REDUCING CYLINDER VIBRATIONS USING SKEWED ANGLE GAPS

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Abstract: The cylinder gaps in web offset presses cause a discontinuity in the pressure relationships between the cylinders. This disturbance can set up vibrations that may show up in the print as 'streaks'. This paper describes a method of reducing the disturbance and thereby improving print quality by making the cylinder gaps skewed at an angle to the cylinder axis. The method of testing and the results obtained with such skewed gap cylinders are presented.

The web-offset process enables high quality printing economically for various run lengths, large or small. The wrap-around plates and blankets make it possible to change forms quickly and produce quality printing under widely varying conditions. This advantage, of using economical plates and blankets, and of being able to change them quickly, does necessitate that the cylinders in web offset presses be constructed with gaps in the surface such that the edges of plate or blankets can be tucked in and locked up. These gaps cause a discontinuity in the pressure relationship between cylinders, which can cause cylinder vibrations and thereby reduced print quality. This becomes increasingly important as the press running speeds go higher.

A certain amount of force is needed to affect the transfer of inked image from plate to blanket and from blanket to paper. The magnitude of this force depends on various factors, such as the compressibility of blankets, ink and paper characteristics, etc. In the non-printing position, the cylinders are away from each other, with a small gap separating them. As these cylinders are brought into the printing position, the cylinder surfaces not only come into contact with each other but also create a compression nip between the surfaces, generating the transfer pressure. The blanket, the packing and the 'height' of the plate and blanket surfaces over the nominal dimension will determine the extent of the transfer pressure. In addition, most presses are designed with bearer rings at

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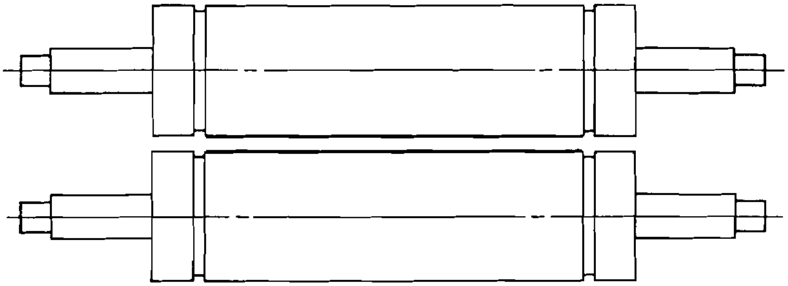


FIG. 1A CYLINDERS IN NON-PRINTING POSITION

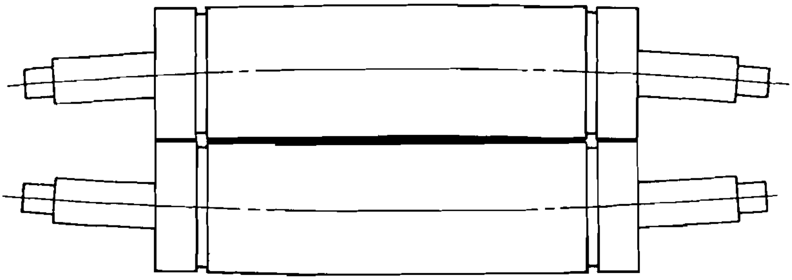


FIG. 1B CYLINDERS UNDER PRESSURE CONTACT IN PRINTING POSITION

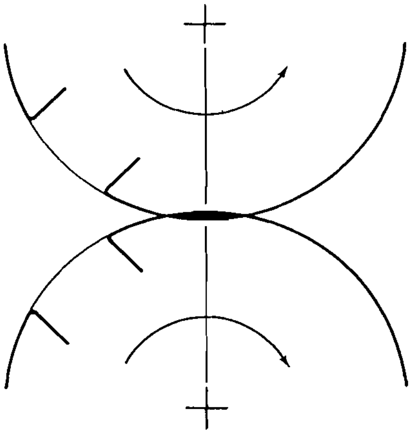


FIG. 1C CYLINDER UNDER PRESSURE CONTACT BEFORE GAP PASSAGE

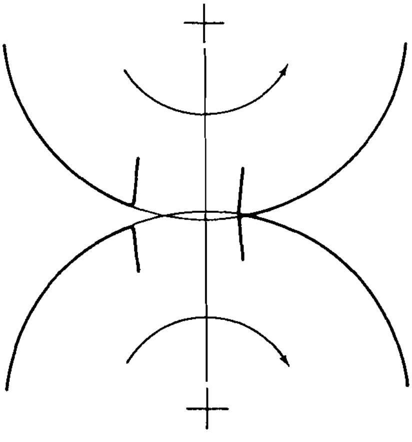


FIG. 1D PRESSURE RELEASE AT GAP PASSAGE

each end and there is a certain amount of pressure, depending upon settings, between the bearers.

This force between cylinders produces deflection and the cylinders assume a deflected shape that depends on the stiffness of the cylinders and its supporting structure as well as the extent and lateral distribution of this force. The cylinders are, therefore, under strain, storing strain energy, similar to a bow with its string pulled. This is illustrated in Figure 1(a) and 1(b).

As the cylinders turn, the gap comes into the printing nip, the 'squeeze' between cylinders is lost and the transfer pressure is released. The stored strain energy causes cylinders to move to its undeflected shape, setting up vibrations at the natural frequency. A little while later, the leading edge of cylinder gaps come into the printing nip to resume printing with previous pressure relationship between cylinders. However, the cylinders have been vibrating and the position of the cylinders at gap closure depends on the relationship between the gap passage time and the time period of natural oscillation for the cylinder. Figure 2 shows the vibrations of cylinder center during passage of cylinder gaps. The sudden release of pressure when trailing edge passes through printing nip, causes cylinders to move towards each other such that at the instant leading edges come into the nip at the end of the gap passage, there is a sudden impact, forcing the cylinders towards their deflected position. This impact sets up vibrations that will show up as print disturbance. This impact and resulting vibrations not only affect the pair of cylinders under examination, but also affect the pressure relationship between all four cylinders in a perfecting web-offset press.

If the cylinders could be made infinitely stiff, then they could generate transfer pressure in the nip without any deflection. In such a case, there would be no vibrations set up as the free state of the cylinder and the printing state would be the same. However, it is not possible to have perfectly rigid cylinder. This does point out the need to make the cylinder and its bearings assembly as stiff as is possible to keep the deflections under transfer pressure to a minimum.

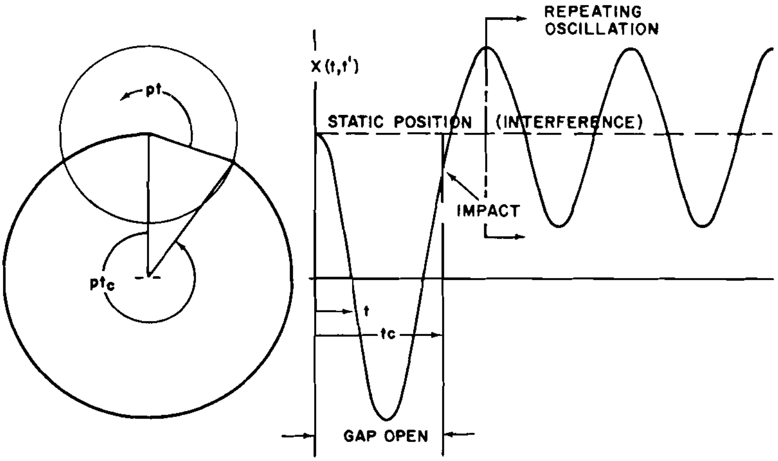


FIG. 2 VIBRATIONS OF CYLINDER DURING PASSAGE OF GAPS

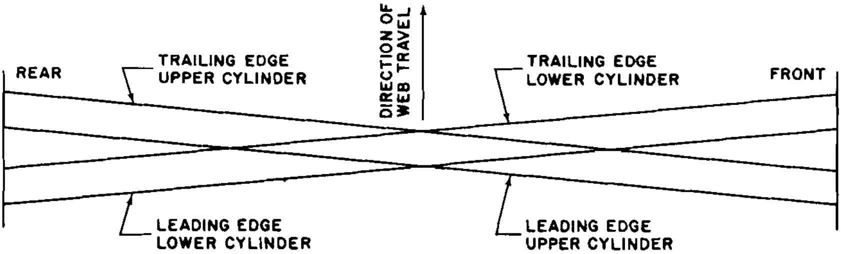


FIG. 3 SKEWED GAPS AT THE CENTER OF GAP PASSAGE

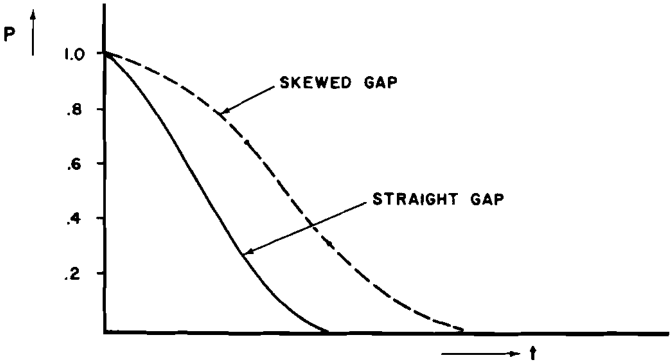


FIG. 4 PRESSURE DROP IN STRAIGHT GAP AND SKEWED GAP CYLINDERS

It would be ideal if the gap passage time was equal to time period of natural oscillation for the cylinder. In such a case, the trailing edge of the gap would release the pressure and set the cylinder vibrating and the leading edges would come in contact after one cycle of oscillation, when the cylinders would be back at the printing state. In most cases, the gap required for such a case is too large to be commercially acceptable. Besides, this would be true only at one speed of operation and printing presses are required to be able to run at various speeds.

This problem of cylinder vibrations has been with web offset process since its inception and has become more crucial as the modern presses are required to run at higher speeds. Various attempts have been made to reduce or eliminate this. Some manufacturers have machined the cylinder gaps with 'ramped' edges to provide gradual release and build-up of pressure. Similar effect is produced by "feathering" of the packing under blankets near the edge of the gap. Other solutions have included dynamic absorber inside the cylinder body, and increasing the cylinder stiffness and frequency by increasing diameter to length ratio.

The Skewed Gap Cylinders

At Hantscho, we have developed a new solution to this problem of cylinder vibrations. This consists of making the gaps in the blanket cylinders non-parallel to cylinder axis. The edges of the gaps in a pair of blanket cylinders is skewed in relation to cylinder axes in opposite directions such that they meet in the printing nip in a crisscross relationship. The major new development is very gradual drop in pressure as the trailing edges come into the printing nip and a corresponding gradual build-up of pressure that eliminates the impact that normally occurs at the meeting of leading edges. Figure 3 shows the gaps meeting in a flat plane. As cylinders rotate, web is released on the outer edge by the upper gap on one side and lower gap on the other side. The shape of unloaded area in the nip is triangular at each end of cylinder. These triangular areas increase in size till the gaps first intersect in the middle. At the midpoint of gap-passage, the gaps overlap each other in the shape of a rhomboid, with blanket to blanket contact still maintained at the ends. The leading edges come into the nip in the reverse manner, first intersecting in the middle and then passing through the nip with area under pressure in the shape of increasing triangles.

The major advantage of these cylinders with criss-crossed skewed gaps is that pressure release at gap passage is substantially stretched in time. Figure 4 shows the pressure release between cylinders with straight gaps and also with skewed gaps. The skewed gaps, by stretching the pressure release in time, lead to a quieter response. The theoretical response of straight and skewed gap cylinders to gap passage is depicted in Figure 5(a) and 5(b). For the speed of 1200 FPM, the pressure release is substantially slower and the resulting amplitude of vibration is roughly half with skewed gaps compared to straight gap cylinders. Analysis shows that with the configuration used, the skewed gap cylinders could run substantially faster to produce the same dynamic conditions as straight gap cylinders.

We have skewed the gaps only in blanket cylinders. As the plate cylinder gap is normally much smaller, the skewing of blanket gaps produces similar advantage in the plate and blanket nip as well. As the gaps are skewed equal amounts in opposite directions on upper and lower blanket cylinders, there is no tendency to pull the web on either side or get uneven release.

The analysis showed that to get the most from skewed gap design, the amount of the skew advance must be made at least equal to the effective gap width. The skewing of the blanket gaps does increase the non-print area. In order to gain advantage of the skewed gap concept, we designed a new blanket lock-up mechanism that provides a very narrow gap in the cylinder surface and uses blankets with bars at one end only. With this design, we have been able to provide a skew advance greater than the effective gap width and still provide a non-print area that is commercially acceptable.

Testing and Evaluation

We made a set of these prototype cylinders and installed these in a Mark IV printing unit at our Stamford R & D center in August 1981. Several hurdles had to be overcome before we could start testing. We ran the printing unit and monitored the vibrations using non-contact proximity sensors against the plate and blanket

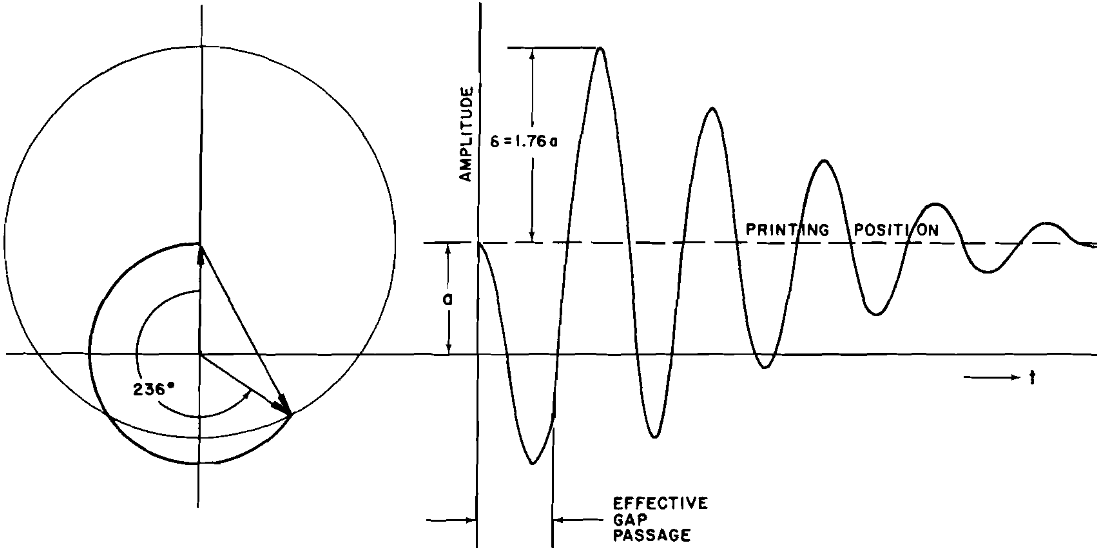


FIG. 5A THEORETICAL RESPONSE OF STRAIGHT GAP CYLINDERS AT 1200 FPM

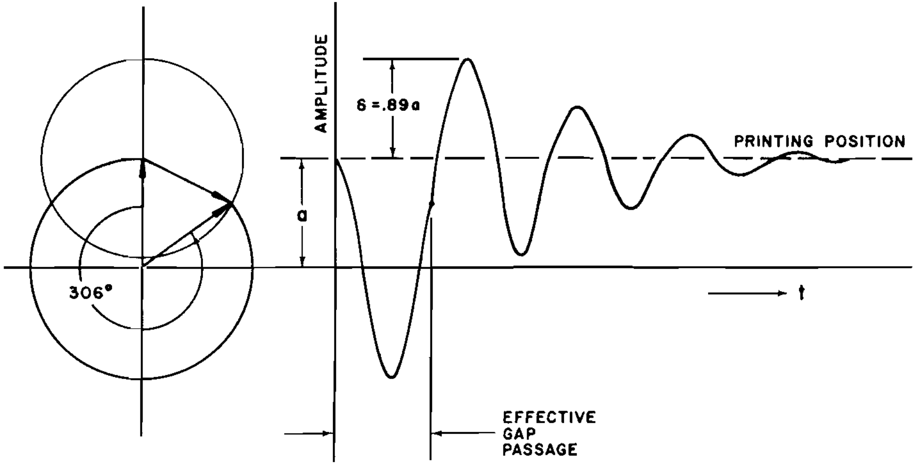


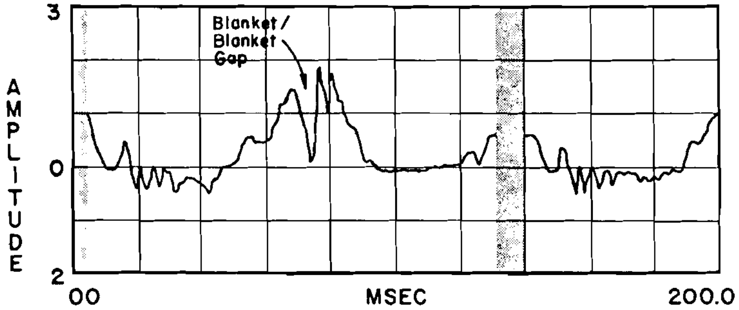
FIG. 5B THEORETICAL RESPONSE OF SKEWED GAP CYLINDERS AT 1200 FPM cylinders. The signals were fed into a dual channel FFT Dynamic Analyzer. The amplitude of vibrations was substantially less than with standard straight gap cylinders. Figure 6 through 9 show the results obtained from these tests.

Based on the success of these tests, it was decided to apply for the patents and to install these in a commercial installation for more detailed testing and evaluation. In September 1982, a four unit Mark IV-B press went into commercial application at Ronalds Printing in Toronto. This press has been in operation since then turning out high quality printing. In addition to minimizing the cylinder vibrations, the press runs much quieter with very little blanket follow-up. These cylinders named SABRE Cylinders, have since been retrofitted in several more presses.

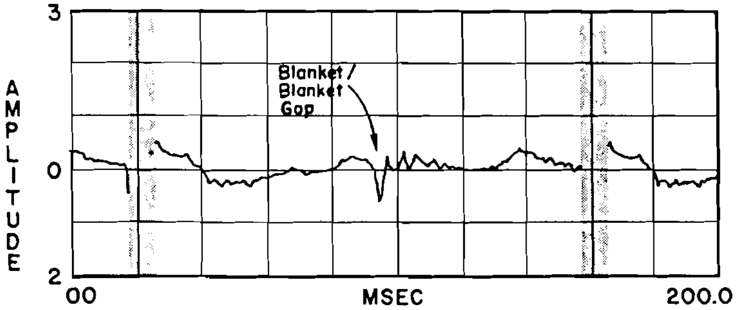
In conclusion, the skewed gap cylinders provide a unique, novel method to reduce cylinder vibrations, enable higher speeds and higher quality printing in web-offset presses.

UPPER BLANKET CYLINDERS

at 800 FPM — 25,000 IPH



STRAIGHT GAP DESIGN

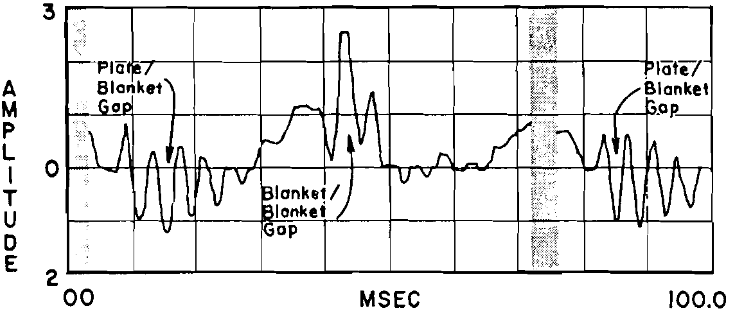


SKEWED GAP DESIGN

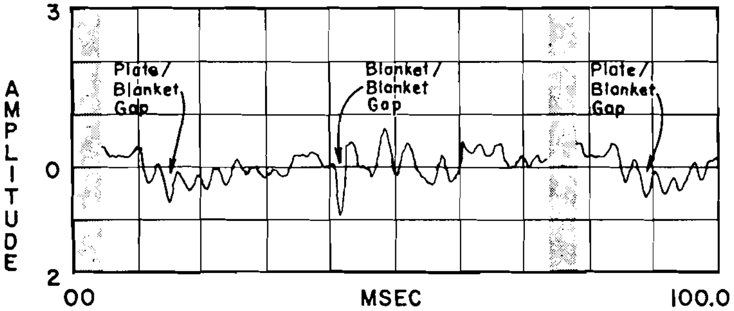
FIG. 6 TEST RESULTS – BLANKET CYLINDERS AT 25,000 IPH

UPPER BLANKET CYLINDERS

at 1520 FPM — 48,000 IPH



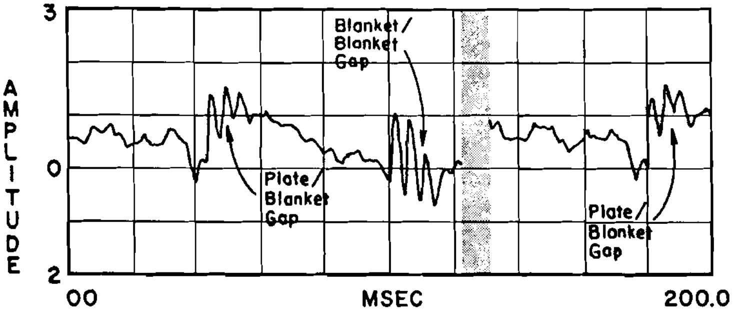
STRAIGHT GAP DESIGN



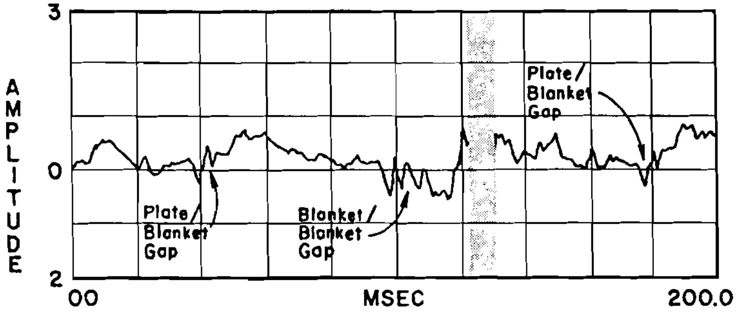
SKEWED GAP DESIGN

FIG. 7 TEST RESULTS – BLANKET CYLINDERS AT 48,000 IPH

EFFECT OF NEW DESIGN BLANKET CYLINDER ON PLATE CYLINDER
at 800 FPM — 25,000 IPH



STRAIGHT GAP DESIGN

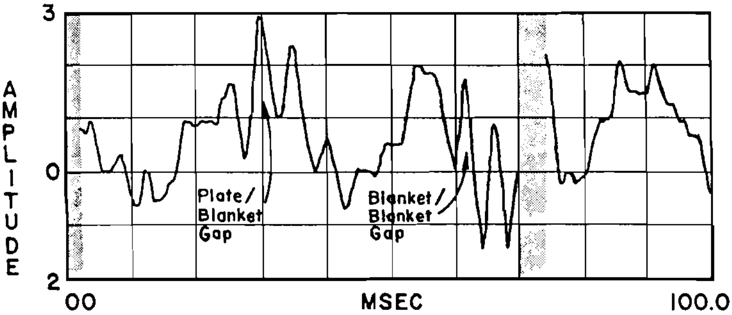


SKEWED GAP DESIGN

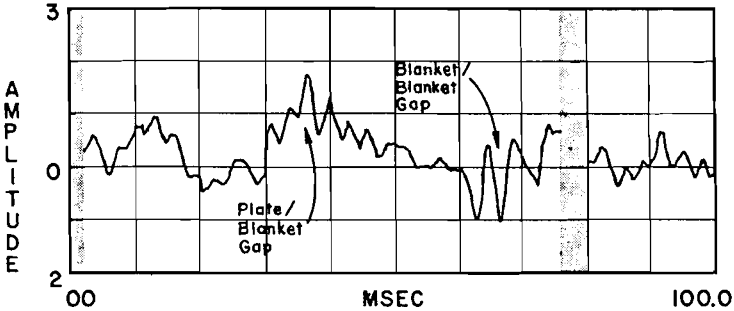
FIG. 8 TEST RESULTS – PLATE CYLINDERS AT 25,000 IPH

EFFECT OF NEW DESIGN BLANKET CYLINDER ON PLATE CYLINDER

at 1520 FPM — 48,000 IPH



STRAIGHT GAP DESIGN



SKEWED GAP DESIGN

FIG. 9 TEST RESULTS – PLATE CYLINDERS AT 48,000 IPH