**Do we really have to murder the grass every day? Golf courses today are under such close scrutiny that greenkeepers are forced to use almost any "fix" to achieve the ultimate appearance. Stephen Bernhard sheds some light...**

# The cutting edge

This might include choice of mower, chemicals, and procedures such as top dressing and so on. What drives us? Is it the desire for approval by our members? Do we search for that ultimate playing surface? Are we looking to improve job security? Lots of issues here! One crucial fact has to be admitted - the last thing one does prior to allowing the customer on the hallowed turf - is to attempt to murder it!

How? By mowing it. Grass doesn't like being cut every day. It's painful and potentially dangerous. But we demand exquisite grass that has to be mown daily.

So a clean healthy cut is perhaps the most important thing we can do daily. Despite a lot of hype about the latest sophisticated mowing equipment the basic requirements are the same as they were when carpets needed mowing with a fine, clean cut - and importantly, with consistency. Even the fanciest mowing machine will be brought to its knees by unsatisfactory cutting performance.

# The cutting edge

## A little history...

Cylinder mowers were first developed by Edwin Budding for shearing the nap of carpets around 1830. Using only straight blades, a threshing action of those first prototypes produced an uneven cut as the material was fanned about.

So, to resolve this, a helix was created by twisting the blades into a spiral. Bottom blades were added to hold the carpet fibers in place, positioning them for uniformity of cut. The helical blades caused the cutting point to be drawn horizontally across the bottom blade creating a scything action. Budding applied his textile shearing concept to mowing grass, patenting his first cylinder mower in 1830 replacing the manual scythe to mow grass.

Johnny Atterton produced griss mill grinders and modified these machines to help create a true cylinder for these early mowing machines. Responding to the growing demand, he soon supplied grinders to Ransomes, Shanks and Lloyds, the three major mower manufacturers of the day.

Atterton also developed and patented the first commercial mower grinder. As small repair shops proliferated, he developed a range and by 1870, Atterton and Ellis, Ltd. (which is owned by Bernhard & Co. today) had four steam or hand driven spin grinders on the market.

"In situ" spin grinding - meaning the cylinder is ground "in the same situation" as the cylinder is used during mowing, rather than removing it and grinding separately - came about the turn of the century. With this method, a grinding stone was positioned where the grass would normally be. Single-blade grinding was initiated in the USA by an Ohio Company called SIP with a machine they called a "hook grinder" around 1935. The concept of lapping was developed because of the need to make single-blade-ground cylinders truly cylindrical. This was the same problem Budding ran into one hundred years earlier, solved then by the use of the Atterton cylindrical grinder. Relief grinding, or blade thinning, was then created to reduce the braking effect of lapped cylinders.

## The cylinder mowing process

Despite the fact that manufacturers have continued to improve designs, much of the original cylinder geometry pioneered by Budding and Atterton remains valid today.

The function of cylinder mowers is simple. As it rotates, the cylinder blade draws the grass blades against the front face of the bottom blade, which positions them for a uniform cut. This also controls the height of cut. The leaf tissue is sheared as the blades pass across the top face of the bottom blade. The cut material is compressed momentarily, then rapidly decompresses and is ejected from the cylinder/bottom blade interface.

The helix of a cylinder is designed to produce the effect of a succession of razor blades passing along the bottom blade without contact, creating the horizontal scything action so critical to a clean cut of the leaf tissue. The flatter the helix angle of the cylinder blade, the higher the velocity with which the point of cut passes along the bottom blade. The bottom blade positions the grass blade at the prop-

Overleaf: A highly magnified section of grass which has been cut cleanly, and right, a section which has not

er angle for mowing. The front face of the bottom blade is the positioning face, while the top face is the ejection face. A correct front face angle must always be acute (< 90°).

Many greenkeepers perceive the problem of "rifling" after noticing streaking on the surface of the turf. This usually points to excessive tightening of cylinder to bottom blade.

Inevitably, this causes the leaf tissue to be cut in a mechanical scissors-like fashion, often in the middle of the cylinder blade surface, rather than at the cutting edge of the cylinder and bottom blade. Instead of the clean cut achieved by scything, the leaf tissue becomes pinched. It is then literally pulled apart and ruptured during the scissoring process, rendering the grass blade vulnerable to many potential problems.

### Scissors vs scythe

This difference between a scissors-cut and a scything action is important to understand. Scissors require two blades moving toward one another in opposing directions. Scissors cut adequately if there is sufficient light contact. Scythes consist of a single cutting blade being drawn obliquely across the leaf tissue, damaging fewer cells in the process. Scissors will, of course, cut but a scythe cuts soft tissue much better. This is precisely why a surgeon uses a single-blade scalpel (which is drawn through the flesh) instead of scissors.

He looks for a surgical clean cut that will heal quickly. In a cylinder mower, one difference between a scythe and scissors action is the velocity of the cutting edge. A properly ground and adjusted mower will operate in a scything action at much greater velocity than one functioning as scissors. Think of the analogy of razor blades shooting along the length of the bottom blade edge.

### So what does lapping do?

Even the most precise angles and adjustments can go awry if not maintained properly once the cylinder and bottom blade start to wear. This is where all the contention about relief vs. no relief, lapping vs. no lapping, and contact vs. no contact adjustment come into play. Inaccurate

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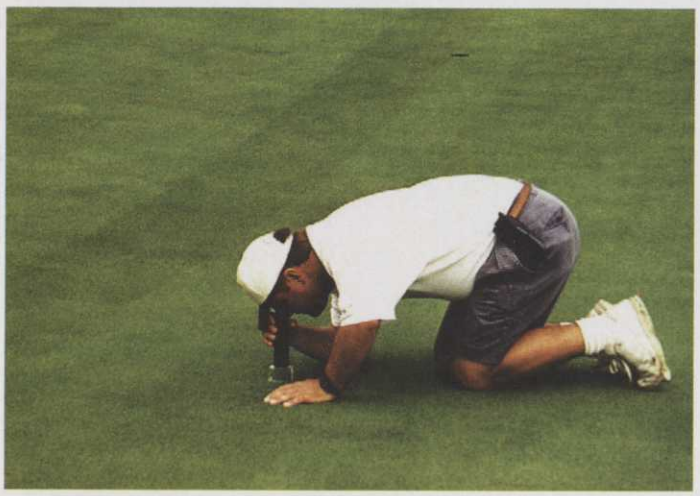
grinding results in varying heights of each cylinder blade. Lapping was invented to make a single-blade-ground cylinder truly cylindrical again even though the exact diameter may vary along its length. During the lapping process abrasive wears down the high blades to the level of the low ones, but also creates two curved, mirrored surfaces from the bottom blade and cylinder tip. The curve assumes the arc of the cylinder rotation. Unfortunately, these two mirrored surfaces act as a drum brake, with the rotating blades of the cylinder forming the drum and the bottom blade acting as the brake shoe. This causes considerable wear to the bottom blade and cylinder, and also requires more power to rotate the cylinder due to the drag factors involved. By effectively wearing away the sharp leading edges of the cylinder blade and bottom blade, lapping also turns a scythe into a scissors cut (requiring light-to-moderate contact between the two surfaces).



Above: Examining the quality of cut

Lapping is essentially "any wearing process", even that of cylinder and bottom blades during normal use of the mower. Normal wear and tear produces curved, mirrored surfaces just as intentional "paste" lapping does, but the surfaces are rounded and irregular - thus requiring greater and greater contact via tighter adjustment to maintain functionality.

Paste lapping can restore some of the cutting ability of worn cylinder tips and bottom blade edges. A well-lapped blade certainly produces a far better finish than a rounded and dull blade, but is a temporary fix until the cylinder can be properly ground and adjusted again.

Grinder technology exists today, allowing a complete regrind of a greens-mower cylinder in less than ten minutes, floor-to-floor, without even dismantling any component nor adjusting any roller or bottom blade.

## The need for relief grinding

To minimise braking effect of lapped surfaces, relief grinding (also called "backing off" or "blade thinning") was invented in the USA during the mid 1930's.

When this relief wears off from lapping and/or excessive blade contact, the cylinder blade tip gets "fat" again. It should then be either lapped to produce a temporarily sharp edge or reground to original angles and dimensions. Very few mowers still have functional relief six months into the season so the drag is massive. Reducing the blade thickness by 3/4 reduces the torque required to turn the cylinder by a factor of 16. But it also increases the vertical (upward) thrust on the cylinder bearings by a factor of 16, Cylinder bearings are not normally designed to absorb vertical loading causing bearings to oval over time and resulting in a fine vibration. This tends to round off the cylinder and bottom blade tips.

More lapping is then required, which in turn causes more vertical thrust, wear, and vibration. And so the vicious circle continues. The need to lap becomes greater as the season advances and many people belief that relief grinding produces a better cut. Actually, relief grinding has no effect whatsoever on the quality of cut, since on lapped cylinders there is no relief at the actual point where the grass is cut. Relief reduces the torque required to turn a lapped cylinder and the subsequent load on the engine and hydraulics of the mower. The best relief is obtained from a properly ground, non-lapped cylinder adjusted for "no contact at all". No contact is ultimate relief.

## Equipment considerations

If you can think of your mower as a horse, regardless of its configuration - and if you appreciate that the real impact upon the turf is where the mower actually cuts the grass - that is the cylinder and bottom blade - it becomes easier to disentangle the complex arguments. The braking effect of wrongly adjusted or over-tightened cylinders often causes undue system load, resulting in engine wear, higher fuel consumption, heat gain to hydraulic systems, overload to seals and hoses, and otherwise unsatisfactory performance. For this reason, many manufacturers insist (quite rightly) upon maintaining relief on their cutting units.

Now it is easy to understand the benefits if NO CONTACT - the ultimate relief.

## The agronomic viewpoint

The way a mower leaves a leaf blade has significant impact on overall plant health. We tend not to think much about what is going on at the microscopic level, where grass is cut. Plant pathology research demonstrates how damaging the use of lapped (or otherwise improperly sharpened) cylinders can be.

Poorly ground mowers tend to flail at the grass, leaving bleeding rough edges. A microscopic inspection of the leaf tip area reveals that a clean, scything cut made by a properly sharpened, non-lapped cylinder results in less leaf surface area exposed to pathogenic infection, and lower transpiration rates. The plant can use more of its nutrients for root growth rather than damage repair.

Moving the maintenance programme up a notch, avoiding "the mower doesn't cut so we need to tighten it down a bit more" syndrome, can yield dramatic improvements (and savings) in several areas. Simply touching up the front face of the bottom blade every week on greens-mowers, every two weeks on tees, maybe monthly on fairway units - whatever works for you - will go a long way toward extending the functional life of a quality grind and save time by forestalling the need to lap.

Investing one hour every two months in sharpening - however you do it, with whatever machine you use - vs. spending four hours lapping over that two months (15 minutes twice per week) will yield even greater benefits to your overall agronomic and turf equipment maintenance programs.