United States Patent [19]

Rastelli

[11] **3,766,767**

[45] **Oct. 23, 1973**

[54] **MULTIPLE ROLL BRIDLE SYSTEM**

[75] Inventor: **Telesfore Rastelli,** Cheshire, Conn.

[73] Assignee: **Textron Inc.,** Providence, R.I.

[22] Filed: **Feb. 26, 1971**

[21] Appl. No.: **119,163**

[52] **U.S. Cl.** **72/249,** 72/443, 72/449

[51] **Int. Cl.** **B21b 35/00**

[58] **Field of Search** 72/249, 443, 449

[56] **References Cited**

UNITED STATES PATENTS

1,594,395	8/1926	Weston	74/675
1,466,642	8/1923	Crook	72/249
3,299,685	1/1967	Kocks et al.	72/249
3,314,264	4/1967	Vater et al.	72/443
1,594,396	8/1926	Weston	74/675
1,594,394	8/1926	Weston	74/675

FOREIGN PATENTS OR APPLICATIONS

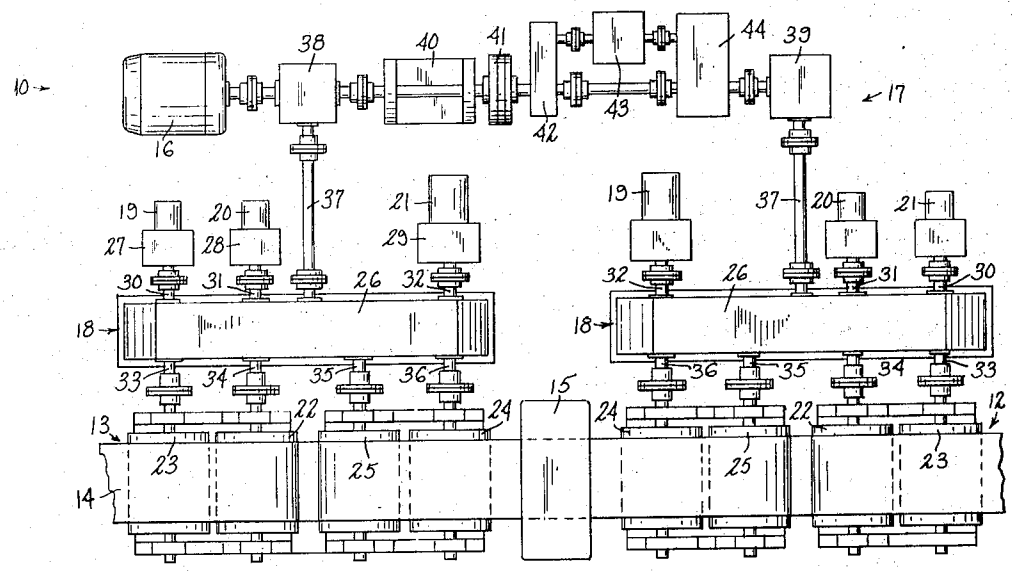
1,652,547	4/1971	Germany	72/249
1,002,719	12/1954	Germany	72/249

Primary Examiner—Charles W. Lanham
Assistant Examiner—M. J. Keenan
Attorney—Belio & Montgomery

[57] **ABSTRACT**

The speed of the individual rolls in multiple roll bridle systems is made adjustable and independent of roll diameter for maximum alteration of strip passing over the rolls, by providing first, plural, independent drive means for a plurality of corresponding rolls in each of a set of entry rolls and a set of exit rolls, and second drive means providing common power input to a plurality of rolls in each said sets. The second drive means is adapted to provide, through a gear train including infinitely variable speed transmission means and differential transmission means, dual power take-offs to corresponding dual planetary gear systems.

16 Claims, 8 Drawing Figures



PATENTED OCT 23 1973

3,766,767

SHEET 1 OF 4

Fig. 1

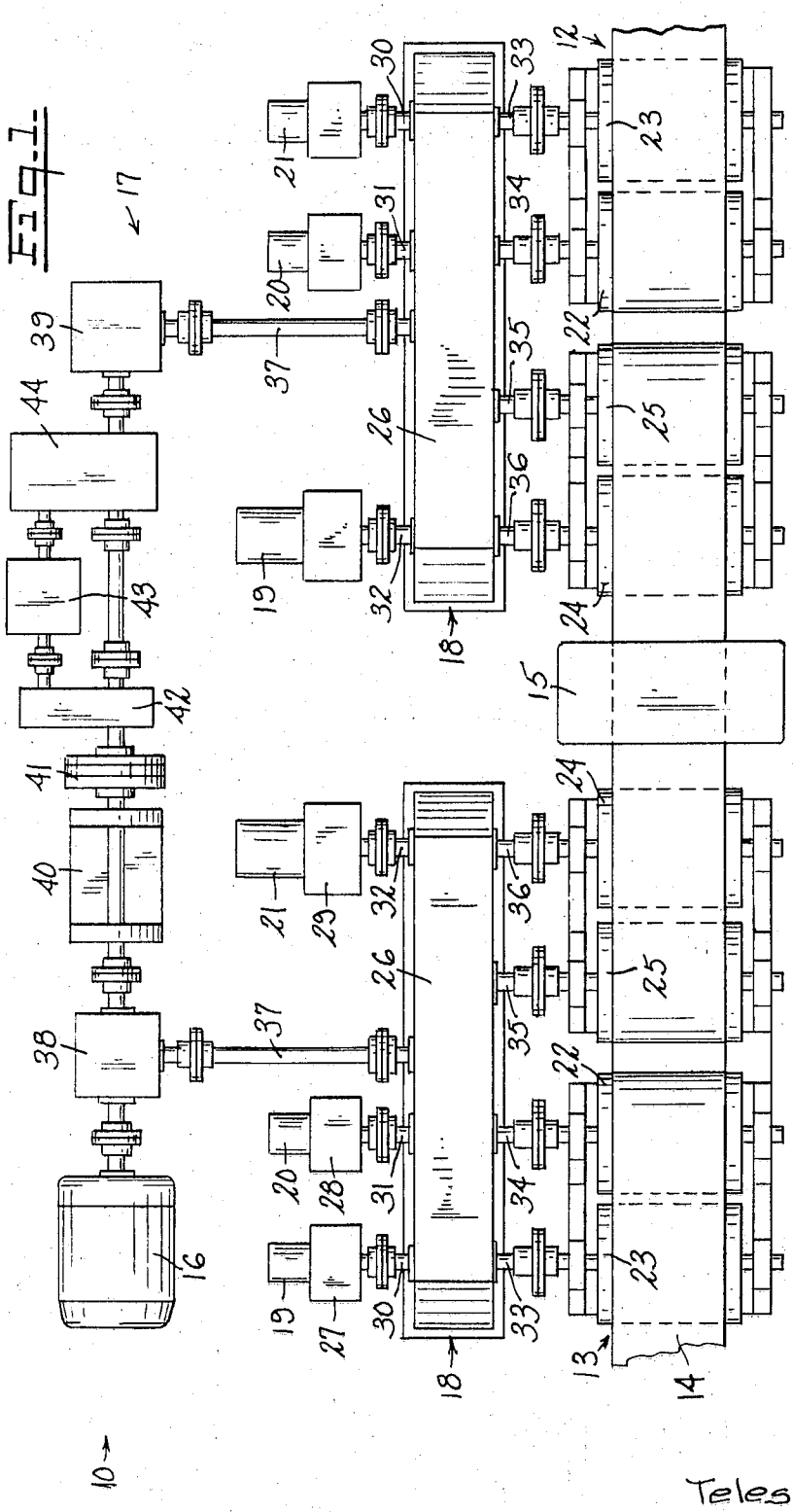
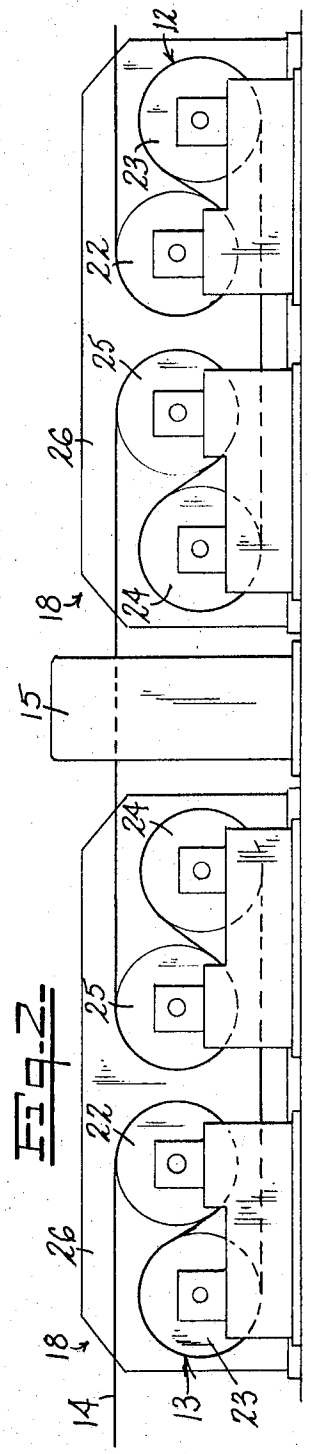


Fig. 2



INVENTOR

Telesfore Rastelli

BY DeLio and Montgomery

ATTORNEYS

Fig. 3

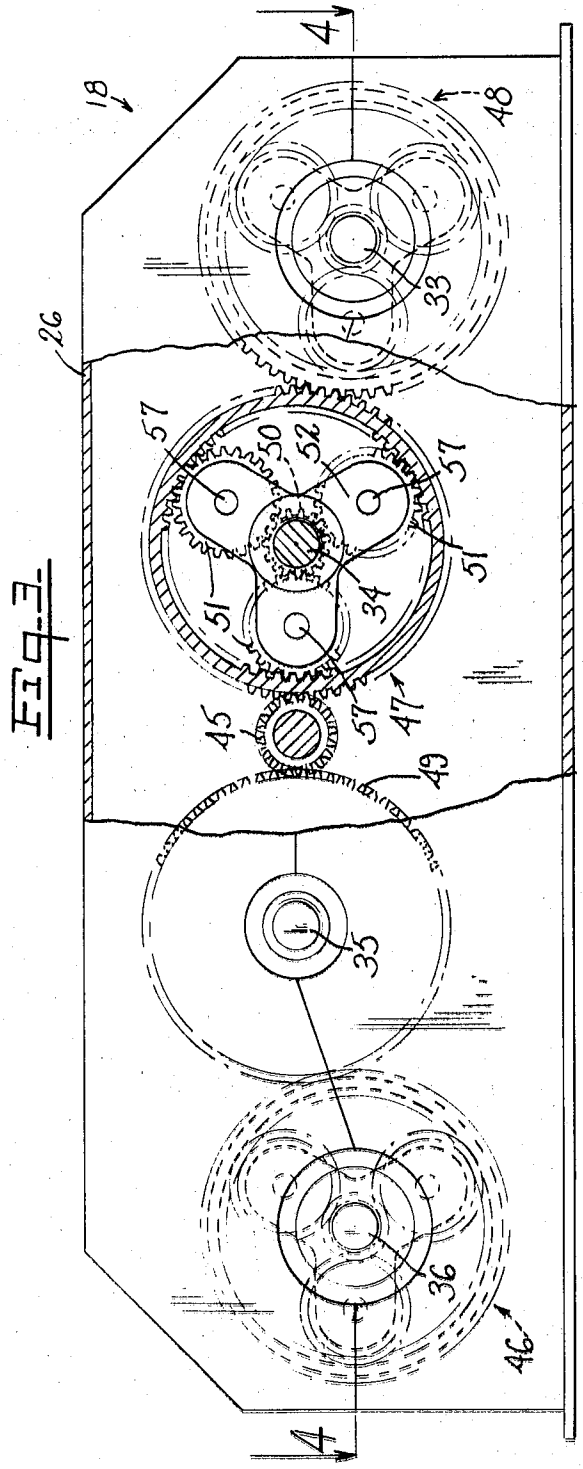
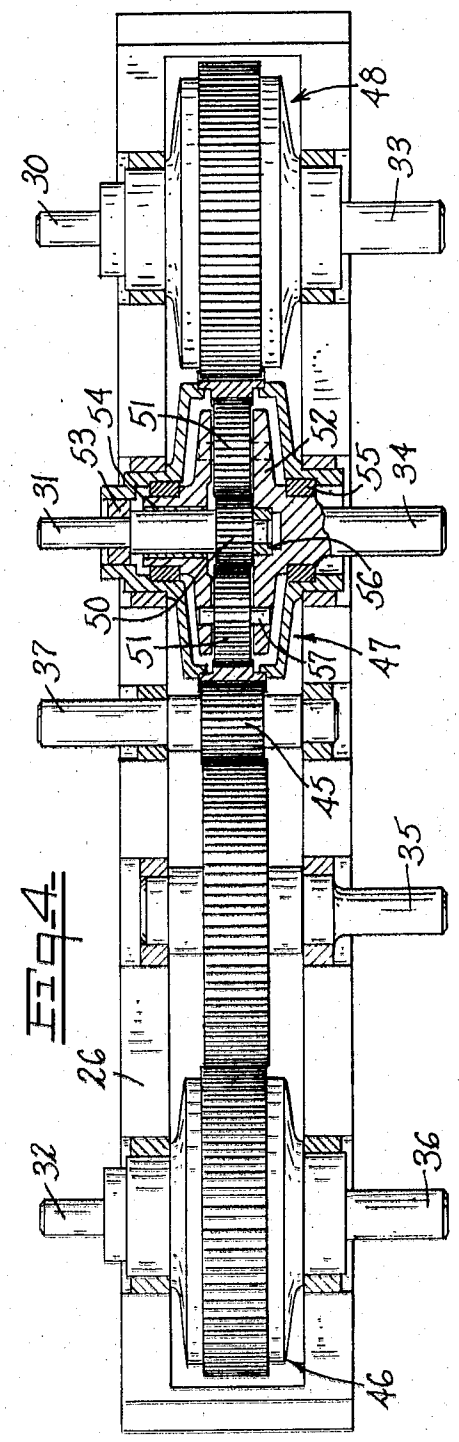


Fig. 4



INVENTOR

Telesfore Raste III

BY DeLio and Montgomery

ATTORNEYS

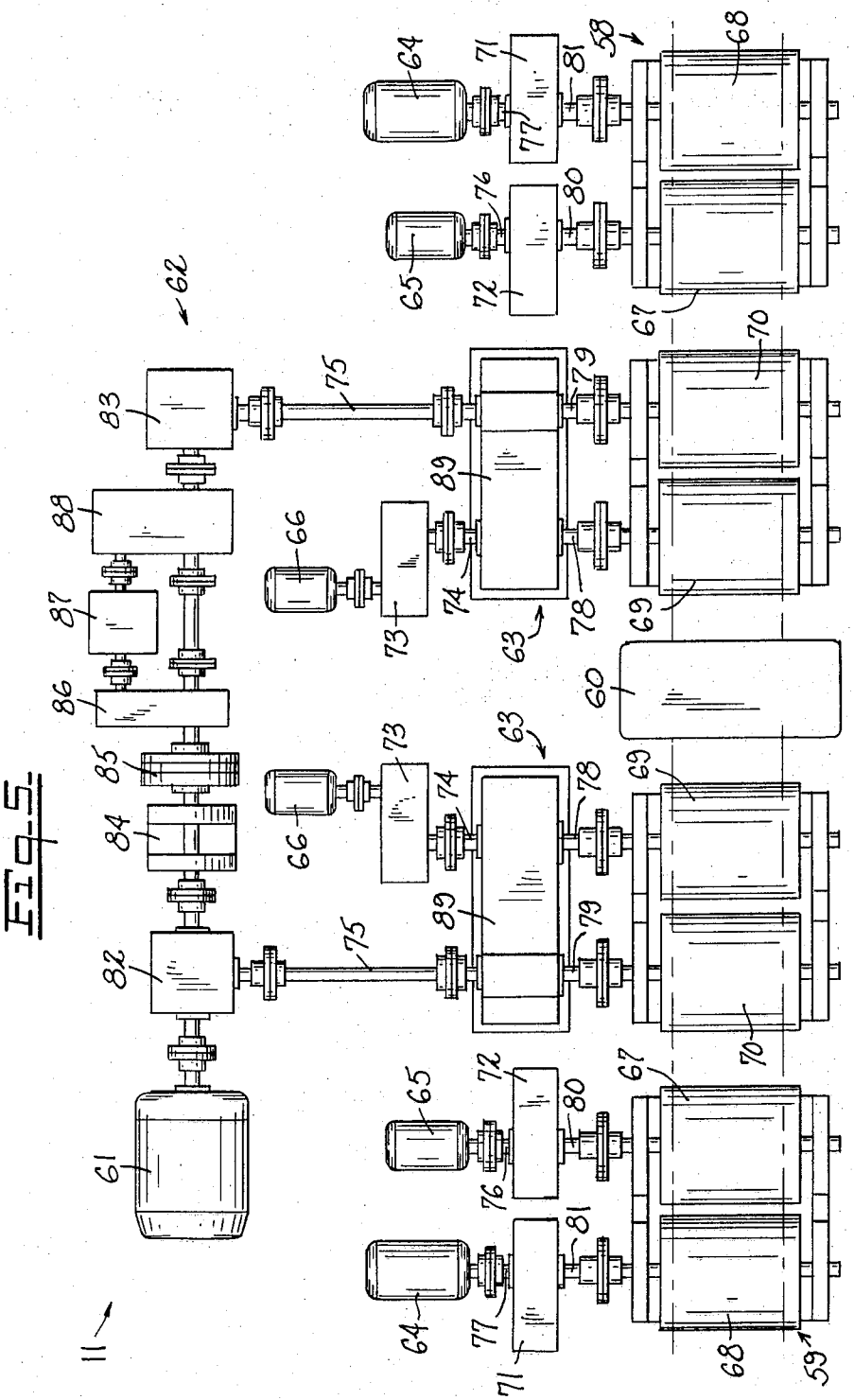


Fig-5

INVENTOR

Telesfore Rastelli

BY De Lio and Montgomery

ATTORNEYS

Fig. 6

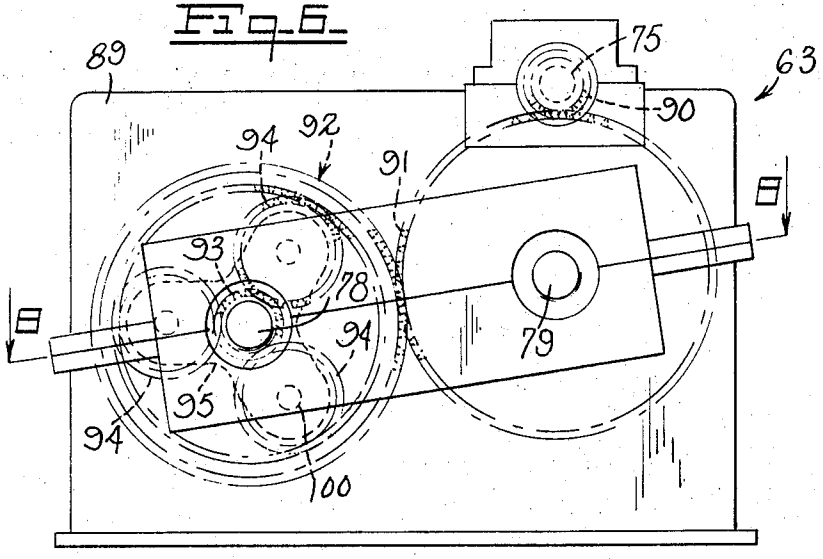


Fig. 7

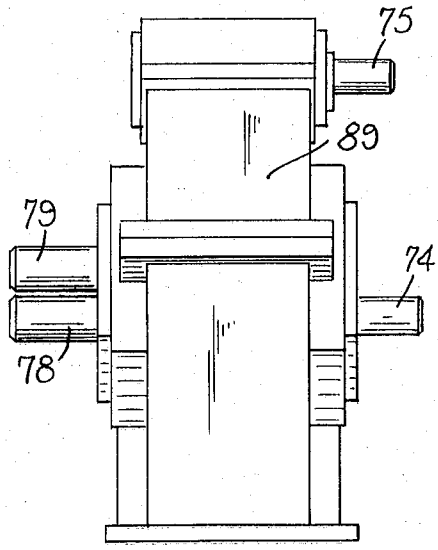
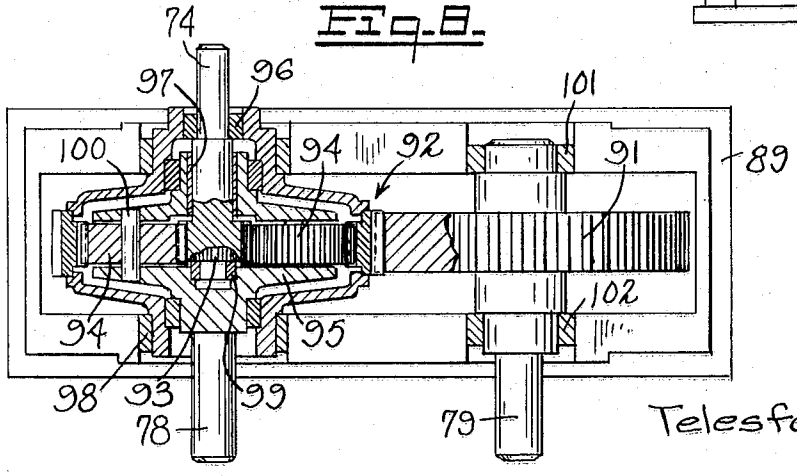


Fig. 8



INVENTOR
Telesfore Rastelli

BY Dorlo and Montgomery
ATTORNEYS

MULTIPLE ROLL BRIDLE SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to multiple roll bridling apparatus for use in metal working or processing. More particularly, this invention relates to bridling apparatus for use in tension leveling lines.

In multiple roll bridle systems, generally comprising a set of entry bridle rolls and a set of exit bridle rolls between which may be positioned a work station, it is desirable to be able to adjust and control the speed of each roll in each set, relative to the other rolls, in order to permit maximum alteration and control of tension between the individual rolls and the sets of rolls. For this same reason and also to conserve space, it is desirable that the diameters of the individual rolls need not be identical.

Bridling apparatus is known in which the entry bridle rolls are geared together by a first set of meshing spur gears and the exit bridle rolls are geared together by a second set of spur gears. The speed of the entry bridle rolls may then be altered relative to the speed of the exit bridle rolls. However, this system requires that all entry bridle rolls rotate at one speed while all the exit bridle rolls rotate at another selected speed, thus requiring matched sets of bridle rolls and therefore not permitting maximum alteration of strip tensions.

Other bridling apparatus is known in which some of the rolls in the entry and exit sets are driven independently of the others. Such systems require that some of the rolls have matched diameters. Accordingly, such systems, in which multiple rolls are driven at the same speed, do not permit maximum alteration of strip tension.

It is also known to provide adjustability of the speed of each roll in each set of entry and exit rolls through a differential gearing system and infinitely variable speed transmission. Such apparatus permits the use of rolls of unmatched diameters and also provides maximum alteration of strip tensions. However, the known systems of this type require expensive mechanical components, are difficult to adjust, and the power requirements tend to be excessive and inefficient.

A similar result is obtained in bridling apparatus in which the rolls are independently driven as by electric motors. Independent speed and adjustment of each roll is permitted but such systems require costly electrical components.

OBJECTS AND SUMMARY

An object of the invention therefore is to provide bridling apparatus in which the speed of each bridle roll of the entry and exit rolls is independently adjustable and controllable.

Another object is to provide bridling apparatus in which the individual rolls may have the same or different diameters in order to facilitate adjustability of speed and to achieve a saving in space.

A further object of the invention is to provide bridling apparatus by which maximum and efficient alterability of strip tension and/or drag may be achieved with minimum power capacity requirements.

An additional object is to provide bridling apparatus in which all or a major part of the power may be mechanically circulated from the drag bridle to the tension bridle whereby the total horsepower requirements

are less than are required where the rolls are individually motor driven.

A still further object is to provide bridling apparatus utilizing easily adjustable and relatively simple gearing components.

These and other objects, features and advantages of the invention will in part be obvious and will in part be apparent from the specification.

Briefly, the present invention is a bridling apparatus comprising the combination of a set of entry rolls; a set of exit rolls; first plural independent drive means providing power input to a plurality of corresponding rolls in each of the sets of rolls; and second drive means providing common power input to a plurality of rolls in each of the sets of rolls. The second drive means preferably includes a single electric motor providing dual power takeoffs to corresponding dual planetary gear systems, through a gear train including infinitely variable speed transmission means, differential transmission means, and an overload clutch. Each planetary gear system preferably includes a pinion gear for transmitting the dual power takeoffs, planetary gears, and a spur gear, wherein the planetary gears include a sun gear, a plurality of planet gears and a spider.

The invention accordingly comprises the features of construction, combinations of elements, and arrangements of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

DETAILED DESCRIPTION

For a fuller understanding of the nature and objects of the invention, reference is had to the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a top plan view of a first embodiment of bridling apparatus of the invention;

FIG. 2 is a side elevation of the bridling apparatus of FIG. 1;

FIG. 3 is a partially sectioned, enlarged side elevation of a portion of the apparatus of FIG. 1;

FIG. 4 is a horizontal section along the line 4—4 of FIG. 3, partially broken away to show underlying structure;

FIG. 5 is a top plan view of a second embodiment of bridling apparatus of the invention;

FIG. 6 is a partially sectioned, enlarged side elevation of a portion of the apparatus of FIG. 5;

FIG. 7 is an elevation of the portion of apparatus of FIG. 6, viewed from the right side of FIG. 6; and

FIG. 8 is a horizontal section along the line 8—8 of FIG. 6, partly broken away to show underlying structure.

For the purposes of this specification, a distinction is made between the terms "planetary gear systems," "planetary gearing" and "planet gears." The first term is generic and includes any system utilizing planetary gearing as at least one of its components. The second term means epicyclic gearing, and the third term means a spur gear utilized in epicyclic gearing.

Referring to FIGS. 1–4, a first embodiment of the bridling apparatus 10 of the invention comprises, as component systems, entry bridle 12, exit bridle 13, a portion of strip 14 passing through the bridling apparatus, a work station 15, and a motor 16 operating through a differential gear system 17. The differential gear system 17 provides power input to dual planetary gear systems

18. The electric motor 16 provides dual power takeoffs to planetary gear systems 18. However, the resulting total power input to the planetary gear systems 18 is augmented by input from electric motors 19, 20 and 21. When the bridling apparatus is designed for strip leveling, it is preferred that the sequence of passage of the strip 14 over the rolls, assuming movement from right to left as indicated in FIG. 1, is as shown, namely, in numerical sequence through rolls 22, 23, 24 and 25. Preferably for strip leveling, rolls 22 and 23 are low torque rolls and rolls 24 and 25 are high torque rolls. As will become evident, however, the diameters of the individual rolls and the power input to the rolls, and therefore torque, may be widely varied in accordance with the metal working or metal processing involved. Accordingly, the work station 15 may provide space for a leveler, a skin pass mill, a looping pit, or various types of metal deforming apparatus. In the case of strip leveling, it is common to refer to the entry bridle as the "drag" bridle and the exit bridle as the "tension" bridle. However, the forces applied by the entry and exit bridles may be widely varied from zero tension or drag, for example when a pinch roll is used, to a relatively high difference in tension between the two sets of rolls. One of the advantages of the invention is the variability of such conditions to meet the particular requirements of the processing involved.

The entry and exit bridles are normally provided with a housing 26 and the motors 19, 20 and 21 are provided with reduction gear boxes 27, 28 and 29, respectively. As indicated in FIG. 1, power transmission from motors 19, 20 and 21 is through input shafts 30, 31 and 32 and power output from the dual planetary gear systems 18 is via separate output shafts 33, 34, 35 and 36, to the individual rolls in each set of bridles. The motors 19, 20 and 21 thus provide independent drive means by reason of the four takeoffs from each of the dual planetary gear systems 18.

The second drive means of the bridling apparatus in the invention provides power input to the dual planetary gear systems 18 via input shafts 37. In turn it will be noted that the power transmission through shafts 37 is via components of the differential gear system 17, namely, spiral bevel gears 38 and 39, a shaft support 40, an overload clutch 41, a spur gear box 42, an infinitely variable speed transmission unit 43 and a differential gear transmission unit 44.

FIGS. 3 and 4 illustrate details of the planetary gearing systems 18, here represented by the planetary gear system associated with the entry bridle (the bridle on the right side of the drawing of FIG. 1). With reference thereto, it will be noted that the power input via shaft 37 is to a pinion gear 45, and thence to three planetary gears 46, 47 and 48. The latter gears each comprise a sun gear 50, a plurality of planet gears 51 (here shown as three such gears), and an arm or spider 52 (here shown as a three-membered arm). As is evident from FIGS. 3 and 4, the power output from the four gears comprising the planetary gear system 18 is via output shafts 33, 34, 35 and 36. Other components of each of the planetary gears 46, 47 and 48 are shown in FIG. 4, these including bearings 53, 54, 55 and 56, and axle 57.

It will thus be apparent that by reason of the dual power takeoffs from the common motor 16 through the differential gear system 17 and the planetary gear system 18, the latter as augmented by the independent power inputs provided by motors 19, 20 and 21, the speed of the individual rolls may be independently controlled for maximum alteration of strip tensions, and matched diameters of rolls need not be employed.

A second embodiment of the invention is illustrated by FIGS. 5–8. With reference thereto, the bridling apparatus 11 includes, as component systems, an entry bridle 58 and exit bridle 59, a work station 60, a motor 61, providing common power input via differential gear system 62. The differential gear system in turn provides dual power takeoffs from motor 61 to dual planetary gear systems 63.

To the foregoing extent the bridling apparatus of FIG. 5 is essentially similar to that of FIG. 1. The differences will become apparent in the description to follow.

It will first be noted that motors 64 and 65 provide power input to rolls 67 and 68 in entry bridle 58 and exit bridle 59, totally independently of planetary gear systems 63. When the bridling apparatus is used for alteration of strip tensions, rolls 67 and 68 are also termed "low torque" rolls and rolls 69 and 70 are termed "high torque" rolls. Motors 64, 65 and 66 are operative through reduction gear boxes 71, 72 and 73, respectively. Power transmission to the low torque rolls 67 and 68 is via input shafts 76 and 77 and output shafts 80 and 81, and the power transmission to planetary gear systems 63 is via input shafts 74 and 75. Transmission from planetary gear systems 63 to the high torque rolls 69 and 70 is via separate output shafts 78 and 79, respectively.

The differential gearing system 62, providing dual power takeoffs from motor 61, includes spiral bevel gears 82 and 83, a shaft support member 84, an overload clutch 85, a spur gear box 86, an infinitely variable speed transmission unit 87 and differential gear transmission unit 88.

FIGS. b–8 illustrate in enlarged detail the components of planetary gear system 63 (the right planetary gear system in FIG. 5). It will be noted that the planetary gear system 63 is contained in a housing 89 and that power transmission from motor 61 is via input shaft 75 to a pinion gear 90. Pinion gear 90 engages a spur gear 91 which in turn engages a planetary gear 92 comprising a sun gear 93, a plurality of planet gears 94 (here, three in number), and an arm or spider 95 (here shown as having three members). Also shown as components of planetary gear 92 are bearings 96, 97 and 98, and axle 100 for planet gear 94. Associated with spur gear 91 are bearings 101 and 102. It will be noted that output from the planetary gearing system 63 is via shaft 79, from spur gear 91, and shaft 78 from planetary gear 92.

The foregoing second embodiment provides for individual speed adjustment for each roll but, as compared with the bridling apparatus of the first embodiment of the invention, is somewhat less costly since it requires only one planetary gear for each planetary gear system as compared with three planetary gears for each of the planetary gear systems of the first embodiment.

Illustrative of the efficiency in alterability provided by the bridling apparatus of the invention is a bridling apparatus of FIGS. 1–4 in which the planetary gears in the planetary gearing systems 18 provide reduction ratios of 5:1, and the spur gears therein provide reduction ratios of 6:1. For such planetary gearing systems, if the torque input to planetary gear 46 is 44,000 lbs. inches at 48 rpm., the output is 218,000 lbs. inches at 48 rpm.,

and if the input via pinion gear **45** is 150,000 lbs. inches at 288 rpm., the output from shaft **35** of spur gear **49** is 625,000 lbs. inches at 48 rpm. Variability in the other planetary gears in the planetary gear system **18** is possible. For example, if the input to planetary gear **47** is 8,000 lbs. inches at 48 rpm., the output is 40,000 lbs. inches at 48 rpm., and if the input to planetary gear **48** is 16,000 lbs. inches at 48 rpm., the output is 80,000 lbs. inches at 48 rpm.

Similarly, the bridling apparatus of FIGS. **5–8** may provide variability and independent control of roll speeds. For example, if planetary gear **92** provides a 5:1 reduction ratio, a power input thereto of 44,000 lbs. inches at 48 rpm. would provide an output therefrom via shaft **78** of 218,000 lbs. inches at 48 rpm. Also, in the same planetary gearing system **63,** if the reduction ratio provided by the combination of pinion gear **90** and spur gear **91** is 6:1, and if the input to pinion gear **90** via shaft **75** is 133,500 lbs. inches at 288 rpm., an output is provided via shaft **79** of 625,000 lbs. inches at 48 rpm. Each of motors **64** and **65** and corresponding reduction gears **71** and **72,** may be chosen as to power and reduction ratios for most efficient coordination with the other power inputs and gearing of the apparatus.

Accordingly, it is apparent that very substantial variability of seeds, and independent control thereof, may be obtained with the bridling apparatus of the invention, with consequent savings in power requirements.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. In a bridling apparatus, the combination of:
a set of entry rolls;
a set of exit rolls;
first, plural, independent drive means providing power input to a plurality of corresponding rolls in each said sets; and
second drive means providing common power input to a plurality of rolls in each said sets;
wherein said second drive means is adapted to provide, through a gear train including infinitely variable speed transmission means and differential transmission means, dual power takeoffs to corresponding dual planetary gear systems, and said first, plural, independent drive means are geared through said dual planetary gear systems.

2. Bridling apparatus according to claim **1** wherein said second drive means includes a single electric motor and said gear train includes an overload clutch.

3. Bridling apparatus according to claim **1** wherein each said planetary gear system comprises a pinion gear for transmitting said dual power takeoffs, planetary gears in the number of one less planetary gear than the number of rolls in each said sets of entry rolls and exit rolls, and a spur gear; said planetary gears including a sun gear, a plurality of planet gears, and a spider.

4. Bridling apparatus according to claim **3** wherein said sets of rolls comprise four entry rolls and four exit rolls, each said set of rolls comprising two high torque rolls and two low torque rolls, and wherein the power input to each said planetary gear system is from electric motors corresponding to each of said low torque rolls and electric motors corresponding to one of the high torque rolls in each set of entry and exit rolls.

5. Bridling apparatus according to claim **1** wherein said first drive means includes reduction gears to said planetary gear systems providing a 20:1 reduction ratio, and wherein said planetary gear systems provide reduction ratios of 5:1 through each of the planetary gears and 6:1 through the spur gear.

6. In a bridling apparatus, the combination of:
a set of entry rolls comprising two high torque rolls and two low torque rolls;
a set of exit rolls comprising two high torque rolls and two low torque rolls;
first, plural, independent drive means providing power input to each of said input and exit rolls through four power takeoffs from each of two planetary gear systems, one of said planetary gear systems being geared to said set of entry rolls and the second of said planetary gear systems being geared to said set of exit rolls; and
second drive means adapted to provide dual power takeoffs to each of said planetary gear systems, through a gear train including an overload clutch, infinitely variable speed transmission means and differential transmission means;
wherein said first drive means includes three motors for each said set of entry rolls and exit rolls, and reduction gearing from each said motors to said planetary gear systems;
wherein said planetary gear systems each include a pinion gear for transmitting said dual power takeoffs, three planetary gears and a spur gear; and
wherein said planetary gears include a spun gear, a plurality of planet gears, and a spider.

7. In a bridling apparatus, the combination of:
a set of entry rolls;
a set of exit rolls;
first, plural, independent drive means providing power input to a plurality of corresponding rolls in each said sets; and
second drive means providing common power input to a plurality of rolls in each said sets;
wherein said second drive means is adapted to provide, through a gear train including infinitely variable speed transmission means and differential tansmission means, dual power takeoffs to corresponding dual planetary gear systems, and one of said first, plural, independent drive means is geared through each of said dual planetary gearing systems.

8. Bridling apparatus according to claim **7** wherein said planetary gearing systems each include a pinion gear, a planetary gear, a spur gear, and a pinion gear which engages said spur gear for transmitting power from said first drive means to said planetary gearing systems.

9. Bridling apparatus according to claim **8** wherein said planetary gear includes a sun gear, a plurality of planet gears, and a spider.

10. Bridling apparatus according to claim 8 wherein said spur gear and planetary gears are adapted to provide power input to high torque rolls in each said sets of entry and exit rolls.

11. Bridling apparatus according to claim 7 wherein the others of said first, plural independent drive means include reduction gears, and said first drive means actuate low torque rolls in each said sets of entry and exit rolls.

12. Bridling apparatus according to claim 11 wherein said reduction gears each provide 21:5:1 reduction ratios.

13. Bridling apparatus according to claim 7 wherein the planetary gear reduction ratio is 5:1 and the pinion gear reduction ratio is 6:1.

14. Bridling apparatus according to claim 7 wherein said one of the first, plural, independent drive means includes a reduction gear providing a reduction ratio of 20:1.

15. In a bridling apparatus, the combination of:

a set of entry rolls comprising two high torque rolls and two low torque rolls;

a set of exit rolls comprising two high torque rolls and two low torque rolls;

first, plural, independent drive means providing power input to each of said low torque rolls;

second drive means adapted to provide dual power takeoffs to dual planetary gear systems, through a gear train including an overload clutch, infinitely variable speed transmission means and differential transmission means;

wherein said planetary gear systems each include a pinion gear transmitting said dual power takeoffs, a planetary gear, and a spur gear; and

wherein said planetary gear includes a sun gear, a plurality of planet gears, and a spider.

16. Bridling apparatus according to claim 7 wherein said second drive means includes a single electric motor and said gear train includes an overload clutch.

* * * * *