BEARERS -- A NECESSARY EVIL?

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Bearers, hardened steel rings at the ends of printing cylinder bodies, have been used for over 100 years. Originally they were fitted to letterpresses to overcome the effects of clearance required in plain journal bearings. Without them, the interrupted impression loads of the letterpress form cause the cylinder journals to move back in the bearing clearance, resulting in uneven impression. They are used on both sheet and web-fed offset litho presses, and are thought by some to be essential for high quality and/or high-speed printing.

The value of bearers in particular presses has been demonstrated; print quality is higher with bearers than without them. But it is also true that many presses have been made without bearers, and run quite successfully on similar kinds of work. Some manufacturers (M.A.N.-ROLAND among them) build some presses with bearers and some without. It is not always clear from comparisons of quality and speed that bearers are necessary, but it is always clear that they take space, are expensive, difficult to set and sometimes fail.

It would seem that after all this time, a quantitative theory of bearers would have been developed and verified by measurement. Most press designers and pressmen have strong opinions as to the value of bearers, some grounded in solid experience, and some rather fanciful. There is much empirical knowledge and significant analytical work has been done, but despite all of this there does not appear to be a comprehensive, quantitative theory.

Because the questions of whether and how to use bearers are important ones for the designers at M.A.N.-ROLAND, and because the available literature leaves many unanswered questions, it was decided to start a program both analytical and experimental, to provide better guidelines for design-

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ers and press operators.

This paper is a summary of the first phase of that program, primarily analytical work done by the New Technology Group of M.A.N. at the request of the Research and Development Group in Augsburg. The New Technology Group is a kind of central research facility which serves the many different operating divisions of M.A.N.

The years of experience with bearers have shown that they affect printing impression in two ways. First, they are a significant factor in the transverse deflection of cylinders, both statically and dynamically. Second, they provide backlash free traction between cylinders, which can control or reduce relative angular motion between cylinders. This paper is concerned with deflection.

Figure 1 is a typical construction of printing cylinders with bearers at the ends of the cylinder bodies. For maximum effect they must be preloaded, that is, the cylinders are brought together until there is a substantial contact force between the bearers while the blanket is compressed to provide the printing pressure. Bearers must be hard to have a reasonable life, and because they are hard, determining the preload is difficult. Very small changes in deflection result in very large changes in force. The causes of the disturbance and vibration in the cylinders are the gaps or gutters, which are used to lockup plates and blankets. As cylinders roll together, the compression load is suddenly relieved when a gap enters the nipp, and then suddenly reapplied as it leaves.

SCHEMATIC CYLINDER ARRANGEMENT

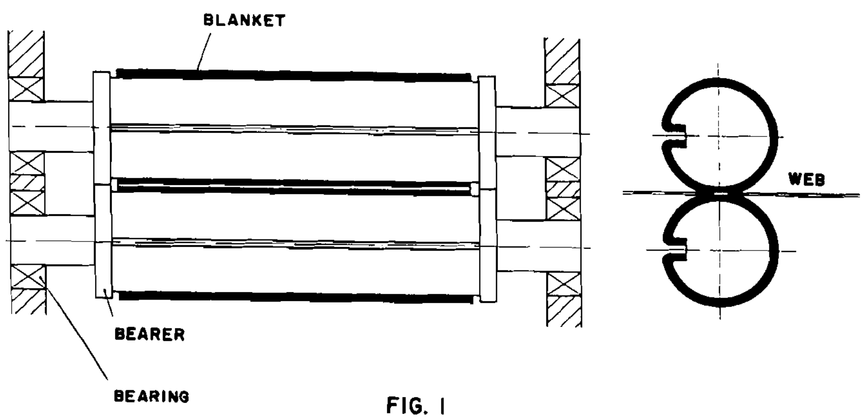

FIG. 1

Figure 2 shows the loads acting on one cylinder. The impression or printing load spread across the face of the cylinder and the bearer preload is resisted by the bearings on the cylinder journals.

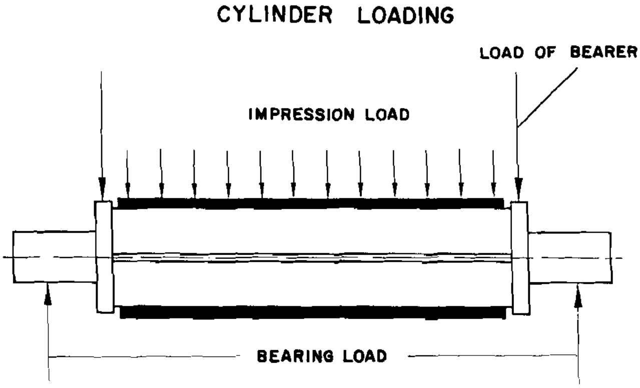

FIG. 2

To begin the analysis a mathematical model was constructed based on a cylinder loaded as shown in Figure 3. All of the loads are represented as springs, because they will change as the cylinders rotate and deflect.

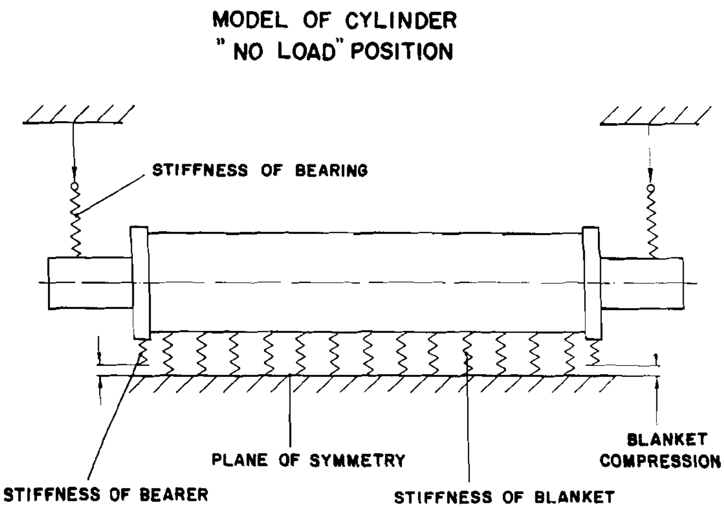

FIG. 3

The mathematical model, illustrated in Figure 4, consists of a series of masses connected to each other, and to the stationary frame by springs. Solution of the differential equations is lengthy and rather complex, but once the program for the general case is written, the effect of the varying dimensions and spring characteristics can be computed and plotted fairly quickly.

DERIVATION OF MATHEMATICAL MODEL

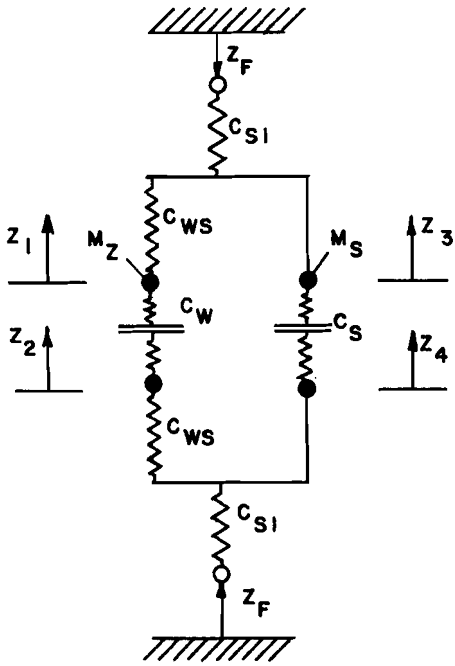

FIG. 4

Characteristics of the deforming materials of "springs" must be determined. The spring rate of the cylinders and bearers can be calculated, but those of the bearings and blankets must be obtained by measurement. Bearing stiffness was obtained from the bearing supplier and verified in a general way by laboratory measurement. The blanket characteristics were obtained by laboratory measurement on cylinders. Typical examples of the two general types of blankets are shown in Figure 5 -- a harder conventional blanket and a softer compressible blanket. Their load deformation characteristics are similar, differing only in degree. Both were included in the modeling work because experience has shown that cylinder vibration or streaking can be affected from one type of blanket to another.

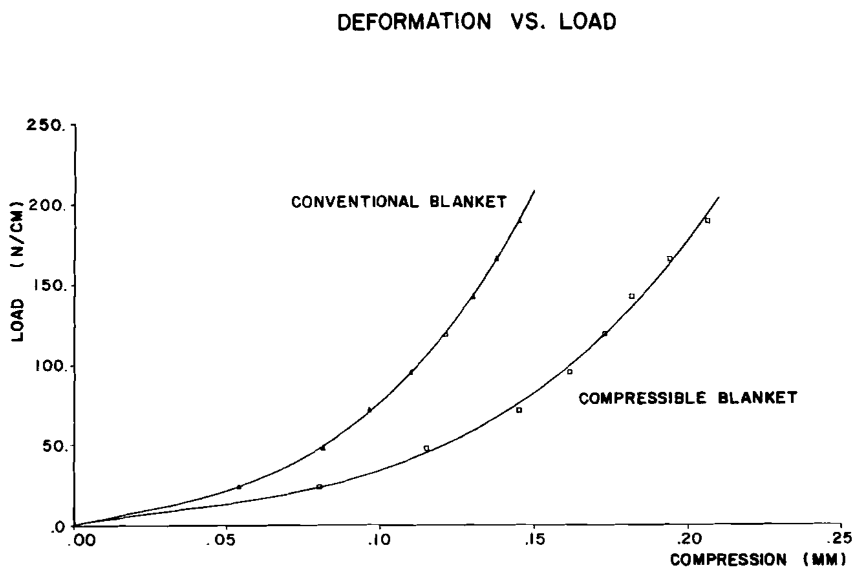

FIG. 5

The model has been used to predict the effect of changes in dimensions, loads, and blanket characteristics. Following is a series of examples which demonstrate the effect of many of the most significant variables.

Figure 6 shows the difference between conventional and compressible blankets run with the same compression.

Impression loads in Figure 6B are significantly different for the two blankets. Because in this case the cylinders have bearers, the bearing loads do not change much (shown in Figure 6C). The most significant variation in the bearer load is shown in Figure 6A. Note that with the hard blanket, the bearer load almost disappears in the second cycle, indicating a possible loss of traction and probable bearer wear.

COMPARISON OF BLANKET CONSTRUCTION

COMPRESSION 0.08 MM

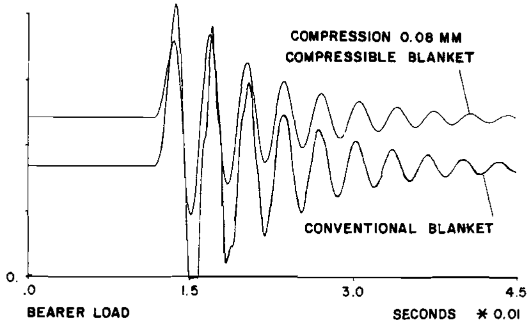

FIG. 6A

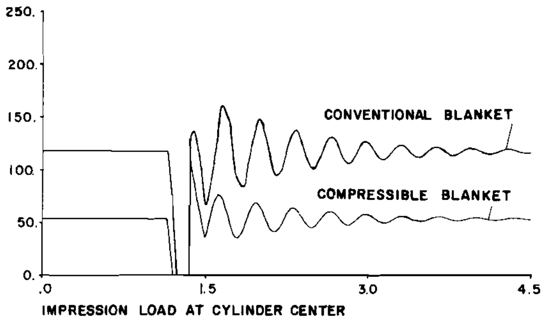

FIG. 6B

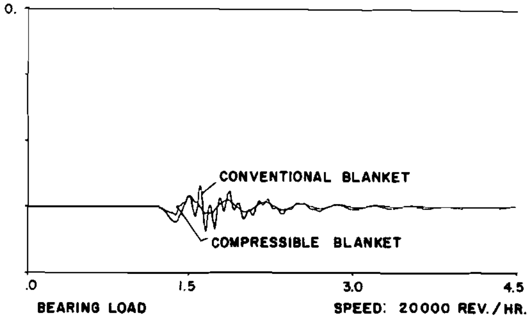

FIG. 6C

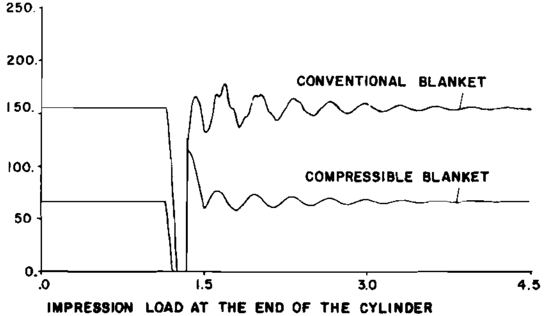

FIG. 6D

As every printer knows, the amount of blanket compression can have a significant effect on the printed results.

Figure 7 plots the effect of different amounts of blanket compression of a compressible blanket. Compression of .12 millimeters is typical for this type of blanket. If the compression increases, by as little as .05 millimeters, a typical thickness of a layer of lint on the blanket, loads change significantly. Note from Figure 7A that with this added compression, the bearer load goes to zero twice, indicating possible wear and traction problems.

A monitoring device has been constructed which uses a vibration pickup to detect variations in deflection resulting from the wide variations in impression load. It can be used to alert press operators to improper settings or lint build-up.

Another variable studied was the width of the gap or gutter in the cylinders. The gap, after all, is the cause of the disturbance. Figure 8 shows how the impression and bearer loads differ as the gap width is changed. The variation in impression load caused by the 15 millimeter gap (Figure 8A) may cause differences in print quality in a streak pattern. Note that the bearer load varies widely (Figure 8B). The stress on the bearer will be higher and its life will be considerably shorter.

But what about cylinders without bearers? Figure 9 compares the same cylinder with and without bearers. Note the much wider variation in impression load without bearers (Figures 9B and 9D), indicating a possible difference in print quality in a streak pattern. This variation will increase if harder conventional blankets are used instead of compressible blankets. Note also, in Figure 9C, that the bearing load can go to zero, so that any play in cylinder eccentrics will allow the cylinder journals to move, resulting in even greater variation in printing pressures, and almost certainly in light streaks in the print.

The advantages of bearers are more uniform print quality, less sensitivity to play or looseness in the cylinder mountings, and longer blanket life. All are a consequence of less variation in impression. Designing cylinder mountings without play can be a difficult task and always results in higher manufacturing cost.

DYNAMIC LOADS VS. BLANKET COMPRESSION

0.06 MM, 0.12 MM, 0.12 MM + 0.05 MM LINTING

COMPRESSIBLE BLANKET

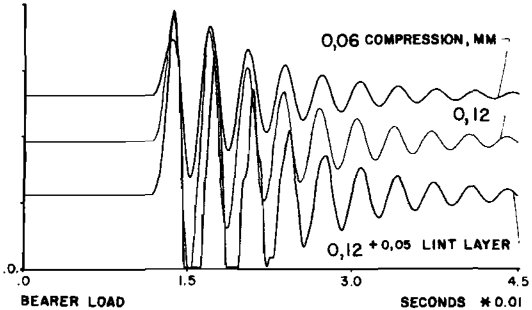

FIG. 7A

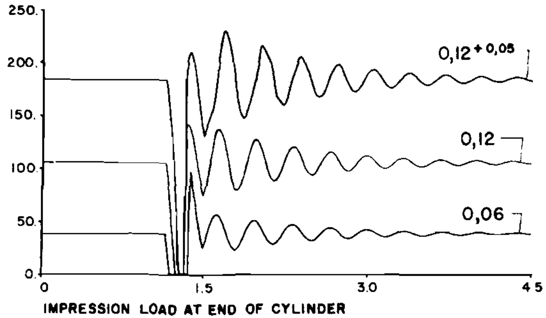

FIG. 7B

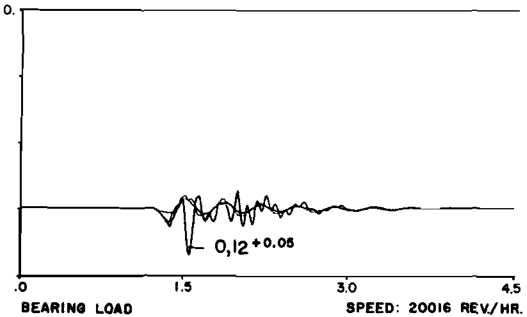

FIG. 7C

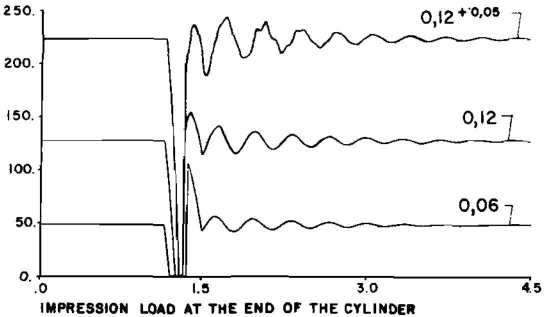

FIG. 7D

EFFECT OF GAP WIDTH

SPEED 30,000 REV./HR.

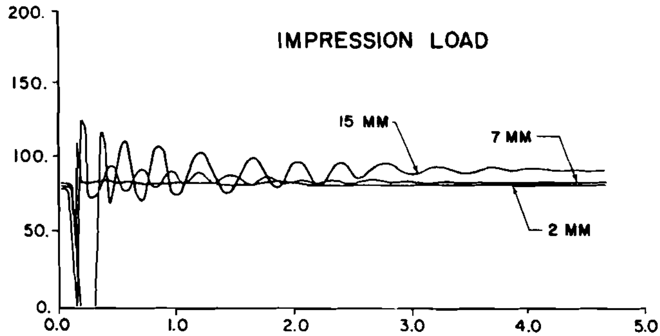

FIG. 8A

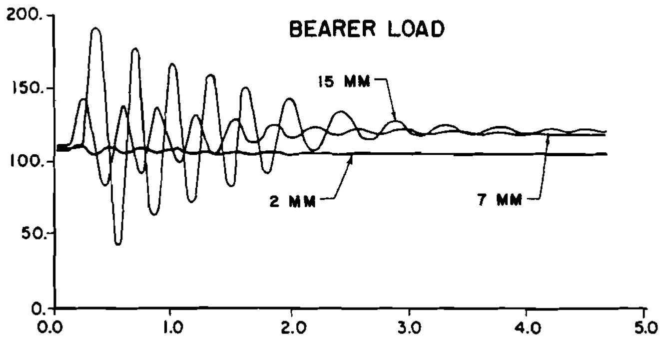

FIG. 8B

EFFECT OF BEARERS

COMPRESSIBLE BLANKET - 0,12 MM COMPRESSION

FIG. 9

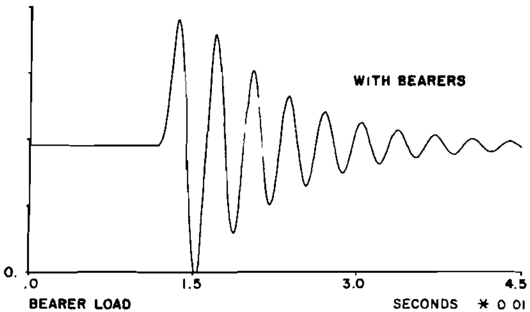

FIG. 9A

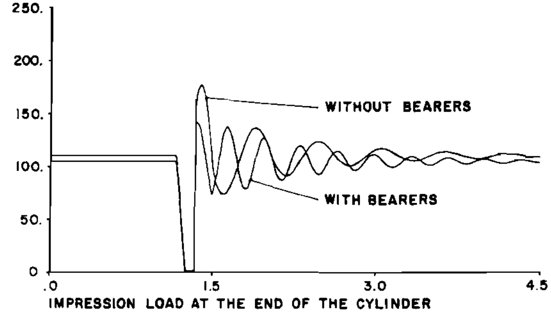

FIG. 9B

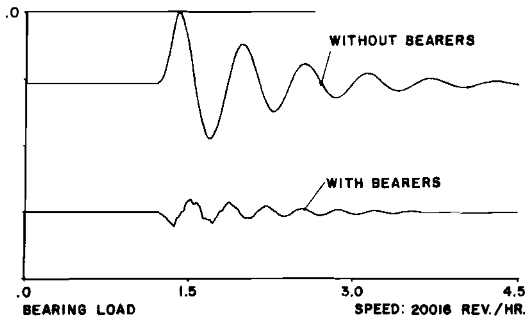

FIG. 9C

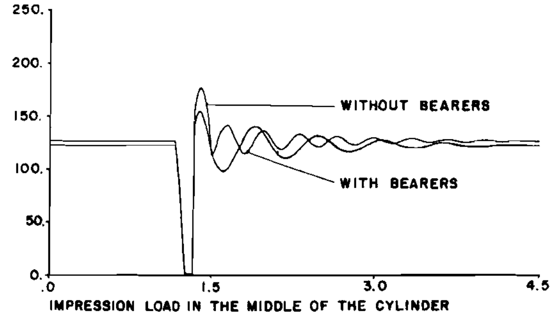

FIG. 9D

To realize the advantages of bearers, they must be preloaded, so the effect of preload was investigated. One limit is the stress on the bearer material and its effect on bearer life, so that bearer preload should be the lowest needed for good printing. Figure 10 shows the effect of different bearer preloads on cylinders with conventional blankets. The preload was varied from 8000 to 63,000 newtons. In Figure 10A, it can be seen that with the low preload, the loads on the bearers go to zero several times. They will thus bounce and possibly skid. Even more significant is the variation on impression load in the middle of the cylinder. Note that with a bearer preload of 63,000 newtons, the impression load comes very close to zero in the first vibration cycle after the gap. It is very likely this will be a light streak in the printing at this point.

There is thus an optimum setting for bearer preload, but determining what the preload is in a press is difficult. The usual techniques of shining light between the bearers when the cylinders are under a higher than normal impression load, or using aluminum or stamping foil between the bearers, do not correlate well with actual loads. A method of measuring bearer preload directly was thus devised.

In the laboratory setup of the system, a hole is drilled in the bearer and is filled with oil. If the hole is the proper distance from the surface of the bearer, the changes in the pressure of the oil trapped in the hole are a reliable measure of bearer preload. At this point the equipment has to be used by trained technicians, and is not yet ready for use by pressmen, but it does provide a way to measure bearer preload directly.

There may be other ways to use bearers besides the conventional approach of putting them at the ends of the cylinder body. One possibility is to put them outside the bearings. The differences in the bending of the cylinders is shown in Figure 11. The scale of the bending is exaggerated, but they are in proportion for the three cases of no bearers, bearers inside the bearings, and bearers outside the bearings.

EFFECT OF BEARER PRELOAD
"CONVENTIONAL" BLANKET - 0,06 MM COMPRESSION

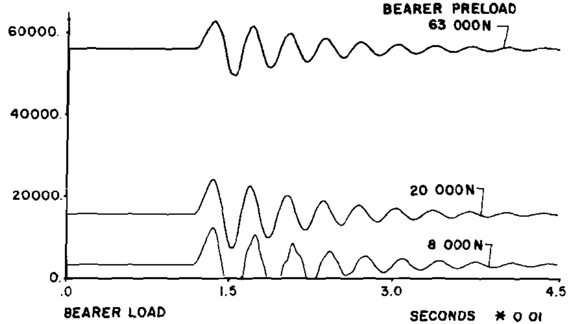

FIG. 10A

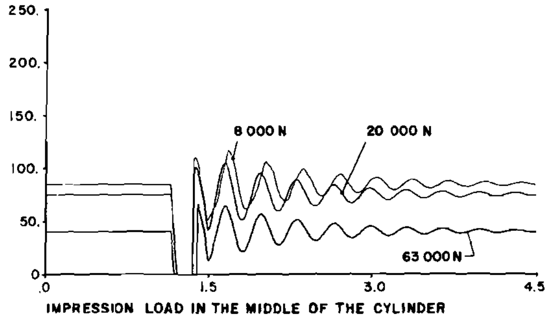

FIG. 10B

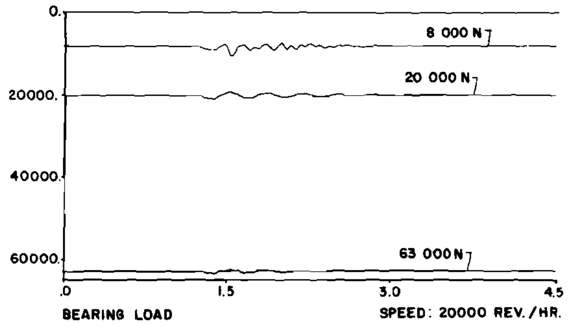

FIG. 10C

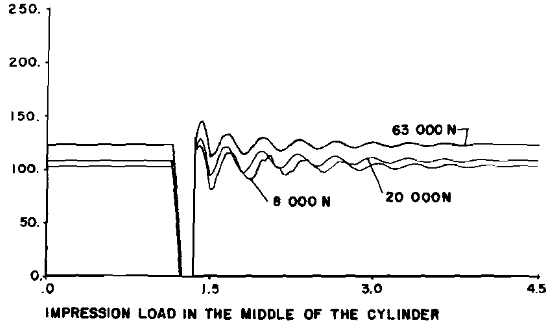

FIG. 10D

CYLINDER DEFLECTION

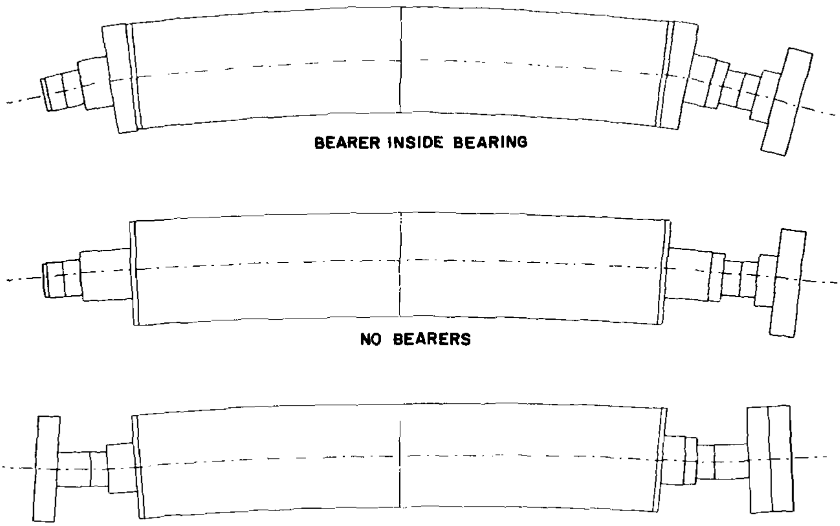

FIG. 11

Some effects of the different locations is shown in Figure 12. There is not much difference in the impression load for the three cases (Figure 12A), but significant differences in both the bearing and the bearer loads. If the bearer is outside the bearing, the bearing load is roughly one-third of that value when the bearer is in the conventional position inside the bearing (Figure 12B). The load on the bearer itself is less than 20 percent when it is outside the bearing, compared with the conventional position inside the bearing (Figure 12C). The life of both the bearings and the bearers would be much longer using this unconventional bearer design.

EFFECT OF BEARER LOCATION

SPEED 30,000 REV./HR.

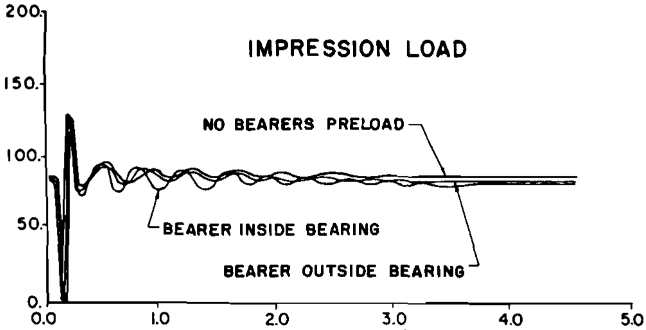

FIG. 12A

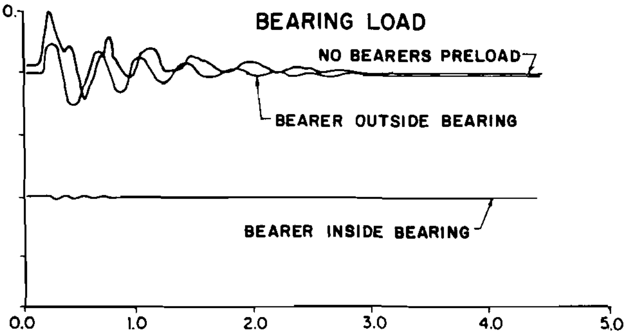

FIG. 12B

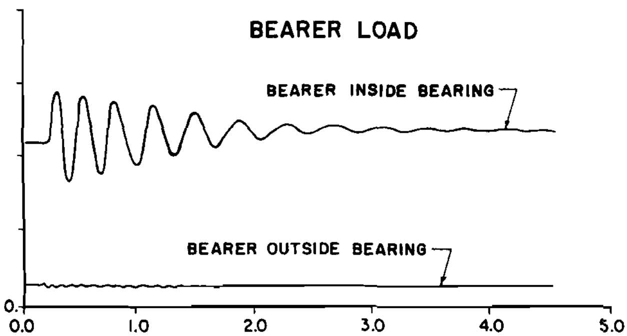

FIG. 12C

CONCLUSIONS

Sophisticated mathematical models can provide a means of quantitatively evaluating cylinder and bearer designs. Many of these calculations have been verified by laboratory measurements. They do not provide a simple answer to the question of whether bearers are necessary, but they do provide a means for the press designer to predict the effect of his design alternatives and to illustrate the advantages of bearers and the significance of proper settings.