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-
ards for clearance (.100" overall) be-
tween the tape and the reel flanges. 
Because of this relatively wide spacing, 
poor stacking of the winds of tape re-
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 mis-
alignment 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 dis-
torted 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 un-
common. This causes the tape to con-
form 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 exist-
ence 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 en-
countered by instrumentation tape 
users with the NAB reel, the 3M 
Company has introduced a new pre-
cision 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 con-
siderably more rigidity 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 compatibility 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 in-
creased 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 pre-
cision 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 tendsion 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, cor-
rosion-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.

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REELS FOR VIDEO TAPE RECORDING

1 = 3M - 10 | 10" | 2.015" | 2.197" |
2 = 3M - 14 | 14" | 2.015" | 2.197" |