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In search of the perfect CUT



by BRIAN MITCHELL

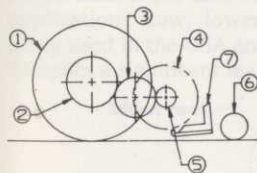
Two basic principles are used in cutting unit adjustment, these being:

■ *Reel adjusted down on to the bottom blade* – This is the system generally used in Europe and is the method used on all Ransomes cutting units except trailed gang mowers. Ransomes trailed gang mower design is based on the original Worthington Patents (USA) and the original method of adjustment has been retained.

■ *Bottom blade adjusted up to the reel* – This is the system used generally in North America and no doubt is based on the original Worthington Patents, the method being extended from its initial trailed gang unit application to all other types of cutting unit.

Trailed Gang Unit Requirement

In trailed gang units the cutting reel is driven through a system of gears from the ground engaging the wheels of the unit. In such a drive system it is of course essential to maintain a constant centre distance between the intermediate gear and reel pinion and this constraint makes it desirable to have a fixed position for the reel.



1. Wheel
2. Gear
3. Intermediate gear
4. Reel
5. Pinion
6. Rear roll
7. Bottom bar and bottom blade

An alternative would be possible by providing a reel bearing housing which pivots about the centre of the intermediate gear, but this would lead to a more complex design and would make the 'quick removal' of a cutting reel from the frame more difficult to achieve.

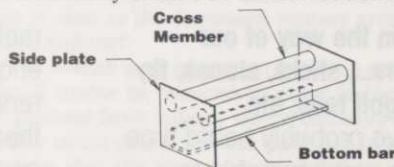
There is good reason, therefore, on a trailed gang unit to position the reel in a fixed position within the cutting unit frame and to adjust the bottom block up to the reel.

The European method of reel and bottom blade adjustment

This is used by all major UK and European manufacturers of commercial grass cutting machinery and provides several benefits.

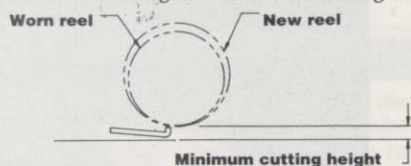
■ *Cutting Unit Frame Design:* This usually takes the form of two side plates which are connected either by tubular

cross members or pressed steel top plates or tie bars and the frame may either be a welded or bolted fabrication.



The stiffest part of any cutting unit, however, is the bottom block and if this can be rigidly connected to the side plates it contributes greatly to the overall rigidity of the frame assembly.

■ *Cutting Unit Adjustment:* With any reel mower it is necessary to maintain correct adjustment between the reel and bottom blade as the cutting surfaces wear. This wear will be greater on the bottom blade than the reel due to the fact that wear on the reel is 'shared' between a multiplicity of blades. Even so, there may well be a difference in reel diameter of up to 3/4" between a new reel and one which has reached the end of its life. By adjusting the reel down on the blade, this wear has no influence on the ability to retain the original minimum cutting height.



■ *Reel and Bottom Blade Alignment:* Even on newly built cutting units there are likely to be slight degrees of misalignment between the reel and bottom blade due to manufacturing tolerances. Efficient grass cutting can only be achieved with quite precise adjustment between the reel and bottom blade and this adjustment needs to be achieved across the whole width of the reel and bottom blade.

Any slight misalignment which may exist can be compensated for by making more – or less – adjustment on one end of the unit or the other, thus ensuring correct setting across the whole width of the unit.

Misalignment is likely to increase during the life of the cutting unit due to unequal wear of the reel blades and bottom blade and possible inaccuracies in re-grinding. By adjusting the reel top the bottom blade, the normal internal clearances of the reel bearings or the use of self-align-

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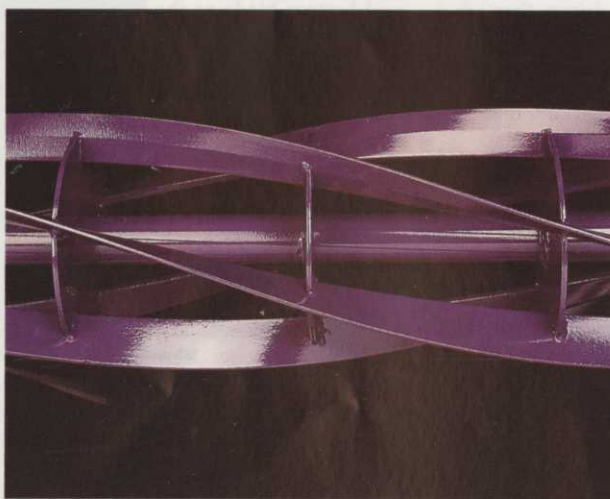
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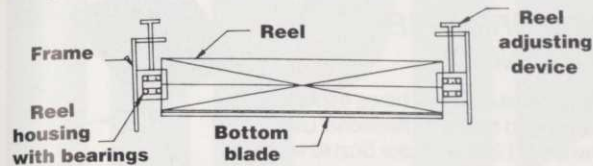
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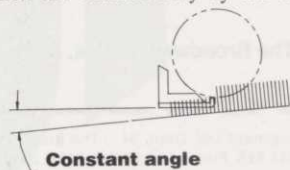
In search of the perfect **CUT**

3 ➔

ing bearings allow varying degrees of adjustment from one side of the unit to the other without inducing strain into any component. The adjustment is made by having an independent adjustment means at each end of the reel.



■ **Bottom Blade Position:** It is advantageous to maintain the cutting edge of the bottom blade as the closest point to the turf. This enables minimum cutting heights to be achieved which are limited only by the height of the knife lip.



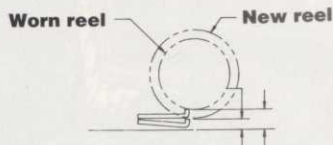
Increased clearance between the rear of the bottom blade ensures minimum drag on the turf and also, in conditions where matt or thatch is present, helps ensure that the unit does not 'sit on' the matt, due to a large area of surface contact between the turf and bottom blade. With a small area of contact the unit will cut down into the matt.

USA Method of bottom blade to reel adjustment

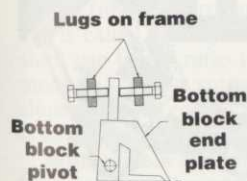
This is used by most of the major US manufacturers of commercial reel mowers and is the method generally recognised by US customers as being superior to the European system. The US system does, however, have a number of disadvantages.

■ **Cutting Unit Frame Design:** Being pivoted on the cutting unit side plates, the bottom block does not contribute significantly to the overall strength and integrity of the cutting unit frame. The reel is, of course, located in a fixed position within the frame, but again, because it is mounted in bearings, cannot completely compensate for the overall reducing rigidity caused by non-rigid mounting of the bottom block.

■ **Cutting Unit Adjustment:** By adjusting the bottom blade up to the reel, the minimum possible height of cut will increase as the bottom blade and reel wears. Until relatively recently this would not have been a significant disadvantage in the USA, due to their use of higher cutting height than is the case in Europe. However, on golf course applications now, lower and lower cutting heights are being used in the USA and the attitude of the bottom blade becomes a significant feature.



■ **Reel and Bottom Blade Alignment:** Any misalignment between reel and bottom blade caused by manufacturing tolerances or uneven wear (see *Reel and bottom blade alignment* on Page 3) can only be compensated for by twisting the bottom block. For this reason our trailed gang units are fitted with 'bottle jack' type adjusters so that a twisting force can be induced into the bottom block. On other units 'opposing screw' type adjustment is used at each end of the bottom block to achieve the same result. Misalignment due to initial manufacturing tolerances or subsequent wear can be removed by



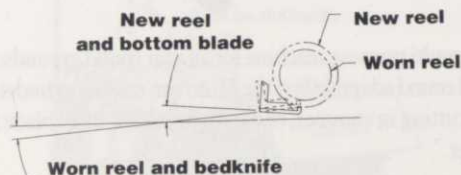
'backlapping' and this may well be the reason that backlapping is carried out as a matter of course in the USA to ensure that correct adjustment of the bottom blade to reel is achieved.

In general, backlapping is used far less frequently in Europe and then as a means of maintaining a keen cutting edge rather than correcting undue mis-match between reel and bottom blade. There are of course other reasons for backlapping – such as the requirement on reels which are 'single blade' ground rather than being cylindrically ground – the 'single blade' grind method being less capable of producing an absolutely cylindrical reel.

■ **Single Point Bottom Blade Adjustment:** In some US cutting units the bottom blade is adjusted up to the reel by using a single adjusting mechanism attached to the bottom block at the centre of the unit. In this system it is absolutely essential that alignment of the reel and bottom blade is perfect, as there is no means to twist the bottom block to compensate for any degree of misalignment. Frequent backlapping to ensure perfect match of reel and bottom blade is therefore essential.

■ **Bottom Blade Position:** The relationship between the bottom blade and turf changes as adjustment is made to compensate for wear of the bottom blade and reel blades. A situation can therefore ultimately arise where the rear of the bottom blade and the bottom block are closer to the turf than the front cutting edge. This results in more drag on the turf, with an increased tendency for the cutting unit to 'ride on' any matt or thatch rather than cutting down into it, due to the increased contact area between bottom blade and turf.

The overall area of contact between cutting unit and turf can of course be reduced by other factors, such as the use of grooved front rollers, which certainly assist in the units ability to cut down into the matt, but it is again interesting to note that the use of grooved rollers is far more prevalent in the USA. This is no doubt partially due to 'climatic' and turf conditions which result in the rapid accumulation of thatch, but I suggest also that cutting edge unit design concepts have contributed toward this requirement.



● **Brian E Mitchell is General Manager Engineering, Ransomes Sims & Jefferies Ltd.**

Conclusions

The above is obviously biased toward the European tradition of adjusting the cutting reel down onto the bottom blade. However, I have attempted to take an unbiased stand but find it hard to reveal any valid technical reason which favours a change to this long accepted method.

Benefits of Adjusting Reel to Bottom Blade

- Bottom block is used as structural member of cutting unit frame contributing significantly to frame strength and rigidity.
- A consistent minimum cutting height is retained during the total life of reel and bottom blade.
- Any misalignment between reel and bottom blade can easily be compensated for by 'unequal' adjustment of reel without inducing twisting forces into any component. Backlapping is then unnecessary for correcting misalignment. (Backlapping only required to maintain keen cutting edges).
- The angle between bottom blade and turf is constant and can therefore be designed for an optimum position to minimise drag on the turf and to present a small area of surface contact with the turf to ensure that the unit will cut down into the thatch or matt, rather than riding over it.
- Reducing need for grooved front rollers, although these still are an advantage. They should not, however, be used indiscriminately. Scuffing of fine turf when turning is more likely with a grooved front roller.

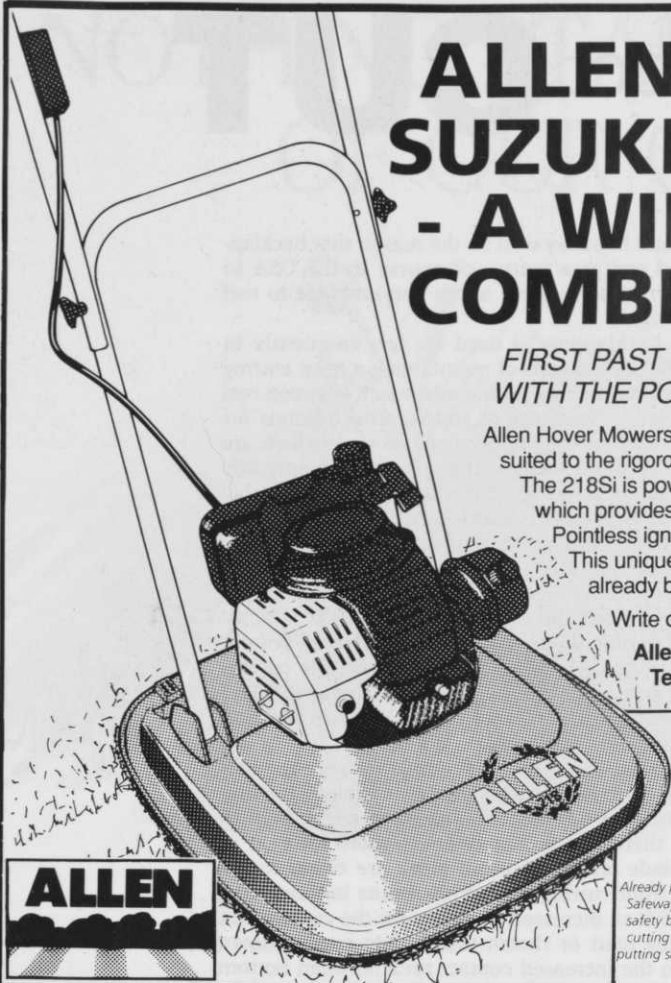
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UPHILL

Struggle



The most unplanned events – such as going out of control on steep banks and slopes – should never be entirely unexpected, warns HUGH TILLEY. Act like a boy scout – and be prepared for the hazards

Slopes and banks are synonymous with landscaping, yet these features cause the greenkeeper many mowing problems. While some banks are obviously essential to level a tee or green etc., some slopes can be reduced in angle to allow easier and safer mechanical maintenance. Grass is a notoriously treacherous surface, particularly when damp, and many smaller and steeper slopes are currently mowed by hand with a hover mower on a rope – a somewhat hazardous operation.

However there are a number of specialised pedestrian mowers with exceptional stability and suitable drive which are able to tackle most slopes, although greater selectivity is needed if reel mowing is required. Over larger areas four wheel drive ride-ons and tractors will safely tackle relatively steep slopes, though extreme caution is needed in certain weather conditions, with certain tyres or without adequate braking. Conventional two-wheel drive provides least ability on slopes and 'ability' is most variable according to vehicle configuration and balance: a rear steer ride-on mower should be safer mowing downhill than a front steer tractor with trailed gangs – depending on the tyres.

'Steep' is often a subjective judgment by the greenkeeper, perhaps depending upon the terrain he is used to, thus it is important to define measurement of slope. There are three systems in common use; one being angle, i.e. 11 degrees, whilst two use ratio of vertical to horizontal as linear measurement (the old 'road' style), such as 1:5 or (new Department of Transport style) as a percentage where 1:1 is called 100%, i.e. 12 degrees = 1:5 = 20%. In this feature I shall use linear ratio (such as 1:5) mainly because it is easiest to measure – with a spirit level and rule/tape. Measuring some typical slopes on your course is extremely helpful as this will give some figures with which you can relate.

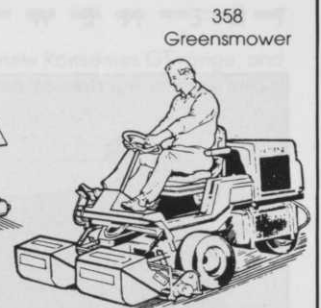
Most tractors and many ride-ons have roll-over protection, ROPS, however most slopes and banks have a run out at the bottom so loss of control seldom results in more than skid marks on the turf. ➔ 11

HUXLEYS

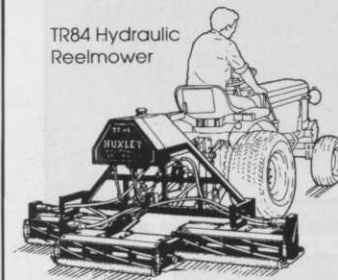
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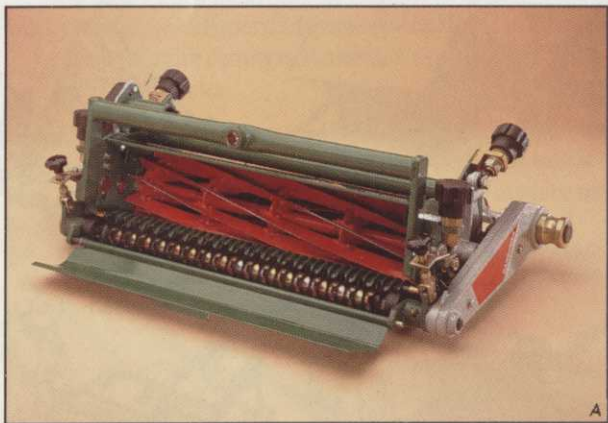


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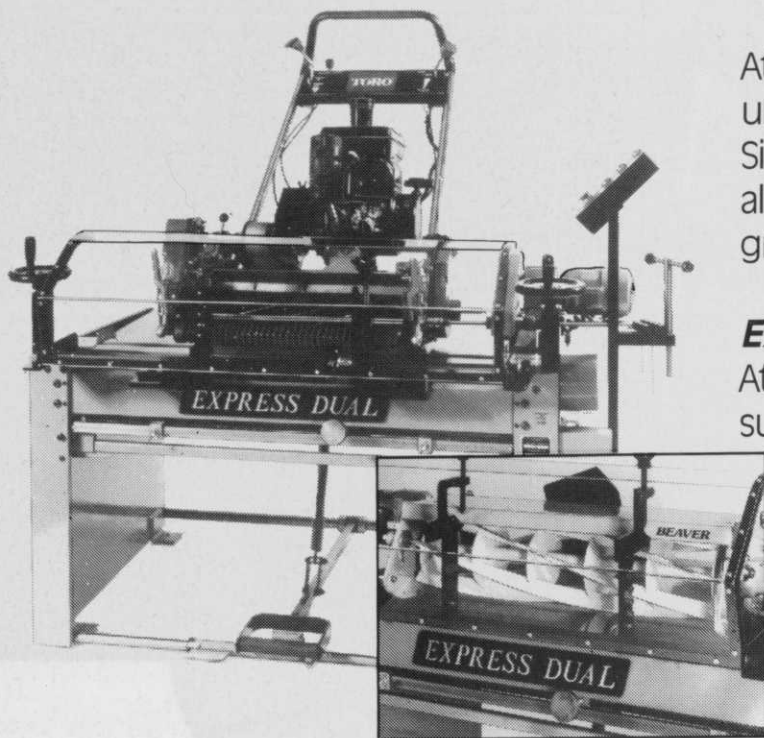
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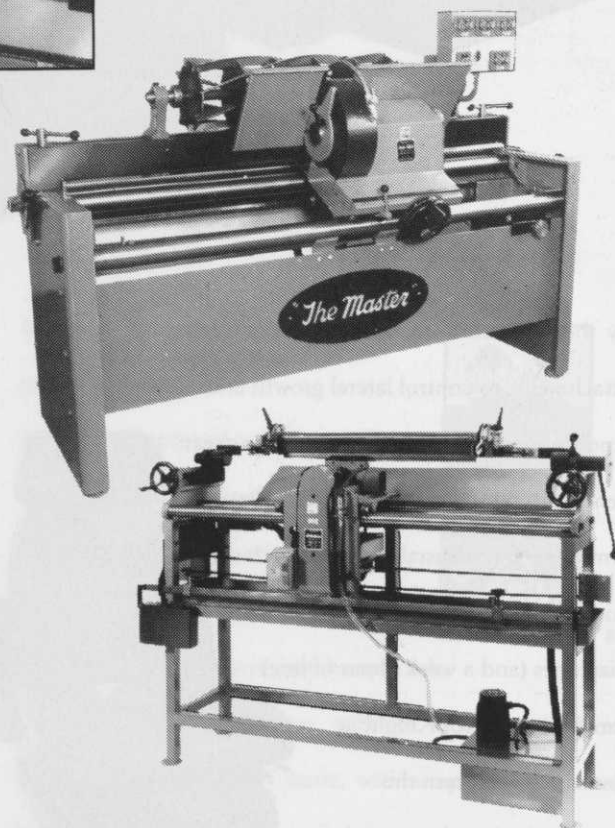
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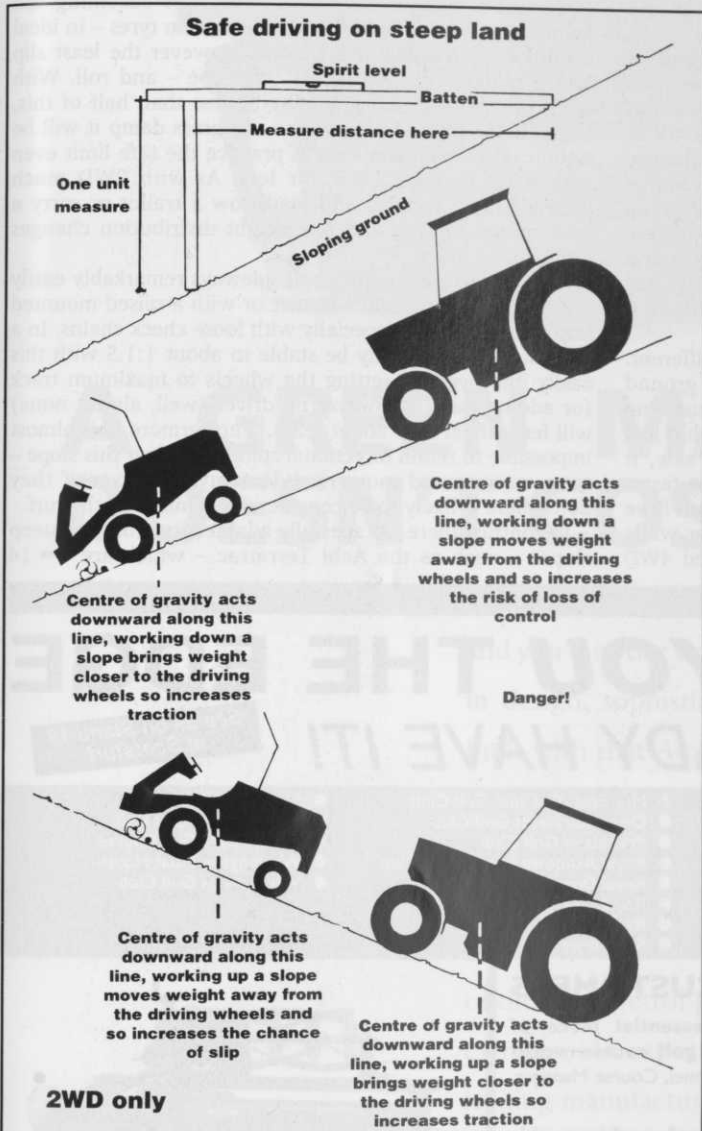
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7 → Banks running into ponds or bunkers may be more of a problem and deserve more respect – even if the only real danger is of having to walk home to the gibes of your mates! Nevertheless it is extremely dangerous to be complacent: tractors can run away or be rolled over remarkably easily given the wrong set of circumstances and similarly applies to other mowers and turf machinery.

Two wheel drive machines should be safe on slopes of up to 1:6 in all but exceptional circumstances, however in dry conditions a well balanced machine will operate on a slope of up to 1:2.5 – in any direction including cross-wise – although this may feel very uncomfortable. Speeds must always be reduced when operating on sloping ground, thus allowing the operator more reaction time and minimising the danger of speed related control loss occurring. Working on a → 12

UPHILL Struggle

11 ➔ slope, especially across it, is safest with the wheels (front and rear) extended to the maximum. Greater safety comes from vehicles with all wheel braking, but only a few machines are so equipped, most having braking only on the drive axle. Be especially wary of transmission brakes. Some trailed gang mowers can be obtained with braking – such systems need to be hydraulically integrated with the tractor brakes rather than of the over-run type – and many modern tractors have a plug-in hydraulic brake coupling. Heavy (ballast) rollers are notorious for pushing a tractor and causing a jack-knife and roll-over.

Realisation of how gravity works on a vehicle (and its load) on a slope will help the greenkeeper to understand where and why the main dangers occur. Basically operating up and down slopes causes the centre of gravity to transfer the machine's weight alternatively from and away from the drive axle. When operating with mounted implements this is further varied according to the load being carried on the linkage – with spreaders and sprayers weight will gradually reduce as spreading progresses and this may reduce traction. Lifting mower units may also effect stability – for better or worse – according to the situation.

With four wheel drive the situation is radically different. Not only is there almost double the (controlled) ground contact area but operating either up or downhill causes no loss of weight from drive axles – thus no measurable loss of traction. As a result 4WD *should* be twice as safe, it isn't! When control is lost the consequence will be faster and more violent. Four wheel drive machines seldom have any more braking than 2WD so they are only safer while 4WD is engaged. Some tractors have badly located 4WD

engagement levers which can be accidentally knocked out, while some (worn) levers drop out of gear in set circumstances. In addition some early hydraulic engagement systems return to 2WD upon loss of pressure, however this is caused, be it due to stopping, stalling, low engine revs or very low oil pressure. True hydrostatic drive should give the best control as this keeps almost equal braking on all wheels, however hydrostatic drive is seldom the favoured system on hills because of its lesser efficiency – you need plenty of revs to move at all.

The other danger with 4WD is that of becoming too ambitious. Four wheel drive – with traction tyres – in ideal conditions will tackle a 1:1 slope. However the least slip and it is likely to turn across the slope – and roll. With worn or turf tyres the grip may be less than half of this, whilst if the ground is hard and the grass damp it will be significantly less again – so in practice the safe limit even with 4WD may be 1:2.5 or less. As with 2WD much depends upon weights and load: tow a trailer or carry a load on the linkage and the weight distribution changes radically.

Agricultural tractors will roll sideways remarkably easily if driven too fast round a corner or with a raised mounted implement or load, especially with loose check chains. In a tilt test the tractor may be stable to about 1:1.5 with this easily improved by setting the wheels to maximum track (or adding duals), however no driver (well, almost none) will feel safe at over about 1:2.5. Furthermore, it is almost impossible to retain directional stability at over this slope – most tractors and mowers slide away, and even if they don't there is likely to be considerable damage to the turf.

In contrast there are specially adapted 'tractors' for steep slopes – such as the Aebi Terratrak – which are ➔ 14

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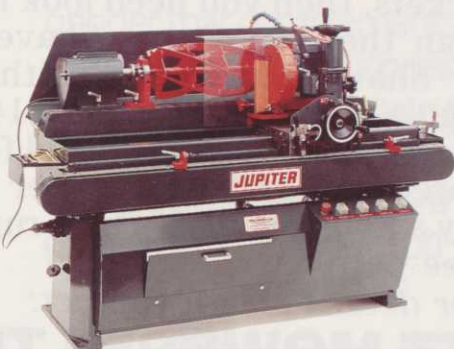
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12 → designed with particularly low centres of gravity and wide track width as well as a low driving position. Such specialist machines are too expensive for the limited areas of steep bank on most golf courses, however there are a number of contractors using them on motorway and reservoir banks and it may be cost effective to bring one of these in occasionally.

Less expensive are a number of pedestrian machines and while these may be less popular with staff they must be safer and more efficient than most other options. Some of the essential requirements for slope work are a low centre of gravity, good balance, independent wheel drive/brakes, wide set wheels and/or dual/cage wheels, slope adapted engine (so that oil keeps circulating) and a dead-man stop control. These requirements restrict the field but then only such machines are designed to operate at the more extreme angles in the region of 1:2 or more and to do the work by the hour without damage or danger. More restricting may be the choice of cutting units – very few machines offer a full range including cylinder, rotary and flail – the most usual 'head' being a reciprocating cutterbar. For slopes of up to 1:2.5 many conventional pedestrian mowers will often suffice, however the operator must be vigilant and the machine must not be so heavy that he has trouble controlling it.

For smaller areas of extreme slope

the use of hover mowers has been general, the advantages being the two-stroke design giving lighter weight and no lubrication or fuel supply problems, with many manufacturers now supplying extension handles. In practice greenkeepers tie a rope to the handle and use the machine in this potentially dangerous way. A safer option is to use a brush cutter, preferably of the knapsack type, with the appropriate grass head and skid or height support.

In the end, no matter how pleasing a course may be to view or play, it is vital that it can be maintained with complete safety – even if this means capital investment to set it up 'right'.



■ The author, Hugh Tilley, is a journalist who specialises in amenity and turf machinery. He used to be a specialist instructor on "safe driving on steep land" with the Agricultural Training Board and maintains that most unplanned events – i.e. going out of control – should be totally predictable.

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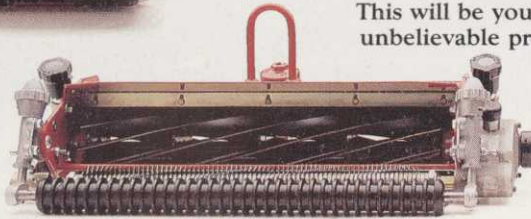
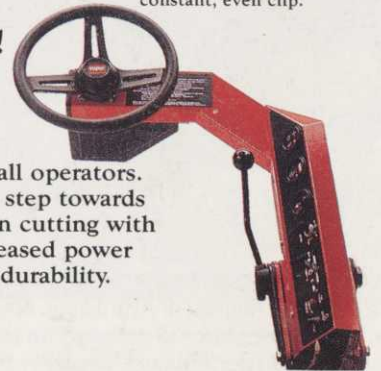


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