A rotary screen printing machine comprising at least one thin-walled cylindrical stencil operative in a printing path defined by the upper flight of an endless belt guided along two turning wheels, at least one of which is positively driven, a pair of stiff rollers being in pressing contact with the belt in a position ahead of the stencils, one or both rollers and all the stencils being operatively connected to said driven turning wheel.
ROTARY SCREEN PRINTER AUXILIARY  
CONVEYOR DRIVE TO ELIMINATE CREEP  

CROSS-REFERENCE TO RELATED  
APPLICATIONS  

This application is a continuation-in-part application of U.S. Pat. Application Ser. No. 125,085, filed Mar. 17, 1971 for "ROTARY SCREEN PRINTING MACHINE" and now abandoned.  

BACKGROUND OF THE INVENTION  

1. Field of the Invention  

This invention relates to a rotary screen printing machine comprising at least one thin-walled cylindrical stencil which is operative in a printing path constituted by a driven endless belt or supporting blanket disposed around two turning wheels one of which is situated at the beginning and the other of which is situated at the end of the printing path, one of the wheels being provided with driving means and with a driving connection with each stencil. Such a machine is known in many embodiments.  

2. Prior Art  

In order to obtain an accurate printing, it was suggested in U.S. Pat. No. 3,420,167, issued on Jan. 7, 1969 to dimension the driving connection in such a manner that in the area of contact between each stencil and the belt, the linear velocity of the belt is slightly greater than the tangential velocity of the stencil. It was an object of this feature to avoid the detrimental consequences of the normally existing clearance or play in the driving means so as to minimize the changing of the friction forces between the material to be printed and the screens due to the force exerted on them by the squeegee, thereby increasing screen life. 

There remains, however, the small fluctuations of velocity of the belt, which occur owing to the fact that the composition of the belt is not fully homogeneous as a result of which the neutral plane or surface of the belt, which is that plane where the length of the belt remains unchanged and, hence, carries no stress, is not always at the same distance from the surfaces of the belt which is in contact with the turning wheel. This neutral plane indicates the area of the belt which on passing over the turning wheel is not subjected to a change of length. The material of the belt which is situated between the neutral plane and the outer surface of the belt away from the turning or driven wheel is tensioned, while the material inwards of the neutral plane toward the driven wheel is compressed. This causes a displacement of the belt along the circumference of the turning wheel relative to the turning or driven wheel which displacement or slippage between the belt and the driven wheel may be termed "creepl The direction of this "creepl depends on the tensile force produced in the upper and lower flight of the moving belt.  

SUMMARY OF THE INVENTION  

It is an object of this invention to eliminate or reduce the symptom of relative displacement of the belt and driven wheel. To that end the machine according to the invention is distinguished in that — as contemplated in the direction of advance of the belt — a rigid pair of rollers is provided at a location ahead of or upstream of the first stencil, at least one of the two rollers having a driving connection with the driven turning wheel and both rollers being adapted to be vigorously pressed toward each other, while the belt is lying between them.

Due to these features an area of line contact is formed between the belt and the rollers to allow the rollers and the belt to have an identical speed, the belt thereby attaining a speed which is equal to the tangential velocity of the driven roller. The "creepl situation of the belt due to the varying position of the neutral plane relative to the driven wheel no longer exerts any detrimental influence. Usually, when the neutral plane moves in an outward direction away from the driven turning wheel, which movement is due to manufacturing variations in the belt, as the belt moves over the circumference of the driven turning wheel, the linear speed of the belt increases. At the same time the tension in the upper flight, or running on part, between the driven turning wheel and the fixed position pair of rollers increases. This causes the "creepl occurring along the circumference of the driven turning wheel due to the compression in the portion of the belt between the neutral plane and the surface of the belt in contact with the driven turning wheel, to move in a direction contrary to the rotational direction of the driven wheel or toward the upper flight of the belt. This "creepl toward the upper flight of the belt in turn causes a decrease in the tension in the upper flight. On the other hand, when the neutral plane moves inward, or closer to the driven turning wheel, which is again due to manufacturing variances of the belt, the linear speed of the belt decreases, the tension in the upper flight decreases and increases in the lower flight. This causes the "creepl along the circumference of the driven turning wheel to move in the direction of rotation of the turning wheel, or toward the lower flight of the belt. The constant changes of fluctuations in the linear speed of the belt impairs the quality of printing produced on the printing machine. The pair of rollers located upstream of the first stencil insure a constant speed of the belt by functioning as auxiliary driving rollers to the driven turning wheel by forcing the upper flight portion of the belt to move at the desired constant speed.

It should be noted, that this effect could theoretically also be obtained by driving the supporting belt or blanket only via the pair of rollers. However, a considerable amount of power is required to drive the belt and it is not feasible with the line contact between the pair of rollers and the belt to develop the needed frictional forces to drive the belt using the rollers alone. The provision according to the invention, i.e., the combined drive by the turning or driven wheel and the pair of rigid rollers, eliminates entirely the harmful effect of the "creepl and requires supplying only a small amount of power to the pair of rollers.

For a more complete understanding of the present invention reference is made to the following detailed description and accompanying drawing.  

BRIEF DESCRIPTION OF THE DRAWING  

The drawing diagrammatically illustrates the most essential parts of a rotary screen printing machine embodying the principles of the invention.  

DESCRIPTION OF THE PREFERRED  
EMBODIMENT  

Now, with reference to the drawing, there is depicted a rotary screen printing machine. The depicted machine is provided with three thin-walled cylindrical
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stencils 1, which are operative in a printing path 2 constituted by a driven endless belt or supporting blanket 3, generally manufactured from rubber or the like, and which is disposed around two turning wheels 4 and 5. The wheel 4 is situated at the beginning and the wheel 5 at the end of the printing path 2. The turning wheel 5 is provided with driving means 6 and with a driving connection 7 to each stencil 1. In a manner analogous to that described in U.S. Pat. No. 3,420,167, the turning wheel 5 is driven by the means 6 via a worm gear 8. Each stencil 1 is driven via a worm gear 9 which in conformity with the above-mentioned patent is dimensioned with respect to the driving worm gear 8 such that a particular desired ratio of speed is obtained between the stencil and the belt in the printing area, i.e., the tangential velocity of each stencil is equal to the tangential velocity of the turning or driven wheel 5.

The provision according to the present invention consists of a pair of stiff or rigid rollers 10 and 11 which, as contemplated, in the direction of advance of the belt 3, are disposed ahead or upstream of the first stencil at the beginning of the printing path 2 opposite that end thereof at which the driven turning wheel 5 is located. The upper roller 10 has a driving connection 7 with the driven turning wheel 5, via a worm gear 12. The two rollers 10, 11 can be vigorously pressed towards one another, while the belt 3 is lying between these rollers thus exerting a force on the belt normal to the longitudinal axis of the belt to provide an adequate direction force between the rollers 10, 11 and the belt so as to cause the belt to have the same velocity as the rollers. The lower roller 11 has a diameter smaller than that of the roller 10. Furthermore, the tangential velocity of the roller 10 is equal to the tangential velocity of the wheel 5.

In practicing the present invention the rigid or stiff rollers 10, 11 are made from any suitable metal. Optionally, the metal may have a thin coating of any suitable hard plastic deposited thereon. The plastic coating increases the frictional contact between the rollers and the belt. The rollers may be either a solid mass or hollow. When the rollers are hollow they are provided with a wall thickness substantially greater than that of the stencils. Generally, stencils are thin-walled members having a wall thickness of about 0.003 inches. The wall thickness of the rollers hereof is greater than the thickness of the walls of the stencils. In this regard it is to be noted that the stencils are generally fabricated from nickel, the squeegees are generally fabricated from a thin strip of spring steel, and the counter-rollers below the belt 3 are usually manufactured from ordinary metal.

The rollers 10, 11 which are biased towards the belt exert a force or pressure on the belt normal to the longitudinal axis thereof ranging from about 1 to 2 kilograms per centimeter of width of the belt. Thus, for example, a belt having a width of 120 centimeters will have a pressure or force of from about 120 to 240 kilograms applied thereto at the area of contact of the rollers 10, 11. Because the rollers and the belt are dry at the area of contact, a great frictional resistance is generated between the rollers and the belt, i.e., no slip. The pressure exerted by the rollers 10, 11 is quite distinct from any pressures exerted by the stencils and their associated squeegees. The stencils, wheel 5 and the associated squeegee 14 do not exert any pressure on the belt. Rather, it is only the internal squeegee 14 which is pressed downwardly, however, the force applied to the squeegee when pressed downwardly is only of the magnitude of about 0.5 kilograms per centimeter of length. The counter-rollers apply an equal and opposite reaction force. However, there is little or no frictional force or resistance generated between the squeegee 14 and the inner surface of the rotating stencil associated therewith because of the printing paste under the convex face of the squeegee. The presence and use of the rigid rollers, as noted, eliminates any speed fluctuations or variations in the belt.

The arrangement is such that the stencils 1 are lying in the portion of the printing path 2 situated between the pair of rigid rollers 10, 11 and the driven turning wheel 5. The driven wheel 5 has a diameter which is at least 250 times the thickness a of the belt 3 to minimize fluctuations in the linear speed of the belt. In this embodiment the upper flight of the belt 3 can be considered as the so-called running-on part, while the lower flight of the belt 3 constitutes the running-off part. In this lower flight some tension rollers 13 are provided. A squeegee 14 is provided within each stencil 1. In operation the turning or driven wheel 5, the stencils 1 and the roller 10 are driven. The rollers 10, 11 drive the belt in conjunction with the driven wheel 5, i.e., they draw the lower flight of the belt 3 in the direction of the wheel 5. A certain tensile stress in the upper and in the lower flight of the belt 3 is produced, the tension in the upper flight normally being greater than in the lower flight. As a consequence of the inevitable unevenness in the composition of the belt 3, the neutral plane S, which is an imaginary surface interior to the belt 3 wherein the belt material remains unchanged in length as the belt is made to curve and hence a surface which carries zero stress will every now and then be closer or farther from the center 15 of the wheel 5. The neutral plane S represents the imaginary plane within the belt 3 which has a velocity corresponding exactly with the angular velocity of the turning wheel 5. Along the circumference of the wheel 5 the material of the belt 3 between the surface of the belt in contact with the wheel and the neutral plane S of the belt is compressed and the “creep” phenomenon occurs. When the neutral plane S shifts outwardly, due to the composition of the belt 3, the speed of the belt increases and the upper flight becomes more tensioned. Owing to the difference in tensile stress of the lower and upper flights of the belt 3, the “creep” will go longitudinally of the belt in the direction of the upper flight. As a consequence the tensile stress in this upper flight diminishes but in the lower flight it increases. As a result, the velocity of the belt adjusts itself in a correcting sense and becomes equal to the constant tangential velocity determined by the roller 10.

If a shifting of the neutral S occurs inwardly, the speed of the belt decreases and the tension of the lower flight will increase. The “creep” produced along the circumference of the turning wheel 5 advances longitudinally in the direction of the lower flight, an analogous effect, but in the opposite sense will be produced and finally a velocity of the belt will be obtained and maintained which corresponds exactly with the circumference of the belt 3 remaining unchanged.
then the diameter of the wheel 4 must be greater than
shown in the drawing but the arrangement of the pair
of rollers 10, 11 remains in conformity with the em-
bodiment described.

It is to be understood that by the practice of the pres-
ent invention, and due to the forces exerted by the rol-
lers 10, 11 on the belt, the traveling speed of the belt
is equal to the tangential speed of the rollers. More-
ever, the driven turning wheel, which is connected
to the driving means, operates the rollers responsively to
the speed at which the belt rotates around the driven
wheel. This responsive operation compensates for vari-
ations in the distance of the neutral plane of the belt
from the center of the driven wheel, thus, permitting
the belt to travel at a constant linear velocity.

Having thus described the invention, what is claimed
is:

1. A rotary screen printing machine comprising at
least one thin-walled cylindrical stencil mounted for ro-
national movement around its longitudinal axis and op-
eratively disposed in a printing path, two spaced apart
rotatably mounted turning wheels, an endless belt dis-
pensed about the two turning wheels having an upper
flight portion one surface of which constitutes the
printing path of the printing machine, driving means
operatively connected to one of the turning wheels, a
pair of rigid rollers being disposed in the upper flight
portion of the belt, one roller of said pair contacting the
printing path, and the other roller being disposed on
the opposite surface of the upper flight portion, each of
the rollers of the pair of rigid rollers being biased
toward the belt to exert a force thereon normal to the
longitudinal axis of the belt to eliminate slippage be-
tween the belt and the pair of rollers, driving means op-
eratively connected to at least one roller of the pair of
rollers, the turning wheel to which the driving means is
operatively connected and the pair of rollers cooperate
with each other to maintain at least in the upper flight
portion of the belt a constant linear velocity.

2. A rotary screen printing machine according to
claim 1 wherein said one roller of the pair of rigid rol-
lers which is disposed in the upper flight portion of the
belt has a larger diameter than said other roller of the
pair of rollers which is disposed on the opposite surface
of the upper flight portion of the belt.

3. A rotary screen printing machine according to
claim 1, wherein the diameter of the turning wheel to
which the driving means is operatively connected has
a larger diameter than the other turning wheel.

4. A rotary screen printing machine according to
claim 3, wherein the diameter of the turning wheel to
which the driving means is operatively connected is at
least 250 times the thickness of the belt.

5. The rotary screen printing machine of claim 1
wherein said pair of rigid rollers exerts a force on the
belt of 1 to 2 kilograms per centimeter of width of the
belt.

6. The rotary screen printing machine of claim 1
wherein the rollers comprise a metal having a hard
plastic coating deposited thereon.

7. A rotary screen printing machine comprising, in
combination:
a frame;
a drive turning wheel and an idler turning wheel ro-
tatably mounted on said frame in horizontally
spaced relation;
an endless belt trained about said turning wheels and
presenting an upper flight for supporting and carry-
ing along material to be printed upon;
at least one cylindrical stencil rotatably mounted on
said frame and extending transversely of said upper
flight of said belt and having a predetermined pat-
tern for engaging and printing upon said material
carried along by said belt;
one and only one pair of rigid pressure rollers con-
tacting said upper flight at a location which is be-
fore the location for any of said engaging and print-
ing upon said material carried along by said belt;
said rigid pressure rollers being firmly and vigorously
pressed towards each other while said endless belt
is disposed between said rollers for exerting a force
on said belt which is perpendicular to the longitudi-
nal axis of said belt so that the speed of said belt
will always be identical to the tangential speed of
said rigid pressure rollers;
drive means for rotating said drive turning wheel,
each said cylindrical stencil, and at least one of said
rigid pressure rollers;
one of said rigid pressure rollers having a diameter
which is larger than the diameter of the other one
of said rigid pressure rollers; and
said endless belt is moved by the combined drive of
said drive turning wheel and the driven rigid pres-
sure roller to eliminate the effect of creep between
said endless belt and said drive turning wheel.

8. A rotary screen printing machine according to
claim 7, wherein said pair of rigid pressure rollers ex-
erts a force on said endless belt of 1 to 2 kilograms per
centimeter of width of said endless belt.

9. A rotary screen printing machine according to
claim 7, wherein the diameter of said drive turning
wheel is at least 250 times the thickness of said belt
and is less than 300 times the thickness of said belt.

10. A rotary screen printing machine according to
claim 7, wherein said pair of rigid pressure rollers acts
on said belt in conjunction with said drive turning
wheel to move and control the speed of said belt and
to force said upper flight of said belt to move at a con-
stant speed.