rotates in conventional manner through a power source, such as an electric motor (not shown) and meshes with respective roller gears 24, 26.

The gear 24 meshes with the upper larger roller gear 30 to rotate the upper roller 18 in response to rotative power supplied by the driving gear 22. The large roller gear 30 in turn meshes with the intermediate gear 32 which turns the next lower large roller 18 through its respective shaft affixed gear 30. Similarly, all of the large rollers 18 rotate simultaneously through the gear train comprising the meshing of alternate roller gears 30 and intermediate gears 32.

As can best be observed in FIGS. 1 and 4, a small diameter, solid roller 34 positions on the feed-in side of the upper large diameter segmented roller 18 and has its associated shaft 36 journalled within the side plates 14, 16 for roller rotation. A gear 38 affixes to one end of the shaft 36 and meshes with the large roller driving gear 30 to thereby simultaneously rotate the rollers 18, 34. An upper small diameter roller 46 cooperates with the upper large roller 18 and positions diametrically opposite from the solid roller 34. The upper small roller shaft 52 journals within the side plates 14, 16 and fixedly receives a gear 39 at one end thereof. The gear 39 meshes with the large roller driving gear 30 to thereby also simultaneously rotate the rollers 18, 52. All of the lower large diameter segmented rollers 18 rotate in unison with the upper large roller 19 through the gear train comprising the large roller gears 30 and the intermediate gears 32. Each segmented roller 18 forms a vertically spaced, film guiding group with a respective pair of diametrically opposed right and left small solid rollers 34, 35. Each segmented roller 18 turns about its shaft 20 which is rotated by its associated driving gear 30. The driving gear 30 meshes with the small roller gears 37, 38 which are affixed to the respective small roller shafts 35, 36 to thereby also rotate the small rollers 34, 35. Similarly, the lower solid roller 64 and the lowest segmented roller 19 can be geared into the system in well known manner for rotative purposes. Thus, rotative power supplied by the driving gear 22 is transmitted throughout the gear train to rotate all of the various rollers within the film transport rack assembly 10.

Each large diameter segmented roller 18 is fabricated with an axially aligned shaft 20 and a pair of spaced, laterally positioned right and left roller segments 40, 42 of cylindrical configuration which define a medial annular space 44 about the roller shaft 20. The annular space 44 provides an open area between the large diameter roller shaft 20 and the adjacent solid small diameter rollers 34 to permit unrestricted, unstressed passage of the film web 12 therethrough as hereinafter more fully set forth. The lowest roller 19 is similarly formed and defines an annular space 43 between the lowest roller shaft 19 and the large solid roller 64.

As observed in FIG. 4, the upper small rollers 46, 48, 50 are formed to the same general diameter as the solid small rollers 34 and turn about their respective shafts 52, 54, 56 which journal within the right and left side plates 14, 16 in the usual manner. Each of the rollers 46, 48, 50 is fabricated with right and left, spaced, transversely positioned, cylindrical segments 58, 60 which securely adhere to their respective shafts 52, 54, 56 for rotation as the shafts rotate. A central section 62 of cylindrical configuration, having a diameter equal to the diameter of the spaced segments 58, 60 positions between the spaced segments and is fabricated with an axially aligned central bore of diameter greater than the diameter of the respective associated roller shafts 52, 54, 56. Thus, each central section 62 freely rotates about its associated shaft and is not rotated by the gear driven rotation of the respective shafts 52, 54 and 56.

A large diameter, solid roller 64 positions immediately above the lowest large diameter segmented roller 18 and tangentially contacts the right and left segments 40, 42 of the segmented roller 19 for film threading purposes. The large diameter solid roller 64 affixes to its shaft 66 which rotatively journals within the right and left sideplates 14, 16 in the usual manner. An externally positioned gear (not shown) connects with the gear train extending from the driving gear 22 to rotate the large roller 64 simultaneously with the rotation of the other rollers within the system. It will be noted that the annular space about the lowest segmented roller 18 provides an area for film travel between the lowest segmented roller 19 and the large diameter solid roller 64, without tensioning, binding, or other film stressing forces being imposed upon the film web 12. It will be observed that the film transport rack assembly 10 generally includes a plurality of spaced groups of rollers each including a large diameter segmented roller 18 which is centrally positioned and a pair of laterally positioned, small diameter solid rollers 34, which tangentially contact the right and left segments 40, 42 of the roller 18 for film threading purposes as hereinafter more fully set forth. The gear train extending from the driving gear 22 powers all of the rollers within the system simultaneously and at constant speed in accordance with well known principles of gear train design.

Referring now to FIGS. 1 and 4, a plurality of right and left film guides 68, 70, 72, 74, 76, 78 will be observed extending inwardly from each side plate 14, 16. It will be appreciated that each of the guides illustrated extends transversely inwardly with respect to the rack assembly 10 a distance approximately equal to the length of each right and left roller segment 40, 42 and 58, 60. In this manner, the film guides define a medial area between the respective right and left guide members which is substantially equal in width to the width between the respective right and left roller segments 40, 42, 58, 60. A top curve guide 68 receives the film and directs it to the nip of the upper cooperating pair of large segmented roller and small diameter solid roller 18, 34 for travel downwardly at the front of the rack assembly 10. A bottom positioned curved guide 70 turns the film web and directs it to the nip of the cooperating lower pair of rollers 19, 64. The rollers 19, 64 urge the film rearwardly toward the rear bottom curved guide 72 which functions to direct the film web upwardly to the nip of the lowest pair of large diameter segmented roller 18 and its associated, cooperating rear small diameter solid roller 35. The cooperating pairs of large segmented rollers 18 and rear solid rollers 35 urge the film upwardly within the film transport rack assembly 10 to the small diameter, segmented guide rollers 46, 48 and 50 which cooperate with the top, curved, rear guide 74 to direct the film into the next adjacent film transport rack assembly 10. A plurality in generally rectangular mid-rack guides 76 project inwardly from the respective side plates 14, 16 to direct the film to the nip of the respective cooperating pairs of front small rollers 34 and the associated large segmented rollers 18 and the rear solid rollers 34 and the associated, large diameter segmented rollers 18. It will be observed in FIG. 4 that the medially positioned mid-rack guides 78 incline between the vertically spaced large diameter roller 18 and serve to direct the film both downwardly at the front of

the rack assembly and upwardly at the rear of the rack assembly.

In order to use our invention, a mule or lead strip **80** is provided of thin, strong, sheet material such as polyester of width sufficient to overlie the spaced segments **40, 42** and **58, 60**. The leading edge of the film web **12** affixes to the trailing edge **82** of the mule **80**, which may be in the form of a film receiving tab **84**. The film may be removably affixed to the trailing edge **82** in any well known, secure manner, such as by plastic or cellophane tape. The tab **84** positions upon the mule **80** to lead the film **12** through the film transport rack within the annular spaces **44** provided between the various rollers. The leading edge **86** of the mule **80** feeds into the rack assembly **12** at the upper top curve guide **68** into the nip of the upper rollers **18, 34**. As hereinbefore set forth all of the rollers within the system are power driven by the gear train so that the upper rollers **18, 34**, nip the lateral edges **88, 90** of the mule between the lateral edges of the solid small roller **34** and the spaced right and left segments **40, 42** of the large diameter segmented roller **18** to direct the mule downwardly through the rack assembly **10**. Generally the downwardly positioned pairs of rollers **18, 34** urge the mule and the affixed film web **12** through the apparatus to the bottom curve guide assembly when then directs the mule **80** to the nip of the cooperating pair of rollers **64, 18**. Similarly, the right and left lateral edges **88, 90** are driven between the lateral portions of the large diameter solid roller **64** and the transversely spaced segments **40, 42** of the bottom roller **18**. The rollers **18, 64** direct the mule to the rear bottom curved guide **72** which directs the mule upwardly to the nip of the various small diameter rear solid rollers **35** and each associated large diameter segmented roller **18**. As before, the lateral edges **88, 90** of the mule are driven through the apparatus and the film itself travels in the annular space **44** without contacting any of the various small diameter solid rollers and large diameter segmented rollers, and so these rollers can place no tension or other stress upon the film web **12**. The mid-rack guides **76** serves to direct the mule through the nip of the various cooperating pairs of rollers without requiring any manual adjustments whatsoever. The three upper rollers **46, 48, 50** having the freely rotatable central sections **62** facilitate the travel of the film web to the next adjacent rack assembly **10**. It will be noted that the large diameter solid roller **64** positions near the bottom of the rack assembly and receives the film web in direct contact without the need for any manual operations. This roller serves to drive the film web forwardly through the system, continuously after the mule has passed out of contact with the roller, **64**.

Referring now to FIG. **3**, we show a modified mule **92** having a plurality of rearwardly positioned tabs **94, 96** for attaching a plurality of film webs **12', 12''** for leading the plurality of film webs simultaneously through the film transport rack assembly. It is the purpose of this invention to construct the central roller section **62**, and the annular spaces **44**, wide enough to accommodate the widest available film. Of course, as narrower films are employed within the apparatus, such as 16 m.m., 35 m.m. or even microfilm, more than one film web may be simultaneously processed. Additionally, once a film web has been started through the film processing equipment, a second film web may be simultaneously introduced by affixing the second web to a mule **80**, or **92** in a position laterally offset from the already processing film web and then introducing the second mule to the apparatus at the upper top curve guide **68**. The second mule will automatically feed through the apparatus and simultaneously with the first film web to thereby automatically and simultaneously feed the second or even a third web through the apparatus.

We claim:

**1.** In a film transport roller system for directing elongate film webs by the leading edge through processing equipment, the combination of

A. a rack assembly including a pair of spaced, side plates;

B. A plurality of first rollers journalled within the said side plates,

1. said rollers being vertically spaced;

C. a plurality of vertically spaced second rollers respectively cooperating with the the said first rollers and journalled within the said side plates,

1. said second rollers being segmented to form cylindrical sections which define an annular space,

2. said cylindrical sections respectively rotatively contacting portions of the said first rollers to form rotative drive areas;

D. a mule of thin, strong material driven by the said first and second rollers,

1. said mule being sufficiently wide to be driven by the said rotative drive areas,

2. said mule pulling the leading edge of the film web through the apparatus,

a. said mule positioning the web within the said annular space.

**2.** The invention of claim **1** wherein the said rotative drive areas transversely nip the lateral edges of the mule to drive the mule through the rack assembly.

**3.** The invention of claim **2** wherein the cylindrical sections are laterally spaced a distance greater than the width of the film web.

**4.** The invention of claim **1** and a plurality of third rollers, each of said third rollers including a shaft journalled within the said side plates and a pair of laterally spaced, cylindrical sections affixed to the said shaft, the said third rollers further including a medially positioned central section of cylindrical configuration positioned between the cylindrical sections, the said central section being free to rotate about its said shaft.

**5.** The invention of claim **3** and a plurality of film guides projecting transversely inwardly from the said side plates, said film guides projecting inwardly a distance not greater than the width of the said cylindrical sections.

**6.** The invention of claim **5** wherein some of the said guides are curved to turn the mule approximately 90 degrees from its initial plane of travel.

**7.** The invention of claim **6** wherein the remainder of said guides are generally rectangular in configuration and direct the mule in the same plane of its travel.

**8.** The invention of claim **7** wherein some of said rectangular guides direct the mule vertically downwardly and some of said guides direct the mule vertically upwardly.

**9.** The invention of claim **8** wherein some of said rectangular guides serve to direct the mule both vertically downwardly and vertically upwardly within the rack assembly.

**10.** The invention of claim **3** wherein the said cylindrical sections are laterally spaced a distance greater than the width of two film webs and wherein the said mule is provided with means to simultaneously pull two film webs through the system.

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