United States Patent

Gnage et al.

[15] **3,670,868**

[45] **June 20, 1972**

[54] MAGNETIC CONVEYOR SYSTEM

[72] Inventors: **Oliver W. Gnage; Gordon F. Connelly,** both of Rochester, N.Y.

[73] Assignee: **Eastman Kodak Company,** Rochester, N.Y.

[22] Filed: **July 6, 1970**

[21] Appl. No.: **52,153**

[52] **U.S. Cl.** .....**198/41,** 29/132, 198/33 AD

[51] **Int. Cl.**.....**B65g 47/00**

[58] **Field of Search**.....198/41, 33 R; 271/63 A, DIG. 3; 226/93; 29/125, 132; 100/DIG. 17; 193/35

[56] **References Cited**

UNITED STATES PATENTS

3,149,403	9/1964	Aurich et al.	100/DIG. 17
3,352,397	11/1967	Becker et al.	193/35 A

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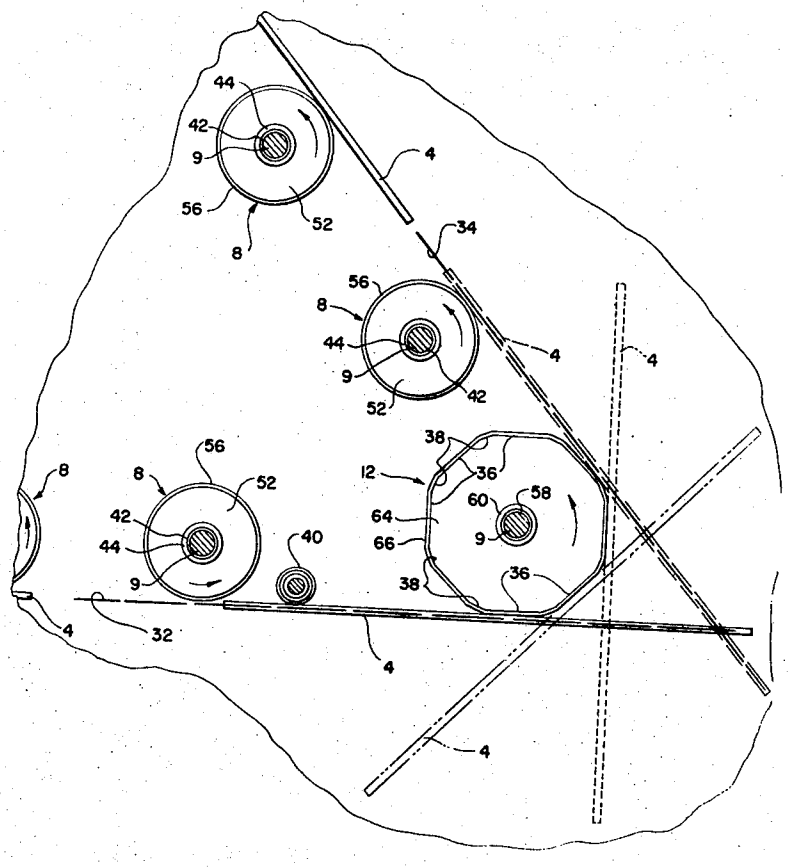
[57] **ABSTRACT**

A magnetic conveyor system is provided for transporting flat elements or plates such as electrophotographic plates or chips which comprise a photoconductive sheet on a conductive backing. This is accomplished by the use of magnetic rollers each of which includes a bar magnet rotatable on a nonmagnetic shaft and having poles at opposite ends thereof to which is attached a pole piece. These pole pieces each have a larger diameter than the magnet to form a groove between the magnet and the pole pieces. This groove is filled with a nonconductive ring or annulus which extends outwardly beyond the edges of the pole pieces to provide a tire or friction bearing surface for the plates or elements to be transported thereby. The plates can be moved from an approach plane to an exit plane by means of a polygonal-shaped roller which is provided at the intersection of the planes and which has alternating flats and ridges so that when an advancing plate engages a polygonal roller and has passed the last round roller in the approach plane it will be rotated with the polygonal roller due to attraction to one of the flats to the exit plane and be fed forwardly by the round rollers in the exit plane. To assure that the plate separates from the last round roller in the approach plane, a stripper bar is provided between the last roller and the polygonal roller which prevents the trailing end of the plate from following the last roller around. Alternatively, the entire roller can be encapsulated in a nonmagnetic material.

6 Claims, 6 Drawing Figures



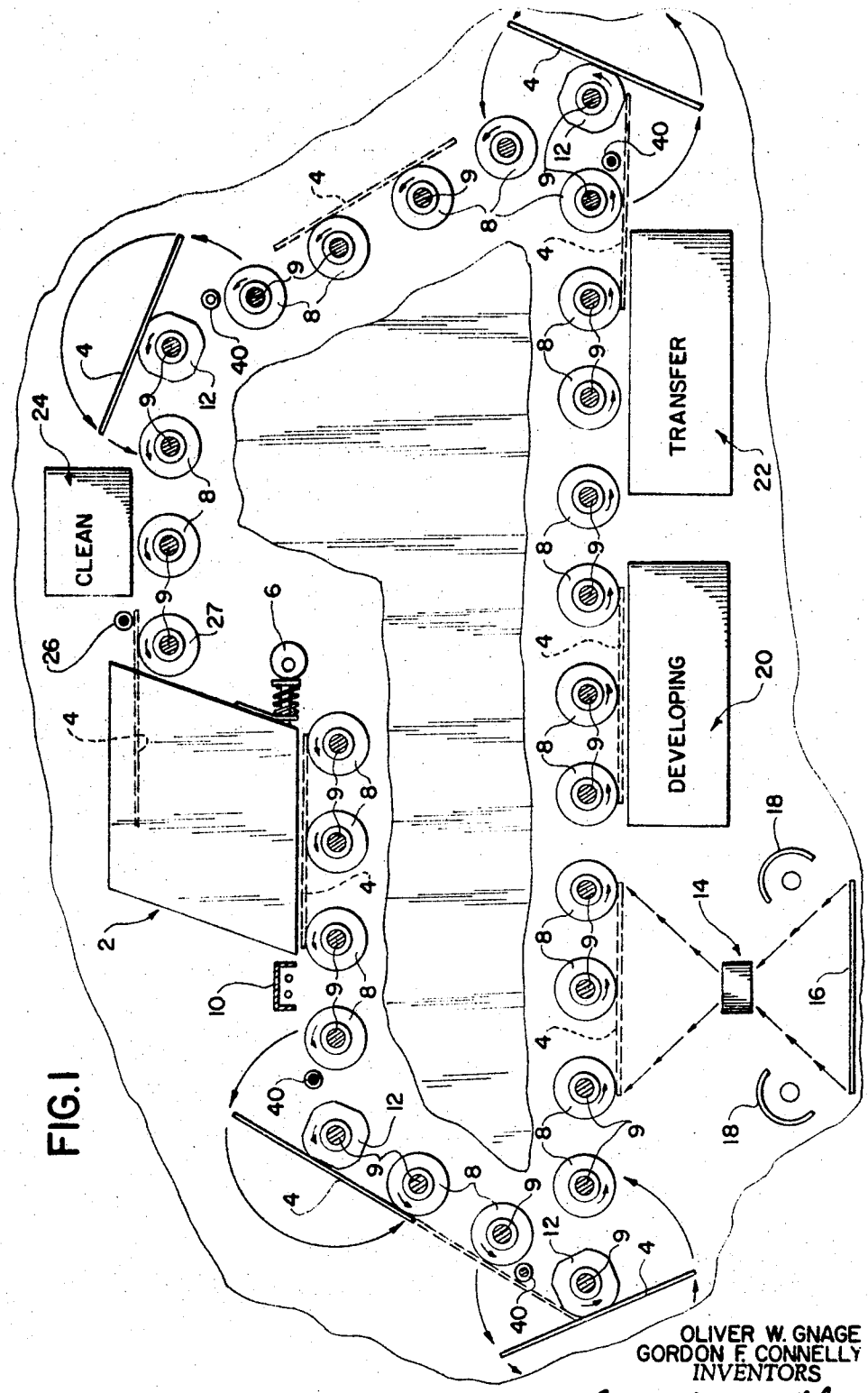


FIG. 1

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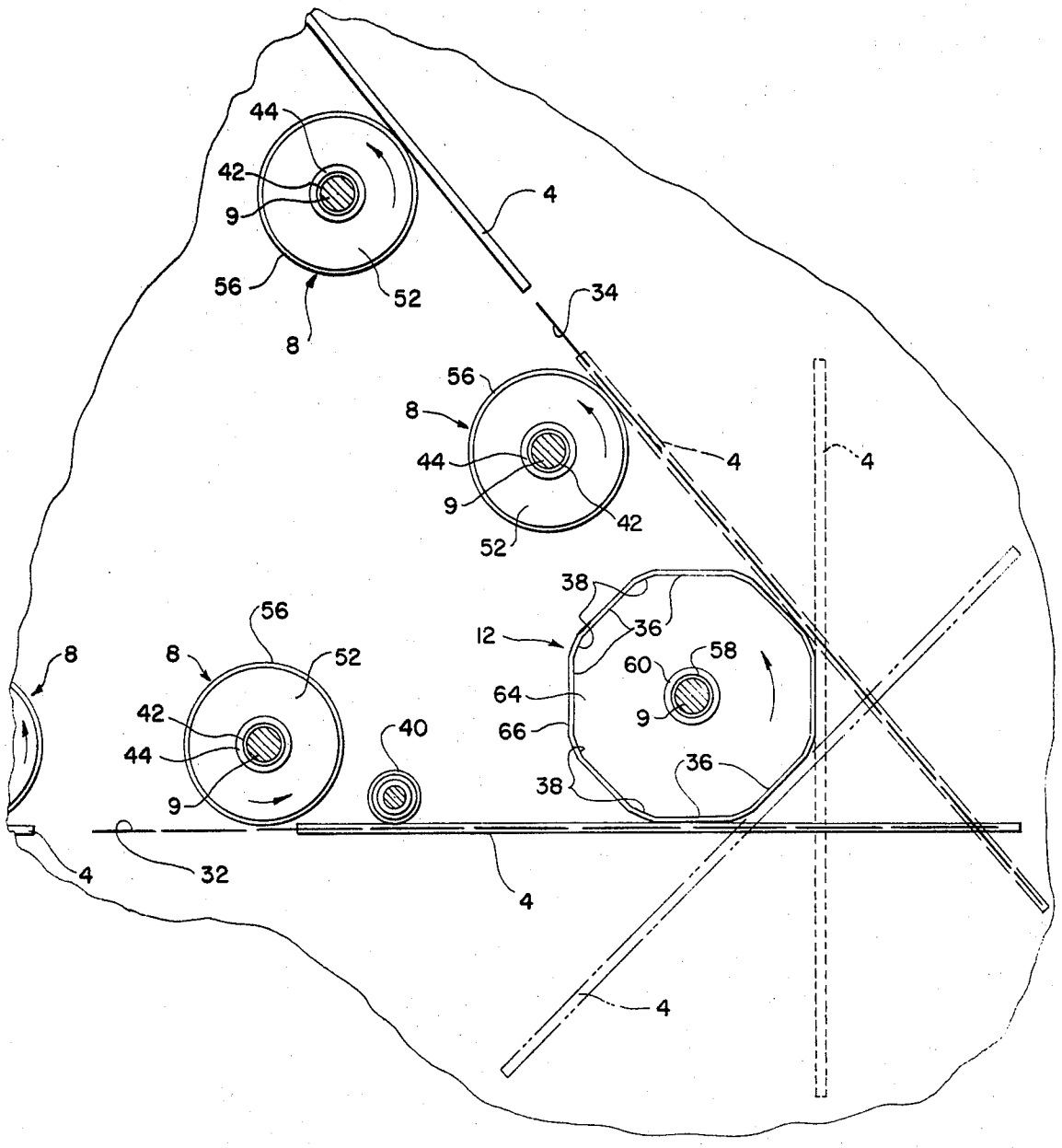

FIG.2

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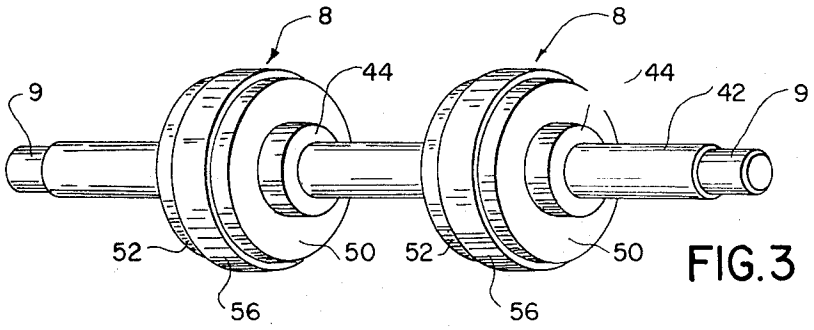

FIG.3

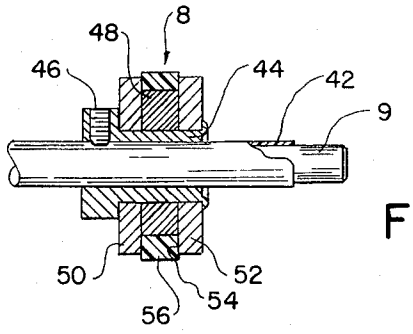

FIG.4

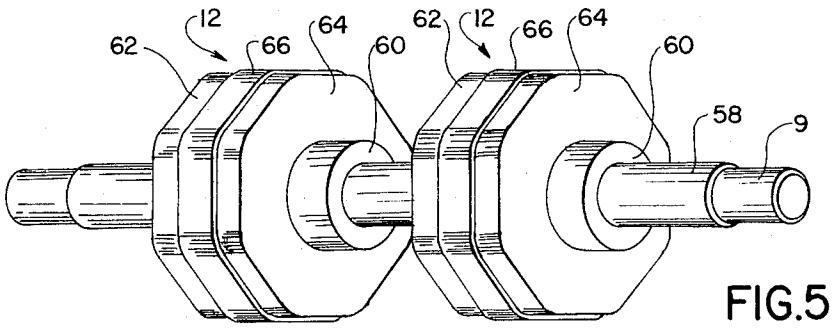

FIG.5

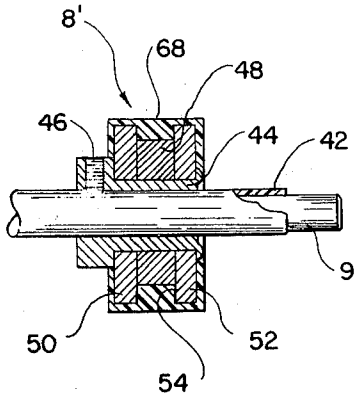

FIG.6

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MAGNETIC CONVEYOR SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

Reference is made to commonly assigned copending U.S. application No. 52,151, entitled "Photoconductive Element;" U.S. application, Ser. No. 52,152, entitled "Gravity-Fed Storage Device;" and U.S. application, Ser. No. 52,154, entitled "Magazine for Photoconductive Elements," all to Oliver W. Gnage and all filed on even date herewith; and to commonly assigned U.S. application, Ser. No. 741,359 entitled "-Method and Apparatus for Making Composite Electrophotographic Prints" and filed July 1, 1968 in the name of John S. Pollock, now U.S. Pat. No. 3,583,807.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a magnetic conveyor system and more particularly to magnetic rollers for transporting flat plates, such as photoconductive elements through a plurality of electrophotographic stations.

2. Description of the Prior Art

In commonly assigned copending U.S. application, Ser. No. 741,359 to John S. Pollock, filed July 1, 1968, now U.S. Pat. No. 3,583,807, a method and device are disclosed for making electrophotographic multiple color prints wherein photoconductive elements or chips in separate stacks or sets are charged and exposed to each of a plurality of color separation images projected from an original. An electrostatic latent thus formed on each of the exposed chips is developed and transferred to a receiver in a predetermined cycle with respect to the other chips wherein the separate images are placed thereon in registry to form a composite color print. In each embodiment, the chips move through charging stations, developing stations, transfer stations, cleaning stations, and finally to a storage station. In order to provide proper time exposure of the chips and proper registry the chips move through the various stations at different rates depending upon the particular exposure and the particular station.

From the above description, it can be seen that suitable means are needed for transporting the photoconductive chips from one station to another and that such means must be capable of directing the chips through a circuitous path along which the chips must change directions when moving from some of the stations to some of the other stations.

Roller conveyors, including magnetic rollers, are well known for transporting articles of various types but such conveying devices are often noisy and may damage the article being transported or may be damaged themselves if the environment in which they are used is corrosive.

SUMMARY OF THE INVENTION

In accordance with the present invention, a conveyor system for transporting magnetically attractible flat plates along a path having an approach plane and an exit plane at an angle to the approach plane is provided. A first set of magnetic rollers are located along the approach plane and a second set of magnetic rollers are located along the exit plane. Between the two sets of rollers is a polygonal roller which has alternating flats and ridges with one of the flats being engageable with a plate as it leaves the last roller of the first set to pivot the plate from the approach plane to the exit plane into engagement with the first roller of the second set. Each of these rollers includes a bar magnet having opposite poles at the opposite ends thereof and pole pieces attractible to each of the poles. A ring or annulus of nonmagnetic material is provided in the groove formed by the pole pieces to form a nonmagnetic tire or friction bearing surface for supporting and transporting the photoconductive chips on either the underside or top side of the rollers as work functions are performed on the chips. This nonmagnetic material may extend just slightly beyond the pole pieces so that the chip does not rest directly on the metal pole pieces but is still influenced by the magnetic field therebetween.

More particularly, the conveyor system contemplates round rollers on nonmagnetic shafts in the approach and exit planes with a polygonal roller therebetween to change the plane in which the chips move. Also, a stripping bar is provided between the last roller of the approach plane and the polygonal roller to separate the trailing end of the chip from the last roller so that it does not follow it around. The material also reduces noise between the chips and the rollers and reduces corrosion of the rollers from developing liquid which may get on the rollers from the chips.

As an alternative, the insulating material can be coated over the entire roller, including the pole pieces to further reduce the change of corrosion.

Additional advantages of this invention will become apparent from the description which follows, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagrammatic side elevation of an electrophotographic device having a conveyor system including magnetic rollers, constructed in accordance with this invention;

FIG. **2** is an enlarged fragmentary side elevation of a portion of the conveyor system of FIG. **1**, showing means for moving a photoconductive chip from an approach plane to an exit plane;

FIG. **3** is a perspective view of a set of rollers constructed in accordance with this invention;

FIG. **4** is a section through one of the rollers of FIG. **3** taken along lines **4**—**4** thereof;

FIG. **5** is a perspective view, similar to FIG. **3**, but showing a set of polygonal rollers; and

FIG. **6** is a section similar to FIG. **4**, but showing an alternative embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In commonly assigned copending U.S. application, Ser. No. 741,359 entitled, "Method and Apparatus For Making Composite Electrophotographic Prints" to John S. Pollock, filed July 1, 1968, an therefor apparatus is disclosed for making electrophotographic color prints from color separation originals wherein the originals are exposed for varying lengths of time to compensate for differences in photoconductive speed to different color ranges and to differences in the original from which the prints are to be made. In the systems disclosed in that application the photoconductive elements or chips are fed through an endless cycle. These photoconductive elements are stored in a storage chamber and fed from the bottom thereof into a charging station and subsequently to an exposure station, a developing station, a transfer station, a cleaning station, and back to the upper end of the storage compartment.

Such a system is disclosed schematically in FIG. **1** wherein a plurality of photoconductive elements or chips **4** are stored in a storage compartment **2**. Chips **4** are received in the storage compartment at the upper end thereof and they are dispensed by gravity to the lower end of the storage compartment where they are stacked as described in my commonly assigned copending U.S. application, Ser. No. 52,152, entitled "Gravity-Fed Storage Device," filed on even date herewith. The chips are then fed seriatim from the bottom of the storage compartment by a pusher mechanism **6** and advanced by a plurality of spaced rollers **8**, which may be magnetic rollers as hereinafter disclosed. The photoconductive chips are fed by magnetic rollers **8**, mounted on shafts **9** past a charging station **10**, such as a corona charging device and onto a multi-sided roller **12** which changes the direction of the chip to cause it to be moved down by additional rollers **8** to a lower plane. The chip again changes direction due to coming in contact with a further multisurfaced roller **12** so that it begins moving in the reversed direction to its initial direction to an exposure station **14** where the charged surface is exposed to an image from an original **16** which is illustrated as being illuminated by light

sources 18. The electrostatic image thus formed is developed at a developing station 20 and this image is transferred to a suitable receiver (not shown) at a transfer station 22. After transfer the photoconductive chip is fed by a series of rollers 8 and 12 to a cleaning station 24 to remove any residual toner particles from the surface of the photoconductive chip prior to being fed by upper and lower pressure rollers 26 and 27, respectively, into the top of storage compartment 2.

As is readily apparent, to advance the chips along an endless path, it is necessary to periodically cause the chip to change directions by turning them from an approach plane. This is accomplished by means of polygonal rollers 12. Looking at FIG. 2, it can be seen that a chip 4 is initially in an approach plane 32 and is transported therealong by rollers 8 to polygonal roller 12 which then rotates the chip as shown in dotted lines until it lies in exit plane 34 and is advanced by a roller 8 adjacent the exit plane. As a chip moving along approach plane 32 comes into engagement with polygonal roller 12 it is alternatingly engaged by flats 36 and ridges 38 thereon until the trailing end thereof leaves the last roller 8 adjacent the approach plane whereupon the chip is supported by a flat 36 and rotated with roller 12 until the leading edge of the chip 4 comes in contact with the first roller adjacent exit plane 34 which advances a chip along that plane. To prevent the trailing end of chip 4 from following the last roller 8 adjacent the approach plane around, a nonconductive means, such as stripping bar 40 is provided between roller 8 and polygonal roller 12, as shown which maintains the trailing end of chip 4 in approach plane 32 until it can be swung in a counterclockwise direction, as viewed in FIG. 2 by polygonal roller 12.

A pair of spaced rollers 8 are illustrated in FIG. 3 as mounted on a shaft 9, as shown which may be coated with nonconductive material 42. The rollers are illustrated as being attached to shaft 9 by means of nonconductive sleeves 44 connected to the shaft, as by a set screw 46, as shown in FIG. 4. Each roller comprises a bar magnet 48, which in the case of roller 8 is cylindrical, one end thereof being the north pole and the other the south pole to which are attached pole pieces 50 and 52, respectively. These pole pieces have a diameter slightly greater than that of magnet 48 so as to form a groove 54 therebetween in which is placed a nonconductive material, such as polyurethane, which is in the form of a ring or annulus 56 extending around the magnet in the groove 54. Ring 56 conveniently extends beyond the edges of pole pieces 50 and 52 to serve as a tire so that a chip supported thereon will not make metal-to-metal contact between the chip and the edges of the pole pieces to reduce noise. A spacing between the edges of the pole piece and the edge of the tire 56 of 0.005 inches has been found satisfactory. Thus, the diameter of the pole pieces can be 0.010 inches greater than the diameter of the magnet. With this spacing or a greater spacing, the chip is still within the magnetic field of the pole pieces so that it is held firmly against the roller. Of course, the spacing indicated is by way of example and can be greater or smaller as required for a particular application. The smaller the spacing the greater the magnetic attraction, whereas the greater the spacing, the less the magnetic attraction and the greater the probability of slippage between the rollers and the chips.

Similarly, polygonal rollers 12 may be mounted on a shaft 9, which has a nonmagnetic coating 58, by means of collars 60 which are also nonmagnetic. The polygonal rollers include magnets, which may be round, to which polygonally shaped pole pieces 62 and 64 are attached and form a groove with the magnet in which a ring or tire 66 of nonmagnetic material is provided.

An alternative embodiment is shown in FIG. 6 wherein a coating 68 completely covers rollers 8', filling groove 54 and extending over the ends and sides of pole pieces 50 and 52. This structure may be desirable if the photoconductive chips have corrosive material on them, such as developer.

From the foregoing, the advantages of this invention are readily apparent. A conveyor system has been provided which includes magnetic rollers for advancing photoconductive chips through a circuitous path and provides means for moving the chips from an approach plane to an exit plane by means of a polygonal roller. A stripping device is provided adjacent the last roller adjacent the approach plane for assuring that the trailing end of the photoconductive chip is separated from the roller so that the polygonal roller can turn the chip into the exit plane. Each roller is constructed with a bar magnet core to which pole pieces are attached and extend beyond the edges of the magnet to form a groove which may be filled with a ring or annulus of nonconductive material to serve as a tire for the photoconductive chips. Thus, the chips can be conveyed on either the top side or underside of the rollers as work functions are performed on the chips. In an alternative embodiment the nonconductive material can completely coat the pole pieces to protect them from any corrosive materials that may come in contact therewith.

The invention has been described in detail with reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

We claim:

1. A conveyor system for transporting magnetically attractable flat plates, having leading and trailing ends, along a feed path of a type including an approach plane and an exit plane which is located at an angle with respect to said approach plane, said conveyor system including:
   - a first generally cylindrical magnetic roller rotatably mounted along said feed path at a location for moving such plates along said approach plane;
   - a second generally cylindrical magnetic roller rotatably mounted along said feed path at a location for moving such plates along said exit plane;
   - a polygonal magnetic roller rotatably mounted along said feed path at a location between said first and second roller, said polygonal magnetic roller having alternating flats and ridges, at least one of said flats being engageable with a plate leaving said first roller and rotatable to pivot such plate from said approach plane to said exit plane and into engagement with said second roller.

2. A conveyor system, as claimed in Claim 1, further including:
   - means, located along said feed path between said first roller and said polygonal roller, for stripping the trailing end of the plate from said first roller.

3. The invention defined in claim 1 wherein each of said rollers includes:
   - a bar magnet having opposite poles at first and second opposite ends thereof;
   - a first pole piece attractable to one of said poles;
   - a second pole piece attractable to the other of said poles, said first and second pole pieces having a larger diameter than said magnet so that said magnet and said first and second pole pieces form a peripheral groove; and
   - an annulus of non-magnetic material mounted in said peripheral groove, said annulus having a larger diameter than said first and second pole pieces so that said annulus periphery contacts and transports such plates.

4. A magnetic conveyor device for transporting magnetically attractable articles along a path, said device comprising:
   - a bar magnet of polygonal configuration and having opposite poles at first and second opposite ends thereof;
   - a first pole piece attractable to one of said poles;
   - a second pole piece attractable to the other of said poles, said first and second pole pieces being of polygonal configuration corresponding to said bar magnet but having a larger diameter than said magnet, said magnet and said first and second pole pieces forming a peripheral groove; and
   - an annulus of non-magnetic material in said groove to form a tire for supporting and transporting said articles.

5. A magnetic conveyor device, as claimed in claim 4 wherein:

said annulus has a diameter greater than said first and second pole pieces.

6. A magnetic conveyor device, as claimed in claim 5 wherein the diameter of said ring is at least 0.010 inches greater than the diameter of said pole pieces.

* * * * *