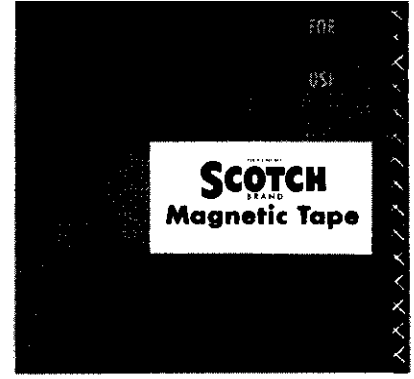
Sound Talk



Bulletin No. 36

SCOTCH BRAND Magnetic Tape

PRECISION REELS FOR INSTRUMENTATION RECORDING

By

R. A. Von Behren

Increased use of magnetic tape in critical instrumentation recording applications has focused attention on efforts to achieve greater precision and reliability throughout the recording chain. To date magnetic tape manufacturers have concentrated largely on producing drop-out-free instrumentation tape and on improving its physical and magnetic properties.

However, experience both in the laboratory and in the field has indicated that the reels themselves on which the tape is wound are important factors in achieving optimum results. The use in the instrumentation field of wider, thinner-base tapes and larger tape reels -- up to 14 inches in diameter -- has resulted in situations where standard tape reels are no longer adequate, and actually represent a weak link in the recording chain.

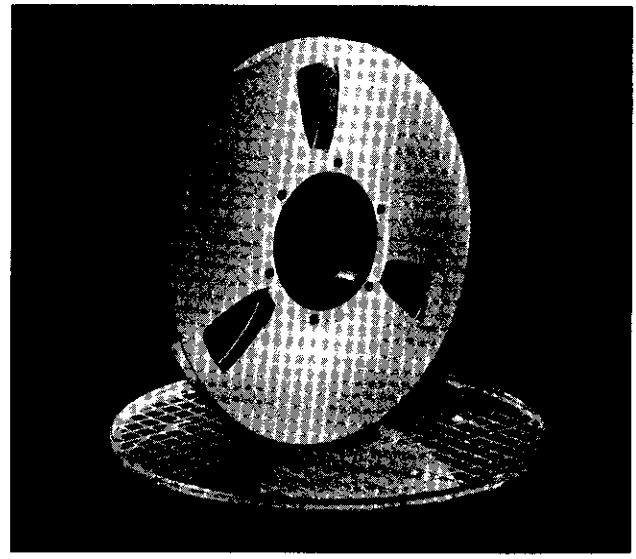
As a result, the Magnetic Products Laboratory of the 3M Company undertook development some time ago of a precision tape reel that would meet the critical requirements of the instrumentation recording field.

PROBLEMS WITH NAB REEL

Standard reels for magnetic tape were developed some years ago under the National Association of Broadcasters (NAB) to fulfill the requirements of the broadcasting industry where 1/4" tape was the standard and where tape speeds, tape tensions and head pressures were lower than those encountered in the instrumentation field. In addition, the single track recordings in the audible range were substantially less critical as compared to today's instrumentation requirements. NAB-type reels are still, however, adequate for audible range recording.

Flange Clearance

One of the major problems encountered in using the NAB-type reel in instrumentation recording lies in the stand-



MINNESOTA MINING & MANUFACTURING CO.
Saint Paul 6, Minnesota

ards for clearance (.100" overall) between the tape and the reel flanges. Because of this relatively wide spacing, poor stacking of the winds of tape results which, in turn, may cause further difficulties with serious results.

One of the results of poor stacking is permanent deformation of the tape -- especially if tightly wound -- called "camber" which stretches alternately the edges of the tape producing a skewing action as it passes through the machine. Such action, in turn, results in poor head-to-tape contact on the stretched portions of the tape.

Another result is improper guidance of the tape and corresponding misalignment of the recorded tracks. This is especially serious where tapes 1/2" or wider are used and conventional edge-guidance becomes less effective since the stiffness of the tape decreases as the tape width increases.

A third problem that arises because of the wide flange spacing is that a single turn of the tape may protrude allowing the edge to be bent over and permanently distorted. Poor head-to-tape contact, resulting from the distorted edge, may result in the loss of information on the edge tracks for a distance of up to several inches.

Hub Design

A second major problem encountered in use of the standard tape reels is in the hub design. Standard hubs may distort the tape permanently and, also, may themselves distort due to high tape tension.

Most common damage to the tape caused by the hub is threading slot distortion where the tape indents as it passes over the 60-mil-wide thread-up slot. If tightly wound, this indentation will appear well out into the reel -- as far as 1" representing some 1000' of tape in the case of 1 mil backing. Such distortion of the tape is permanent and results in lifting of the tape away from the head upon playback.

Another form of tape distortion is caused by hubs that are not a perfect cylinder, but tend to be slightly cone shaped -- something which is not uncommon. This causes the tape to conform to the cone and stretches one edge so that the resultant curve in the tape tends to lift the long edge away from the head causing loss or reduction of signal.

Shortcomings in the hub design which may result in damage to the hub itself can be attributed largely to the existence of the threading slot. Because this weakens the hub, it will sometimes compress and distort to an out-of-round condition under high tape tension -- especially during storage -- so that it is no longer possible to load it on the recorder.

OVERALL RIGIDITY

The third major defect of the NAB-type reel for instrumentation recording use is in overall lack of strength and rigidity adequate for handling when wide-widths and long lengths of tape are used. For example, a reel of 1 mil tape 2" wide and 4800' long weighs 13 pounds and if accidently lifted off the recorder by the top flange only, the 50-mil-thick aluminum flange will bend and permanently distort, rendering it unusable.

Additional problems stem from the spoke design employed. Because of the large areas of exposed tape, the tape edges are unduly subjected to handling -- a serious problem if individual edges are exposed and subsequently bent over.

NEW PRECISION REEL

As a remedy to the problems encountered by instrumentation tape users with the NAB reel, the 3M Company has introduced a new precision reel which, tolerance-wise, is equal to the critical standards of the instrumentation tape itself.

The new reel features a fully machined -- rather than stamped -- construction with narrowed spacing between the flanges for a more even tape wind. It also features a tapered flange for a lower moment of inertia, yet has considerably more rigidty than older reels.

Finally, it completely eliminates the conventional threading slot.

In designing a tape reel for instrumentation use which overcomes the problems found in the NAB reel, however, a number of problems had to be overcome.

FLANGE SPACING

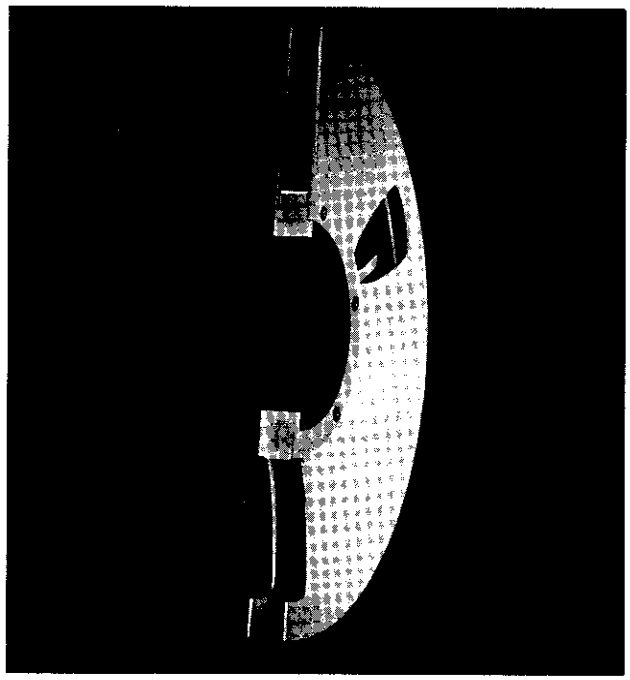
First of all, the flange spacing must be reduced in order to assure more even stacking of the tape during winding. However, the problem of tolerances arises immediately. This is due to three factors: (1) lack of precision in the recording equipment; (2) shortcomings in the conventional construction of the reels themselves; and (3) necessity for compatability of any new reel with existing equipment.

Most common problems in the recording equipment result from (1) spindles or pedestals tilted so that the tape skews and rubs against the flange; (2) spindles or pedestals not properly centered up and down so that the tape rubs against either the top or bottom flange; and (3) mis-aligned tape guides producing the same problems.

Another problem is in the flanges themselves. Stamped out of relatively thin aluminum, they seldom have a perfectly flat surface. This is further complicated by handling of the reels which tends to bend the flanges. Therefore a thicker flange is required to permit machining of the aluminum to a flat surface which will not easily distort.

Moment of Inertia

In addition to spacing of the flanges, a



second major improvement in the 3M precision reel is in regard to the moment of inertia which increases considerably with the use of a heavier flange. This presents problems in stopping, starting and braking the machine.

Experiments have shown, however, that to maintain rigidity, increased thickness near the hub with the section tapering toward the rim provides maximum strength with minimum weight.

The moment of inertia, on the other hand, varies as the square of the distance from the mass to the center of rotation. Hence it is very sensitive to the thickness of the flange at the rim.

This enabled an excellent compromise to be made in the new 3M precision reel by employing a relatively thick flange at the center machined on the outside surfaces to a thinner section

at the rim. Thus advantages are gained both in strength and a low moment of inertia.

If an untapered reel were to be made having the same thickness near the hub as the new 3M reel, the moment of inertia would be increased four times. By machining the flanges to a taper, however, the moment of inertia is increased only 1.8 times. In addition, this design makes the new reel fully 10 times as rigid as the old under a deflection load.

Two other factors in the design which are important are the ability to thread the tape on the reel and the ability to see the tape and determine easily how much is left on the reel.

While the large exposed tape area of the old style reels cannot be eliminated, it has been possible to reduce the open area considerably. In effect, the new 3M reel -- with its three narrow openings for visual observation and for threading -- is essentially a solid disc with slots.

As a result, it is an easy matter to thread the reel through the openings, yet the reduced size of the openings contributes considerably to the overall rigidity of the reel.

THREADING RING

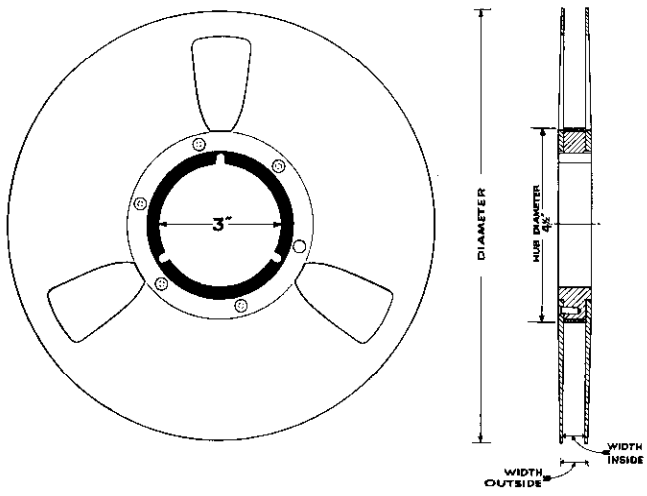
A major improvement in the new 3M reel is complete elimination of the threading slot itself by using a precision moulded and ground synthetic rubber ring .040" thick around the hub. With its higher coefficient of friction, the rubber threading ring makes thread-up possible by simply starting a turn of tape on the takeup reel so that the end of the tape is "buried." This is sufficient to anchor the tape and start it winding properly when the machine is started.

A subsidiary benefit of the rubber threading ring is that it provides a certain amount of resilience further reducing any tendance for the hub (already made stronger by elimination of the thread-up slot) to distort when the tape is tightly wound.

In addition, both the flanges and the hubs of the new reel are fully machined and anodized to obtain a hard, corrosion-resistant surface.

A final, but equally important feature in the design of the new precision reel is a new method of centering the flanges on the hub. In the standard NAB reel, this is accomplished by the use of three mounting screws only, and centering is something less than precise.

However in the new reel, a raised shoulder is precision ground into the hub so that the flanges can be attached in one position only -- perfectly centered. In addition, six screws are employed to insure a rigid mounting. As a result of these two factors, the total runout of the new reel is held to a tolerance of .010" at the rim -- significantly less than possible with the standard type reels.



CATALOG NUMBER (Tape Width - Instrumentation - Reel Diameter)	REEL DIAMETER	WIDTH INSIDE	WIDTH OUTSIDE
1/4 - IR - 10½	10½"	.265"	.447"
1/4 - IR - 14	14"	.265"	.447"
1/2 - IR - 10½	10½"	.515"	.697"
1/2 - IR - 14	14"	.515"	.697"
3/4 - IR - 10½	10½"	.765"	.947"
3/4 - IR - 14	14"	.765"	.947"
1 - IR - 10½	10½"	1.015"	1.197"
1 - IR - 14	14"	1.015"	1.197"
REELS FOR VIDEO TAPE RECORDING			
2 - IR - 10½	10½"	2.015"	2.197"
2 - IR - 14	14"	2.015"	2.197"