United States Patent

Küsters

[15] **3,685,443**

[45] **Aug. 22, 1972**

[54] **IMPRESSION CYLINDER FOR GRAVURE PRINTING PRESS**

[72] Inventor: **Eduard Küsters,** Finkenwey 18, Krefeld-Forstwald 1, Germany

[22] Filed: **Feb. 24, 1966**

[21] Appl. No.: **529,871**

[30] **Foreign Application Priority Data**

Feb. 25, 1965 Germany....................K 55382

[52] **U.S. Cl.** **101/153,** 29/132, 101/219

[51] **Int. Cl.** **B41f 9/00,** B41f 13/18

[58] **Field of Search**......101/216, 219, 348, 375, 376, 101/153, 141, 174; 29/116, 132; 100/170

[56] **References Cited**

UNITED STATES PATENTS

2,156,385	5/1939	Freedlander	29/132 X
2,178,421	10/1939	Freedlander	29/132 X
2,324,631	7/1943	May	101/407
2,353,462	7/1944	Harkins	29/132
2,607,292	8/1952	Harless et al.	101/153
2,908,964	10/1959	Appenzeller	29/116
3,043,211	7/1962	Appenzeller	100/170
3,288,060	11/1966	Miller	101/219 X

FOREIGN PATENTS OR APPLICATIONS

683,021	3/1964	Canada	29/132
749,541	6/1956	Great Britain	29/132

Primary Examiner—J. Reed Fisher
Attorney—Kenyon & Kenyon

[57] **ABSTRACT**

The disclosure includes a gravure printing press with an impression cylinder covered with elastically deformable polyurethane having a hardness in the range of 88° – 96° Shore A. Other features are disclosed.

4 Claims, 9 Drawing Figures

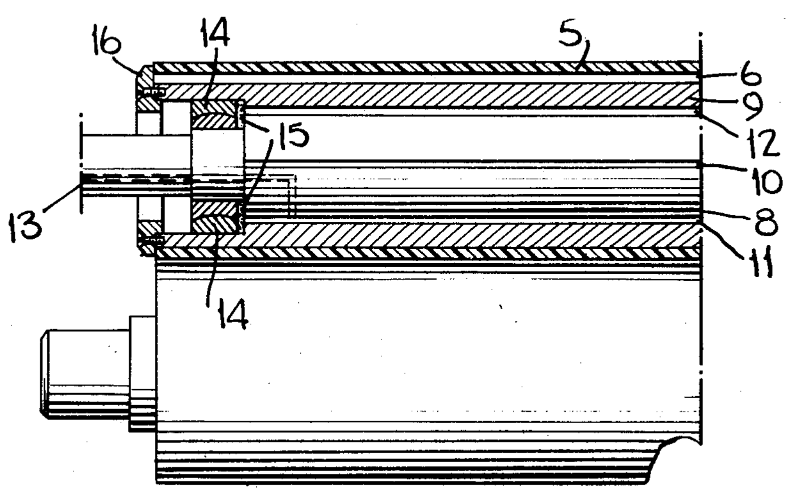


Fig.1.

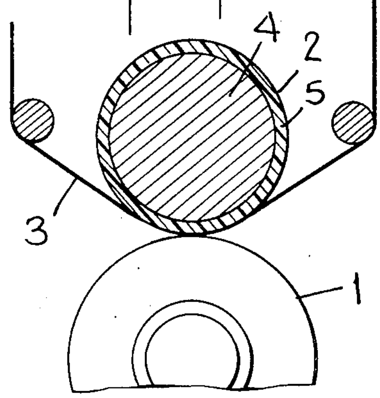


Fig.2.

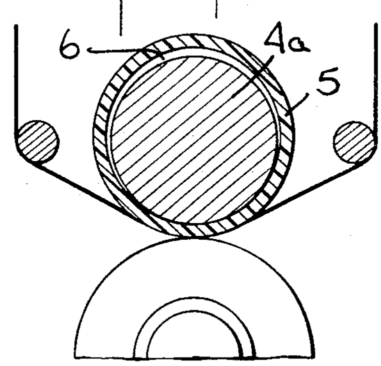


Fig.3.

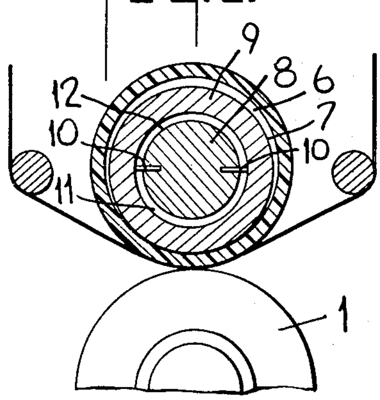


Fig.5.

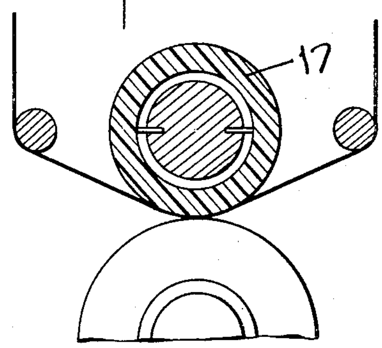
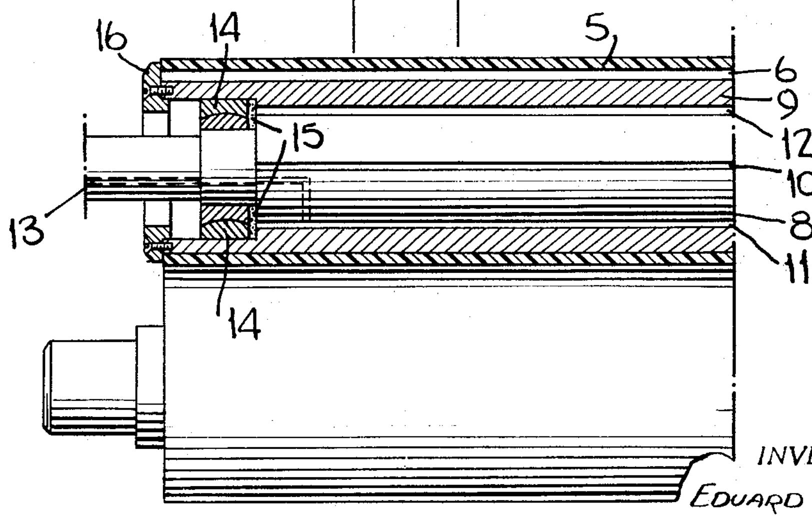


Fig.4.



INVENTOR.
EDUARD KUSTERS
BY
Kenyon & Kenyon
ATTORNEYS

Fig. 6.

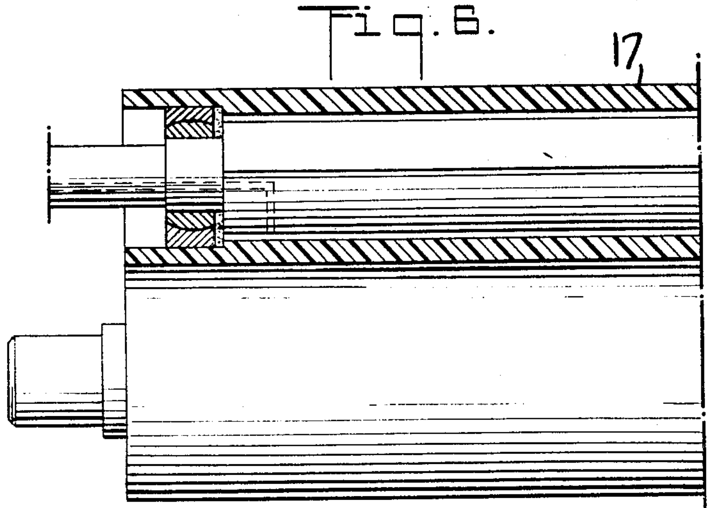
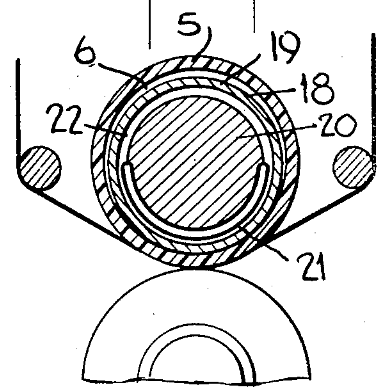


Fig. 7.



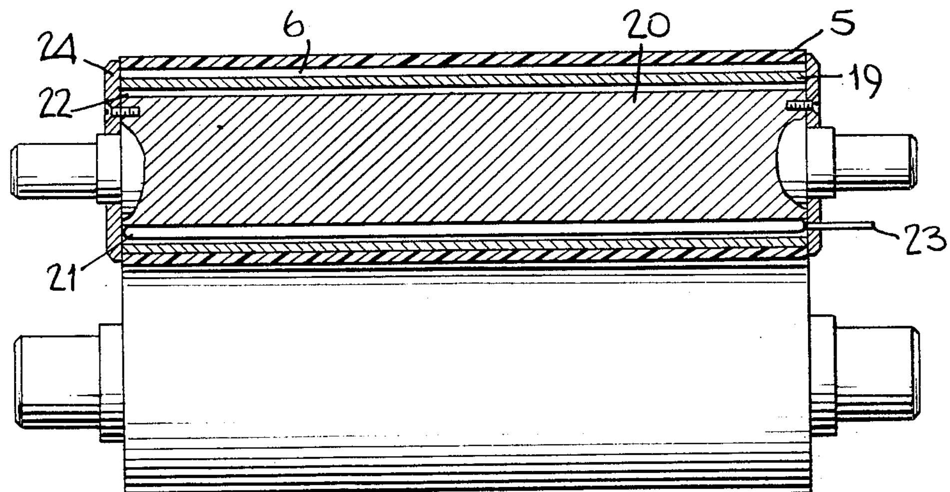
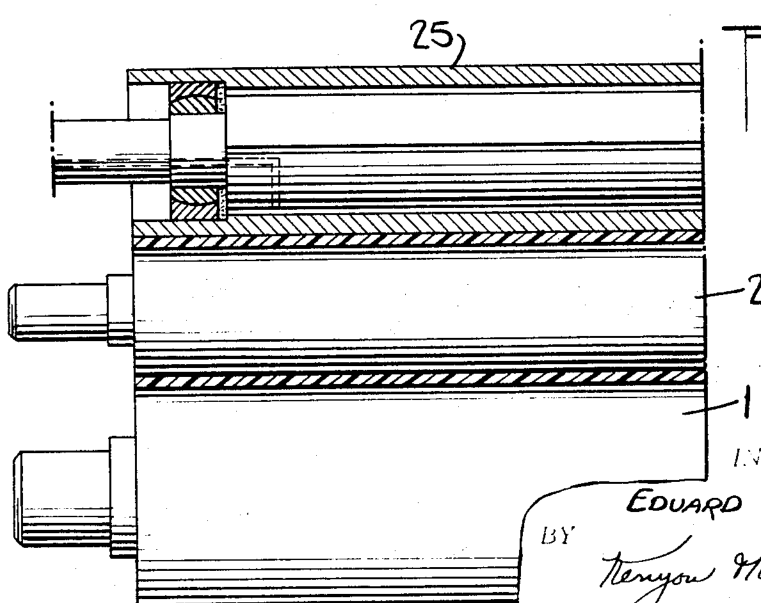


Fig. 8.

Fig. 9.



INVENTOR.
EDUARD KUSTERS
BY
Kenyon & Kenyon
ATTORNEYS

IMPRESSION CYLINDER FOR GRAVURE PRINTING PRESS

This invention pertains to a gravure printing press and more particularly to the impression cylinders utilized in the printing units of such a press. In accordance with the invention, the peripheral working surface of such impression cylinder is formed by a layer of a synthetic material of high elasticity and hardness such as a polyurethane elastomer.

In gravure printing, e.g., in a rotogravure press, the individual printing unit comprises two adjacent counter rollers, an etched or engraving printing or plate cylinder and an impression cylinder, between which rollers the paper web or sheet is passed. The impression cylinder presses the paper web or sheet against the printing cylinder, causing the paper to take up the ink in the etched depressions on the surface of the printing cylinder. The required pressure can be exerted through the impression cylinder directly or by means of an auxiliary support roller through which the required pressure may be transmitted to the impression cylinder.

Conventionally, the impression cylinder for the printing units of a rotogravure press have been rollers made of rubber with a Shore A hardness between 80°–85. Steel rollers with a sleeve or covering of an elastic material having a Shore A hardness lying between 80°–85° have also been utilized as impression cylinders. The use of these conventional types of impression cylinders has not resulted in the best possible printing quality primarily because of excessive deformation of the surface of the cylinder in the printing zone (i.e., the area of contact between the impression cylinder and the web as the former exerts the required pressure to force the latter against the printing cylinder surface) and the consequent frictional effects.

In addition, in a rotogravure press involving a plurality of printing units, such as are required in multi-color printing, the use of conventional cylinders results in variations in the speed with which the paper web is passed through the individual printing units. The pressure to be exerted by the impression cylinder must be varied in accordance with the nature and dimension of the etching on the printing cylinder and with the particular color to be applied by the particular printing unit. Where high pressure is applied, the deformation of the surface of the impression cylinder in conformity to the surface of the printing cylinder in the printing zone is greater than when lower pressure is applied. In other words, at any given instant, the arc of contact along which the impression cylinder bears on the web and the web bears against the printing cylinder along its circumference is greater at higher pressure than at lower pressure. The result is a difference in the speed of the web as it is passed through the different individual printing units, a problem which exists in conventional rotogravure presses irrespective of whether rubber rollers or rollers with an elastic covering of about 80° Shore A hardness were utilized. In the past, the principal manner of correcting this unsatisfactory variation in the speed was to use impression cylinders of different diameters. Thus in a printing unit requiring comparatively low pressure, an impression cylinder of greater diameter was provided so as to attempt to provide an arc of contact between web and printing cylinder approximately equivalent to that of a printing unit in which an impression cylinder of smaller diameter exerted a greater pressure on the web. In this way it was sought to maintain the speed of the paper web through the various printing units at an approximately constant level.

However, increasing the arc of contact between web and printing cylinder by increasing the diameter of the impression cylinder has a decidedly detrimental effect on the quality of the resultant printing. Moreover, the efforts to adapt the size of the impression cylinder to the pressure to be applied requires the stocking of an extensive number of impression cylinders with differences in circumferences to up to 36 mm for a given rotogravure printing press.

An object of the present invention is to improve the quality of the printing. A further object is to minimize the differences in speed of the paper web as it passes through the several individual printing units and thus to eliminate the need to use impression cylinders with different diameters. A still further object of the invention is to enable control of the deflection of impression cylinders and to provide for the application of a uniform pressure along the entire length of the impression cylinder in the printing zone.

In accordance with the invention, the impression cylinder comprises a roller with at least one peripheral layer of an elastic synthetic material such as, for example, a polyurethane elastomer, such material having a Shore A hardness ranging from 88° – 98°. Applicant has found that the hardness of the working surface of the impression cylinder to a great degree determines the quality of the resultant printing and that, through the use of the impression cylinders with a hardness as called for by the invention, a substantial improvement in the quality of the printing is attained. Applicant has determined that even small variations in the hardness are reflected in the quality of the printing. The best quality of printing has been achieved with a polyurethane roller of 98° Shore A hardness. The quality of such printing is excellent even on rough, non-calendared paper, because the surface of the impression cylinder is insensitive to the surface roughness of the paper. However, irregularities in the strength of the paper can tend to effect the quality of the print at a Shore A hardness of 98°. For this reason, a degree of hardness of 95° – 96° Shore A is preferred for paper of normal quality.

A further advantage of impression cylinders made in accordance with the invention lies in the fact that the difference in speed of paper web in passing through the individual units can be minimized or eliminated entirely, which in itself will enhance the quality of the printing.

Through use of impression cylinders in accordance with the invention, the speed of the paper web through individual printing units will remain substantially the same irrespective of the particular pressure applied through the impression cylinder of a particular unit. In the conventional rubber cylinders, the length of the arc of contact between the impression cylinder and the web, as taken in the direction of the web movement along the circumference of the printing cylinder varies between 15 mm and 22 mm depending upon the pressure applied. When impression cylinders of the invention with a Shore A hardness of 98° are used, the length of this arc of contact will be between 6 mm and 8 mm, irrespective of the pressure applied. In the case of a somewhat softer cylinder with a Shore A hardness of 88°, the length of this arc will be between 8 – 11 mm, irrespective of the pressure applied. Thus, in the case of impression cylinders made in accordance with the invention, changes in the pressure applied do not substantially change the degree of deformity of the surface of the impression cylinder; the length of the arc of contact remains substantially the same. Consequently, the speed of the paper web through the individual printing units will always approximate the speed at which the web is being carried by the printing cylinder. Of principal significance, there will be only slight variation in the speed of the paper web through the various individual printing units irrespective of the pressure applied by the impression cylinder of any given unit. Consequently, the necessity for providing impression cylinders of various diameters for a single gravure printing press is eliminated.

It is impossible to achieve these results by using conventional rubber rollers which have been hardened to the level of Shore A hardness called for by the invention through the use of filler material. Rubber rolls of such hardness have only a slight degree of elastic recoferability, i.e., they have a high permanent set. The material used in the rolls of the invention, on the other hand, exhibits a considerable degree of elasticity, i.e., a low permanent set, in the required ranges of hardness. On the other hand, it is clear that, in addition to the polyurethane elastomers specifically referred to, other materials having a sufficient high elasticity and the required hardness can be used. Preferably, the circumferential surface of the impression cylinder comprises a pre-formed, seamless covering or hollow sleeve made of a synthetic material such as a polyurethane which is disposed on a roller serving as a core. By using a preformed coating or hollow sleeve, the difficulties of applying a polyurethane material directly onto a steel roller are eliminated.

The hollow sleeve is cast of polyurethane and the necessary additives in a high-speed centrifugal casting form so that air bubbles are driven off and the polyurethane material is cross-linked in a minimum amount of time. The hollow sleeve thus produced is tempered and then can be shrunk onto a steel roller.

It is, however, also possible, and in many cases advantageous, to dispose the sleeve onto the core roller such as a steel cylinder with some radial play, i.e., by making the inner diameter of the hollow sleeve somewhat greater than the diameter of the steel cylindrical core. The amount of possible radial displacement of the sleeve with respect to the core need only be small and need amount to no more than a few millimeters. The sleeve can simply be pushed on to the cylindrical core. The sleeve can thus easily be replaced.

This simple and inexpensive embodiment of the impression cylinder in accordance with the invention is appropriate for small working widths, i.e., cylinder lengths up to approximately 800 mm. In such cases it can also suffice to place the sleeve onto a conventional rubber roller. In view of the small deflections which occur with this small working width, the elasticity of the rubber roller is sufficient to provide virtually uniform pressure along the entire length of the roll.

Because of the great hardness of the sleeve of synthetic material it becomes necessary to take into account the deflection of the printing cylinder and of the impression cylinder more than has hitherto been necessary in the case of the softer sleeve coverings. In accordance with the invention, this difficulty can be overcome by utilizing, as the core of the impression cylinder upon which the sleeve is disposed, a controlled deflection roll of the kind disclosed in U.S. Pat. No. 2,908,964. Rolls of the general type disclosed in U.S. Pat. No. 2,908,964 are sold in the United States under the Trademark "Swimming Roll" and have been a great commercial success. The use of such a roll as a core of the impression cylinder of the invention enables the exertion of a uniform pressure over the entire length of the cylinder and a consequent evenness and improvement in the quality of the resulting print.

Other controlled deflection rolls permitting the application of uniform pressure along the entire length of the roll, such as a roll of the type disclosed in U.S. Pat. No. 3,043,211 can also be utilized as a core for the impression cylinder in accordance with the invention.

The polyurethane sleeve or coat can be shrunk onto a "Swimming Roll" or can be of such a diameter as to provide radial play when mounted onto such a roll. In such a case end seals can be provided to prevent the axial displacement of the sleeve with respect to the "-Swimming Roll" which serves as core of the impression cylinder.

In addition to this preferred embodiment, the polyurethane sleeve can itself comprise the outer shell of the "Swimming Roll" construction as set forth in U.S. Pat. No. 2,908,964.

A support roll can be provided on the side of the impression cylinder hereinabove described opposite the printing cylinder which support roll can itself be a controlled deflection roll such as that disclosed in U.S. Pat. No. 2,908,964 or a controlled deflection roll of the kind disclosed in U.S. Pat. No. 3,043,211.

Specific examples of roller assemblies embodying the principles of the present invention are described below and illustrated by the accompanying drawings of which

FIG. 1 is a schematic transverse vertical cross section of a printing unit showing the impression cylinder embodying the invention as counter roll to the printing cylinder;

FIG. 2 is a schematic transverse vertical cross section of a printing unit showing another impression cylinder in accordance with the invention as counter roll to a printing cylinder;

FIG. 3 is a schematic transverse vertical cross section of a printing unit showing another impression cylinder embodying the present invention as counter roll to a pressure cylinder;

FIG. 4 is a longitudinal vertical cross section of the printing unit shown in FIG. 3;

FIG. 5 is a schematic transverse vertical cross section of a printing unit illustrating still another impression cylinder embodying the invention as counter roll to a printing cylinder;

FIG. 6 is a longitudinal vertical cross section of the printing unit shown in FIG. 5;

FIG. 7 is a schematic transverse vertical cross section of a printing unit showing still another impression cylinder embodying the present invention as counter roller to a pressure cylinder;

FIG. 8 is a longitudinal vertical cross sectional view of the printing unit of FIG. 7;

FIG. 9 is a longitudinal vertical view of a printing unit in which an impression cylinder in accordance with the invention is disposed between the printing cylinder and a support roller.

A gravure printing press comprises a plurality of printing units; each such unit in turn comprises a printing cylinder and an impression cylinder, the paper web or paper sheet passing between the impression and printing cylinder, the impression cylinder serving to press the paper against the printing cylinder to achieve the desired printing.

In FIG. 1, such an individual printing unit is shown, the paper web or sheet **3** passing between the printing cylinder or roller **1** and the impression cylinder or roller **2**. The impression cylinder **2** in accordance with the invention comprises an inner core **4** which can be of steel or rubber or other conventional construction, and an outer sleeve **5** which is disposed around the core.

The outer sleeve is made of polyurethane elastomer or other synthetic material of high elasticity and sufficient hardness to lie within the required range. In accordance with the invention the sleeve has a hardness of about 88° – 98° Shore A.

The elastic synthetic sleeve serves as a working surface of the impression cylinder. In FIG. 1 it is shrunk on to the core **4**. In the impression cylinder as shown in FIG. 2, the inner diameter of the polyurethane sleeve **5** is somewhat greater than the diameter of the core **4*a*** so as to leave a space or gap **6** between the inner surface of the sleeve and the surface of the core permitting some radial displacement of the core with respect to the sleeve.

In the impression cylinder as shown in FIGS. 3 and 4, the core **7** is a controlled deflection roll of the type disclosed in U.S. Pat. No. 2,908,964 and sold in the United States under the Trademark "Swimming Roll." Such a roll comprises a stationary shaft **8** and an outer rotating shell **9**. The inner diameter of the outer shell is greater than the diameter of the shaft leaving a space between the shaft and the inner surface of the shell. Longitudinal seals **10** are provided which divide the space into two longitudinal chambers **11** and **12**. The chamber **11** on the side of the roll adjacent to printing cylinder **1** is filled with a fluid pressure medium which is introduced through a bore **13** in the stationary shaft **8**. The shaft is positioned with respect to the shell by self-aligning bearings **14** and the longitudinal chambers **11** and **12** are frontally sealed by seals **15**. The inner diameter of the polyurethane sleeve or covering **5** is somewhat greater than the outer diameter of the shell **9** of the controlled deflection roll **7**, leaving a space **6** between the core and the polyurethane sleeve and enabling radial displacement of the controlled deflection roll core with respect to the polyurethane sleeve.

A sealing disc **16** is provided to prevent axial displacement of the sleeve or covering **5** with respect to the core **7**. In operation, the sleeve **5** and the outer shell **9** will rotate together while the shaft **8** remains stationary. The pressure of the fluid within the chamber **11** can be adjusted. The forces otherwise tending to cause the lengthwise deflection of the working surface of the roll are transferred by the hydraulic pressure medium to the stationary shaft **8** which will deflect relative to the outer shell in accordance with the fluid pressure applied. The pressure will be uniform along the entire length of the impression cylinder. Further details as to the construction of this type of controlled deflection roll are disclosed in U.S. Pat. No. 2,908,964.

It is also possible to construct the outer shell of the "-Swimming Roll" of polyurethane or a similar high-elastic synthetic material of sufficient hardness and thus eliminate the necessity of a separate sleeve or covering in the impression cylinder construction. This embodiment of the invention is shown in FIGS. **5** and **6** in which the polyurethane shell **17** serves as both the outer sleeve which provides the working surface of the impression cylinder and the rotating outer shell of the "Swimming Roll" construction.

The controlled deflection roll to be used as the core for the impression cylinder of the invention may also be, as shown in FIGS. **7** and **8**, of the type disclosed in U.S. Pat. No. 3,043,211. Such a controlled deflection roll **18** comprises an outer rotating shell **19**, a stationary inner shaft **20** of a diameter smaller than the inner diameter of the outer shell. A pressure member **21** for containing hydraulic pressure medium is disposed in the space **22** thus formed between the inner surface of the outer shell and the stationary inner shaft on the working side of the controlled deflection roll, i.e., the side of the impression cylinder adjacent to the printing cylinder **1** in the printing unit shown in FIGS. **7** and **8**. The hydraulic pressure within the pressure member **21** can be adjusted through conduit **23** and the inner shaft **20** will deflect with respect to the outer shell in accordance with the hydraulic pressure applied within the pressure member **21**. The sleeve **5** is disposed on the controlled deflection roll **18**, the outer diameter of the latter being somewhat smaller than the inner diameter of the former providing for a space **6** between the sleeve and the core and thus permitting radial displacement between the polyurethane sleeve and the controlled deflection roll **18** serving as the core of the impression cylinder. The sealing disc **24** prevents axial displacement of the sleeve with respect to the core. The sleeve **5** and the outer shell **19** rotate together in the operation of the printing unit while the shaft **20** remains stationary. The pressure along the entire working length of the impression cylinder is uniform.

In FIG. 9, a support cylinder **25** is disposed on the side of the impression cylinder **2** opposite from the printing cylinder **1**. This support cylinder is shown as a roll, the working circumference of which can follow the deflection of the impression cylinder. The roll **25** as shown is of the same construction as the controlled deflection roll **7** which serves as the core of the impression cylinder in the embodiment of the invention shown in FIGS. **3** and **4**. However, any other type of controlled deflection roll such as, e.g., the type of roll disclosed in U.S. Pat. No. 3,043,211 can be used as the support roll.

What is claimed is:

1. An impression cylinder assembly for a gravure printing unit including a cylindrical core and a preformed, seamless sleeve of synthetic elastic material disposed on said core to form the outer working surface of the impression cylinder assembly, said sleeve having a hardness lying in the range of about 88° – 98° Shore A, said material being a polyurethane elastomer and said core comprising a controlled deflection roll, said

controlled deflection roll comprising a rotating outer shell, a stationary inner shaft disposed within said outer shell, the diameter of said shaft being smaller than the inner diameter of said shell providing a space between the shell and the shaft, longitudinal seals dividing the space between the shaft and the shell into two longitudinal chambers, one of said longitudinal chambers being on the side of the shaft adjacent the working surface of the roller, the other longitudinal chamber being on the side of the shaft opposite the working side of the roller, the said chamber adjacent to the working surface of the roller being filled with a fluid pressure medium, the pressure within said chamber being adjustable whereby the shaft can deflect with respect to the shell and uniform pressure is exerted by the roll along the entire length of the roll.

2. An impression cylinder assembly for a gravure printing unit including a cylindrical core and a preformed, seamless sleeve of synthetic elastic material disposed on said core to form the outer working surface of the impression cylinder assembly, said sleeve having a hardness lying in the range of about 88° – 98° Shore A, said material being a polyurethane elastomer and said core comprising a controlled deflection roll, said controlled deflection roll comprising a rotating outer shell, a stationary inner shaft disposed within said outer shell, the diameter of said shaft being smaller than the inner diameter of said shell providing a space between the shell and the shaft, a pressure member for containing a hydraulic pressure medium disposed in said space between the inner surface of the outer shell and the stationary inner shaft on the working side of the roll, said pressure member being filled with a fluid pressure medium, the pressure within the pressure member being adjustable whereby the shaft can deflect with respect to the shell and uniform pressure is exerted by the roll along the entire length of the roll.

3. A printing unit for a gravure press including a printing cylinder, an impression cylinder adjacent and parallel to said printing cylinder, said impression cylinder comprising a cylindrical core and a preformed, seamless sleeve of a polyurethane elastomer disposed on said core to form the outer working surface of said impression cylinder, said sleeve having a hardness lying in the range of about 88° – 98° Shore A and a support roller disposed adjacent and parallel said impression cylinder on the opposite side of said impression cylinder from a printing cylinder, said support roller comprising a controlled deflection roll comprising a rotating outer shell, a stationary inner shaft disposed within said outer shell, the diameter of said shell providing a space between the shell and the shaft, longitudinal seals dividing the space between the shaft and the shell into two longitudinal chambers, one of said longitudinal chambers being on the side of the shaft adjacent the working surface of the roller, the other longitudinal chamber being on the side of the shaft opposite the working side of the roller, the said chamber adjacent to the working surface of the roller being filled with a fluid pressure medium, the pressure within said chamber being adjustable whereby the shaft can deflect with respect to the shell and uniform pressure is exerted by the roll along the entire length of the roll.

4. An impression cylinder assembly for a gravure printing unit including a cylindrical core and a preformed, seamless sleeve of synthetic elastic material disposed on said core to form the outer working surface of the impression cylinder assembly, said sleeve having a hardness lying in the range of about 88° – 98° Shore A, said material being a polyurethane elastomer and said core comprising a controlled deflection roll, said controlled deflection roll comprising a rotating outer shell subject to deflection, a shaft located within said shell and extending at least for the length of the working surface of said shell, and means for applying variable pressure from said shaft to the inside of said shell at a location and in a direction providing a reaction to the deflection of said shell, the inside of said shell forming a space permitting said shaft to deflect when stressed by said pressure.

* * * * *