United States Patent

Cavella

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[54] SELF-REVERSING RIBBON DRIVE

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[52] **U.S. Cl.** **242/67.4,** 74/354, 74/405, 197/162, 197/164, 242/201

[51] **Int. Cl.** **G11b 15/44**

[58] **Field of Search** 242/54, 55, 200, 201, 202, 242/67.4; 74/354, 384, 404, 405, 406; 197/160, 162, 164, 169

[56] **References Cited**

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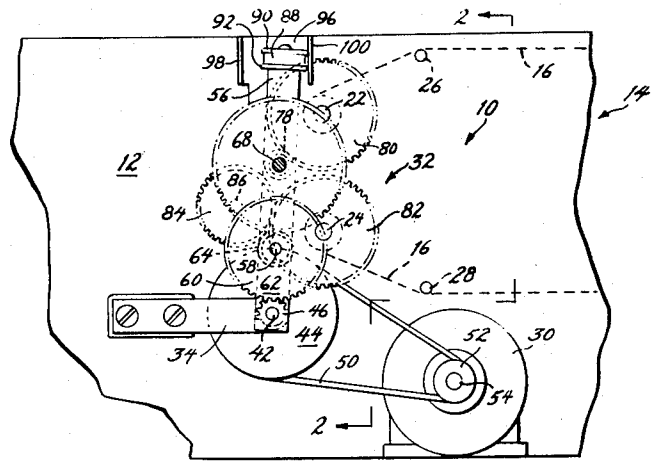
[57] **ABSTRACT**

A self-reversing drive mechanism for a ribbon or other web-like article is disclosed. The mechanism includes a pair of spools, spaced to serve alternately as supply and take-up spools, and a driver gear shiftable in response to radial gear tooth forces thereon between positions wherein it is drivingly coupled to first one and then the other of the spools. The radial tooth forces are determined by tension in the ribbon, and reach the values necessary to effect shifting of the driver gear after the ribbon is fully unwound from the supply spool.

14 Claims, 5 Drawing Figures



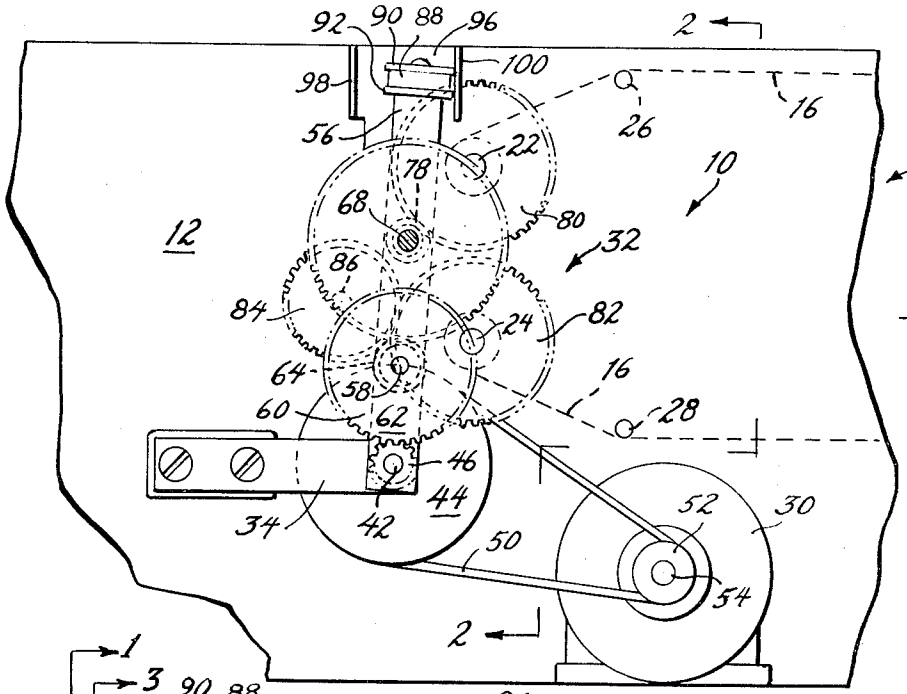


Fig. 1.

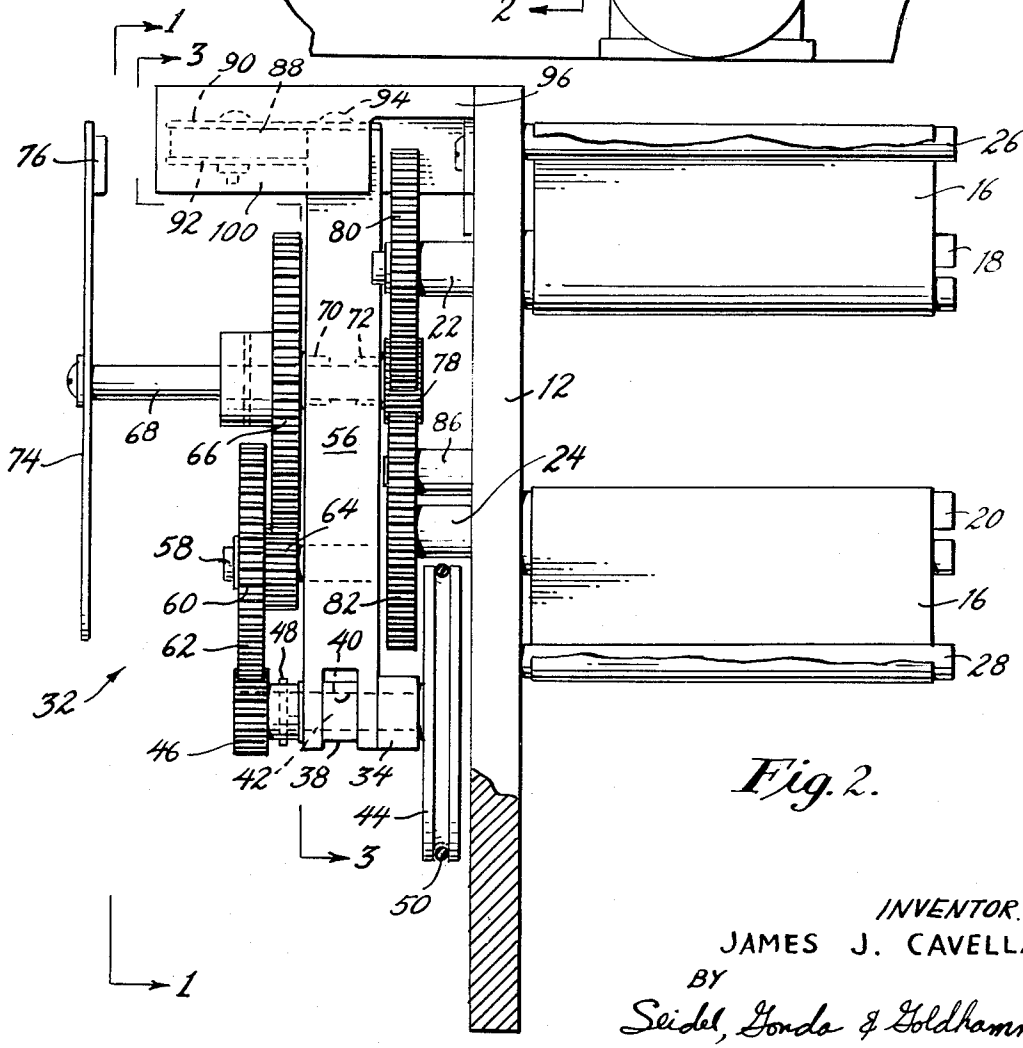


Fig. 2.

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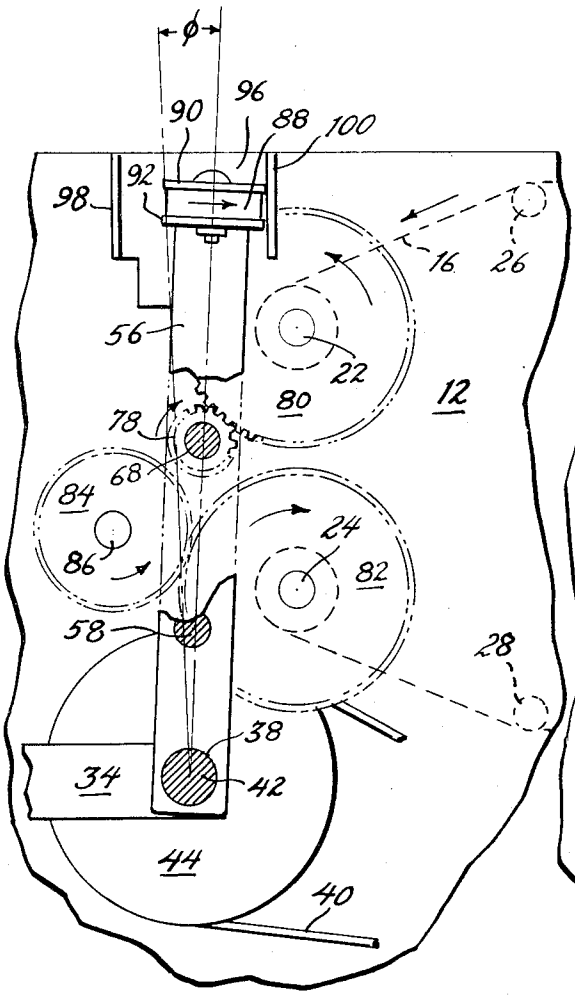

Fig. 3.

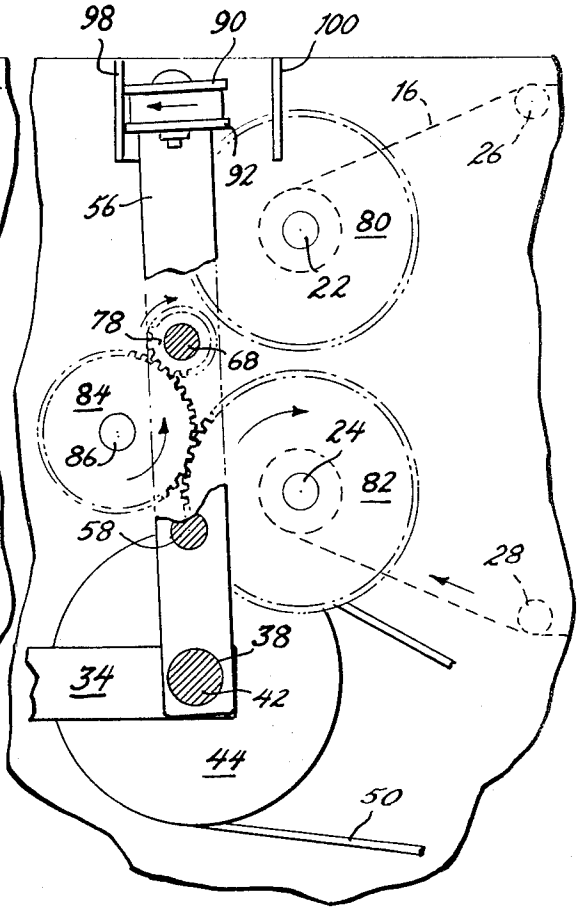

Fig. 4.

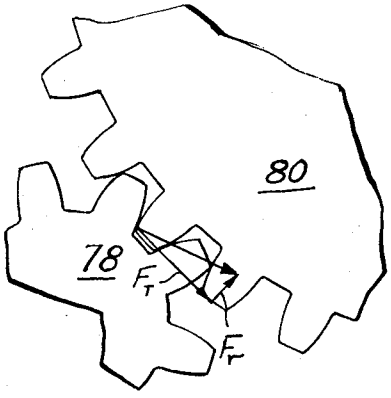

Fig. 5.

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SELF-REVERSING RIBBON DRIVE

This invention relates to a self-reversing ribbon drive mechanism, and more particularly, to a drive mechanism for a ribbon or other web-like member wherein tension in the ribbon causes a constantly driven drive gear to shift between respective operative positions wherein it drives the ribbon in opposite directions.

In its broadest aspect, this invention relates to an apparatus for obtaining a self-reversing motion of a flexible member, such as a printing ribbon or the like. Although it is described herein as having particular applicability to ribbons for printers, the principles of the invention are applicable to apparatus for handling other flexible web-like members as well.

In printing devices using transfer ribbons, it is conventional to provide ribbon drive devices for advancing the ribbon after printing of one or more characters. Advancement of the ribbon greatly enhances the clarity of the printed characters. It is conventional to draw the ribbon from a supply spool to take-up spool until the supply spool is fully unwound. Then, the direction of ribbon feed is reversed, the original take-up spool becoming the supply spool, and vice versa. Periodic reversal of the direction of ribbon feed, it has been found, increases the useful life of the ribbon.

Heretofore, reversal of the ribbon drive has conventionally been accomplished by means of switches, relays, solenoids, clutches and a variety of mechanical linkages, many of which have proven to be costly, complicated and unreliable.

It has also been suggested, as in U.S. Pat Nos. 2,621,864 and 3,179,948 that gearing, shiftable in response to sensed web tension, be used to effect reversal. In the first of these, directed to a reversible winder for strip film, a complex planetary gear train, associated with a spring-urged movable motor mount, is employed. In the latter, wherein ribbon drive in intermittent rather than constant, worm gearing, rather than simple spur gearing is used.

It is a principal object of this invention to provide a self-reversing ribbon drive mechanism using ordinary spur gears having a conventional tooth profile.

It is another object of this invention to provide a simple and effective self-reversing ribbon drive, wherein shifting movement of a drive gear to effect reversal is positive and reliable, without need of expedients such as movable or spring-biased motor mounts.

It is yet another object of this invention to provide a self-reversing ribbon drive mechanism wherein constant rather than intermittent motor drive is accommodated.

Other objects will appear hereinafter.

The foregoing and other objects are accomplished, in a presently preferred form of the invention, by apparatus wherein the first and second web-bearing spools are alternately driven in opposite directions by a driver gear, shiftable between respective positions wherein it is drivingly coupled to first one and then the other of the spools. Shifting of the driver gear out of driving engagement with one of the spools and into engagement with the other is initiated in response to the increase in radially directed tooth forces occasioned by exhaustion of the web from the spool functioning as the supply spool. The possibility of the driver gear lodging at a dead-center position, wherein it is coupled to neither of the spools, is effectively eliminated in the present apparatus through the use of a rotating eccentric weight, the periodic impulses of which prevents the driver gear from coming to rest in any but its respective spool-driving positions. Mechanical biasing means, such as magnets or the like, are also associated with the driver gear to maintain it in its respective spool-engaging positions.

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it is being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIG. 1 is a side elevation view, partly in phantom, showing a ribbon drive mechanism in accordance with the present invention.

FIG. 2 is a cross-sectional view, taken along the line of 2—2 in FIG. 1.

FIG. 3 is a side elevation view of the mechanism showing the driver gear in a first position, drivingly coupled to one of the ribbon spools.

FIG. 4 is a side elevation view showing the driver gear in another position, drivingly coupled to the other of the spools.

FIG. 5 is a view, partly broken away, showing the interengagement of the driver gear and a gear associated with one of the spools, and illustrating the matter in which the tooth forces thereon may be resolved.

Referring now to the drawings in detail, wherein like numerals indicate like elements, there is seen in FIG. 1 a self-reversing ribbon drive mechanism designated generally by the reference numeral **10**. The ribbon drive mechanism **10** is shown associated with the frame **12** of a high speed printer, designated generally by the reference number **14**, of the sort used in the data processing field. It should be understood, however, that the utility of the present ribbon drive mechanism is not limited to such an application.

Referring to FIG. 2, opposite ends of a flexible ribbon **16** are coupled to respective spools **18** and **20**, received upon and rotatable with a pair of drive shafts **22** and **24**. The drive shafts **22** and **24** are journaled in the frame **12**, and in the illustrated embodiment, have parallel axes of rotation. Guide spindles **26** and **28**, coupled to the frame **12**, serve to guide and support the ribbon **16** adjacent the spools **18** and **20**.

When it is desired to advance the ribbon **16** in one direction, the shaft **22** and associated spool **18** are driven in a counter-clockwise direction as seen in FIG. **1**. In this instance, the spool **18** serves as a take-up spool, and the spool **20** as a supply spool. When it is desired to advance the ribbon **16** in the other direction, the drive shaft **24** and its associated spool **20** are driven in a clockwise direction as seen in FIG. **1**. In this instance, it is spool **20** which serves as the take-up spool, and the spool **18** as the supply spool.

Rotation of the drive shafts **22** and **24** in their respective directions is effected by a uni-directional electric motor **30**, seen in FIG. **1**. The torque and rotation of the motor **30** are imparted to the drive shafts **22** and **24** by a gear train designated generally by the reference numeral **32**, which will now be described in detail.

A cantilever arm **34**, best seen in FIG. **1**, is affixed to the frame **12**. Referring to FIG. **2**, associated with one end of the cantilever arm **34** is a bearing portion **36**, which provides an external cylindrical bearing surface **38** and an internal bearing sleeve **40**. A shaft **42** is rotatably received in the bearing sleeve **40**.

Coupled to opposite ends of the shaft **42** for rotation therewith are a drive pulley **44** and a pinion **46**. A pin **48** secures the pinion **46** to the shaft **42**.

Referring again to FIG. **1**, a drive belt **50**, threaded over the drive pulley **44** and another pulley **52** associated with the output shaft **54** of the motor **30**, transmits rotation to the shaft **42** and pinion **46**.

Rotatably mounted on the cylindrical bearing surface **38** is toggle arm **56**. A shaft **58** is anchored at one of its ends to the toggle arm **56**. A cluster gear **60**, which includes coaxial gear portions **62** and **64**, is rotatably mounted on the shaft **58**. The gear portion **62** is in meshed and constantly driven relation with the pinion **46**. The gear portion **64** is in meshed and constantly driving relation with another gear **66**, affixed to a shaft **68**.

The shaft **68**, which in the illustrated embodiment is parallel to the above-mentioned shaft **58** is journaled, by means, for example, of bearings **70** and **72**, in the toggle arm **56**. Secured to the shaft **68** and rotatable therewith is a disk **74**, to which an eccentrically placed fly-weight **76** is affixed. The purpose of the disk **74** and fly-weight **76** will be described in detail later. Also secured to the shaft **68** and rotatable therewith is a driver gear or pinion **78**.

As is apparent from FIGS. **1** to **4**, a gear **80** is affixed to an end of the drive shaft **22** for the spool **18**. Also, a gear **82** is affixed to an end of the drive shaft **24** for the spool **20**.

Referring to FIGS. **1**, **3** and **4**, an idler gear **84**, rotatably mounted on a stub shaft **86** affixed to the frame **12**, is pro-

vided. The idler gear **84** is in constant meshing interengagement with the gear **82**. The idler gear **84** and the gear **80** associated with the drive shaft **22** lie in a common plane with the pinion **78**.

The pinion **78** is shiftable between respective positions wherein it is drivingly coupled to the gear **80** and drive shaft **22**, and the idler gear **84**, gear **82** and drive shaft **24**. In FIGS. **3** and **4**, the pinion **78** is seen in the above-mentioned respective positions.

Shifting of the pinion **78** occurs upon angular rotation of the toggle arm **56** about the shaft **42**. In FIG. **3**, the toggle arm **56** is shown in its position wherein the pinion **78** meshes with an drivingly engages the gear **80**.

In FIG. **4**, the toggle arm **56** is shown in a position wherein the pinion **78** meshes with and drivingly engages the idler gear **84**.

Means are provided in association with the toggle arm **56** to maintain the arm in one or the other of the positions shown in FIG. **3** and **4**. For this purpose, a magnet **88** is affixed adjacent the distal upper end of the toggle arm **56**. In the illustrated embodiment, the magnet **88** is retained between a pair of pole pieces **90** and **92**, the pole piece **90** being affixed to the toggle arm **56** by a screw **94**.

An armature **96**, of magnetic material, provides a pair of parallel legs **98** and **100**, extending outwardly away from the frame **12**. As is seen in FIGS. **1**, **3** and **4**, the legs **98** and **100** straddle the magnet **88** and pole pieces **90** and **92**, and contact the pole pieces **90** and **92** when the toggle arm **56** is at the respective positions shown in FIGS. **3** and **4**. Magnetic attraction between the pole pieces **90** and **92** and the legs **98** and **100**, together with the force of gravity, tend to maintain the toggle arm **56** in the aforementioned positions, wherein the pinion **78** drivingly engages either the gear **80** or the idler gear **84**.

Referring to FIGS. **3**, **4** and **5**, shifting of the toggle arm **56** and pinion **78** in response to web tension will now be described. Referring first to FIG. **5**, meshing of the pinion **78** and gear **80** is seen in an enlarged scale. As is well known, in involute gearing, force is transmitted between meshing gears along a line of action extending between the base circles of the respective gears, and intersecting a line between centers of the gears at an angle known as the working pressure angle ϕ. The tooth forces can be resolved into components F_r and F_t, extending in the radial and tangential directions with respect to the meshed gears. The effect of the radially directed forces, of course, is to tend to separate the meshed gears. This effect, in the present invention, has been used to trigger shifting of the pinion **78** between its positions illustrated in FIGS. **3** and **4**.

The tooth forces sensed by the pinion **78** are a function of tension in the ribbon **16**. Referring to FIG. **3**, rotation of the pinion **78** results in a corresponding rotation of the gear **80** and its associated drive shaft **22** and spool **18**. The spool **20** associated with the drive shaft **24**, gear **82**, and idler gear **84**, are free to rotate. Accordingly, as the pinion rotates in its usual clockwise direction, the gear **80**, drive shaft **22** and spool **18** rotate in the counter-clockwise direction shown by the arrow in FIG. **3**. Ribbon **16** is unwound from the spool **20**, causing free rotation of the drive shaft **24** and gear **82** in the illustrated counter-clockwise direction. When ribbon **16** is completely unwound from the spool **20**, rotation of that spool stops. Rotation of the pinion **78** and gear **80** continues, however, tightening the portion of the ribbon **16** already wound upon the spool **20**. As the ribbon **16** is tightened on the spool **18**, the torque transmitted from the pinion **78** to the gear **80** increases, and the radially directed force tending to separate the pinion **78** and the gear **80** increases as well.

The radially directed force F_r manifests itself as a moment tending to cause rotation of the toggle arm **56** in a counter-clockwise direction about the shaft **42**. The moment created by F_r is resisted by a moment due to magnetic attraction of the pole pieces **90** and **92** and the leg **100**, and also by a much smaller moment attributable to the weight of the toggle arm **56** and the parts thereon. Eventually, however, F_r, acting over its moment arm, becomes sufficiently strong to cause separation of the pole pieces **90** and **92** and the leg **100**.

As is well known, the force of magnetic attraction varies inversely as the square of the distance between the attracted bodies. Hence, upon separation of the pole pieces **90**, **92** and the armature **100**, the attractive force due to the magnet **88** falls off rapidly. Moreover, the tightly wound ribbon acts as a spring to maintain torque on the pinion **78** until it completely disengages from the gear **80**. The inertia of the toggle arm **56** and the various parts thereon tends to carry the arm **56** overcenter, so that the pole pieces **90** and **92** ultimately contact the armature **98**, and the pinion **78** falls into driving engagement with the idler gear **84**. Firm engagement of the pinion **78** and idler gear **84** is insured by the magnetic attraction between the pole pieces **90**, **92** and the armature **98**. The rotating weight **76** effectively eliminates the possibility of the toggle arm **56** and pinion **78** lodging at dead-center, in engagement with neither the gear **80** nor the idler gear **84**.

Whether engaged with the gear **80** or the idler gear **84**, the pinion **78** is driven by the motor **30** in the same direction. The idler gear **84**, however, causes the gear **82** to rotate in a clockwise direction, opposite from the direction of rotation of the gear **80**. Thus, when the gear **82** is driven, the ribbon **16** is wound around the spool **20**. Such winding continues until all of the ribbon **16** is exhausted from the spool **18**, the ribbon tension builds sufficiently to cause reversal once again.

It should be apparent that if the ribbon **16** becomes tangled or disarrayed in such a way that the torque required to wind it becomes sufficiently great, the direction of winding will change automatically, to assist in unfouling the ribbon **16**. Thus, damage to the ribbon **16** and the drive mechanism **10** is automatically adverted.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specifications as indicating the scope of the invention.

I claim:

1. A self-reversing drive mechanism for a flexible web, comprising first spool means adapted to receive one end of said web, second spool means adapted to receive the other end of said web, and means for alternately driving said first and second spool means in opposite directions, said means for driving said first and second spool means comprising respective driven gears operatively associated with said first and second spool means, and a pinion shiftable between respective positions wherein it is drivingly coupled to one or the other said driven gears, said pinion being rotatably mounted on a support member movable in response to radial tooth forces on said pinion to initiate shifting of said pinion, biasing means for urging said support member to respective positions in which said pinion is drivingly coupled to one of said gears, and rotating eccentric weight means coupled to said support member for effecting shifting of said support member after initiation of shifting by the tooth forces.

2. Apparatus in accordance with claim **1**, wherein said biasing means comprises magnetic means.

3. Apparatus in accordance with claim **1**, wherein said support member comprises an elongated arm member rotatable about a pivot disposed adjacent a lower end thereof, said pinion being disposed at a location spaced from said pivot, whereby rotation of said arm about said pivot causes shifting of said pinion.

4. Apparatus in accordance with claim **3**, wherein rotation of said arm member about said pivot traverses a vertical position of said arm member, respective positions of said arm member in which said pinion is drivingly coupled to one of said driven gears being disposed on opposite sides of the vertical position, and said rotating eccentric weight being effective to prevent lodging of said arm in intermediate positions wherein said pinion is out of engagement with both driven gears.

5. Apparatus in accordance with claim 4, wherein said biasing means comprises magnetically attractable means coupled to said arm member remote from said pivot, and fixed magnetically attractable means straddling said arm member and positioned to contact said first-mentioned magnetically attractable means when said arm member is in said respective positions.

6. Apparatus in accordance with claim 1, and means coupled to said pinion for driving said pinion unidirectionally, and an idler gear drivingly engaged with one of said driven gears, said pinion being engaged with said idler gear when drivingly coupled to one of said driven gears.

7. A self-reversing drive mechanism for a flexible web, comprising first spool means adapted to receive one end of said web, second spool means adapted to receive other end of said web, and means for alternately driving said first and second spool means in opposite directions, said means for driving said first and second spool means comprising respective driven gears operatively associated with said first and second spool means, and a pinion shiftable between respective positions wherein it is drivingly coupled to one or the other of said driven gears, said pinion being rotatably mounted on a support member movable in response to radial tooth forces on said pinion to initate shifting of said pinion, means coupled to said pinion for driving said pinion unidirectionally, and an idler gear drivingly engaged with one of said driven gears, said pinion being drivingly engaged with said idler gear when drivingly coupled to said one of said driven gears, said support member comprising an elongated arm member rotatable about a pivot disposed adjacent a lower end thereof, said pinion being disposed at a location spaced from said pivot, whereby rotation of said arm about said pivot causes shift of said pinion.

8. Apparatus in accordance with claim 7, wherein rotation of said arm member about said pivot traverses a vertical position of said arm member, respective positions of said arm member in which said pinion is drivingly coupled to one or the other of said driven gears being disposed on opposite sides of the vertical position.

9. Apparatus in accordance with claim 8, and biasing means for urging said support member to respective positions in which said pinion is drivingly coupled to one of said driven gears, said biasing means comprising magnetically attractable means coupled to said arm member remote from said pivot, and fixed magnetically attractable means straddling said arm member and position to contact said first-mentioned magnetically attractable means when said arm member is in said respective positions.

10. Apparatus in accordance with claim 9, and rotating eccentric weight means coupled to said support member for effecting shifting of said support member after initiation of shifting by the tooth forces, said rotating eccentric weight means being driven by said means for driving said pinion.

11. A self-reversing drive mechanism for a flexible web, comprising first spool means adapted to receive one end of said web, second spool means adapted to receive the other end of said web, and means for alternately driving said first and second spool means in opposite directions, said means for driving said first and second spool means comprising respective driven gears operatively associated with said first and second spool means, and a pinion, means for driving said pinion in a predetermined direction, said pinion being shiftable between respective positions wherein it is drivingly coupled to one or the other of said driven gears while said means drives said pinion in said direction, said pinion being rotatably mounted on a support member movable in response to radial tooth forces on said pinion while said pinion rotates in said direction to initiate shifting of said pinion, said support member comprising an elongated arm member rotatable about a pivot disposed adjacent a lower end thereof, said pinion being disposed at a location spaced from said pivot, whereby rotation of said arm about said pivot causes shifting of said pinion.

12. Apparatus in accordance with claim 11, wherein rotation of said arm member about said pivot traverses a vertical position of said arm member, respective positions of said arm member in which said pinion is drivingly coupled to one or the other of said driven gears being disposed on opposite sides of the vertical position.

13. Apparatus in accordance with claim 12, and biasing means for urging said support member to respective positions in which said pinion is drivingly coupled to one of said driven gears, said biasing means comprising magnetically attractable means coupled to said arm member remote from said pivot, and fixed magnetically attractable means straddling said arm member and position to contact said first-mentioned magnetically attractable means when said arm member is in said respective positions.

14. Apparatus in accordance with claim 13, and rotating eccentric weight means coupled to said support member for effecting shifting of said support member after initiation of shifting by the tooth forces, said rotating eccentric weight means being driven by said means for driving said pinion.

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