

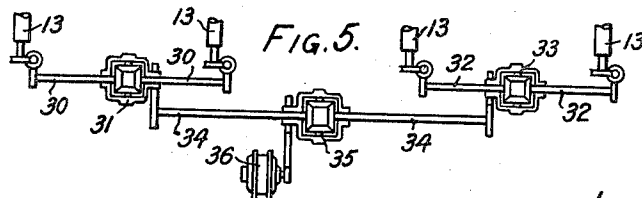
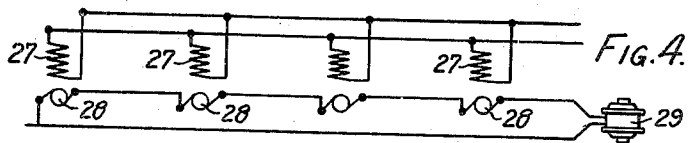
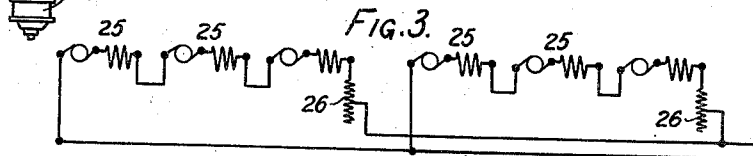
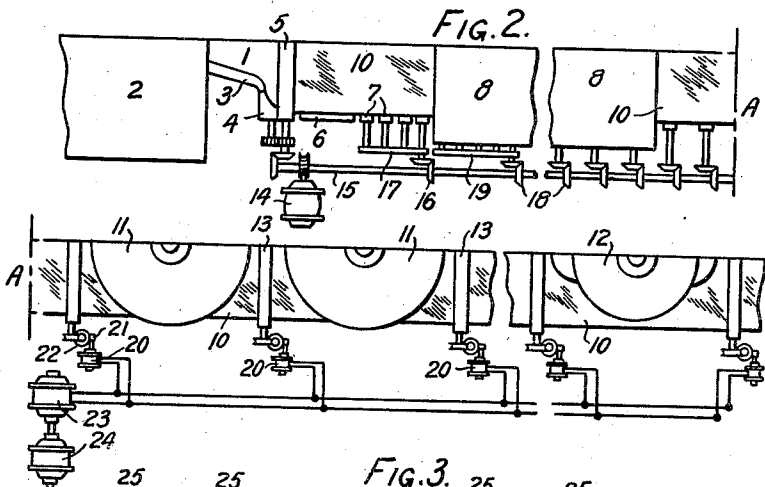
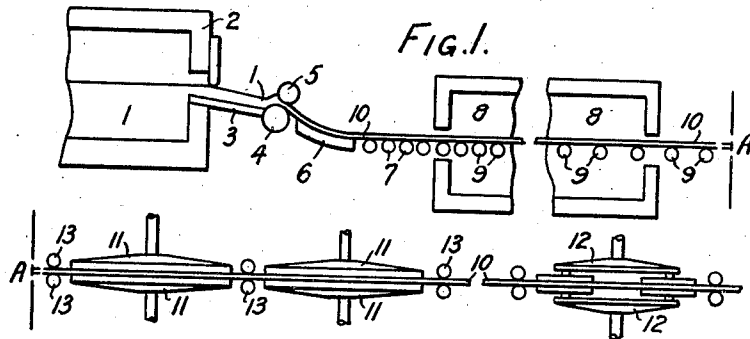
Jan. 20, 1942.

F. B. WALDRON ET AL

2,270,362

APPARATUS FOR PRODUCING GROUND OR POLISHED GLASS STRIP

Filed March 17, 1938



INVENTORS,
Frederic Barnes Waldron
Patrick Macintosh Hogg
Granville Hugh Baillet
By Morrison, Kennedy & Campbell
Attorneys.

UNITED STATES PATENT OFFICE

2,270,362

APPARATUS FOR PRODUCING GROUND OR
POLISHED GLASS STRIP

Frederic Barnes Waldron, Prescott, Patrick Mackintosh Hogg, St. Helens, and Granville Hugh Baillie, London, England, assignors to Pilkington Brothers Limited, Liverpool, England, a British company

Application March 17, 1938, Serial No. 196,418
In Great Britain March 17, 1937

8 Claims. (Cl. 51-112)

This invention relates to the production of ground or polished glass strip from the molten mass in a continuous process and has for its object means for driving the strip through the apparatus.

The type of apparatus to which the invention is applicable is that in which a continuous glass strip is formed from glass in a tank furnace, by a rolling machine or other means and is then passed through a lehr and is then passed through a grinding or grinding and polishing apparatus in which both sides of the strip are ground or ground and polished simultaneously.

In the following, the terms grinding apparatus or grinding tool will be used to include polishing apparatus and polishing tool.

The speed of formation of the strip is determined primarily by the speed of the rolling machine or other forming apparatus. Sometimes, however, the rollers on which the strip rests while still plastic are driven slightly faster than the strip issuing from the forming machine so as to stretch the strip, but in any case the strip is delivered to the lehr at a predetermined speed. The lehr rollers are driven at this speed or groups of them are driven at speeds of which the average is this speed. The small differences in diameter which necessarily exist in the rollers do not lead to any difficulty, because the strip rests on the rollers by its weight and any roller having a diameter such that its peripheral speed differs from that of the strip, is able to slip on the strip. In the grinding apparatus, however, in which the strip is driven by rollers located in the space between one pair of grinding tools and the adjacent pairs, a considerable tractive force must be applied to the strip by the rollers in order to overcome the frictional resistance between the strip and the grinding tools. Sufficient force can be applied only by pairs of rollers pressed together, to grip the strip. These rollers, therefore, cannot slip to compensate for small differences in diameter, at any rate until the tension or compression in the strip is considerably greater than the normal.

In apparatus heretofore constructed, the driving rollers in the grinding machine have been driven at a rate of revolution which bears a constant ratio to that of the lehr rollers. Since the strip contracts between the lehr and the grinding machine because it cools, the rate of revolution of the rollers in the grinding machine has been such as to give a peripheral speed as nearly as possible equal to the speed of the strip in the grinding apparatus which is less than the above-

mentioned predetermined speed of the strip. It is, of course, impossible to avoid small differences in diameter in the rollers, and the tension and compressions which result from them have in practice caused breakage of the strip, either by direct tensile break or as the result of buckling the strip.

According to the invention, one or both of the rollers of each pair of gripping rollers in the grinding apparatus is driven by means which exercise a predetermined torque on the rollers. Each pair of rollers may be driven by an induction motor, all the motors being supplied preferably by an alternator, and means for driving the alternator at a constant, but adjustable speed. Alternatively, each pair of rollers may be driven by a direct current series motor, all the motors or groups of motors being connected in series to the mains through an adjustable resistance. Alternatively, each pair of rollers may be driven by a direct current shunt motor, of which the shunt is connected to the mains, while the armatures of all the motors are connected to a source of constant current. Instead of each pair of rollers being driven by an independent motor, one motor may drive a plurality of pairs of rollers, differential gears being included in the driving means so that the total torque of the motor is equally distributed between the pairs of rollers.

In the accompanying drawing:

Figure 1 is a diagrammatic side view of a strip producing apparatus, the part A in the upper part of the figure being continued at A' in the lower part;

Figure 2 is a half plan view thereof; and

Figures 3, 4 and 5 show diagrammatically alternative methods of driving the rollers.

Referring to Figures 1 and 2, the molten glass 1 in the tank furnace 2 flows down the spout 3 to the rolling apparatus with rollers 4, 5. The strip 10 formed in the rolling apparatus passes over the bed 6 on to the roller bed 7 and then into the lehr 8, in which it rests on the roller bed 9. From the lehr 8, the strip passes between pairs of grinding tools 11 and pairs of polishing tools 12, these tools operating simultaneously on the two surfaces of the strip 10. Between the tools are located pairs of rollers 13 which grip the strip 10 between the rollers of each pair, and are driven by means hereinafter described to drive the strip between the tools.

A variable speed motor 14 drives the shaft 15, which drives the rolling apparatus 4, 5, at a predetermined speed. The shaft 15 also drives the

rollers 7 through the bevel gears 16 and the chain 17, and the lehr rollers 9 through bevel gears 18, either directly or through chains 19. The pairs of rollers 13 in the grinding and polishing apparatus are driven each by an independent induction motor 20, through worm shafts 21 and 22. All the motors 20 are driven by an alternator 23, which is driven at constant, but adjustable, speed by a motor 24.

The strip 10, at or near the entrance to the lehr 8, travels at a speed determined by the motor 14, and, in the grinding apparatus it travels at a speed which is lower, by reason of the contraction of the strip, but bears a constant ratio to the speed determined by the motor 14. By means of the arrangement shown, the peripheral speed of all the rollers 13 is the speed of the strip, although their speed in revolutions per minute differs in consequence of the inevitable small differences in their diameters. At the same time the torque exerted on all the pairs of rollers 13 is substantially the same. Thus, suppose that the rollers 13 are 10 inches in diameter and that they are made correct to size within 0.01 inch. A roller 0.01 inch larger than the adjacent rollers will turn one-tenth of one per cent slower in revolutions per minute, and this corresponds, in ordinary induction motors, to about one per cent higher torque. Since variations in torque of even 10% are of no importance, the motors 20 drive the strip with substantially constant torque in spite of inevitable difference in diameter.

If now the speed of the strip is varied, for instance, to produce glass of different thickness, by varying the speed of the motor 14, the frequency of the supply to the motors 20 is correspondingly varied, by varying the speed of the motor 24, and the rollers 13 turn with substantially constant torque at the different speed of the strip. The torque exerted by all the motors 20 may be adjusted by adjusting the speed of the alternator 23, and it may be adjusted so that there is any desired small tension or compression, in the strip between the lehr and the grinding apparatus, as ascertained by a polarised light strain viewing apparatus at this portion of the strip.

Figure 3 shows an alternative to the induction motors 20, a group of direct current series motors 25 each driving a pair of rollers 13 being connected in series to the mains through a rheostat 26. In this case the torque on each pair of rollers is determined by the current through the motors and, within the limits in practice, is nearly independent of the speed of the strip. The torque may be adjusted by the rheostat 26.

Figure 4 shows another alternative, using shunt motors, of which the field coils 27 are connected to the mains, while the armatures 28 are connected to a source of constant but adjustable current, which may be a constant current dynamo 29, or may be an automatic regulating device taking current from the mains.

Instead of employing an independent motor to drive each pair of rollers 13, a group of pairs of rollers may be driven by a single motor through differential gears, as in Figure 5. Two pairs of rollers 13 are connected together by shafts 30 with differential gear 31, and two other pairs of rollers are connected together by shafts 32 with differential gear 33. The two differential gears 31 and 33 are connected by shafts 34 with differential gear 35, and this is driven by a single motor 36. Thereby the torque exerted by the motor 36 is evenly distributed between the four

pairs of rollers 13, even though their speeds in revolutions per minute differ slightly. In a similar way, a single motor may be employed to drive two pairs of rollers or eight pairs of rollers.

Preferably, both rollers of each pair of rollers are positively driven, as by the worm shaft 22, but the invention is applicable when only one roller of each pair is positively driven.

Having described our invention we declare that what we claim and desire to secure by Letters Patent is:

1. In a glass grinding apparatus of the type in which a continuous strip of glass is advanced to and through the apparatus from a lehr entrained with a continuous strip forming machine and in which the speed of advance of the continuous strip through the grinding apparatus is determined by the speed of formation of the strip, the combination of a plurality of pairs of strip-gripping rollers located at intervals along the length of the grinding apparatus for applying a tractive force to the advancing strip sufficient to overcome the frictional resistance between the strip and the grinding tools, the rollers of each pair contacting with the opposite sides of the advancing strip, and a plurality of constant torque motors connected to the strip-gripping rollers, at least one roller of each pair being connected to an independent motor of the plurality.

2. In a glass grinding apparatus of the type in which a continuous strip of glass is advanced to and through the apparatus from a lehr entrained with a continuous strip forming machine and in which the speed of advance of the continuous strip through the grinding apparatus is determined by the speed of formation of the strip, the combination of a plurality of pairs of strip-gripping rollers located at intervals along the length of the grinding apparatus for applying a tractive force to the advancing strip sufficient to overcome the frictional resistance between the strip and the grinding tools, the rollers of each pair contacting with the opposite sides of the advancing strip, a plurality of induction motors connected to the strip-gripping rollers, at least one roller of each pair being connected to an independent motor of the plurality, an alternator connected to all the motors and a motor driving the alternator at constant but adjustable speed.

3. In a glass grinding apparatus of the type in which a continuous strip of glass is advanced to and through the apparatus from a lehr entrained with a continuous strip forming machine and in which the speed of advance of the continuous strip through the grinding apparatus is determined by the speed of formation of the strip, the combination of a plurality of pairs of strip-gripping rollers located at intervals along the length of the grinding apparatus for applying a tractive force to the advancing strip sufficient to overcome the frictional resistance between the strip and the grinding tools, the rollers of each pair contacting with the opposite sides of the advancing strip, a plurality of direct current motors connected to the strip-gripping rollers at least one roller of each pair being connected to an independent motor of the plurality and means for supplying the armatures of all the motors with a constant but adjustable current.

4. In a glass grinding apparatus of the type in which a continuous strip of glass is advanced to and through the apparatus from a lehr entrained with a continuous strip forming machine and in which the speed of advance of the con-

tinuous strip through the grinding apparatus is determined by the speed of formation of the strip, the combination of a plurality of pairs of strip-gripping rollers located at intervals along the length of the grinding apparatus for applying a tractive force to the advancing strip sufficient to overcome the frictional resistance between the strip and the grinding tools, the rollers of each pair contacting with the opposite sides of the advancing strip and at least one roller of each pair being driven, and each roller in the plurality being free to turn, whatever its diameter, at a peripheral speed corresponding to the speed of advance of the strip, and driving means for the driven rollers operating to apply a predetermined constant torque to each driven roller and to maintain its constancy during variations in the revolutions per minute of any one driven roller relative to the revolutions per minute of another driven roller, said driving means being adjustable to regulate the value of said predetermined constant torque.

5. In a glass grinding apparatus of the type in which a continuous strip of glass is advanced to and through the apparatus from a Lehr entrained with a continuous strip forming machine and in which the speed of advance of the continuous strip through the grinding apparatus is determined by the speed of formation of the strip, the combination of a plurality of pairs of strip-gripping rollers located at intervals along the length of the grinding apparatus for applying a tractive force to the advancing strip sufficient to overcome the frictional resistance between the strip and the grinding tools, the rollers of each pair contacting with the opposite sides of the advancing strip, a driving shaft for each pair of rollers, a single shaft connected to each pair of driving shafts through a differential gear, and driving means for the single shafts operating to apply a predetermined constant torque to each single shaft and to maintain its constancy during variations in the revolutions per minute of any one single shaft relative to the revolutions per minute of another single shaft.

6. In a glass grinding apparatus of the type described in which a continuous strip of glass is advanced to and through the apparatus at a speed determined solely by its advancing means, the combination of a plurality of strip-gripping rollers located at intervals along the length of the grinding apparatus for applying a tractive force to the advancing strip sufficient to overcome the frictional resistance between the strip and the grinding tools, the rollers of each pair

contacting with the opposite sides of the advancing strip and at least one roller of each pair being driven, and each roller in the plurality being free to turn, whatever its diameter, at a peripheral speed corresponding to the speed of advance of the strip, and driving means for the driven rollers operating to apply a predetermined constant torque to each driven roller and to maintain its constancy during variations in the revolutions per minute of any one driven roller relative to the revolutions per minute of another driven roller.

7. In a glass grinding apparatus of the type in which a continuous strip of glass is advanced to and through the apparatus from a Lehr entrained with a continuous strip forming machine and in which the speed of advance of the continuous strip through the grinding apparatus is determined by the speed of formation of the strip, the combination of a plurality of groups of pairs of strip-gripping rollers located at intervals along the length of the grinding apparatus for applying a tractive force to the advancing strip sufficient to overcome the frictional resistance between the strip and the grinding tools, the rollers of each pair contacting with the opposite sides of the advancing strip, a plurality of constant torque motors, and gearing connecting at least one roller of each pair of rollers to an independent motor of the plurality, each motor being adapted to maintain the constancy of its torque during variations in the speed of the gearing of any one group relative to that of another group.

8. In a glass grinding apparatus of the type described in which a continuous strip of glass is advanced to and through the apparatus at a speed determined solely by its advancing means, the combination of a plurality of pairs of continuously-acting members for applying a tractive force to the advancing strip, operative at a plurality of points in the length of the strip, sufficient to overcome the frictional resistance between the strip and the grinding tools, and driving means for at least one of the members of each pair of said continuously-acting members, each driving means operating to apply to the driven of each pair a predetermined constant torque which is substantially constant and equal at all points of the said plurality.

FREDERIC BARNES WALDRON.
PATRICK MACKINTOSH HOGG.
GRANVILLE HUGH BAILLIE.