ABSTRACT: The specification describes a foraminous printing apparatus in which a squeegee inside a screen or stencil cylinder is flexible in the direction of its length and is adapted to be attracted by a magnet placed under the screen cylinder.
ROTARY FORAMINOUS PRINTING MACHINE WITH
MAGNETICALLY ATTRACTIONS INTERNAL INKER

The present invention relates to foraminous printing such as
screen printing, stencil printing and film printing making use
of rotating screen or stencil cylinders. The invention is more
particularly concerned with squeegee arrangements which are
provided in the interior of the screen or stencil cylinder. Such
squeegees have a V-shape or wedge-shape in radial section
and engage the interior of the screen or stencil cylinder along
an edge so that during rotation of the screen or stencil cylinder
ink, that is to say the material which is to be applied by the
printing apparatus, is held in a mass on the upper side of the
squeegee and is pressed into the fine openings of the
screen or stencil through it passes, in accordance with the
image to be printed, onto paper, textile material, or other
sheets to be printed. In printing machinery with which the
present invention is concerned the sheets to be printed are
supported on a carrier which can for example be in the form of
a rotating rubber belt which moves under the rotating screen
or stencil cylinder while being itself supported by a rotary
roller.

In the context of such printing machinery arrangements
have already been proposed which include the use of a compression
spring, a loading weight, or a pneumatic device in order
to press the squeegee against the screen or stencil. Also
the use of magnetic force has previously been considered
holding rotary distributor or pressure rollers against screens or
stencils. Such pressure rollers are, just as is the case with
known squeegee mounts, rigid in the longitudinal direction
and therefore cannot adapt themselves to the unavoidable
unevenesses in the material to be printed and the carrier. In
such cases monks and friars result, that is to say the ink density
varies and the work cannot be used. In the case of the use
of screens or stencils woven from synthetic or natural fibers
instead of smooth metal stencils there is the further difficulty
that the intersecting warp and weft threads leave recesses
between them which make it difficult for a squeegee made of
a hard material to perform its proper function of pressing the
ink through the screen or stencil so that a sufficient quantity of
it is applied to the sheet to be printed. This difficulty with
screens or stencils woven from synthetic or natural fibers cannot
be overcome by the use of a higher pressure on the squeegee
and the only result of increasing pressure is to increase the
rate of wear of the thin screen or stencil material.

One object of the present invention is to provide a screen
printing machine comprising a horizontal rotary foraminous cylinder,
a horizontal rotary roller whose axis is parallel to that of the
cylinder, and which is adjacent to the cylinder for holding a
sheet to be printed against the cylinder for printing, a carrier
for guiding sheets to be printed between the cylinder and the
roller, a squeegee inside the cylinder, the squeegee being flexible
along its entire length and comprising material which can
be magnetically attracted, and magnet means in the roller for
attracting the squeegee.

It has been found with such an arrangement that the part of
the squeegee engaging the foraminous cylinder, that is to say
the screen or stencil cylinder, can adapt itself to differences in
level, it is to say to recesses and depressions, in the inside face
of the foraminous (that is to say screen or stencil) cylinder due
to unevenesses in the carrier, and possibly in the screen or
stencil material. Since the screen is extremely thin it is readily
deformed to adapt itself to unevenesses in the material to be
printed under the action of the edge of the squeegee. In this
manner good printed images are obtained and damage to the
comparatively delicate screen or stencil material is avoided. It
is also possible to print material which has a greater thickness
more satisfactorily than hitherto since although the magnetic
force may be somewhat weakened by the thickness of the material
to be printed, it is still sufficient to draw a flexible
squeegee effectively against the screen or stencil along the
whole of the length of the squeegee.

In accordance with a preferred form of the invention which
is more particularly suitable for metal screens or stencils, the
squeegee is made of sheet metal which is angled in radial sec-
tion so as to define an apical ridge which engages the inside of
the foraminous cylinder. The sheet metal can for example be
soft iron or another ferrous material which is capable of being
magnetically attracted.

In accordance with a further preferred feature of the inven-
tion, which is more particularly suitable for screens or stencils
of woven natural or synthetic fibers, the squeegee comprises
elastically soft, abrasion-resistant material which has a V-
shaped radial section so as to define an apical ridge engaging
the cylinder, and magnetic material. The soft material can for
example be rubber or synthetic resin and the magnetic materi-
als can be soft iron. In order to increase the flexibility of the
squeegee, the magnetic material can be divided up lengthways
into segments.

In accordance with a further preferred feature of the inven-
tion use is made of resilient means carrying the squeegee in the
cylinder so as to allow it to move bodily in a radial direction while preventing movement about the axis of the
cylinder. Mounting means for the squeegee can include hold-
ing arm means in the cylinder extending away from the axis of
the cylinder, and strip spring means which extends against the
direction of rotation of the cylinder from the holding means
to the squeegee and is fixed to the arm means and to the
squeegee. If required, strip means can be applied for loading
the arm means. An especially advantageous arrangement in
accordance with the invention is, however, one in which the
strip spring consists of a single piece of resilient strip metal
which extends from one or more holding arms in a direction
opposite to the direction of rotation of the foraminous
cylinder in a curved plane as far as the squeegee which is
attached to it. With this arrangement the flexibility of the
squeegee to adapt itself to the unevenesses is still further in-
creased.

In accordance with a still further preferred feature of the in-
vension the apparatus comprises a hollow shaft extending
coxially through the cylinder and carrying the holding means,
the shaft being arranged to act as a supply duct for printing
ink. With such an arrangement in which the ink extends under
the front part of the squeegee as far as the edge of the
squeegee which contacts the cylinder and therefore tends to
produce a wedging action on the squeegee owing to the rota-
tion of the cylinder, there is no net upward thrust on the
squeegee since the dragging of the squeegee against the
cylinder and the tangential component of the thrust exerted
by the ink are converted into a downward thrust owing to the
particular arrangement of the strip spring extending from the arm
means in a direction opposite to the direction of rotation of
the cylinder. Therefore, if there is an increase in the resistance
offered by the ink in front of the squeegee, it is not necessary
to apply any additional force urging the squeegee against the
cylinder since the downward thrust on the squeegee is in-
creased so as to overcome the upward force exerted to the
wedging action of the ink under the front part of the
squeegee upstream from its edge which contacts the cylinder.
It is thus possible to consider the arrangement as amplifying
the force provided by the magnetic means since the downward
thrust on the squeegee initially depends upon the magnetic
force, and this upward thrust is increased by ink resistance in
the cylinder so that the thrust is amplified proportionally. In
this manner setting of the squeegee so that it only applies
light pressure in the stationary condition of the cylinder is suf-
ficient for applying sufficient ink through the cylinder for the
production of a high quality image.

Further features of the invention will be gathered from the
following particular description.
Embodiments of the invention are now described with reference to the accompanying drawings.

FIG. 1 shows a screen printing machine with a screen or stencil cylinder and a squeegee arrangement embodying the invention in accordance with the section line I-1 of FIGS. 2 and 3.

FIG. 2 is a transverse section on a larger scale of the screen printing machine, following the line II-II of FIG. 1.

FIG. 3 is a diagrammatic side view of a screen printing installation with three screen cylinders in a tandem arrangement.

FIG. 4 is a partial section through a modified form of squeegee arrangement.

FIG. 5 is a partial perspective view and section of a squeegee forming part of an embodiment generally similar to that of FIG. 4 but in which the magnetic armature is segmented.

The part of a screen printing machine shown in FIGS. 1 and 2 is more especially adapted for use with metal screens or stencils which are preferably in the form of screen cylinders 1 made of thin metal sheet perforated in accordance with the image to be printed. Each screen cylinder 1 is carried at both ends by the flanges of two end plates 2 and 3 which are journaled by means of ball of needle bearings 4 on a stationary hollow shaft 5 which passes through the cylinder lengthways. The hollow shaft 5 is carried at positions opposite to the end plates 2 and 3 by stands 6. The cavity or bore 7 in the hollow shaft 5 is closed at both ends by means of plates 8 and is connected by means of a hose connection 9 with a container 10 filled with printing ink 11. The hollow shaft 5 is provided with openings 12 through which the printing ink 11 flows into the interior space 13 of the stencil cylinder 1.

The bearing bush 14 of end plate 3 of the screen or stencil cylinder 1 passes through an outer or support bearing 15 in the adjacent stand 6 serving for supporting the hollow shaft 5. To the end of this bearing sleeve 14 a gearwheel 16 is attached which cooperates with a pinion 17 on the output shaft 18 of a stepdown gearing 19 whose input shaft 20 is connected by means of a V-belt pulley 21, a V-belt 22 and a further V-belt pulley 23 on the output shaft 24 of an electric motor 25.

With this drive means the screen or stencil cylinder 1 on the fixed shaft 5 can be caused to rotate in the direction of the arrow S (see FIG. 2).

In the interior space 13 of the screen or stencil cylinder 1 two partitions 27 are fixed to the hollow shaft 5. These rings, which form parts of holding arms 29, can be swung about the shaft in releasing setting screws 28, the setting screws serving to set the angular position of the arms 29 as may be desired. The holding arms 29 extend radially from the shaft in a downwardly sloping direction in the interior space 13 of the screen or stencil cylinder 1. At the free ends of the holding arms 29 a thin strip spring 30 is attached which is in the form of a thin metal sheet extending along practically the entire length of the screen cylinder 1 and at the two ends of the cylinder extends slightly short of the flanges of the end plates 2 and 3. This sheet metal plate constituting the strip spring 30 is made of a flexible material such as steel sheet, brass sheet or synthetic resin. If required, the strip spring 30 can be made up of several strip spring elements with axial spacing between them. The strip spring 30 extends from its end attached to the holding arms 29 in a direction opposite to the direction S of rotation of the screen or stencil cylinder 1 in a curved plane as far as a position near the periphery of the cylinder 1 approximately vertically under the shaft 5. At this position, that is to say at the lower edge of the strip spring 30 there is a squeegee 31 extending along the whole length of the strip spring. This squeegee consists of an armature sheet which is of V-shaped cross section. The material is soft iron or other material, such as a steel alloy which is capable of being attracted by a magnet. The angle of the squeegee 31 as seen in a radial plane has such a shape that it serves to press the mass of ink 11 into the screen or stencil cylinder for passage of the material through the whole of the cylinder in accordance with the image to be printed. The strip spring 30 serves to press the squeegee consisting of the angled piece of sheet metal against the interior of the screen or stencil cylinder, the squeegee making actual contact with the interior of the cylinder with its apical ridge or edge 32. The squeegee 31 is not rigid in the direction of its length so that it can be easily bent and thus adapt itself to differences in level along the length of the screen which it overlies, whether these differences be due to differences in the thickness of the screen or stencil material itself or due to the material to be printed or to unevenesshes in the sheet carrier 34 about to be described.

The sheet 33 to be printed by means of ink which is pressed through the screen cylinder 1 by means of the squeegee, is carried on the carrier 34 and held on it temporarily by tacking with glue. In accordance with the embodiment shown the sheet carrier consists of an endless band of rubber sheet which, as shown in FIG. 3, runs over end guide rollers 35 which are journaled in a machine frame 36. The sheet 33 to be printed, for example in the form of a band or strip of paper, textile material or synthetic resin, is, in the embodiment shown in FIG. 3, unwound from a supply roll 37 and passes onto the carrier 34 moving in the direction of arrow 6. The material is then printed with three colors in the three printing stations arranged along the carrier 34.

At each printing position, that is to say under the hollow shaft 5 of each screen or stencil cylinder 1, the carrier 34 is supported by a hollow cylindrical roller 38 which is journaled on a nonrotary elongated magnet assembly by means of needle bearings 39. The magnet assembly, which is carried at its ends in the stands 6 of the machine, could comprise a series of permanent magnets, but in the embodiment described is made up of electromagnets in order to provide for a variable field strength. The electromagnets 40 are arranged inside the rotary hollow roller 38 and their windings 41 are connected by means of leads 42 with a DC power pack 43 which includes a transformer. The electromagnets 40 can all have U-shaped cores so that their magnetic axes are directed towards the screen or stencil cylinder 1 above for attracting the sheet metal of the squeegee 31 so that it is pressed magnetically along its whole length against the interior face of the screen or stencil cylinder 1. The rotary hollow roller 38 preferably consists of a nonmagnetic material in order not to hinder the attraction of the squeegee by the electromagnets.

The forms of squeegee shown in FIG. 4 and 5 have been described for use, more especially with screens or stencils woven from natural or synthetic fibers. In this arrangement I make the squeegee of a resilient material, for instance rubber or synthetic resin for the purpose of enabling the edge of the squeegee to adapt itself to the small recesses in the fabric due to the crossing of the weft and warp threads of the screen or stencil fabric. I have found that printing is more satisfactory with a squeegee made of such a resiliently soft material and that this I attribute to the material of the squeegee being able to adapt itself to the recesses between the threads of the screen or stencil and thus being able to act more effectively on the ink between the threads. In the embodiment shown in FIG. 4 the lower end of the strip spring 30 is fitted into the squeegee which, as just mentioned, is made of an elastically soft material which is, however, resistant to abrasion against the interior face of the screen or stencil cylinder. The material can be readily selected from available rubbers and synthetic resin on the basis of the property to be obtained. On the squeegee 44 there is an armature sheet 45 which overlies the edge 46 of the squeegee which contacts the interior face of the screen or stencil cylinder.

The armature sheet 45 can, if it is sufficiently flexible extend over the whole length of the squeegee 44 which is V-shaped in radial cross section. Electromagnets as in FIG. 1 are provided inside roller 38. In order to increase the flexibility of the squeegee 44 and in particular in the use of a comparatively thick sheet 45 it is possible to divide the sheet 45 up into parts 45' shown in FIG. 5. These parts 45' have small clearances between them.
shows that the strip spring 30, instead of consisting of a single metal or other resilient sheet extending along substantially the whole length of the screen cylinder 1, can be made up of separate strips 30' with gaps between them which are considerably greater than the axial width of the strip themselves. These individual strips 30' are attached to the holding arms 29 as was the case with single resilient metal sheet while their lower or free ends are connected with the elastic squeegee 44.

I claim:

1. A foraminous printing machine comprising a horizontal rotary foraminous cylinder, a horizontal rotary roller whose axis is parallel to that of the cylinder, and which is adjacent to the cylinder for holding a sheet to be printed against the cylinder for printing, a carrier for guiding sheets to be printed between the cylinder and the roller, the roller serving to support the carrier in contiguous relation with the cylinder, a squeegee blade which is held inside the cylinder in a position adjacent to the roller and in pressure contact with the inside of the cylinder, the squeegee blade being flexible along its whole length for flexure in a radial plane in relation to the cylinder and comprising material which can be magnetically attracted, magnet means in the roller for attracting the squeegee, at least one movable lever arm carrying at one free end the squeegee blade, means carrying the other end of the lever arm in a stationary fashion inside the cylinder behind the squeegee blade with reference to the direction of rotation of the cylinder, the squeegee blade having a V-shaped ridge that makes substantially linear contact with the inner surface of the cylinder, a leading side of the blade with reference to the direction of rotation of the cylinder making an acute angle with the carrier.

2. A printing machine in accordance with claim 1 in which the squeegee blade is made of sheet material which is angled in radial section so as to define an apical ridge which engages the inside of the foraminous cylinder.

3. A printing machine in accordance with claim 1 in which the squeegee blade comprises elastomeric abrasion-resistant material which has a V-shaped radial section so as to define an apical ridge engaging the cylinder, and magnetic material forming part of the squeegee blade and extending with the squeegee blade along the interior of the cylinder.

4. A printing machine in accordance with claim 3 in which the magnetic material is divided up transversely into segments.

5. An apparatus in accordance with claim 1 comprising a shaft in the cylinder, holding arm means in the cylinder extending away from the axis of the cylinder and carried by the shaft, and strip means which extends against the direction of rotation of the cylinder from the holding means to the squeegee blade and is fixed to the arm means and to the squeegee blade.

6. An apparatus in accordance with claim 5 in which the strip spring means is in the form of a single resilient sheet extending in an axial direction along substantially the whole length of the squeegee blade.

7. An apparatus in accordance with claim 5 in which the strip means includes several metal strips.

8. An apparatus in accordance with claim 1 in which the magnetic means is in the form of an elongated assembly which carries the roller.

9. An apparatus in accordance with claim 8 in which the magnetic means comprises a row of electromagnets with their magnetic axes directed towards the cylinder.