Historic England

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA



Binders

-

Setup, Adjustment and Operation

Prepared by SCARLETT RESEARCH LTD

Version 1.0 – October 2026

This is one of a series of thatching straw machinery technical guides prepared by Scarlett Research Ltd on behalf of Historic England and Historic Environment Scotland *(see Section 13 for further details)*. It is intended to provide an informative overview of procedures which **may** be followed. It is **not** intended to be a comprehensive reference.

Safety Warning



The operation, adjustment & maintenance of power-driven agricultural machinery creates risks which need to be managed, so:

PLEASE BE AWARE OF THESE RISKS, ASSESS THEM AND TAKE APPROPRIATE STEPS TO MANAGE THEM

- **NEVER** approach any machine when it is under power / in motion
- **ALWAYS** ensure that any Operator on the machine is in a safe position **and** ready for work to commence **BEFORE** engaging drive to the machine **and/or** starting work
- **ALWAYS** disengage the drive to a machine **and** ensure its components are in a safe, stationary position **BEFORE** opening guards and/or attempting to clean, maintain or adjust it
- **ALWAYS** ensure that all safety guards are in good condition **and** in place whenever the machine is under power / in use. **ALWAYS** replace safety guards following machine adjustment.

Disclaimer

The information presented in this guide is intended for information and guidance purposes only and may be subject to change without notice. Whilst every effort has been made to ensure the information is both relevant and accurate, neither Scarlett Research Ltd nor Historic England nor Historic Environment Scotland will accept any liability for any error or omission, or reliance on any part or all of the content of this guide, or any associated written or oral advice given, in any context.

This guide is intended for users who are competent in the operation & adaptation of machinery. Users should take all necessary safety precautions and pay due regard to the safety warnings contained herein.

Information presented regarding legislation is based upon our current understanding of the law, which may change and is not definitive: only the courts may interpret legislation definitively. It may be necessary to seek advice on individual circumstances

Acknowledgements

Scarlett Research Ltd gratefully acknowledges the kind assistance provided by a number of individuals during the preparation of this guide, including Mark Allsop, James Carter, Andrew Ford, Henry Jones, Graham Kirk, Stephen Letch, Jack Packham, Justin Scleater, Peter Snell, Chris Thomas, Paul & Tobias Watkin and Mark & Peter Wheeler.

We are particularly grateful to the Vintage Harvesters Group (Witton) for sharing their knowledge and providing access to numerous pieces of machinery during the preparation of this guide.

Copyright © Historic England, 2026 - All rights reserved

Images/illustrations © Scarlett Research Ltd unless otherwise stated

Contents

		Page
1	**Introduction**	**5**
2	**Binders – History and Evolution**	**8**
3	**Binders – How they Work**	**11**
3.1	Power Source	11
3.2	Crop Cutting	12
3.3	Crop Conveying	14
3.4	Crop Packaging, Tying and Discharge	14
3.5	Binder Operating Adjustments and Controls	19
4	**Binder Pre-Season Preparation**	**22**
4.1	Binder Driveline Components	22
4.1.1	Power Take-Off (p.t.o.) Shaft	22
4.1.2	Other Driveshafts	23
4.1.3	Slip / Safety Overload Clutches	23
4.1.4	Drive Gears	25
4.1.5	Chains and Sprockets	26
4.2	Cutter Bar	28
4.3	Reel	32
4.4	Crop Conveying Mechanism	33
4.5	Crop Packaging and Tying Mechanism	34
4.6	Knotter Engagement (Trip) Clutch	36
4.6.1	Trip Clutch Engagement & Disengagement	37
4.6.2	Knotter Trip Clutch – Problems & Adjustments	40
5	**Preparing a Binder for Work**	**47**
5.1	Fitting the Canvases	47
5.2	Transport to Working Position	53
5.3	Fitting the Knife	55
5.4	Twine Threading and Tension Adjustment	57
5.5	Machine Lubrication	60
6	**In-Field Operation**	**61**
6.1	Machine Safety	61
6.2	In-Field Machine Settings	62
6.2.1	Cutting Height	62
6.2.2	Reel Position	63

6.2.3 Binder Operating Speed 64
6.2.4 Sheaf Size, Appearance & Twine Band Tightness 65
6.3 Binder Operating Techniques 69
6.3.1 Starting the Field 69
6.6.2 Turning Corners 69
6.6.3 Width of Cut 71
6.3.4 Rescuing a Part-Laid Crop 71
6.4 Stooking 73
6.4 In-Field Maintenance 76
6.6 Troubleshooting and Fault-Finding 77
6.6.1 Crop Cutting 77
6.6.2 Crop Conveying 77
6.6.3 Crop Packaging & Tying 78

7 Out-of-Season Maintenance 82

8 Machine Safety (Guarding) 83
8.1 (Legal) Binder Safety and Guarding Requirements 83
8.2 Potential Guarding / Safety Control Measures 88
8.2.1 Operator Access & Seating 88
8.2.2 Power Take-Off (p.t.o.) and Other Driveshafts 89
8.2.3 Other Power Transmission Components 90
8.2.4 Moving Parts Involved in the Work Process 93
8.2.5 Stopping Devices / Emergency Stop 96
8.2.6 Warning Signs / Decals 97

9 Upgrading Your Binder 98
9.1 Cutter Bar 98
9.2 Knotter Unit 101
9.3 Remote Controls 102

10 Binder Spare Parts Availability 105

11 Sourcing Your Binder 107

12 Summary 109

13 Thatching Straw Harvesting Machinery – Technical Guides 111

1 Introduction

Purpose of this Guide

The twine-tying reaper binder *(or Binder)* was originally introduced in 1878 and, apart from a change from horse power to tractor power, remained in production with few changes until the late-1950s. A recent (2023) survey found that approximately 80% of UK thatching straw was still harvested with binders: so their correct setup, operation and maintenance remains an important aspect of thatching straw production.

A binder performs a sequence of actions: crop cutting, crop conveying, crop packaging/tying and package discharge; all at quite high-speeds. It is therefore a relatively complex 'field machine' and, during its heyday, was probably one of most complicated machines which a farm worker *(as opposed to a visiting, specialist contractor)* would be expected to setup & operate.

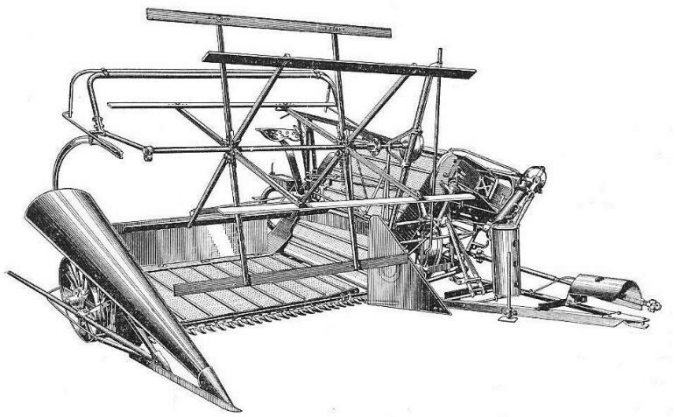
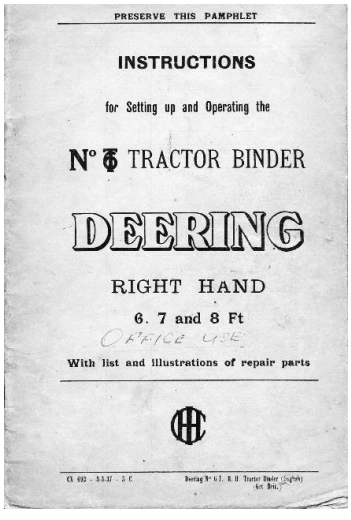


Fig.1.1 Typical (p.t.o.-driven) tractor binder

Ideally a Binder should be setup to:

- Cut the crop cleanly & efficiently, and
- Gather & package it into neat, robust sheaves to permit:
  - Further in-field ripening
  - Re-handling into storage & *(eventually)* to threshing or combing.

Binders produced in the 1920s – 1950s were usually issued with an Operator Instruction Manual but, where examples have survived, they are of limited use. Unfortunately, all too often these manuals provide limited guidance regarding correct machine setup & operation, but instead mainly contain instructions for initial machine assembly *(from the packing case)* and an illustrated Parts List. Correct assembly was undoubtedly important and a spare parts list is helpful, but it doesn't really help an inexperienced thatching straw grower operate the machine effectively today.


PRESERVE THIS PAMPHLET

INSTRUCTIONS

for Setting up and Operating the

N° 6 TRACTOR BINDER

DEERING

RIGHT HAND

6. 7 and 8 Ft

OFFICE USE

With list and illustrations of repair parts

Fig.1.2 Example binder operator instruction manual

In the absence of other sources of information, knowledge regarding binder setup, adjustment & operation was usually passed from person to person, and it may not always have been correct! Some effort was directed towards farm machine operator training during times of national food shortages *(e.g. First & Second World Wars)* but, by the time agricultural machinery education became widely available *(late-1950s to early-1960s)*, the binder was rapidly being replaced by the combine harvester for harvesting of cereal crops and it was 'yesterday's machine'.

Regrettably today, with the passage of time, only a few people will have experienced either operating or servicing/supporting binders during their frontline agricultural use. Its therefore important to gather, record and redistribute this invaluable 'knowledge' whilst it is still available.

The purpose of this technical guide is therefore to illustrate:

- Binder setup, adjustments & operating techniques to help improve their efficiency of operation
- Important safety control measures which *(unless already in place)* should be implemented to allow the continued safe & legal operation of these machines in the 21st century.

Knotters

It's essential that a binder's knotter & twine tying mechanism is setup correctly & operates reliably. This is so important that a separate technical guide has been prepared, covering all aspects of knotter setup, adjustment & fault-finding.

Click on the adjacent image or scan the QR code to access the Knotter Guide



Conventions and Units used by this Guide

Left and Right As viewed from the tractor or binder seat, facing forwards

Imperial or Metric? With the possible example of European-manufactured machines, binders originate from a time when imperial units were used exclusively. However, this guide always shows both metric & imperial units. Whichever is shown first is believed to be the original unit of measurement used.

Safety Precautions and Statutory Requirements

When binders were originally manufactured *(1880s–1950s)*, Workplace Health & Safety was not a particular priority, especially in agriculture. Few, if any of the driveshafts, gears, chains, sprockets or other dangerous moving parts on these machines were guarded in any way.

This was not very good at the time and, by the 1950s, was no longer considered acceptable. To address this, a whole range of new safety requirements for agricultural machinery were introduced in the early 1960s, both for new machinery and that already in-use. Machine safety & guarding requirements for binders were specified by:

- **The Agriculture (Field Machinery) Regulations (1962):** These regulations were applied in stages to particular types of agricultural implements. From 1st January 1965, binders were required to be fitted with suitable safety guarding on all driving belts, chains, gears, sprockets & driveshafts. A suitably supportive, non-slip seat, together with adequate & convenient footrests, was required for the operator, together with a suitable jack for the binder's drawbar.

With hindsight these particular safety regulations were:

- Relatively reasonable & sensible
- Prescriptive *(they said exactly what machine modifications were required)*
- Retrospective *(they applied to all binders – new or old)*

However, their introduction coincided with the ending of binder manufacture and a rapid decline in their use in mainstream UK agriculture. So, unfortunately, the necessary safety modifications were not always made to the target machines. This is evident on many examples which have since been resurrected and used for harvesting thatching straw.

These 1962 Regulations have since been replaced by other, more general safety legislation *(see below)*, but the safety control measures they prescribed for binders remain appropriate even today. Their potential implementation is discussed further in Section 8.1.

Today, the following safety legislation applies to the use of any kind of machinery in the workplace:

- **Health & Safety at Work Act (1974) *(HSWA)*:** Applies to anyone who supplies *(sells or hires)* equipment for use at work *(whether new or second-hand)*. It also places duties on the user/employer. Essentially, it requires that all equipment supplied to or used in the workplace must be safe for use.
- **Provision and Use of Work Equipment Regulations (1998) *(PUWER 98)*:** Primarily apply to the machine user *(employer, employee or self-employed)*. Require that any equipment provided for use for work must:
  - Be safe for use
  - Be suitable for the intended use
  - Be properly maintained in a safe condition
  - Feature suitable safety control measures *(i.e. guards, markings & warnings)*

  Additionally, the machine user must be adequately trained / instructed and be provided with appropriate information to enable safe use of the machine.



REMEMBER, the penalties for failing to comply with the requirements of safety legislation can be severe, but the human cost can be far higher.

- Basic procedures for hazard identification and the assessment & control of (safety) risks are outlined in Section 8.1
- Practical safety control measures *(e.g. potential machine guarding options & other measures)* for binders are discussed in Section 8.2.

2 Binders – History and Evolution

The twine-tying Reaper Binder *(or self-binding Reaper)* resulted from an intense period of cereal harvesting machinery development in the mid-19th century. One of the first mechanical reaping machines was made by a Scotsman, the Revd Patrick Bell, in 1826 *(Fig.2.1).* Pushed by two horses & driven by gearing from its supporting wheels, Bell's reaper used a reciprocating knife with double-edged blades to cut the crop. A rotating reel transferred the cut crop back onto a cross-conveyor, which moved it sideways and deposited it in a swath. A separate team of workers was then required to gather & tie it into sheaves for stooking & further ripening.

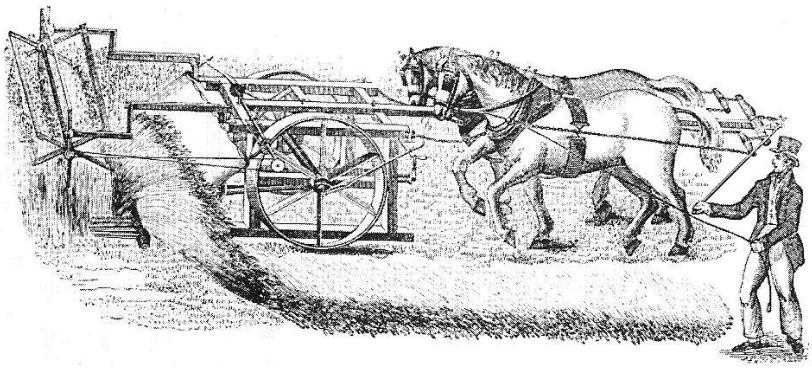


Fig.2.1 Bell's reaper at work *(©MERL))*

Despite its advanced features, Bell's machine was not a commercial success, but horse-drawn reapers produced by American manufacturers such as McCormick or Hussey most certainly were and many were imported to the UK. However, these didn't feature a crop conveyor and so required a second operator rake the cut crop from the machine back onto the field for tying.

By 1860 the self-raking or 'sail' reaper had been developed *(Fig.2.2)*. This removed the need for a second person on the machine, but still required four or five additional workers to follow behind to bind the crop into sheaves.

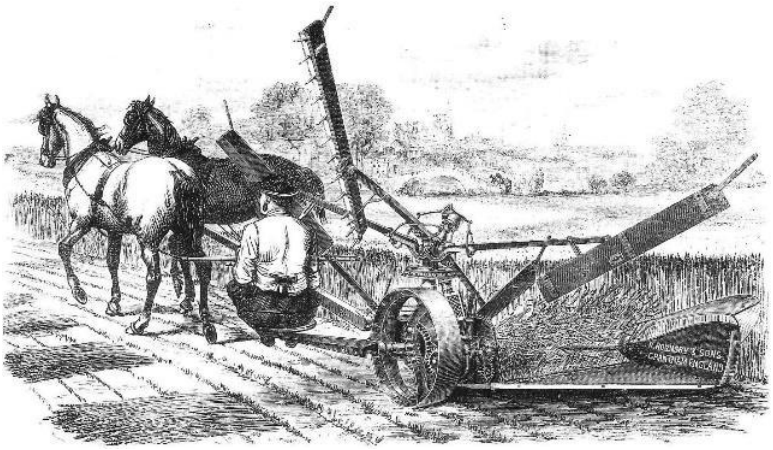


Fig.2.2 Hornsby 'Royal' self-raking or 'sail' reaper, 1875 *(©MERL))*

Tying or binding of the crop during reaping was the final task to be mechanised. The Marsh reaper of 1862 incorporated a canvas cross-conveyor & mechanical bunching mechanism, which delivered the crop to a platform where two additional operators, riding on the machine, tied it into sheaves.

The breakthrough in automatic crop binding was achieved by John Appleby, an Englishman living in America, who in 1869 developed a mechanical wire-twisting mechanism to bind the sheaves. This was licenced to a number of U.S. reaper manufacturers including McCormick and Walter A. Wood.

However, fears for livestock safety prompted the development of an alternative solution in 1874, once more from Appleby, in the form of an automatic knotter mechanism which utilised sisal twine. From 1878 onwards, Appleby licenced the use of his knotter to numerous reaper manufacturers including Deering and McCormick: the system soon became widely adopted by reaper-binder manufacturers on both sides of the Atlantic.

The twine-tying Reaper Binder had arrived and its design & configuration remained largely unchanged from the 1890s to the 1950s *(Figs 2.3 & 2.4)*. During this time its motive power changed from a team of horses to a single tractor and versions were developed which derived their power from the tractor's power take-off (p.t.o.) shaft rather than from the binder's large, ground-driven *(Bull)* wheel.

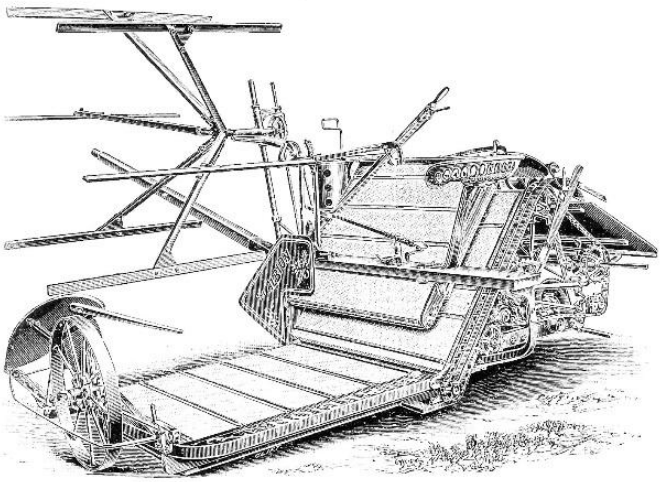


Fig.2.3 Albion No.1 steel binder, 1900 *(©MERL))*

Binders intended for tractor use *(whether ground-wheel or p.t.o. driven)* were of more robust construction, to withstand the greater stresses & loadings resulting from operation at higher forward speeds *(a tractor could pull a binder twice as fast as a team of horses & it didn't become tired)*. However, despite the operational advantages of p.t.o.-driven versions, ground wheel-drive binders remained in production *(alongside p.t.o.-driven variants)* well into the 1950s.

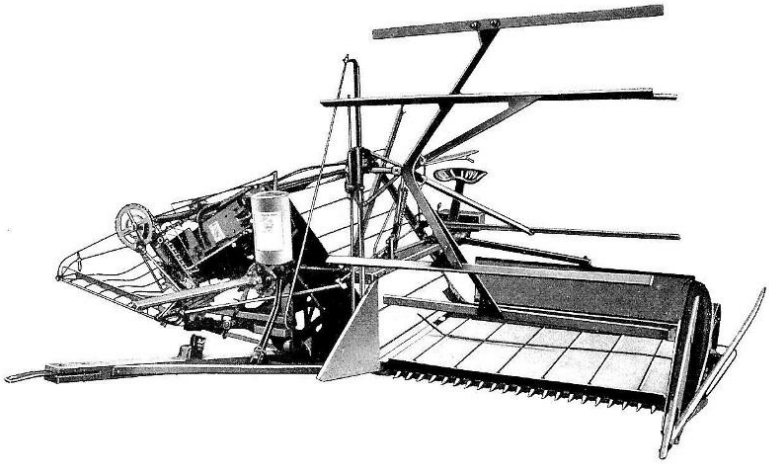


Fig.2.4 (Massey-Harris) Sunshine 6B 6ft cut binder, mid-1950s

The number of binders on UK farms peaked *(at 150,000)* in 1950, but thereafter began a steady decline as combine harvesters became more widely adopted: binder numbers had reduced to 99,000 by 1958. Observers have commented that a number of wet harvests during the late 1940s and early 1950s did much to accelerate the move from the binder to the combine. During difficult harvesting conditions, crop cut by a combine was safely in the barn, whereas that cut with a binder was just at the start of a weather-dependent ripening & handling process.

During the late 1940s and early 1950s, attempts were made by some manufacturers to modernise & update what were otherwise largely unchanged binder designs: however most recognised that the equipment was 'yesterday's machine'. Bisset, a long-established Scottish binder manufacturer, introduced a novel, semi-mounted design in 1950, which attached directly to the tractor's rear linkage and was supported by pneumatic-tyred castor wheels at the rear *(Fig.2.5).* The cutting platform of this light, manoeuvrable machine folded-up for road transport; also, all of it's controls could be operated by the tractor driver, removing the need for a separate operator on the binder.

The Danish manufacturer JF developed a novel binder for fitting to the front of a tractor but, again, this was not a great commercial success. The Bisset was the only binder exhibited at the 1960 Royal Smithfield machinery show in London.



Fig.2.5 Bisset semi-mounted 6ft cut binder, 1950

North American-built binders *(e.g. Deering, McCormick, Massey-Harris)* were popular in the UK, but home-produced machines *(e.g. Albion, Bisset, Hornsby, Wallace)* also had a loyal following.

Today, the majority of binders used commercially for thatching straw harvesting date from the 1930s to late 1950s and were generally *(but not exclusively)* built either by Albion, Bisset, Deering, Lanz, McCormick, Massey-Harris or Sunshine.

Table 1 Manufacturers of binders sold on the UK market
(Parent company names shown in brackets)

North American	UK and Europe
Deering *(International Harvester Co.)*	**Albion** *(Harrison, Mc Gregor & Co.)*
Frost & Wood *(Cockshutt)*	**Bamlett**
John Deere	**Bisset**
McCormick *(International Harvester Co.)*	**Hornsby**
Massey-Harris	**Howard of Bedford**
Oliver-Cockshutt	**Lanz** - *Germany*
Osborne *(Case-Osborne)*	**McCormick** – *France*
Sunshine *(Massey-Harris) - Australia*	**Samuelson**
Walter A. Wood	**Wallace**

3 Binders – How They Work

All Binders perform three distinct, sequential operations:

- Crop Cutting
- Crop Conveying *(to the packaging mechanism)*
- Crop Packaging *(into tied Sheaves of uniform size)* and Discharge.

So how do these various power-driven mechanisms perform these tasks?

Click on the adjacent image or scan the QR code to view video of Binder operation



3.1 Power Source

In addition to being towed round the field, a binder requires power to drive its various components. Horse-drawn machines obtained drive from the machine's main *(Bull)* wheel via a series of sprockets, chains & gears *(see Fig.3.13)*. Later, tractor binders could either be ground / land wheel-driven or *(from the 1920s onwards)* power-driven from the tractor's power take-off (p.t.o.) shaft *(Figs 3.1 & 3.2)*. This offered a number of benefits, particularly in difficult harvesting conditions because the tractor's forward speed could be adjusted without affecting the speed of the binder's mechanism. So thick or partly-laid areas of crop could be dealt with at a slower forward speed, to give the binder's mechanism more time to cope.

P.T.O.-driven binders aren't reliant on good soil-wheel grip to obtain a consistent drive, which can be a problem in wet or soft conditions. They could also be fitted with rubber/pneumatic tyres, which potentially reduced levels of ground-induced vibration transmitted to the machine *(and to the Operator)* and give both a prolonged working life!

Nonetheless, a market existed for ground-driven binders almost until the end of production. Even today, some users claim that *(in good harvesting conditions)* the overall workrate of a ground-driven binder can be greater than that of a p.t.o.-driven machine: the ability of the former to turn corners tighter & quicker in-field being cited as one advantage. However, the majority of users favour p.t.o.-driven machines: and p.t.o.-drive conversion kits for ground-driven binders were sold successfully.

Ground-driven binders are fitted with a manually operated clutch to allow disengagement of the drive when not required *(see Fig.3.13)*. This also incorporates a freewheel mechanism to prevent the binder's mechanism from being driven backwards *(and damaged)* when the machine is reversed.

Irrespective of its power source, **the binder's driveline must always be fitted with an effective safety overload/slip clutch** *(see Section 4.1.3)*, to protect the machine from overload & serious damage if / when a blockage or other problem arises. Replacement parts availability for binders is now very poor, so every step should be taken to prevent *(foreseeable)* damage to the machine.

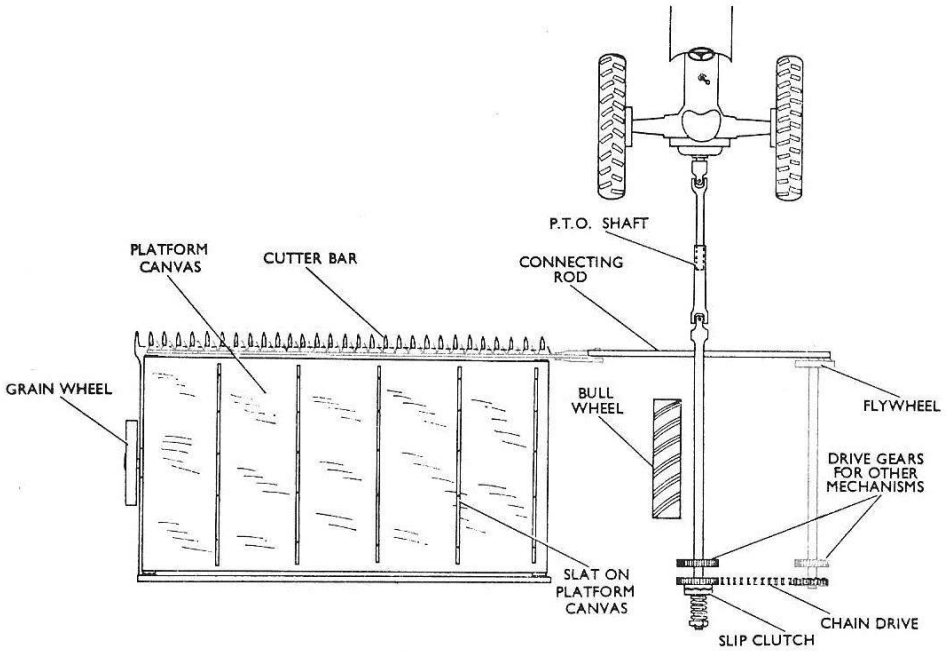


Fig.3.1 Schematic layout of a binder's crop cutting & *(initial)* conveying mechanism *(p.t.o.–driven machine)*

(courtesy Shippen & Turner)

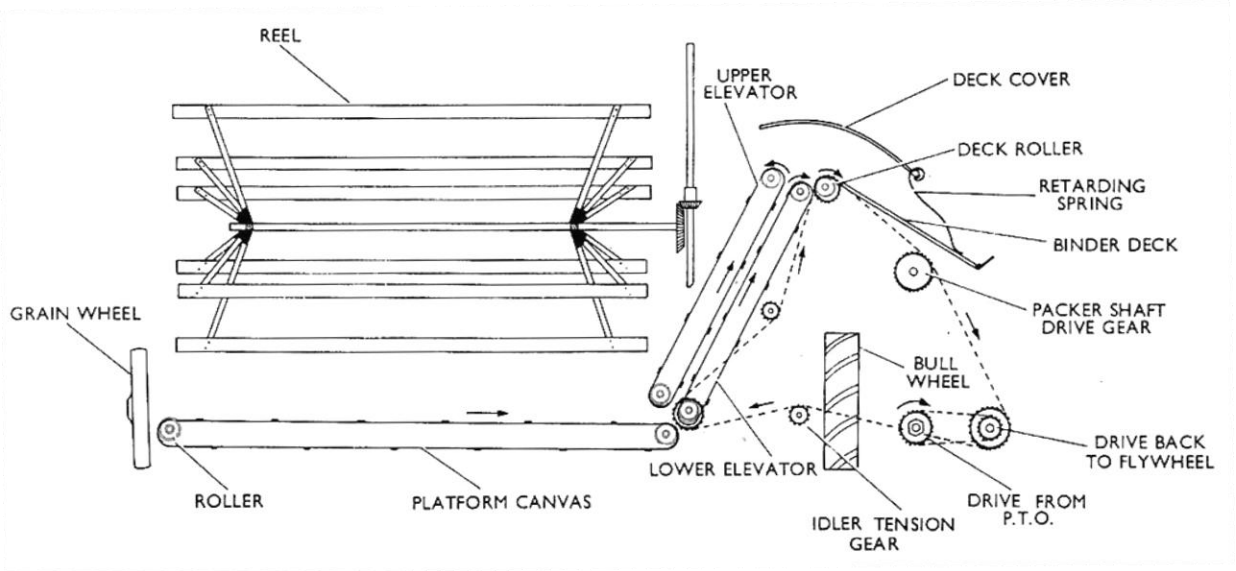


Fig.3.2 Rear view of a binder's key components - *(**N.B.** Crop packaging & tying mechanism not shown)*

(courtesy Shippen & Turner)

3.2 Crop Cutting *(see also Section 4.2)*

Binders are usually offset implements: depending on their design they may be constructed to cut the crop either to the right or left of the towing tractor *(Fig.3.1)*. The crop is cut by reciprocating 'knife & finger'-type Cutter Bar of typically five, six or seven foot cutting width (~1.5, 1.8 or 2.1 m).

The knife is formed of a row of double-edged triangular blade 'sections', each riveted to a steel bar. This slides from side-to-side within slots in the fingers *(Fig.3.3)*, creating a scissor-like cutting action as it passes through them. Spring steel 'crop lifter' extensions can be fitted to occasional fingers *(see Fig.6.13)* to help lift laid crop up to the Cutter Bar, so that it may be cut & gathered.



Fig.3.3 Binder cutter bar - Triangular knife sections reciprocate in slots within the fingers

The Cutter Bar is attached to a rectangular steel 'Platform', which in turn is attached to the binder's main frame. Crop cutting height is adjusted by raising or lowering the binder's Main *(Bull)* wheel and Grain wheel relative to the main frame & Platform *(see Figs 3.1 & 3.2).* The Binder Operator may also tilt the whole machine forwards or backwards during work, to provide further adjustment of cutting height *(see Fig.3.12).*

A power-driven, revolving 'Reel', constructed of a series of wooden slats or 'sails' *(Fig.3.4)*, is positioned to gently sweep the top of the crop back towards the binder so that it falls readily onto the Platform as it is cut. Effective gathering of the crop is highly dependent of the correct fore-aft & height adjustment of the binder's Reel.

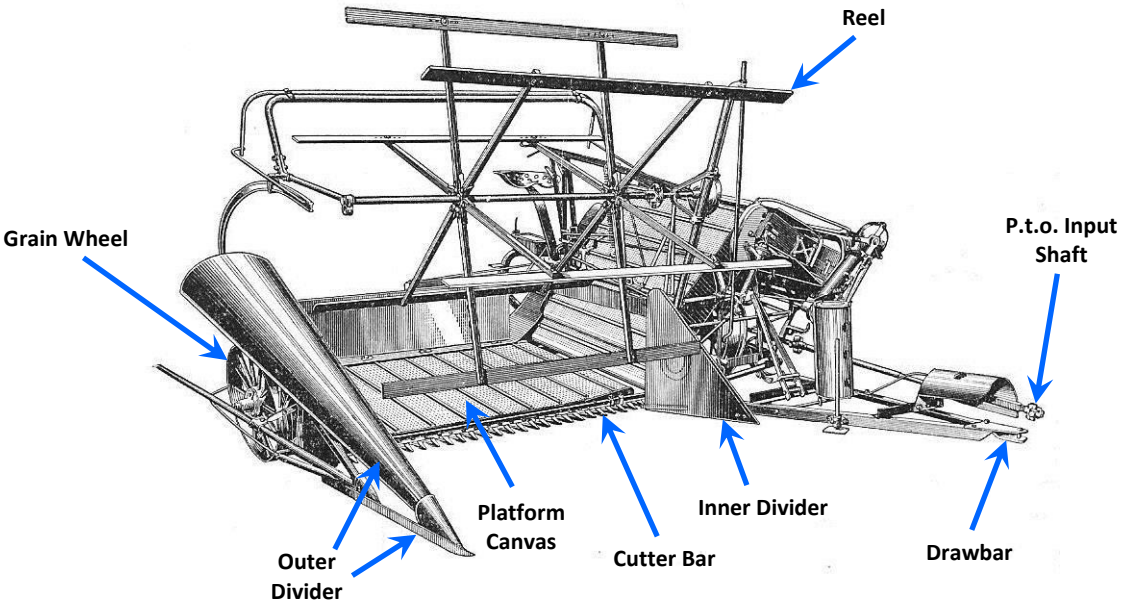


Fig.3.4 P.t.o.-driven tractor binder

Sheet-steel 'Dividers' are mounted at each end of the Cutter Bar *(Fig.3.4)*. The Inner Divider helps to guide the edge of the uncut crop onto the Cutter Bar and also provides a lateral guide for the tractor driver to drive by.

The Outer Divider *(sometimes a 'Torpedo' divider)* separates the crop left-to-right, guiding part onto the Cutter Bar and gently pushing the rest to one side so that it doesn't become entangled around the advancing Grain Wheel. Some German and Scandinavian binders incorporated a power-driven, rotating, auger-type outer divider which apparently worked well in tangled & laid crops. However, such a crop would most probably not be considered suitable for thatching straw and so such a device would probably not be required.

3.3 Crop Conveying *(see also Section 5.1)*

Having been cut, the crop is conveyed by a series of power-driven canvas conveyors (Canvases) with wooden slats attached to their surfaces at regular intervals *(Figs 3.1, 3.2 & 3.5)*.

The Platform Canvas runs laterally, immediately behind the Cutter Bar and transfers the cut crop to the bottom/lower ends of the *(Upper & Lower)* Elevator Canvases. The crop is then conveyed diagonally upwards between the Elevators to the Deck Roller, which transfers it to the binder's Deck for packaging & tying *(Fig.3.6)*. The Upper Elevator has the ability to 'float' to accommodate different volumes of crop *(which depends on crop plant density, binder cutting width & forward speed).*

Grain Retarder

In dense, good-yielding crops which are common today, the weight of the Ears *(of grain)* causes them to be conveyed more effectively by the canvases than the lighter Butt ends of the straw. Consequently, having fallen onto the Platform Canvas, the Ears tend to travel ahead of the Butt ends, causing the crop to go up the elevators somewhat diagonally, which in turn causes the binding mechanism to not be fed properly, leading to the production of badly shaped sheaves.

To prevent this, binders are sometimes fitted with an adjustable Grain Retarder: a thin steel strip attached to the outer end of the Platform and laid across Platform Canvas *(a distance behind the Cutter Bar)*, so that the Ears fall onto the Retarder rather than directly onto the Canvas. This encourages the lateral feeding of the Butt ends to the elevators and the correct feeding of the binding mechanism. Some users have fitted a strip of webbing or other material as a Retarder *(Fig.3.5)*: the important feature(s) are its fore-aft location on the Canvas for the particular height of crop being cut & that it should extend across the full width of the Platform.

3.4 Crop Packaging, Tying and Discharge

Arguably the most unique action of a binder is the packaging and tying *(binding)* of the crop into sheaves. In a modern, thick crop of wheat grown for thatching straw, this process may occur as frequently as every 1½ - 2 seconds, so the mechanism works hard and it must do so reliably.

The Upper & Lower Elevators pass the crop to the Deck Roller, which transfers it onto the inclined Deck *(see Fig.3.6 & video clip overleaf)*, where it slides down to a series of crankshaft-driven Packers. These operate in a semi-rotary motion & compress the crop against the Compressor Arm and a pre-tensioned strand of twine *(Figs 3.6, 3.7 & 3.8)*. At the same time an adjustable, reciprocating Buttor *(board)* hits against the Butt ends of the stems to form a neat base end of the sheaf.





Fig.3.5 D.I.Y. Grain Retarder fitted to a binder's Platform *(arrowed)*

- Ideally the Retarder should extend almost across the full width of the Platform Canvas
- It should be positioned fore-aft so that the Ears fall onto the Retarder rather than onto the Canvas

Click on the adjacent image or scan the QR code to view video of the Binder's crop packaging & tying mechanism



The Compressor Arm retains the crop on the binder's Deck until a sufficient volume *(weight)* of material has accumulated to form the sheaf. The tying mechanism is then automatically tripped; the Knotter ties the sheaf and it is ejected from the machine by the rotating Discharge Arms.

How Is the Tying Mechanism Tripped?

This depends on machine make & design. Some *(e.g. Albion, Hornsby & Massey-Harris)* use a spring-loaded, pivoting Trip Lever which protrudes through the binder's Deck in the area where the sheaf is formed *(Fig.3.8)*. The accumulating crop bundle pushes down on the lever against *(adjustable)* spring pressure until the Knotter Engagement Clutch is tripped and the tying mechanism operates.

Other machines *(e.g. Deering & McCormick)* sense the reaction force exerted by the forming sheaf on the Compressor Arm, again via a spring-loaded mechanism. When this exceeds a given *(adjustable)* level, the tying mechanism is tripped. Adjustment of the Knotter Trip Mechanism permits sheaf size & twine band tightness *(sheaf density)* to be varied to suit particular requirements *(see Section 6.2.4).*

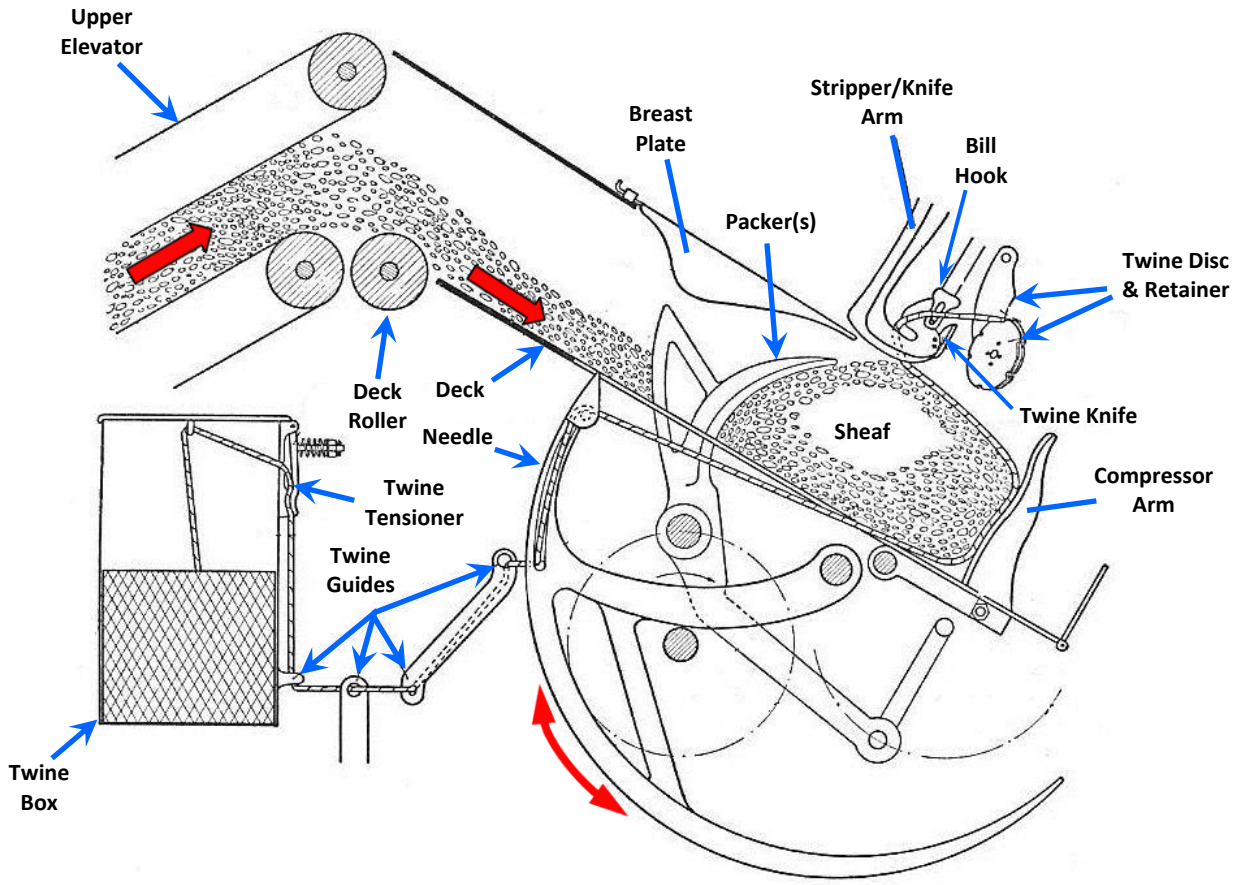


Fig.3.6 Binder crop packaging and tying mechanism, showing the twine path – *(Left-hand cut machine)*

(after Berglund & Andersson)

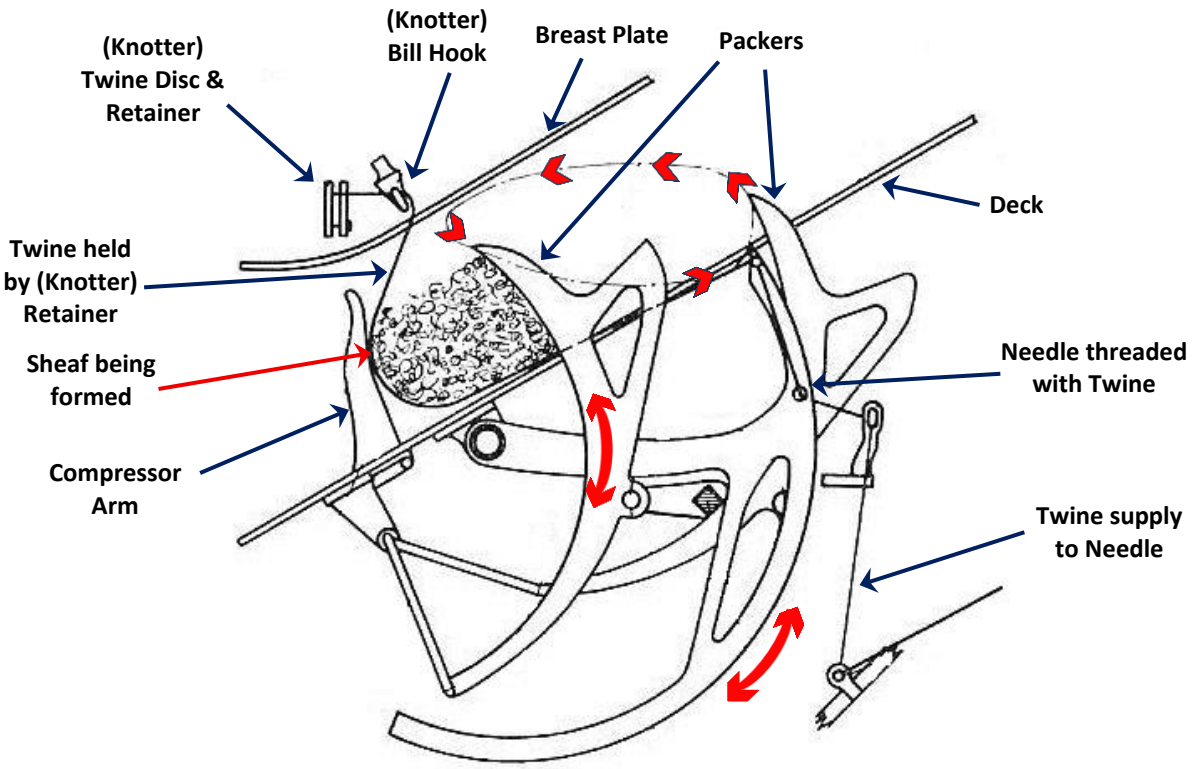


Fig.3.7 Binder crop packaging and tying mechanism, showing action of Packers – *(Right-hand cut machine)*

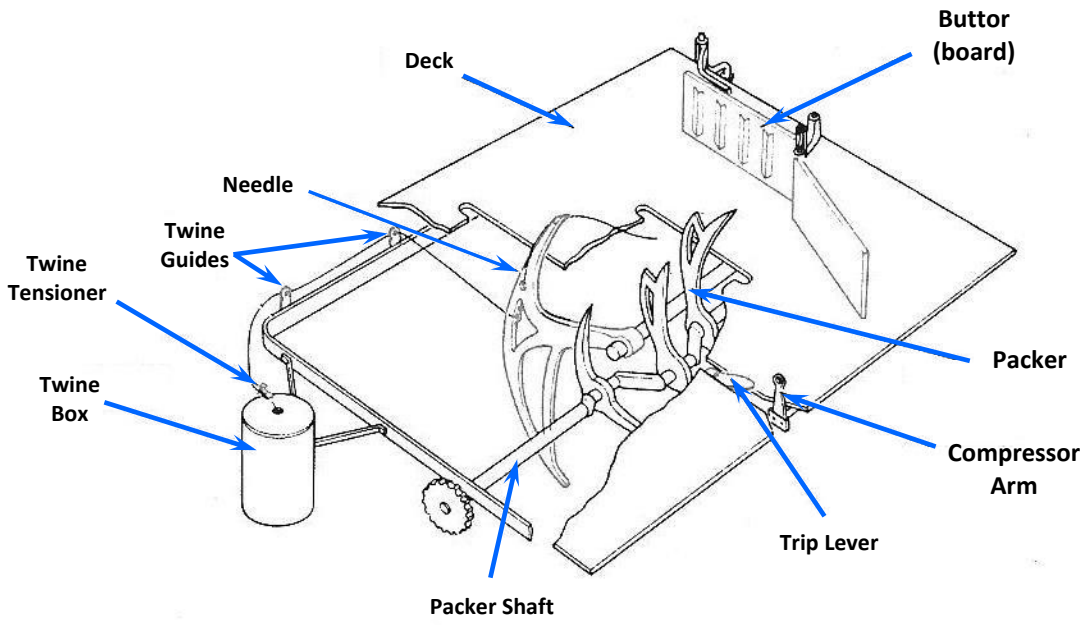


Fig.3.8 Binder Deck and crop packaging mechanism - Key Components - *(Left-hand cut machine)*

N.B. Tying mechanism not shown *(after Shippen & Turner)*

Once the tying mechanism is tripped and the binder's Tying Cycle begins, a number of carefully synchronised actions occur very rapidly, both within the Knotter mechanism and elsewhere. In essence these are as follows:

1) **Tying Mechanism 'tripped':** Drive is engaged from the Packer Crankshaft to the Knotter *(drive)* Shaft, the Needles & the Compressor Arm

2) **Needle:** Rises through an aperture in the Deck and places a band of twine around the sheaf & into the Knotter's mechanism *(over the Bill Hook & into the Twine Disc & Retainer)*. The lower 'stem' section of the Needle also squeezes the crop bundle against the Compressor Arm *(Fig.3.9)*, so it is compressed when the twine band is tied. The Needle retracts back below the Deck once the knot is tied

3) **Knotter**: Knotter Shaft rotates once, causing the Knotter to tie the twine while the crop bundle is compressed between the Needle & Compressor Arm

4) **Discharge Arms**: Rotate with the Knotter Shaft, contacting the upper surface of the sheaf immediately after the knot is tied. The Compressor Arm then retracts / lowers, enabling the Discharge Arms to eject the sheaf from the Deck.

N.B. Depending on the specific design of Knotter fitted, the 'ejection' action of the Discharge Arms can also serve to remove the completed knot from the Knotter's bill hook.

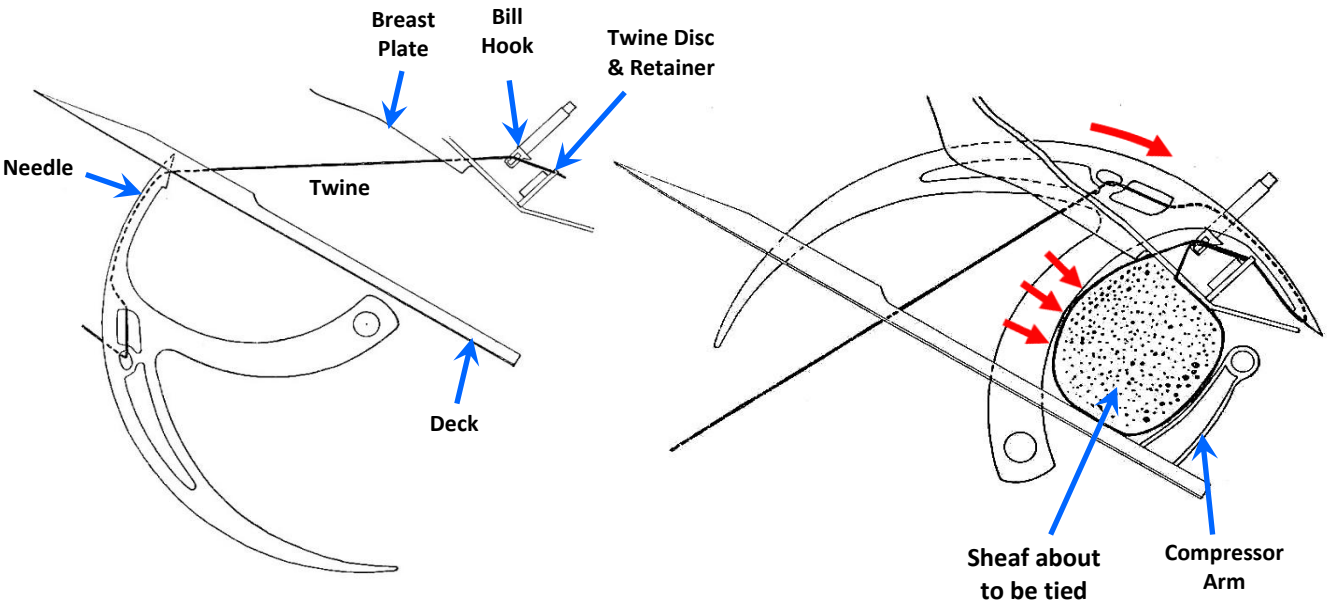


Fig.3.9 Binder Needle operation during the tying cycle

- **(Left)** Needle lies below the binder's Deck – The end of the Twine is held in the Twine Disk & Retainer
- **(Right)** Needle rises through the Deck, compresses the Sheaf and delivers the free-end of the Twine over the Bill Hook and into the Twine Disc



Fig.3.10 Fore-aft adjustment of binder packing and tying mechanism to vary position of the twine band on the sheaf

- **(Left)** Binding mechanism fully rearwards – for long / tall straw
- **(Right)** Binding mechanism fully forwards – for short straw

(Note the different positions of the Knotter Cam Gear relative to the 'I' and 'N' in 'ALBION')

Adjustment for Straw Length *(Sheaf Band Position)*

To produce a well-balanced & stable sheaf, it's important that the twine band is placed as close to the middle of the bundle as possible. However, as the crop is fed from the binder's Cutter Bar, across the Platform Canvas and up the Elevator Canvases and onto the Deck, the Butt ends will always come onto the Deck in approximately the same fore-aft position.

Unfortunately, cereal straw crops can grow to different heights, even within different areas of the same field. This potential variation in straw length means that, in order to place the twine band in the middle of the sheaf, some means is required to adjust the *(fore-aft)* position of the binder's tying mechanism relative to the crop as it flows onto the Deck.

This is achieved on virtually all binders by mounting the entire Deck and packing, tying & sheaf discharge mechanism *(i.e. the packers, needle, knotter unit & discharge arms)* on a separate frame, supported by a series of rollers & slides. The Binder Operator can then move it forwards / rearwards, relative to the Elevator Canvases, by operating a lever from his/her seat *(Figs 3.10 & 3.11).* See Section 6.2.4 for further information.

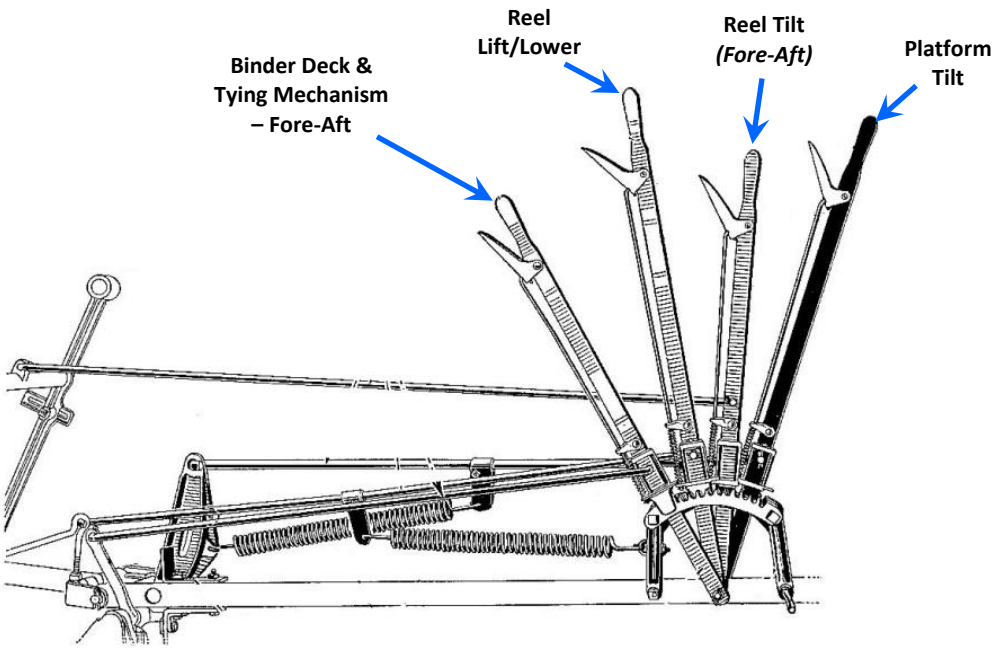


Fig.3.11 Main operator controls of a binder *(McCormick)*

3.5 Binder Operating Adjustments and Controls

Binders usually provide controls to permit certain operating adjustments to be made from the Operator's seat whilst the machine is in motion. Most are made via hand levers *(Fig.3.11)*, but foot pedals are sometimes also used. Depending on machine configuration, additional controls may also be provided for certain other features *(e.g. Sheaf Carriers)*.

Platform Tilt *(Cutting Height)*

Stubble cutting height is *(coarsely)* adjusted by raising / lowering the Bull and Grain Wheels relative to the binder's main frame via screw adjusters. However, further fine adjustment(s) during work are then made by tilting the binder's Platform *(in fact the entire machine)* forwards / backwards relative to the drawbar via a hand-operated lever. This effectively raises / lowers the Cutter Bar *(see Fig.3.12 & Section 6.2.1).*

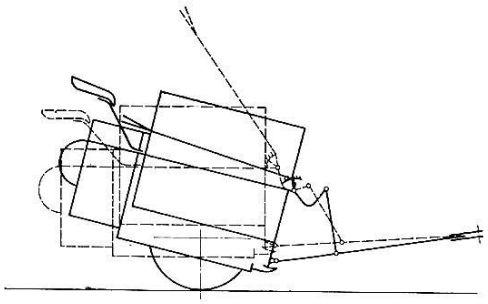


Fig.3.12 Adjusting binder cutting height by tilting the platform / main frame *(courtesy Heyde)*

Reel Position *(see Section 6.2.2)*

Correct and *(if necessary)* regular adjustment of the Reel's position is important in order to get the best performance from the binder in anything other than extremely consistent crop conditions. Both height and fore-aft position *(relative to the Cutter Bar)* can be readily adjusted via separate hand levers. Fore-aft adjustment is sometimes referred to as 'tilt' because the Reel is often mounted on a bottom-pivoting mast. However, in reality, the Reel is moved forwards or backwards.

Tying Mechanism *(Sheaf Band)* Position

Fore-aft movement of the binder's Deck and sheaf packing / tying / discharge mechanism, as described in Section 3.4, to compensate for variations in crop height.

Buttor *(Board)* *(see Fig.3.9)*

The position of the Buttor's mid-pivot can be adjusted forwards / backwards relative to the binder's Deck, by a hand lever. This increases / decreases the severity of action of the Buttor on the Butt ends of the forming sheaf **BUT it should not** be used to try to adjust the twine band position.



Fig.3.13 Ground-driven binder - Combined main drive disengagement and overrun clutch *(left)* and clutch operating lever *(arrowed)* *(right)*

(courtesy P. Wheeler)

Main Drive Disengagement Clutch *(Ground-driven Binders)*

Ground-driven binders are fitted with a manually operated clutch to allow disengagement of the drive when not required *(Fig.3.13)*. The clutch also incorporates an overrun mechanism to prevent the binder's mechanism from being driven backwards *(and damaged)* whenever the machine is reversed.

Sheaf Carrier

Some binders were fitted with *(optional)* Sheaf Carriers *(Fig.3.14)*: a 'basket' arrangement of steel tines mounted below the Binding Deck to collect the sheaves as they are discharged, so that a number may be placed in a single location and the subsequent stooking operation made more efficient. Sheaf Carriers were usually pedal-operated by the Binder Operator.



Fig.3.14 Binder 'Corner' Sheaf Carrier in collecting *(left)* and discharge position *(right)* – *(Albion)*

Today, the higher plant density of most modern thatching straw crops means that binders discharge sheaves extremely close to each other *(Fig.3.15)*. This largely makes the Sheaf Carrier redundant. However, it can serve a useful purpose by collecting any sheaves which may be discharged whilst cornering, thereby preventing the tractor from accidentally driving over them during the next round.

In fact many binder manufacturers offered two distinct designs of Sheaf Carrier: a 'Corner' carrier with a capacity of 3 - 4 sheaves, intended solely for catching sheaves when turning corners *(see Section 6.3.2)*, and a larger 'Regular' carrier capable of collecting 6 – 8 sheaves *(Fig.3.16)*



Fig.3.15 Very closely spaced sheaves produced by a 7 ft (2.1 m) cut binder working in a thick crop of Maris Widgeon

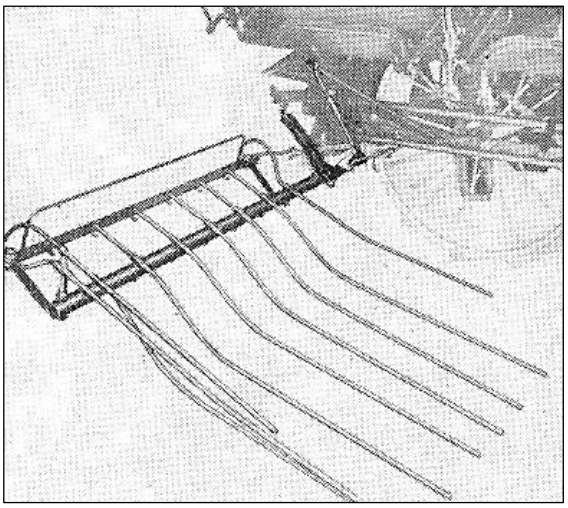


Fig.3.16 'Regular'-type binder Sheaf Carrier - 6 - 8 sheaf capacity – *(McCormick)*

4 Binder Pre-Season Preparation

With each passing year, Harvest seems to come round a little bit quicker. So often there never seems to be the time to check-out the machine(s) properly before it's time to start again. So why is binder pre-season preparation so important? Here are few reasons why you should get it done:

- Most binders in commercial use will now be 75-100 years old. Of course it depends how many hours you expect to use it each year, but like it or not, the 'newness' will just about have worn off the machine by now; with inevitable consequences
- Binders only break down when you're using them ….. In the middle of the field, often at a time or weather-critical moment
- Many growers have spare binders, to guard against breakdowns: **BUT** you will still lose a certain amount of precious time *(and money)* swapping from one machine to another.

So it makes sense to make time to go through the machine a few months before Harvest, to identify any worn components and to make sure that everything is setup properly & in good condition. This won't prevent a breakdown, but it will strongly reduce the likelihood of one occurring.

4.1 Binder Driveline Components

4.1.1 Power Take-Off (p.t.o.) Shaft *(see Fig.4.1)*

Of course, only present on p.t.o.-driven machines. Particular points to check-out / inspect include:

- **Tractor Drawbar Position *(Length)*:** Whilst it might seem convenient, it's **NOT a good idea** to convert a binder's drawbar to attach via the tractor's pick-up hook. For any implement p.t.o. drive to operate with the minimum of vibration & wear when turning corners under power, the tractor - implement drawbar hitch point should ideally lie midway between the p.t.o. shaft's two Universal Joints (UJs). This isn't always achievable **BUT**, if the tractor's drawbar is set in its fully extended position, you should be getting close to the ideal.

- **P.T.O. Shaft Overlap:** Three key requirements regarding the *(sliding)* male & female sections of the shaft. They should:
  - **Overlap** by at least 6 inches (150 mm)
  - **NOT bottom-out** when the tractor & binder are turning sharply
  - **Be well-lubricated** so that they slide freely when transmitting power

- **P.T.O. Shaft Universal Joints (UJs)**
  - **Check** the UJ *(needle roller)* bearings for seizure and/or wear
  - **Ensure** they are properly lubricated and that grease reaches all four of the bearing cups

- **P.T.O. Shaft Guarding**
  - **Ensure** the p.t.o. shaft guard is in good condition **and** is fitted with a suitable restraint chain so that it doesn't rotate with the shaft
  - **Also ensure** the tractor's 'master' guard and the shaft guards on the binder are present, are in good condition and are properly secured.

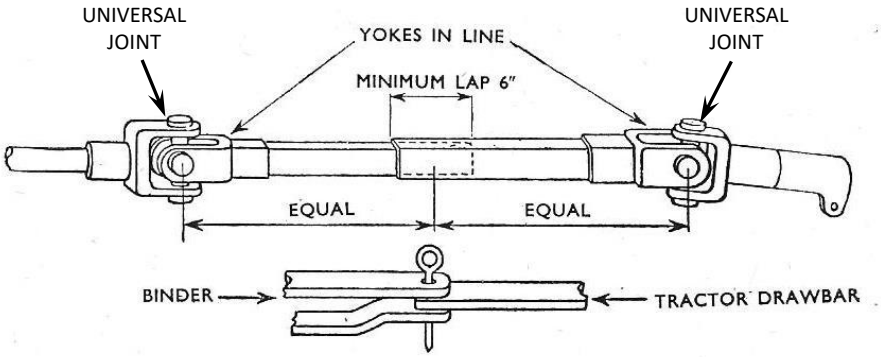


Fig.4.1 Tractor – Binder p.t.o. driveshaft showing minimum shaft section overlap and desired position of the tractor – binder drawbar hitch point - ***(N.B.** Shaft guarding removed for sake of clarity)*

(after Farm Mechanization)

4.1.2 Other Driveshafts

Regarding other drive-transmitting shafts on the machine, the basic requirements are to:

- **ENSURE** that each shaft is straight / not bent, so that it doesn't wobble or vibrate as it rotates *(stranger things have been known!)*
- **ENSURE** that all shaft supporting bearings are not worn, that they both support and locate the shaft(s) as intended and are adequately lubricated.

4.1.3 Slip / Safety Overload Clutches

Both p.t.o. and ground-driven binders should be fitted with one or more safety overload / slip clutches, to protect the machine's components from overload & serious damage if/when a blockage or other problem arises. Depending on machine design, this may be incorporated within the actual p.t.o. shaft or be located elsewhere within the machine's drive mechanism: perhaps only on the drive to the Packers and Tying Mechanism.

Some older, North American-produced ground-driven binders may not have incorporated slip clutches, relying instead on the Drive Wheel slipping on the ground in the event of an overload. This may well happen & you might be happy to rely on this feature to protect your binder. **BUT remember** that the those machines were built to**:**

- Operate in dry, North American crop conditions
- Cope with far thinner crops than those grown today in the UK.

Returning to pre-season preparation, points worth bearing in mind include:

- The slip clutch will almost certainly be of the spring-loaded, serrated-face 'clatter' type *(Figs 4.2 4.3 & 4.4)*, not the more modern friction plate type. The loading at which the clutch slips can be adjusted by loosening / tightening the spring compression nut
- The largest overall power demand *(which might cause the clutch to slip inadvertently)* is likely to occur at the point of sheaf tying & ejection. The driveline load will reach a maximum as the Needle compresses the sheaf *(see Fig.3.9 (right))*. The slip clutch(es) should be adjusted to just provide sufficient drive *(and no more)* at this point

- **BEWARE** that the clutch faces can stick / seize together during over-winter storage. To guard against this, before putting the binder to work each year:
  - Slacken off the spring securing nut *(having first noted the spring's length)*
  - Sparingly lubricate the *(serrated)* clutch faces
  - Re-tighten the spring securing nut to the previous setting or, better still, just enough until a reliable non-slip drive can be achieved
- **NEVER** be tempted to over-tighten the slip clutch. It will eventually prove to be a costly mistake, causing major *(potentially irreparable)* damage to your binder
- **IF** your p.t.o.-driven binder has been *(or is ever)* fitted with a replacement p.t.o. shaft, **ENSURE** the new shaft incorporates a suitable slip clutch which has an appropriately low overload setting. Otherwise, when a blockage occurs, the binder's components won't be protected.

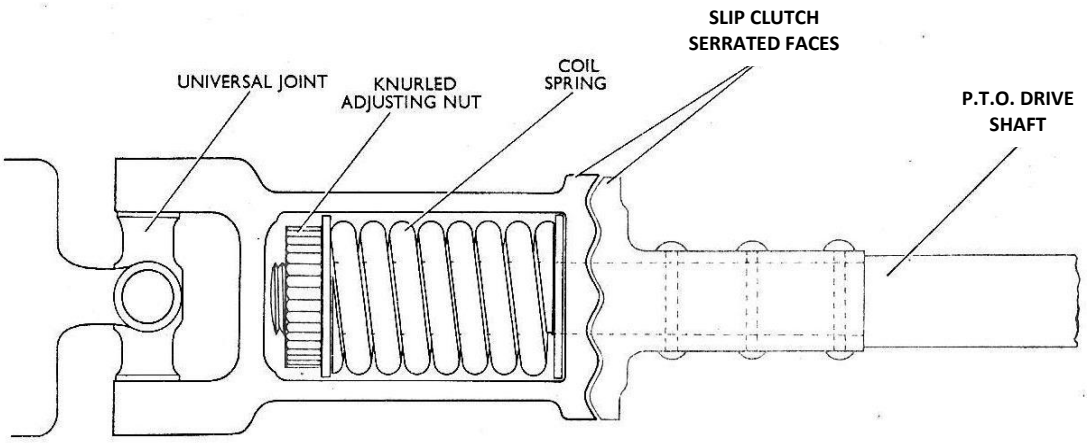


Fig.4.2 Adjustable serrated-face slip clutch incorporated within a Binder's p.t.o. driveshaft

(courtesy Shippen & Turner)



Fig.4.3 Spring-loaded serrated-face slip clutch incorporated within the binding mechanism drive sprocket on an Albion binder *(arrowed)*

(courtesy P. Wheeler)

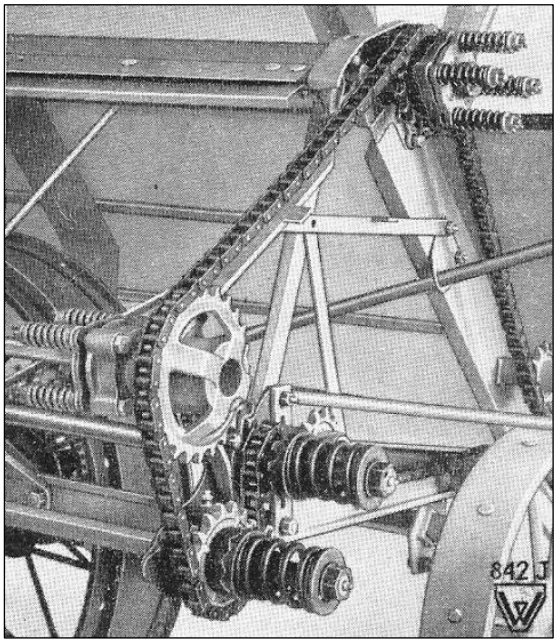


Fig.4.4 Multiple overload-protection slip clutches on the component drives of a Scandinavian-built ground-driven binder – Note use of roller-type drive chain

(courtesy Shippen & Turner)

4.1.4 Drive Gears

There aren't too many drive gears on a binder: power is transmitted mainly via shafts, sprockets & chains. However, gear sets are normally used where:

- Drive needs to be passed through 90 degrees *(e.g. main drive on ground-driven machines, drive to needle & knotter shaft, reel & buttor board)*
- Component timing is important *(e.g. needle, knotter shaft & knotter unit drive)*
- Component drive(s) are close to each other and may need to move relative to each other *(e.g. Deck roller & Elevator canvas drive rollers)*

On most later design of binders, the majority of gear sets are enclosed in oil or grease-filled housings. There isn't much which can be done other than to keep the lubricant topped-up **and** occasionally remove & completely renew it. Whilst doing so, check for play in the bearings which support the gear-driven shafts and wear on the gear teeth.

Gear Set Wear and Backlash

Like it or not, gear sets will wear over time, albeit fairly slowly. The first sign of trouble is the presence of excessive free play or 'backlash' between the driving & driven gears. Whilst it might be tempting to ignore it, it's important not to because, once present, the gears will wear even quicker. A certain amount of backlash is normal, but when it starts to become excessive, it's time to act.

If possible, try to insert shim washers on the driving or driven shafts, to push the gears ever so slightly closer into contact with each other, **BUT** not to the point that they no longer turn freely. It's a delicate balance, but it will help to delay the time when the gears either need to be repaired or replaced: if replacement parts are indeed available. Some binders are fitted with 'gear thrust' adjusting bolts in certain locations, to adjust / maintain the degree of inter-gear mesh.



Fig.4.5 Chain types commonly used on older Binders - Pintle *(left)* and Hook or Detachable Link *(right)*

4.1.5 Chains and Sprockets

There are three type of drive chain which **may** be found on a binder: Pintle, Hook *(or Detachable)* Link and *(Precision)* Roller. Their selection depends largely on the operating speed & the amount of power to be transmitted.

- **Pintle Chain:** *(Fig.4.5 (left))* Single-piece cast or pressed steel, tapered links joined by removable pins. No separate rollers. Often used as the main *(slow-speed)* drive chain on ground-driven binders. The narrow end of the chain link must lead *(point in the direction of chain movement) (see Fig.3.13 (left))*
- **Hook *(or Detachable)* Link Chain:** *(Fig.4.5 (right))* Square, malleable steel links with slotted 'hook' ends to enable joining / detachment. Historically used for most other chain drive applications on binders *(Fig.4.3)*. Must be installed with the hook 'slot' outwards and the hook end pointing in the direction of travel *(Fig.4.6 (left))*
- **Roller Chain:** The everyday *'Renold'* or 'precision', bicycle-type chain made of series of rollers mounted on hardened pins, rivetted to interconnecting links on either side of the rollers. Normally used for higher-speed applications. Very common on post-war agricultural machinery & found on binders of this era. Important to install the clip-retained 'joining' links in the correct orientation relative to the direction of chain travel *(Fig.4.6 (right)).*

Care of Chain & Sprocket Drives

- **Lubrication:** With a few exceptions *(on more modern machines)*, chain drives on binders will be exposed: to dust, dirt and debris. Lubrication can attract dirt and encourage wear **BUT unless working on abrasive soils in really dusty conditions, chain drives should be lubricated**. Modern spray chain lubricants are readily available: alternatively, old *(clean)* gear oil and a paint brush can suffice.

  However, do remove the chains out-of-season, clean them off in diesel & soak them in oil before refitting.

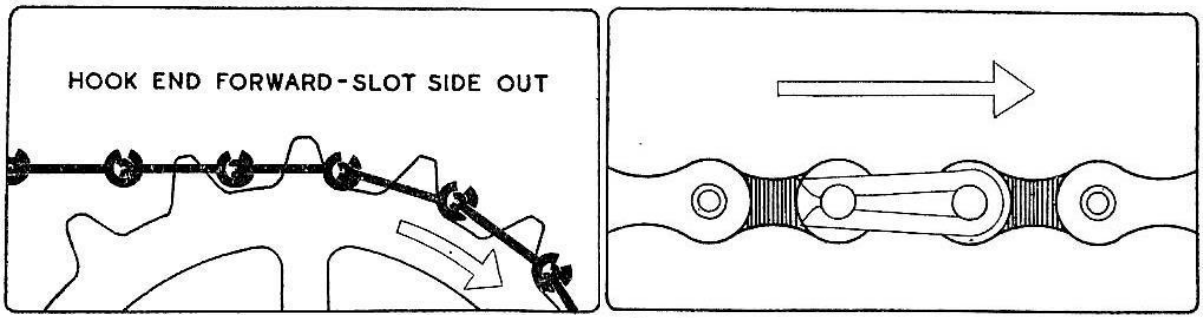


Fig.4.6 Correct installation of different chain types

- **(Left) – Hook Link** – Slots outwards, hook ends point in the direction of travel
- **(Right) – Roller** – Open end of connecting link clip should face away from direction of travel

Care of Chain & Sprocket Drives *(continued)*

- **Chain Tension:** Don't be tempted to run a drive chain too tight: it will increase wear. You don't want it to flap about or cause critical machine component timings to vary *(e.g. Needle & Knotter timing on Massey Harris or Sunshine machines)*, but generally being on the 'slightly loose side of tight' is OK.

  For Hook Link-type chains, the tension is about right if it's just possible to move the links from side to side across the sprocket teeth

- **Wear:** Over time both chains and their sprockets will wear. As a chain wears, its inter-link distance or 'pitch' will increase, causing it to ride up on the sprocket teeth. Eventually these will become 'hooked' and require replacement.

  It's recognised bad practice to fit a new chain to a worn sprocket, **BUT** replacement, imperial pitch Pintle or Hook Link chain is still readily available. Coarse Roller-type chain(s) may even be substituted for the Hook Link type.

  Obtaining a new sprocket for a binder is a far bigger challenge. It may be possible to find & adapt a different sprocket but, ultimately, a replacement chain will at least minimise further wear in the short term. If sprockets are really badly worn, it may be necessary to rebuild their teeth profiles by bronze welding.

  Remember to also check chain & sprocket alignment which, if not correct, will also cause rapid wear.

4.2 Cutter Bar

A binder's reciprocating 'knife & finger' type Cutter Bar has a hard life. It has lots of fast moving components, most in 'metal-to-metal' contact, operating in dust & dirt close to ground level, potentially waiting to hit stones. Consequently, the Cutter Bar components will experience considerable wear in-service and in order to perform effectively, will require setup & maintenance, both Pre-Harvest and also during subsequent use.

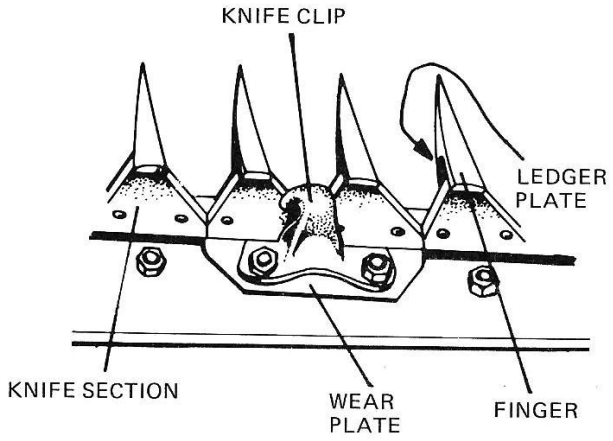


Fig.4.7 Knife and Finger Cutter Bar - Key components

(courtesy Bell)

Components and Setup *(see Figs 4.7 & 4.8)*

The construction of a binder's Cutter Bar is very similar to those found on finger bar grass mowers of the same era, albeit with a few subtle differences *(see Fig.4.14)*. The key components and their setup & maintenance requirements are:

- **Finger:** Bolted to the Cutter Bar at 3 inch (~76 mm) intervals. Made either of cast steel with an integral Ledger Plate or malleable iron with a replaceable hardened steel Ledger Plate rivetted in place
- **Ledger Plate:** Integral, inner surface of the Finger. Provides a hardened, flat surface for the Knife Sections to pass over, creating a scissor-like cutting action. Ledger Plate sides should be ground back to provide a slight reverse bevel, to maintain a sharp cutting edge *(Fig.4.10)*.

  The upper surfaces of all the Ledger Plates should be in line with each other *(and also with the Inner & Outer Shoes)* across the Cutter Bar *(see Fig.4.13)*
- **Knife Back:** Rectangular cross-section strip of steel driven to reciprocate within the Cutter Bar. The *(triangular)* Knife Sections should be tightly riveted to it. Check by tapping the *(removed)* Knife on a hard surface: loose Sections will rattle
- **Knife Sections:** Triangular pieces of hardened steel with bevelled edges, which are rivetted to the Knife Back and *(in conjunction with the Ledger Plates)* provide the cutting action. To cut properly, the Knife Sections must:
  - Be held down in close contact with the Ledger Plate(s)
  - Have their plain, bevelled edges kept sharp *(Fig.4.11)*.

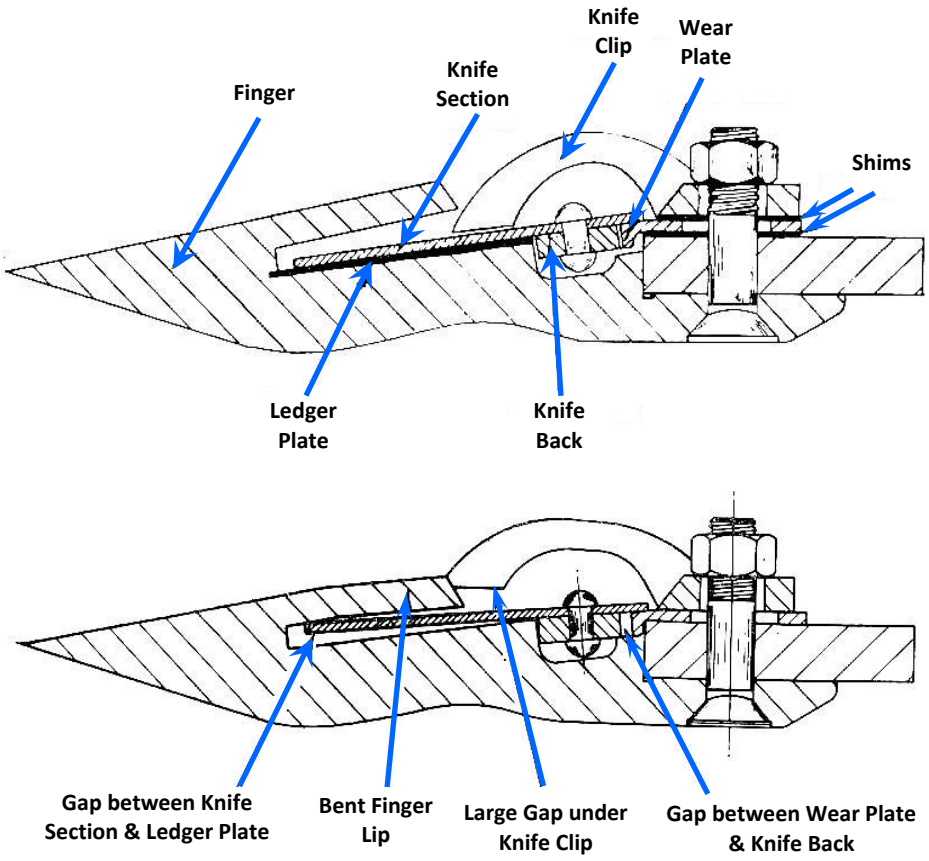


Fig.4.8 Binder Cutter Bar – sectional view – Correct setup of components *(top)* and incorrect setup *(bottom)*

- **Knife Clip:** Made from either malleable or cast iron. Should hold the Knife Sections down **close** to the Ledger Plates without actually pressing on them *(there should be a slight clearance between the Clip & Knife Section – approx. 1.0 mm – the thickness of a Postcard)*.

  Adjust malleable clips by removing the Knife and *(lightly)* hammering the Clip to bend it into position. Cast clips should be adjusted by shimming with the Knife in place *(Fig.4.8 (top))*. Worn Clip surfaces should be rebuilt with bronze weld

- **Wear Plate:** Often overlooked component which does an important job. Helps keep the Knife Sections in the correct location & attitude, in contact with the Ledger Plates. Should be adjusted *(via slotted mounting holes & by shimming)* to:
  - Fit snugly against the rear of the Knife Back, to keep the Knife Sections pushed forward into the slots in the Fingers
  - Support the back edges of the Knife Sections so that they sit at the right angle on the Ledges Plates.

- **(Knife) Connecting Rod or Pitman:** Transfers drive from the Crank Pin on the knife drive flywheel to the end of the Knife Assembly *(see Figs 3.1 & 4.9)*. The 'throw' of the crank determines the travel of the knife on each stroke which, unlike a mower, on a binder is 6 inches (~152 mm) rather than 3 inches (~76 mm).

  The Connecting Rod is usually made of wood as it provides better stress absorption & some safety overload *(by breaking)* **BUT** wear in the end connecting points will reduce knife travel & disrupt the Knife's 'register' setting *(Fig.4.14)*.

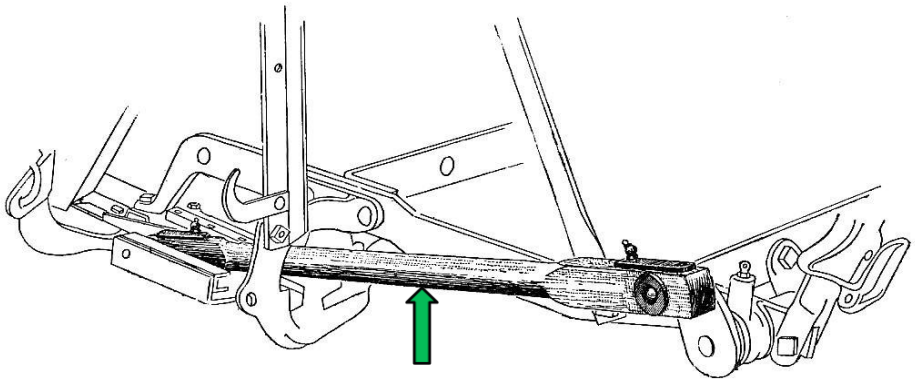


Fig.4.9 (Wooden) binder knife connecting rod or pitman *(arrowed)* – *(McCormick)*

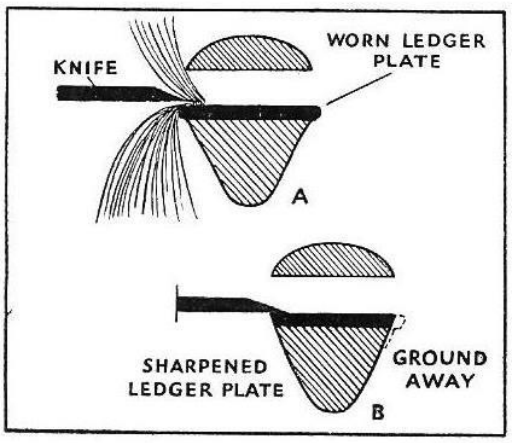


Fig.4.10 Grinding of Finger / Ledger Plate sides to maintain a sharp cutting edge

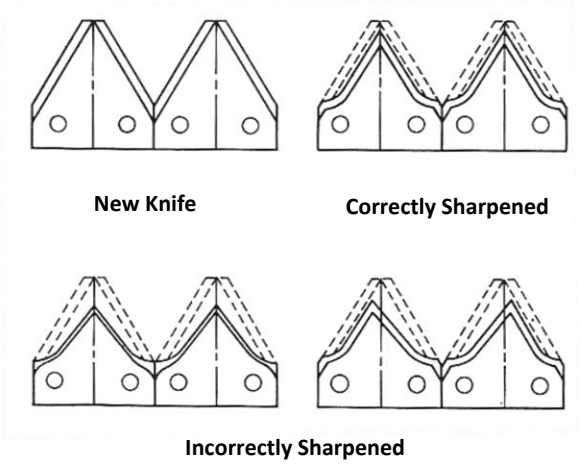


Fig.4.11 Correct and incorrect sharpening of Knife Sections – It is also important to maintain the original *(knife edge)* bevel angle

Knife Sharpening & General Care

The general condition of the Knife and Fingers on a binder is not so critical as on a mower, simply because the crop material being cut is *(or should be)* much more ripe, brittle & easier to cut. However, if crop weed control has been sub-optimal and there's any quantity of grass or greenstuff in the bottom, knife setup becomes increasingly important, if blockages, holdups and poor crop feeding are to be avoided.

All binder knives were originally fitted with 'plain', bevelled edge Knife Sections which require regular sharpening in-work *(usually every 3-4 hours)*. Two knife assemblies were usually supplied with each binder, enabling one to be sharpened / held in reserve while the other was in use.

Combine harvester cutter bars have used self-sharpening, serrated-edge knife sections since the late-1960s. Many binders have since been converted to accept such knife sections & their accompanying fingers *(see Fig.3.3 & Section 9.1)*, partly to avoid the chore of knife sharpening and partly due to poor availability of original replacement parts. These conversions work well **BUT** if persevering with Plain Knife Sections and knife sharpening *(with a spare knife)*, **it is important to alternate the Knives, using each in turn.** Otherwise the Knife Back of one will wear more than the other and become a poor fit in the Cutter Bar, leading to poor cutting performance, even if the Knife Sections are sharp.



Fig.4.12 Knife Section securing rivet removal/replacement tool *(Spaldings)*

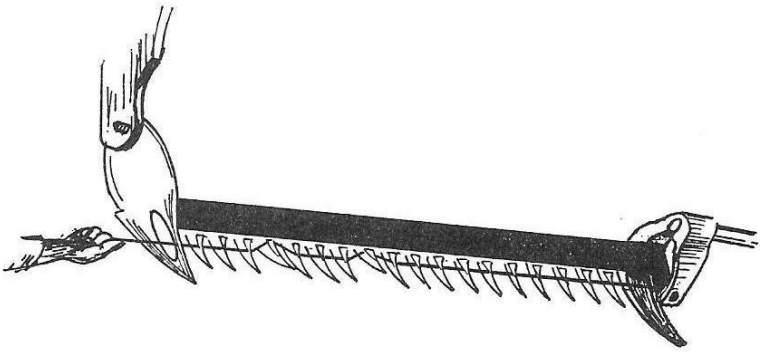


Fig.4.13 Checking Cutter Bar Finger alignment with a thin piece of string *(mower cutter bar shown)*

N.B. String should be stretched over the Ledger Plates **NOT** over the Fingers

(courtesy Lovegrove)

Damaged/broken Knife Sections are removed / replace by removal of the securing rivets. It's important that these are kept tight. Proprietary tools are available to aid rivet removal / replacement *(Fig 4.12)*: some even permit this to be done with the knife in-situ, **BUT** when in the workshop, a hammer & anvil is likely to deliver a superior result.

As previously mentioned, the sides of the Ledger Plates should be ground back occasionally , when they have become rounded, to provide a slight reverse bevel and maintain a sharp cutting edge *(Fig.4.10).* Alternatively, the Fingers may be replaced, assuming replacement parts are available. In any case this is only likely to be necessary once a season, unless a lot of stones are encountered.

Alignment of the Ledger Plate upper surfaces *(rather than the Fingers themselves)* is important. Stretch a thin piece of string through the slots in the Fingers and also the Inner & Outer Shoes *(Fig.4.13)*. Bend or lightly tap the Fingers back into line. A steel bar with a short piece of tube welded to its underside *(to fit over the end of the Finger)* is a useful tool for this purpose.

In-Field Knife Sharpening & Rivet Removal



However tempting it may be, perhaps think twice before reaching for the battery-powered angle grinder for knife sharpening or rivet head removal when in a dry harvest field. A file and a hammer & chisel may be a more prudent choice. Field fires rarely care if they destroy a modern or a precious vintage piece agricultural machinery.

Knife Travel & Register

The Fingers of both mower and binder Cutter Bars are spaced 3 inches (~76 mm) apart. However, in each stroke a binder's Knife travels 6 inches (~152 mm), from the centre of one Finger to the next alternate Finger *(Fig.4.14)*. A mower's Knife only travels 3 inches (~76 mm) *(to the centre of the adjacent Finger)*, but does so at a greater speed.

To cut most effectively, the **Knife's Register** should be adjusted so that the Knife Sections travel to the centre of the Fingers at each end of the stroke. Wear in the Connecting Rod or knife drive mechanism can upset this. Different brands of binder have different means of adjustment by which it may be corrected.

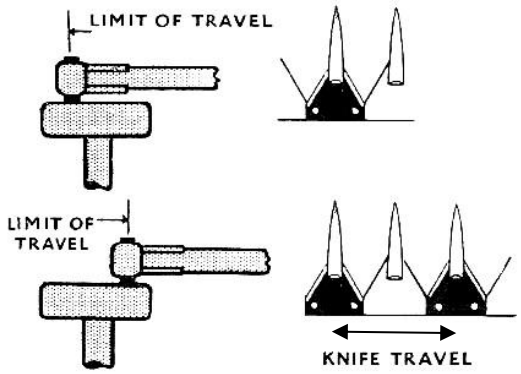


Fig.4.14 Binder Cutter Bar knife travel and Register



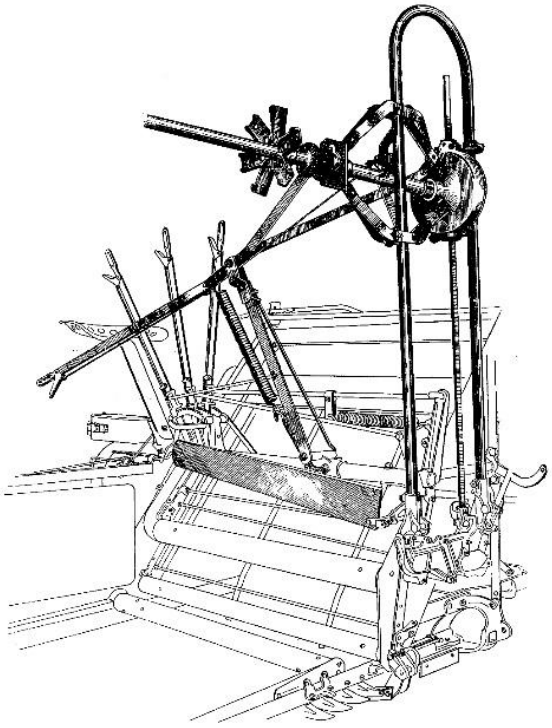


Fig.4.15 Alternative binder reel drive arrangements – Chain and sprocket *(left)* and Bevel gear and shaft *(right)* - Both examples are McCormick machines

4.3 Reel

The pre-season preparation of a binder's reel isn't particularly demanding. It's sufficient to check / verify the mechanical condition and correct adjustment & operation of the Reel's:

- **Wooden components** *(e.g. Bats / Sails / Laths and Arms / Spokes)*
- **Height and Fore-Aft adjustment mechanisms**
- **Drive mechanism**: Some earlier binders *(e.g. McCormick)* used chain & sprocket drives, but the majority used bevel gear & shaft arrangements *(e.g. Albion, Deering, Massey-Harris/Sunshine & later McCormick models) (Fig.4.15)*. Check chain & sprocket drives for excessive wear & correct chain tension. Check gear drives for wear, condition of the shaft(s) & the Universal Joint and particularly the sliding gear on the Reel Post.

4.4 Crop Conveying Mechanism

For the binder to operate properly, its crop conveying mechanism must work effectively & reliably. These parts of the machine move a great deal of crop each season, so a bit of careful inspection and *(where necessary)* care & attention is likely to pay dividends.

Platform & Elevator Canvases - Condition

Hopefully, these were removed from the binder at the end of last season and stored in a dry, vermin-free place. Before re-fitting carefully inspect them for general wear / damaged areas, worn / damaged / loose securing straps, buckles and *(wooden)* slats. Canvases can be repaired: alternatively, new canvases can be manufactured for your binder, albeit at a cost *(see Section 10)*.

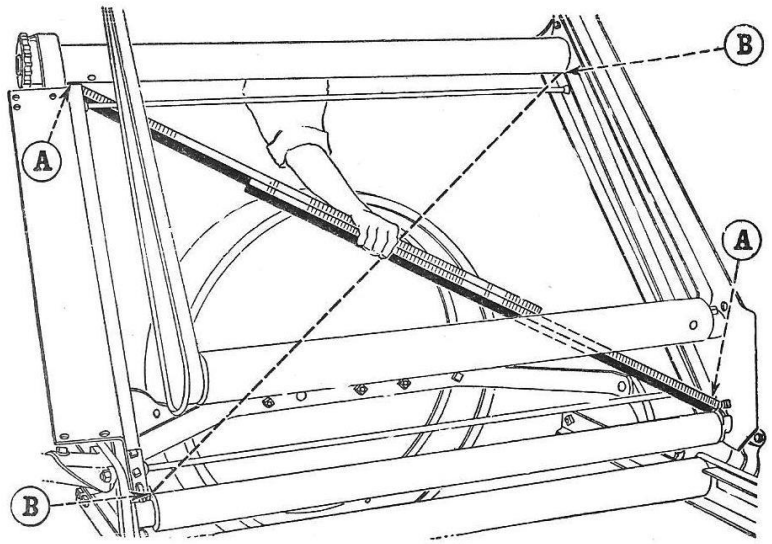


Fig.4.16 Checking a binder's elevator drive and idler rollers for parallel and 'square'

- Diagonal distance 'A – A' should be the same as distance 'B – B'
- Always check & adjust the rollers of the Lower Elevator before those of the Upper Elevator

(courtesy IHC)

Canvas *(Drive & Idler)* Rollers and Tensioning Mechanisms

Particular things to check include:

- ***(Drive & Idler)* Rollers:** Check each roller for straightness, cracks, *(untreated)* woodworm & any other physical defect. Also the roller support bearings & drives
- **Tensioning & Locking Mechanisms:** Ensure that these operate freely and secure / release the rollers as required, to permit easy tensioning & slackening of the canvases
- **Roller Alignment:** For the canvases to 'track' properly and not run towards one side or the other, the drive & idler rollers must be parallel and 'square' with each other. The canvases' slats should be parallel to the rollers.

  Check by measuring the left & right diagonal distances between the ends of each pair of rollers *(Fig.4.16)*. For a given pair of rollers, the two measurements should be the same. If not, they should be corrected by adjusting tie-rods within the support frames. Don't forget to check the Platform as well as the Elevator.

4.5 Crop Packaging and Tying Mechanism

Guidance regarding the setup & adjustment of a binder's Knotters and it's broader tying mechanism *(e.g. Needles, Twine Supply system, etc)* is provided in the dedicated 'Knotter Setup' technical guide, produced in this series of publications *(see below & Section 13)*.

Click on the adjacent image or scan the QR code to access the Knotter Guide



Fig.4.17 Knotter technical guide

However, there are a number of things which are worth checking, to make sure that things are in decent condition before you get to the field & find otherwise.

Things to Check

- **Twine *(Quality)*:** Nothing to do with the actual Binder, **BUT** essential for its reliable operation. Poor quality twine is a waste of both your precious, in-field time & also your money. It's likely to be of variable thickness and/or prone to shedding fragments / debris. Either will cause the binder's Twine Tension setting *(i.e. the pre-tension in the twine supply to the Needle)* to vary, resulting in poor / erratic knotter performance. All too often this results in mis-guided adjustment of the Knotter, when in fact it probably wasn't to blame.

  Take time pre-season to buy-in a suitable stock of good-quality twine from a reliable supplier. 'No. 0' grade Sisal twine seems to be the preferred choice of most users

- **Twine Guides:** Check for wear grooves in the Guides which may either cause the twine to snag or *(at best)* cause variations in twine tension: which in turn will disrupt the Knotter's performance. Also check for & remove any corrosion or roughness from the Guides, so the twine can flow smoothly & freely. Unfortunately, the Old Hand's fix of squirting some oil in the centre of the Twine Spool is an imperfect & primitive solution, just as likely to cause issues elsewhere in the binder's tying mechanism.

  Twine guides *(see Figs 3.6 & 3.8)* can sometimes be rotated to present an unworn surface for use **BUT,** more likely, any grooves will require rebuilding back to their original profile by bronze welding

- **Twine Tensioner:** Is usually located near the Twine Box *(see Figs 3.6, 3.8 & 5.3)*. It must apply sufficient pre-tension to the twine to control its behaviour, both during sheaf formation & then also during the tying cycle. Designs vary but usually the twine passes between a pair of spring-loaded plates or spring-loaded, inter-meshing gears.

  Check the Tensioner(s) for correct operation, the absence of wear grooves *(which will cause unwanted tension variations)* and ready adjustment. Repair / rebuild any wear grooves which may be present. See Section 5.4 for recommended twine tension settings.

- **Twine Tensioner *(continued)*:** Some binders *(e.g. Massey-Harris/Sunshine, Albion & others)* incorporate additional tensioning devices to help prevent twine breakage during the rapid flow of twine which occurs either during Needle movement or prevent 'twine looping' immediately following Needle deployment.

  Often these are in the form of 'spring arm'-type twine guides which can deflect sideways when the twine is suddenly pulled and provide some 'give' in the twine supply system *(see Fig.5.3)*

- **Needle *(Wear)*:** Check any parts of the Needle through which the twine passes: **particularly the Needle's 'Eye'.** Wear groves will develop over time and these will cause:
  - Twine tension variations and possible twine snagging / breakages, particularly as 'joining' knots between twine spools pass through
  - Incorrect twine placement into the Knotter Unit.

  Some Needles feature rollers within their 'eyes': if worn these should be replaced. Wear slots in 'solid' needles may be repaired by brazing or, as a temporary fix, with 'liquid metal'-type epoxy resin filler. It's a quick, temporary fix and may get you through to the end of the season

- **Needle Adjustment *(Lateral & Vertical position)*:** See Section 4.1.3 of the 'Knotter' technical guide

- **Needle *(Travel)* Adjustment:** Also see Section 4.1.3 of the 'Knotter' technical guide. The correct setting is very specific to your particular make of binder, or rather the type of Knotter fitted to it.

  However, for those fitted with McCormick-type knotters, the Needle travel should be adjusted so that the Needle's shank is tight against the Twine Bridge *(Breast Plate Finger)* when the knotter's Bill Hook is at 90 degrees to the Needle *(Fig.4.18)*. Needle travel can be adjusted by **carefully** shortening or lengthening the Needle drive connecting rod *(see Figs 4.22 (left) & 4.26)*

- **Knotter Setup:** It's often said that if a Knotter is working properly, leave it well alone. There's a lot to recommend this approach **BUT** it does make sense to keep a lookout for potential problems & address them before they become serious. Have a look at Section 4 of the 'Knotter' Technical Guide for general setup & troubleshooting information and Section 5 for specific information concerning the knotters fitted to your particular binder

- **Binder Deck – Free Movement:** Ensure the binder's Deck and Packing / Tying Mechanism can move freely *(backwards / forwards)* when required, to adjust sheaf band position. Lubricate the supporting roller(s) & slides and also the sliding driveshaft to the Packer Crankshaft. Make sure the adjusting lever & locking mechanism operates properly

- **Discharge Arms:** Check that these are tight / fixed securely on the Knotter Shaft *(Fig.4.18)*. Otherwise they will move and eventually create undesirable wear.

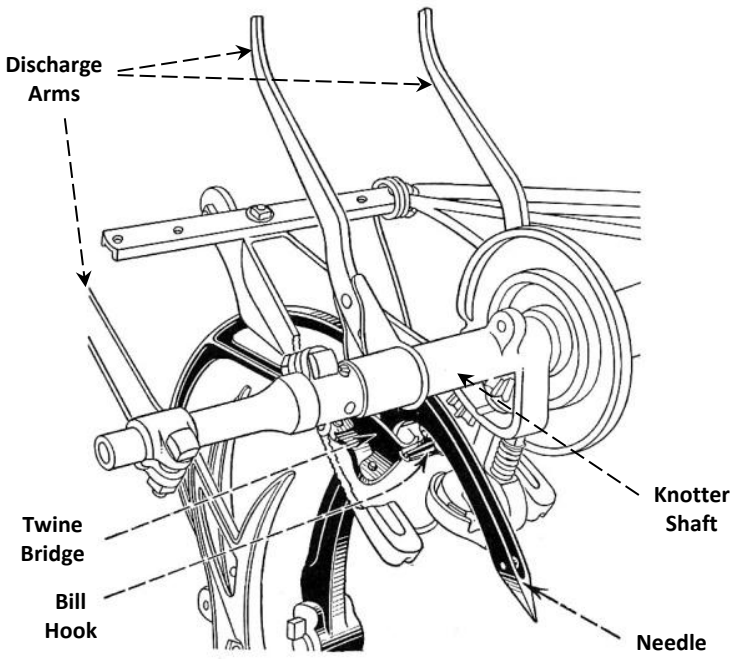


Fig.4.18 McCormick binder - Needle travel adjustment

- Needle shank should be tight against the Twine Bridge *(Breast Plate Finger)* when the knotter's Bill Hook is at 90 degrees to the Needle

(courtesy IHC)

4.6 Knotter Engagement *(Trip)* Clutch

All binders incorporate a mechanically-tripped, dog-type clutch to engage drive to the tying mechanism *(i.e. the Needle, Knotter and Compressor & Discharge Arms)* every time a sheaf is tied & ejected. A binder's Knotter is such an important & complex component that its setup justifies a dedicated technical guide.



Fig.4.19 Straw Trusser knotter trip and drive engagement clutch *(highlighted)*

However, the Knotter Trip Clutch isn't too far behind in terms of importance. It must engage drive to the Knotter Shaft rapidly, when the tying mechanism is tripped, and then disengage precisely at the end of the tying cycle. It must do this reliably, every 1½ - 3 seconds, many thousands of times every season. Unless it functions correctly, the Knotter won't tie and no sheaves will be produced. So the setup & operation of the Trip Clutch is vitally important to the binder's operation.

The Trip Clutch is usually mounted on the end of the *(continuously rotating)* Packer Crankshaft *(Fig.4.19)*. When 'tripped' it transfers drive to the Knotter Shaft and associated Discharge Arms *(Fig.4.18)*, either via a chain & sprockets *(Massey Harris/Sunshine)* or a bevel gear & driveshaft arrangement. Heavier-duty Straw Trussers typically use a series on intermeshing gears, but the Trip Clutch functions in exactly the same way.

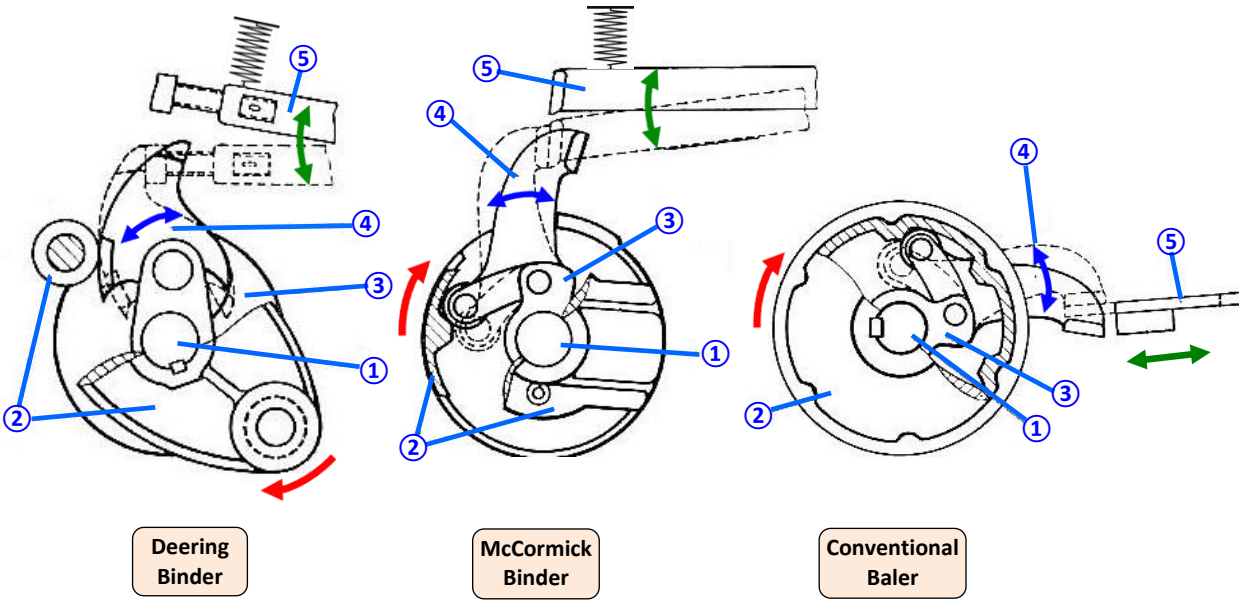


Fig.4.20 Alternative types of Knotter Engagement *(Trip)* Clutch used on binders – Conventional Baler clutch is included for comparison

(1) Packer or Knotter Shaft, (2) Drive Flange incorporating drive rollers or cams/lugs, (3) Drive Hub, (4) Drive Pawl / Trip Arm *(pivots on the Drive Hub)*, (5) Stop Arm *(trip/pawl stop)*, actuated by the knotter trip mechanism

(after Berglund & Andersson)

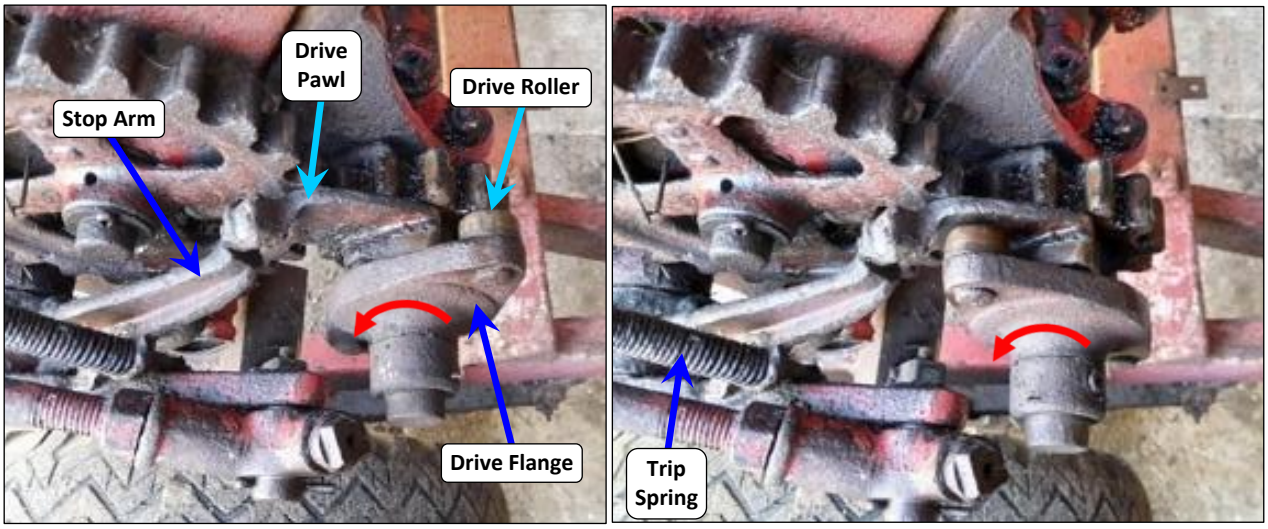
Trip Clutch designs & terminology differ between binder brands *(Fig.4.20)*, but all incorporate:

- A continuously rotating driving element *(Drive Flange / Dog Driver)*, fixed to the Packer Crankshaft. This incorporates one or more drive cams / lugs or rollers
- A spring-loaded, pivoting Drive Pawl *(Trip Arm or Dog)*, which sometimes incorporating a roller. This is mounted on a *(Drive)* Hub, which is part of the driveline to the Knotter Shaft:
  - When tripped / released, the Drive Pawl rotates slightly *(under spring pressure)*, its lower end moves outwards & engages with one of the drive cams / lugs or rollers on the Drive Flange
  - The Drive Pawl then temporarily locks the *(outer)* Drive Flange to the *(inner)* Drive Hub and drive is transmitted to the Knotter Shaft & sheaf tying / discharge mechanism *(Fig.4.21)*.

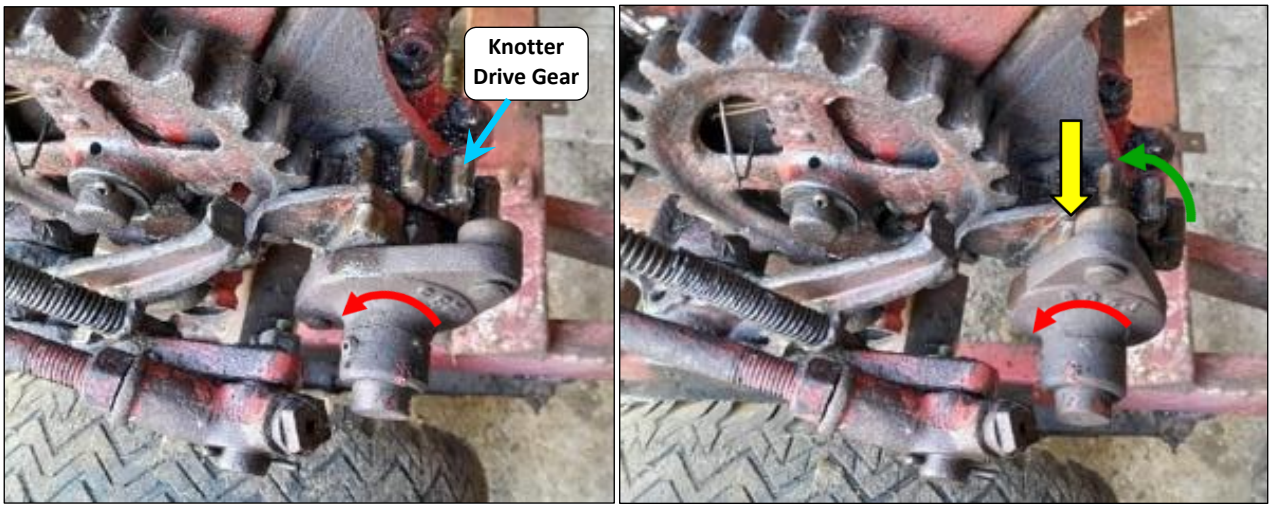
4.6.1 Trip Clutch Engagement & Disengagement

Between tying cycles, the Trip Clutch is kept disengaged. The Stop Arm *(Fig.4.20, Item 5)* contacts the leading face of the Drive Pawl *(Item 4)* and *(if correctly adjusted)* holds the Pawl back against its internal spring. This keeps the inner *(driving)* end of the Pawl out of contact with the Drive Flange cams / rollers. When the tying mechanism is tripped, the Stop Arm raises clear of the Drive Pawl *(against pressure exerted by the Trip Spring)* and allows the Pawl to pivot & engage with the next passing drive cam or roller on the Drive Flange *(Figs 4.20 & 4.21)*.

A workshop manual might say that *"Disengagement is the reversal of the Engagement procedure"*: almost, but it's a bit more complicated. To disengage the Clutch, the Stop Arm is moved back into the rotational path of the Drive Pawl / Trip Arm, so the front face of the Pawl contacts the Stop Arm on its next revolution. This causes the Pawl to pivot back, against its spring, and disengages the drive. The complicated bit is ensuring that all this occurs at the right point in the tying cycle, so that the Knotter and Discharge Arms are able to complete their tasks & return to their 'at-rest' position.



① & ② Trip Clutch Disengaged – Stop Arm in contact with the Drive Pawl – Drive Roller(s) pass over the lower part of the Drive Pawl as the Drive Flange rotates



③ Clutch is 'tripped' – Stop Arm is raised & the Drive Pawl pivots forwards, causing its lower end to rise

④ Drive Roller contacts the lower end of the Drive Pawl *(yellow arrow)*, 'engaging' the Clutch & transferring drive to the Knotter Drive Gear *(green arrow)*

Fig.4.21 Deering-type binder trip clutch installed on a Howard straw trusser – Method of clutch engagement

Trip Clutch Engagement & Disengagement *(continued)*

Whenever a binder, trusser or baler ties a knot, the Knotter Shaft rotates once & returns to its original 'at-rest' position. On a baler, the Trip Clutch is usually mounted on the end of the Knotter Shaft, which simplifies things. When tripped, the Knotter Clutch simply has to engage, remain engaged for one revolution of the Knotter Shaft and then disengage.

It's slightly more complicated on a binder *(or trusser)*. The Trip Clutch is *(normally)* mounted on the end of the Packer Shaft *(Fig.4.21)*. The Knotter Shaft still only needs to make one revolution during each tying cycle, **BUT** the reduction *(gear or sprocket)* ratio between the shafts means that the Packer Shaft & Trip Clutch must rotate three times to achieve this. So, once engaged, the Trip Clutch on a binder or trusser must be allowed to rotate at least twice before the Stop Arm moves back in, to contact & disengage the Drive Pawl towards the end of the Clutch's third rotation. An interlock mechanism takes care of this; but the whole process isn't quite so simple as on a baler.

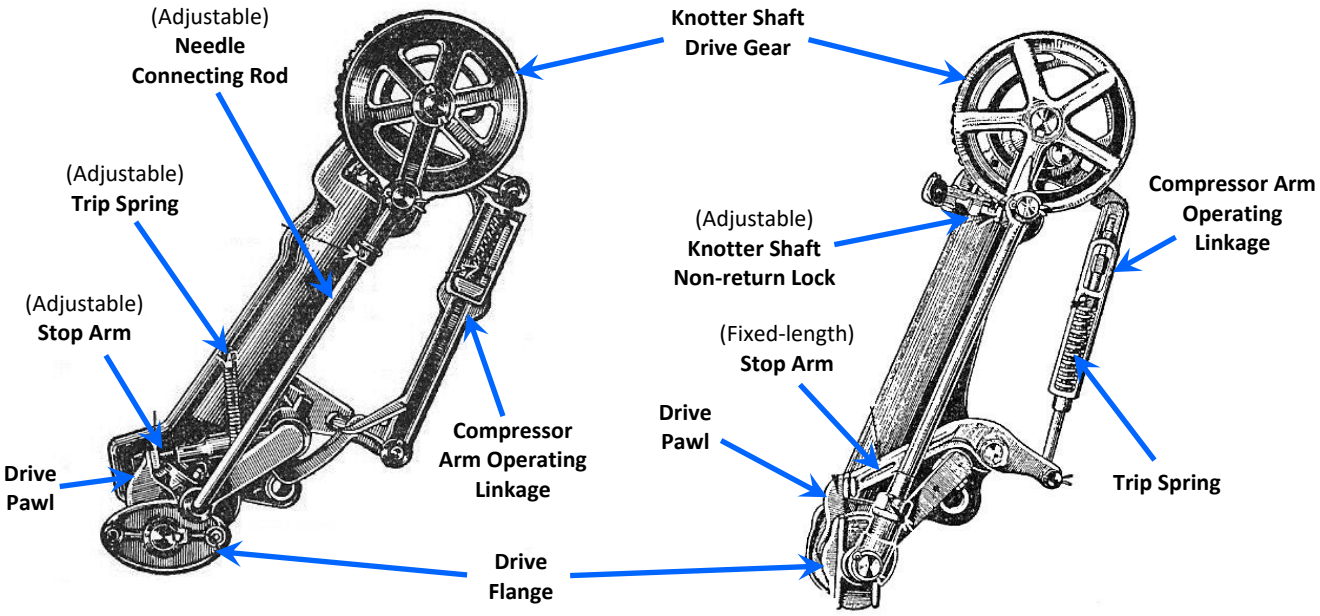


Fig.4.22 Example Binder Trip Clutch and Knotter Shaft drive arrangements – Deering *(left)* and McCormick *(right)*

N.B. Both machines use bevel gear & shaft drives and Compressor Arm reaction force to trip the Clutch

(after Berglund & Andersson)

Knotter Shaft *(Non-Return)* Lock

Between tying cycles the Knotter Shaft, Knotter unit and Discharge Arms should remain stationary in the 'at-rest' position, with the Discharge Arms pointing outwards, parallel to the binder's Deck. This is important because any slight *(inadvertent)* backward rotation of the shaft, perhaps caused by the Discharge Arms 'drooping' under their own weight as the binder travels over rough ground, will potentially:

- Cause the Trip Clutch Hub to rotate slightly *(via the Knotter Shaft driveline)*, so the Drive Pawl moves out fractionally and is 'tapped' or 'pounded' by the clutch Drive Flange *(see Table 2)*
- Interfere with the correct / reliable tripping of the Clutch
- Move the Needle tip slightly through the binder's Deck, into the crop flow.

To prevent all this a Non-Return Lock is fitted, usually to the binder's Knotter Shaft Drive Gear *(Figs 4.22 (right) & 4.23)*, to prevent any backward rotation of the gear & shaft after each tying cycle.

Knotter Trip Clutch - Tripping

As previously explained *(see Section 3.4)*, different binders use slightly different ways to trigger the Knotter Trip Clutch and start the tying cycle. Some *(e.g. Albion, Hornsby & Massey-Harris)* use a spring-loaded, pivoting Trip Lever which protrudes through the binder's Deck in the area where the sheaf is formed *(see Fig.3.8)*. Others *(e.g. Deering & McCormick)* sense the reaction force exerted by the forming sheaf on the Compressor Arm, again via an adjustable spring-loaded mechanism. When either the Trip Lever or the Compressor Arm is tripped, the Stop Arm should lift clear of the Drive Pawl and allow the clutch to engage *(Figs 4.20, 4.21 & 4.22).*

Particular adjustment of these mechanisms advances or delays the point at which the Knotter Trip Clutch is engaged, enabling sheaf size & twine band tightness *(sheaf density)* to be varied to suit particular requirements *(see Section 6.2.4).*

4.6.2 Knotter Trip Clutch – Problems & Adjustments

It's important that, between tying cycles, the Stop Arm contacts the Drive Pawl and keeps the Trip Clutch properly disengaged: otherwise it can start to mis-behave and cause all sorts of problems *(see Table 2)*. Other than repairing or replacing worn components, there are two particular things which are likely to require occasional mechanical adjustment, namely:

- Stop Arm – Drive Pawl clearance *(Figs 4.23 & 4.24)*
- Trip Clutch – Knotter Shaft Driveline timing *(Figs 4.25 & 4.26)*.

Means of adjusting the Stop Arm – Drive Pawl clearance is usually provided, but different binder manufacturers do this in different ways; some less obvious than others *(see 'Hidden Relationships' box)*.

Hidden Relationships *(see Figs 4.22 & 4.23)*

- Although the Knotter Trip Clutch and the Knotter Shaft *(non-return)* Lock are located at opposite ends of the binding mechanism, they are mechanically linked via the driveline between the Packer and Knotter Shafts. So if the Knotter Shaft Lock is adjusted, it will also affect the setting & behaviour of the Trip Clutch and vice-versa.

Different binder designs exploit this relationship

- If the Trip Clutch Stop Arm appears to be of fixed length, with no means of adjustment *(e.g. McCormick)*, the Trip Clutch Stop Arm – Drive Pawl clearance is actually corrected by adjusting the Knotter Shaft Non-return Lock.

The method of adjustment likely to be found on popular binders are:

- **Fixed-length Stop Arm & adjustable Knotter Shaft Lock**
    - early-Albion, McCormick *(Fig.4.22 (right))*, early-John Deere
- **Adjustable Stop Arm & fixed *(position)* Knotter Shaft Lock**
    - later-Albion, Deering *(Fig.4.22 (left))*, later-John Deere.

Diagnosing (Knotter) Trip Clutch Problems *(see Table 2)*

- If a binder's tying mechanism fails to trip properly or mis-behaves, one of the first symptoms the Binder Operator might notice is the strange behaviour of the Discharge Arms.
- The Discharge Arms & Knotter Unit are mounted on the same *(Knotter)* shaft so, when the Discharge Arms don't operate properly, they are kindly 'advertising' a problem with the drive to the Knotter Shaft – which is controlled by the Knotter Trip Clutch.
- **So when troubleshooting, keep an eye on the behaviour of the Discharge Arms: they are your Diagnostic Aid!**

Table 2 Knotter Trip Clutch problems and likely remedies

Problem / Symptom	Possible Cause(s)	Likely Remedy
Discharge Arms Fail to Start, or Revolve Part-way & Stop	• Weak, broken or missing Drive Pawl Pivot Spring **N.B.** Ensure that the Tying Mechanism isn't being overloaded	• Weak spring can perhaps be stretched to effect a temporary repair • Replace broken or missing spring **Beware –** Apparently right & left-handed springs were produced for certain right & left-hand cut binders. Make sure the replacement spring matches the original
Discharge Arms Revolve with a Jerky Motion - Drive slips whenever the load increases	• Drive Flange and/or Drive Pawl driving faces are badly worn • Drive Pawl Pivot Pin or Drive Hub central bush is worn, permitting component misalignment • Weak Drive Pawl Spring	• Rebuild or replace component(s) • Rebuild or replace component(s) • Replace spring
Discharge Arms Revolve Continuously – Trip Clutch Fails to Disengage	• Stop Arm and Drive Pawl are badly out of time	• Carefully re-time the driveline components between the Packer & Knotter Shafts • See text and/or Binder Operator's Manual for further details
Trip Clutch 'Taps' or 'Clicks' during Normal Machine Operation - Will cause component wear over time	• Drive Pawl not being sufficiently disengaged / held back by the Stop Arm Stop Arm – Drive Pawl clearance *(when Drive Pawl is pulled back manually)* is excessive	**Depending on Binder model:** • Lengthen Stop Arm slightly *(if adjustable)*, **or** • Reduce the clearance on the Knotter Shaft *(non-return)* Lock *(if adjustable)*, **or** • Build-up the striking face of the Stop Arm **ENSURE the required *(minimum)* ⅛" (~3 mm) clearance is maintained** ***(see text)***
Trip Clutch Drive Flange Pounds the Drive Pawl ***(and Discharge Arms vibrate)***	• Stop Arm adjustment incorrect • Knotter Shaft (non-return) Lock adjustment incorrect • Knotter Shaft driveline incorrectly timed • Knotter Shaft (non-return) Lock loose or broken	• Re-adjust *(if possible)* • Re-adjust *(if possible)* • Reset driveline timing *(see text or Operator's Manual)* • Repair or replace
Occasional Small Sheaf Produced	• Trip clutch engages prematurely on occasion Caused by Stop Arm & Drive Pawl striking faces becoming worn and/or bevelled, allowing one to occasionally slip past the other Worn Stop Arm or Drive Pawl pivot points can create the same effect	• Rebuild components to original profile or replace • Re-bush any worn pivot points

Stop Arm – Drive Pawl Clearance

When the Knotter and Discharge Arms are in their 'at-rest' position *(following a tying cycle)* and the Knotter Shaft is 'locked' *(prevented from turning backwards)* by the Non-Return Lock, there should be a small clearance between the Trip Clutch Stop Arm and Drive Pawl *(Fig.4.23).*

This clearance setting is important. It enables the Trip Clutch to function properly:

- **Too Large** and the clutch will partially engage when it should be disengaged
- **Too Small** and the clutch won't engage or disengage properly

The precise clearance setting differs between binder brands: from $^{1}/_{16}$" (~1.5 mm) for a McCormick up to $^{3}/_{16}$" (~5 mm) for certain others. However, $^{1}/_{8}$" (~3 mm) is a pretty good target for most.

As previously mentioned, for convenience, many binders incorporate an adjuster within the Stop Arm *(Fig.4.24)*, but on others which don't, the clearance is actually adjusted by an adjuster on the Knotter Shaft Lock *(Fig.4.23).*

However, one important piece of information the Operator's Manuals don't seem to provide. **When everything is 'at-rest', no Stop Arm – Drive Pawl clearance will be visible.**

Why? The Drive Pawl is spring-loaded, so that it pivots forwards when the Stop Arm is raised *(thereby engaging the Clutch).* When the Stop Arm is lowered, the Drive Pawl's spring will always keep the Pawl's leading edge in contact with the Stop Arm, so no clearance will be evident.

In order to measure and/or adjust the clearance, it's first necessary to pull & hold the Drive Pawl right back against its Spring *(Fig.4.24)*.

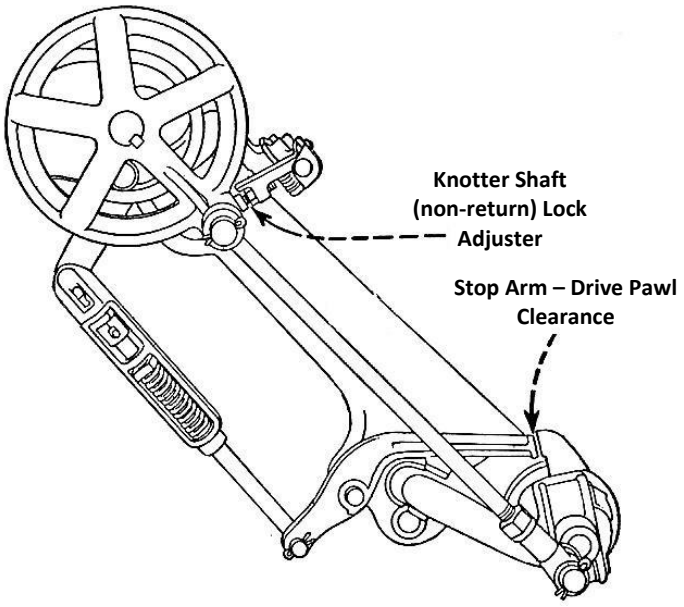


Fig.4.23 McCormick binder Trip Clutch clearance adjustment *(fixed-length Stop Arm)*

(courtesy IHC)

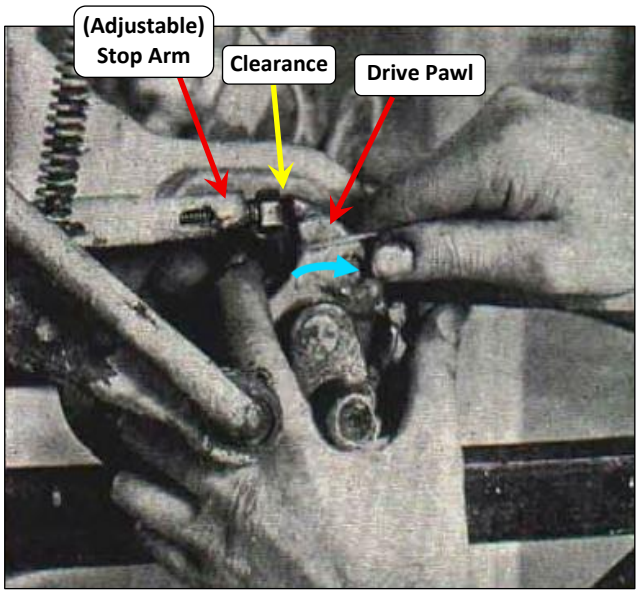


Fig.4.24 Deering binder Trip Clutch clearance adjustment *(adjustable-length Stop Arm)*

N.B. Drive Pawl **MUST** be pulled back manually, off the Stop Arm, before measuring the clearance

(after Reed)

The gap which then opens up between the Drive Pawl and Stop Arm is the elusive 'clearance'.

Re-Timing the Trip Clutch & Knotter Shaft Driveline

To understand what *(if anything)* needs to be done, it's easier to consider things a little 'back-to-front':

- The Knotter Shaft is driven from the Packer Shaft via a mechanical *(chain & sprocket or bevel gear & shaft)* driveline. The driveline is engaged / disengaged by the Knotter Trip Clutch
- Because they are linked by the driveline, the rotational position of the Knotter Shaft indirectly controls the position of the Trip Clutch's Drive Hub *(and the integral Drive Pawl)*
- Towards the very end of each tying cycle, the Trip Clutch Drive Pawl should contact the Stop Arm & disengage the Clutch at the correct moment, so the Knotter Shaft *(non-return)* Lock can engage and hold the Knotter Shaft *(and Discharge Arms)* in the 'at-rest' position.

N.B. The Knotter Shaft Lock actually helps to hold the Trip Clutch in its 'disengaged' position. At this point there should be a slight clearance between the Stop Arm & Drive Pawl *(Fig.4.24)*.

- Component wear or incorrect re-assembly of the Driveline can cause the Stop Arm and Drive Pawl to become mis-timed, causing the following symptoms:
    - **Trip Clutch Disengages Too Early:** The Knotter Shaft Lock will fail to engage. The Drive Flange will 'pound' the Drive Pawl & the Discharge Arms will vibrate **below** their 'at-rest' position.
    - **Trip Clutch Disengages too Late:** The Knotter Shaft will rotate slightly past the Non-Return Lock. The shaft & Discharge Arms will then fall back slightly *(to engage the Lock)*, causing the Drive Pawl to protrude & be 'pounded' by the Drive Flange. The Discharge Arms will vibrate **above** their 'at-rest' position.
- The severity of the mis-timing will be obvious by the symptoms displayed:
    - **Slightly Mis-Timed:** The Drive Flange will 'pound' the Drive Pawl & the Discharge Arms will shake / vibrate
    - **Badly Mis-Timed:** The Trip Clutch will fail to disengage & the Discharge arms will revolve continuously.

Some binders provide means to adjust driveline timing, to compensate for component wear *(Fig.4.26)*. Others don't, instead maintaining a fixed *(marked)* relationship between the driveline components which link the Knotter & Packer Shafts, and expecting any worn components to be repaired / replaced.

If the Knotter Shaft driveline becomes badly mis-timed, due to incorrect re-assembly or general wear, it is possible *(with care)* to re-time it *(see 'Timing Different Drivelines' and 'Basic Procedure' boxes).*

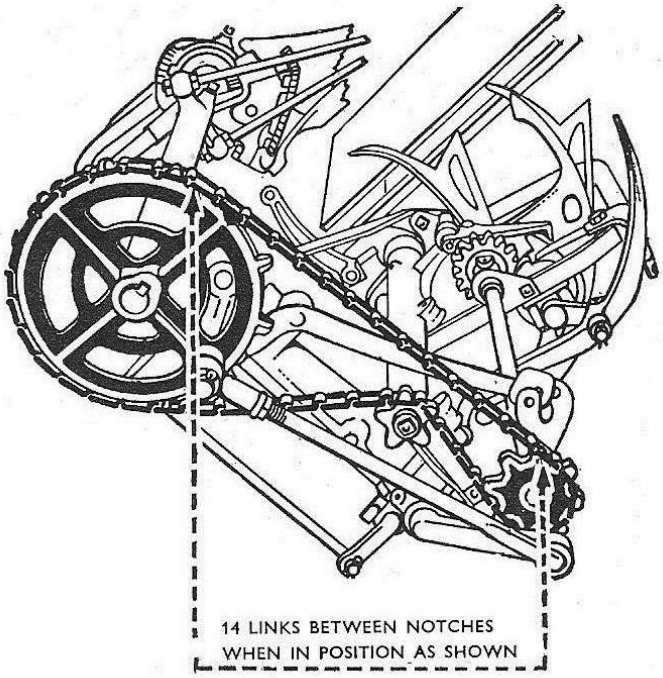


Fig.4.25 Correctly timed *(chain & sprocket)* Knotter Shaft drive arrangement as used on Massey-Harris, Sunshine and Frost & Wood *(Cockshutt)* binders

(courtesy Massey-Harris)

Timing Different Drivelines

When the Knotter & Discharge Arms are 'at-rest' following a tying cycle *(i.e. Knotter Shaft Lock is engaged)***:**

- **Machines with a chain & sprocket-driven Knotter Shaft** *(e.g. Massey-Harris / Sunshine & Cockshutt)*:
  - There should be 14 drive chain links between the timing marks on the driving & the driven sprockets when the marks are in the position shown *(Fig.4.25)*
  - Mis-timing is corrected by renewing the chain and/or sprocket repair / replacement
  - **ENSURE** the drive chain is correctly tensioned
- **Machines with a *(Non-Adjustable)* Gear & Shaft-driven Knotter Shaft** *(e.g. Albion)*:
  - The timing marks found on each pair of drive gears should coincide with each other. There is only one 'correct' position for each gearset
  - *(Slight)* mis-timing is corrected by drive gear repair or replacement
- **Machines with an *(Adjustable)* Gear & Shaft-driven Knotter Shaft** *(e.g. McCormick (see Fig.4.26))*:
  - Usually only found on machines with a fixed-length Trip Clutch Stop Arm
  - The intermediate driveshaft can be rotated & the gearsets re-meshed in alternative positions *(see text)*
  - Permits correction of mis-timing & also excessive Stop Arm – Drive Pawl clearance.

Re-Timing a Gear & Shaft-type Knotter Shaft Driveline – Basic Procedure

- **Move** the Knotter Shaft & Discharge Arms to the 'at-rest' position ***(Knotter Shaft Lock engaged)***
- **Remove** the Trip Clutch Drive Flange
- **Release** & slide the Trip Clutch Drive Hub Gear out of mesh with the bevel gear it drives *(at the lower end of the Intermediate Driveshaft – see Fig.4.26)*
- **Holding the Drive Pawl fully back against its Spring** *(see Fig.4.24)*
  - **Rotate** the Drive Hub & Pawl on the Packer Shaft until the Pawl's leading edge touches the Stop Arm
  - **Push** the Drive Hub Gear back into mesh with the gear on the Intermediate Driveshaft
- **Replace** the Trip Clutch Drive Flange
- **Check** the Stop Arm – Drive Pawl Clearance & adjust if necessary.

WHENEVER driveline components are removed / replaced, **ALWAYS re-time the driveline working from the Knotter Shaft back down to the Trip Clutch / Packer Shaft**

Re-Timing / Adjusting a McCormick Knotter Shaft Driveline *(see Fig.4.26)*

The design of a McCormick binder's Knotter Shaft driveline and its (re)timing / adjustment procedure is rather novel. Drive is transmitted conventionally from the Packer to the Knotter Shaft, through two pairs of bevel gears & an intermediate driveshaft. **However:**

- None of the drive gears have any timing *(reference)* marks
- The drive gear on the lower *(Trip Clutch)* end of the Intermediate Shaft has a slightly different number of teeth to the gear at the top *(Knotter Shaft)* end. Consequently, if the Intermediate Shaft is pulled out of mesh with the Knotter & Packer Shafts and rotated slightly *(by one or two teeth)*, the *(driveline)* timing between the two shafts may be adjusted.

So the Timing adjustment procedure is very similar to the 'Basic' procedure outlined above, but with a few subtle differences:

- Firstly, mark the relative positions of each meshing gearset *(for reference)*
- Clamp the Knotter Shaft by some means, so it can't move
- Remove the Drive Key from the Knotter Shaft Drive Gear and slide the Gear out, just far enough so it's not in mesh with the corresponding gear on the Intermediate Shaft
- Remove the Trip Clutch Drive Flange and slide the Drive Hub & Hub Gear out along the Packer Shaft until it is also out of mesh with the Intermediate Shaft
- Rotate the Intermediate Shaft by one or two *(gear)* teeth
- Re-install & fix the Drive Hub & Knotter Shaft Gears & the Drive Flange in position
- Check the Stop Arm – Drive Pawl Clearance *(when pulled back against its spring).*

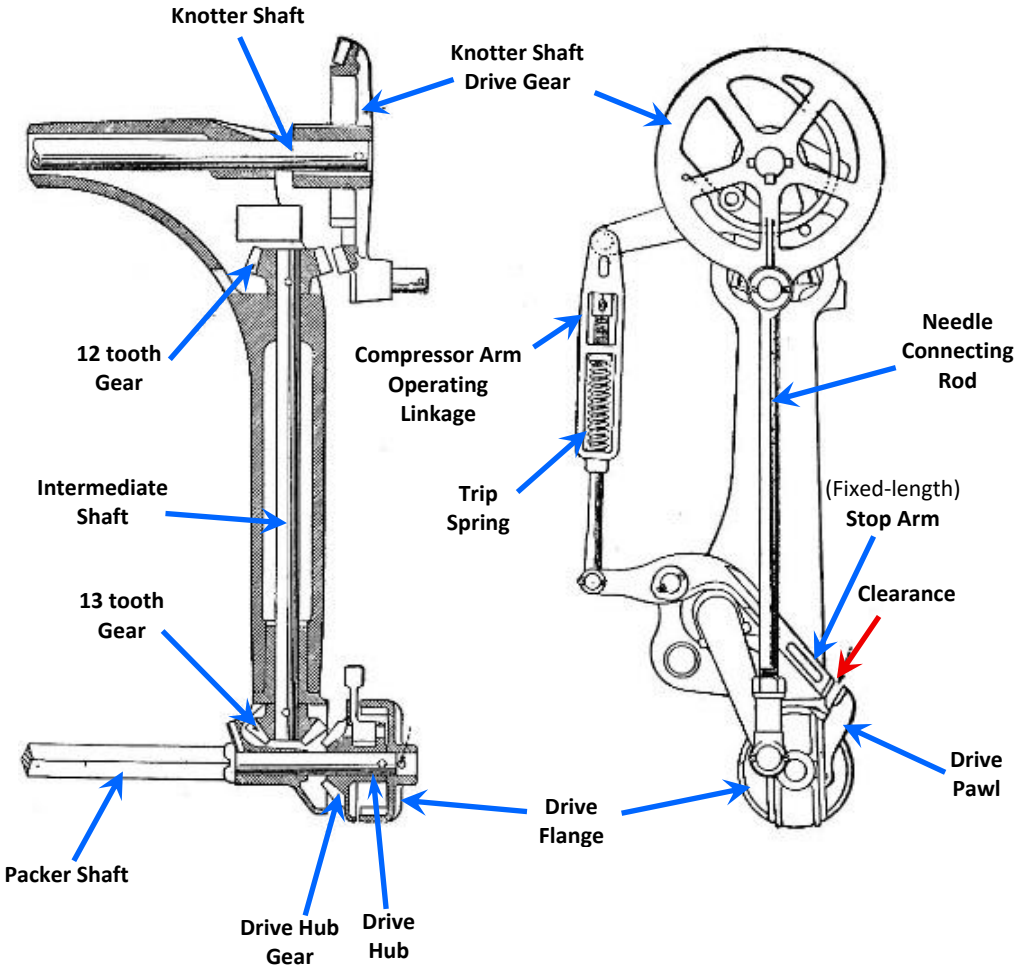


Fig.4.26 McCormick binder - Knotter Shaft driveline components, showing method of timing adjustment

N.B.
- The Trip Spring location on McCormick machines is unique
- The coil spring in the Compressor Arm operating linkage of certain other binders **IS NOT the Trip Spring**

(courtesy IHC)

5 Preparing a Binder for Work

5.1 Fitting the Canvases

A binder's canvases should be fitted in this order:

1) Lower Elevator
2) Upper Elevator
3) Platform

The following images show the process of fitting the canvases to an Albion 5A binder. It's easier if the machine is in the 'Working' rather than the 'Transport' position *(see Section 5.2)*. Before starting, always fully raise the Reel and move it fully forward, to provide space in which to work.

Lower Elevator Canvas



① Lower Elevator canvas is laid out on the Platform, Slats uppermost & Buckle end nearest the Elevator



② End of the canvas is fed over the Lower Elevator bottom *(idler)* roller



③ End of the canvas is fed up the guides towards the *(Lower)* Elevator top *(drive)* roller



④ Buckle end of the canvas is fed over the *(Lower)* Elevator top *(drive)* roller



⑤ End of the canvas is fed back down towards the bottom *(idler)* roller, over the Reel drive shaft

*(**N.B.** Guards removed for clarity)*



⑥ Buckle end of the canvas is fed under the *(Lower Elevator)* bottom *(idler)* roller



⑦ *(Lower Elevator)* Bottom roller pivots upwards to allow canvas securing straps to be fitted



⑧ Centre buckle & strap *(1 of 5)* is secured first



⑨ The other straps are then secured, working from the middle to the outside edges of the canvas



⑩ All buckles & straps are secured. Make sure the same hole is used on each strap



⑪ Front end of *(Lower Elevator)* bottom roller is pushed downwards. It pivots over-centre & tensions the canvas



⑫ Rear end of *(Lower Elevator)* bottom roller is pushed down, over-centre to tension the canvas. The roller is flipped up at the end of each day, to slacken the canvas



⑬ Lower Elevator canvas has been fitted & tensioned: now the end-flap should be secured. This should be tied with Binder Twine – **NEVER use plastic cable ties.**



Fig.5.1 The Upper Elevator bottom *(idler)* roller pivots upwards *(left)* to release tension on the canvas - It pivots down to tension the canvas & is locked in position by a spring-loaded catch *(right)* *(Albion)*

Upper Elevator Canvas

The procedure is very similar to that used for the Lower Elevator Canvas, but there are a few subtle differences. Here's the method used on an Albion 5A binder.



① Upper Elevator canvas is laid out on the Platform, Slats downwards, with the Buckle end nearest the Elevator



② End of the canvas is fed up towards the Upper Elevator top *(drive)* roller





③ **&** ④ Buckle end of the canvas is fed up & over the *(Upper)* Elevator top *(drive)* roller



⑤ Buckle end of the canvas is pulled back down towards the bottom *(idler)* roller



⑥ Buckles & straps are now ready to be secured



⑦ Centre buckles & straps are secured first, followed by those at the canvas edges



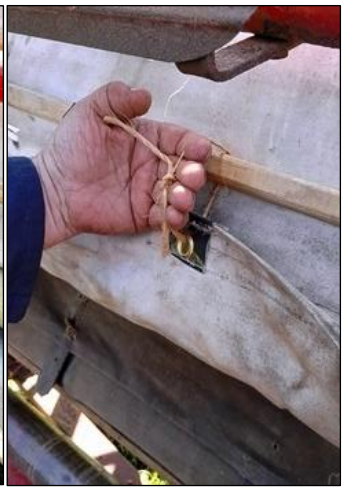
⑧ Bottom (idler) roller is pushed downwards & is latched, to tension the canvas





⑨ **&** ⑩ The canvas' end-flap is now tied up with Binder Twine.
Thread the twine under the Slat immediately behind the Buckles using an old hacksaw blade or other thin strip of steel with a hole in the end





⑪ **&** ⑫ Pass the twine through the end-flap's eyelet & tie up in a loop *(middle eyelet first, then the others)*.
Don't tie the loop too tight – Leave space to fit four fingers inside it.
DON'T use plastic cable ties!



Fig.5.2 Platform outer *(idler)* roller *(left (arrowed))* tensions the platform canvas – On Albion binders, canvas tension is adjusted by a lever & locking pin arrangement *(right (arrowed))*. Most other machines use screw adjusters

Platform Canvas



① Platform canvas is placed, part-concertina fashion on the Platform, Slats uppermost & Buckle end nearest the base of the Elevator



② Buckle end of the canvas is fed over & around the Platform drive roller and back along Platform floor, below the wooden runners



③ Buckle end of the canvas is pulled towards the end of the Platform, while the 'Strap' end is unrolled along the top of the wooden runners



④ Buckle end of the canvas has reached the idler roller end of the Platform. The 'Strap' end of the canvas continues to be unrolled



⑤ Buckle end of the canvas is passed under & back up & over the Platform idler roller. The 'Strap' end is now fully unrolled



⑥ The buckles & straps are now secured **BUT** the outer straps are secured first, followed by those in the middle of the Canvas



⑦ When all the buckles & straps are secured *(in their correct holes)*, the Platform Canvas is tensioned *(see Fig.5.2)*. The End-Flap is then secured with binder twine, by the same method as used for the other canvases.

Fitting Binder Canvases – Hints & Tips

- **Get Some Help:** One or more extra pair of hands is likely to be very useful
- **ENSURE** the buckles, straps & end-flap eyelets are in good condition **before** you start
- **ALWAYS** fit the canvases with the buckles 'leading' in the direction of travel
- **DON'T** use Plastic Cable Ties to secure the End-Flaps of the canvases:
  - Cable Ties aren't sufficiently flexible and will wear the canvases
  - **Use Binder Twine BUT** leave some slack in the loops
- **DON'T** overtighten the canvases – Use just enough tension to prevent them slipping on the drive rollers
- **REMEMBER** to slacken the canvases when the binder is left overnight and/or if it gets damp:
  - Canvases will shrink & tighten as they get damp and distort the drive & idler rollers.

5.2 Transport to Working Position

Due to the offset arrangement of its Cutter Bar and Platform *(see Figs 3.1 & 3.2)*, a binder is too wide to be towed along a road *(or through many field gateways)* in its 'working' position.

To overcome this limitation, binders are supplied with removable 'transport' wheels which attach to the machine's main frame. (Usually) a dedicated 'transport' drawbar is fitted under the Platform, while the main 'working' drawbar is folded-up & locked in an almost vertical position.

The machine is then towed 'endways', some of the Reel 'sails' & spokes/arms having been removed to reduce its overall width *(Fig.5.3)*.



Fig.5.3 Albion binder in 'transport' position

The following images show how an Albion binder is converted from 'transport' to 'working' position.



① The binder is uncoupled from the towing tractor & the transport drawbar placed on a suitable (wooden) block



② The 'Grain Wheel' end of Platform is lifted up, to allow removal of the transport drawbar. The Grain Wheel is then lowered to support end of Platform



③ The Bull Wheel is fully lowered *(& chocked)* to raise the Transport Wheels clear of the ground



④ A (wooden) block is placed under the front corner of the main frame, to prevent the binder pitching forward once the right-hand Transport Wheel is removed



⑤ The binder is tilted back, by pulling back/down on the Seat, to allow the front *(right-hand)* Transport Wheel to be removed



⑥ The main *(work)* Drawbar is now folded down, its *(adjusting)* stays are attached & it's supported on a block



⑦ The rear *(left-hand)* Transport Wheel is then removed



⑧ The binder is re-attached to the tractor *(for stability)* & the Bull Wheel raised to lower the machine close to the ground



⑨ Reel 'sails' which were previously removed for transport, are re-fitted



⑩ Height of the drawbar-mounted p.t.o. shaft support bearing should be adjusted to give a 'straight-line' drive from the tractor to the binder ***(N.B.** Shaft guards removed for clarity)*



⑪ **&** ⑫ The Inner Divider *(left)* and Outer Divider *(right)* are each lowered from transport into working position

5.3 Fitting the Knife *(see also Section 4.2)*

This is not a particularly complicated operation, but here are a few tips that might be useful:





① The Knife is inserted into the Cutter Bar *(into the gaps in the Fingers)* from the Elevator end of the Platform.

The Knife should require a degree of effort to push it home

② The Connecting Rod is already attached to the Knife end *(Head)* & is used to help push the Knife into position



③ To prevent the end Knife Section from hitting the Knife Clips, push it down with a hammer handle or other suitable piece of wood as the Knife is inserted.

NEVER ever use your fingers!



④ When the Knife is in place, the outer 'drive' end of the *(wooden)* Connecting Rod is fitted over the Crank Pin on the Knife Drive Flywheel



⑤ The Connecting Rod is retained on the Crank Pin by a pivoting, steel clip *(shown at end of pointing finger)*

5.4 Twine Threading and Tension Adjustment *(see also Section 4.5)*

The use of good quality twine, pre-tensioned to the right level, are probably two of the most important *(and least considered)* requirements for trouble-free binder operation. If care & attention is taken to ensure these two things are correct, the odds of reliable binder operation really improve. However, if they are not as they should be, all manner of sheaf tying difficulties are likely to be experienced: **and it won't be the fault of the Knotter Unit!**

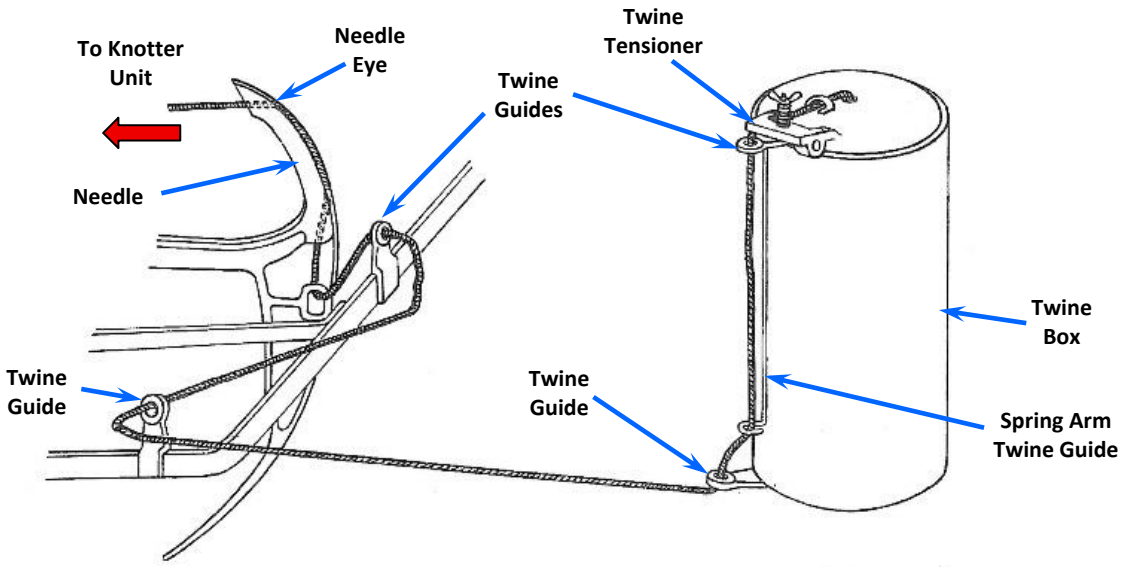


Fig.5.3 Twine path on later-model Albion binders

(courtesy Harrison, McGregor & Co. Ltd)

Correct Twine Path

Assuming that decent quality twine is being used and any worn Twine Guides or Twine Tensioner components have been repaired *(see Section 4.5)*, the first task is to make sure that the twine is threaded through the machine, from the Twine Box to the Needle, in the correct way.

Different makes & models of binder may use slightly different routes but, in general, they are all very similar to that shown in Fig.5.3, namely:

- From the Twine Box, through the *(adjustable)* Twine Tensioner
- Through any Spring Arm Twine Guide or other device intended to prevent twine 'looping' during / after Needle movement
- Through a series of frame-mounted Twine Guides to the body of the Needle, & then up to the Needle's eye and finally to the Knotter Unit.

On most machines the Twine Tensioner is quite remote from the point where it's trying to control the twine tension, namely the Needle 'eye' and the Knotter Unit. This is why it's so important to make sure that any Twine Guides or other items along the twine's path make the least possible *(additional)* contribution to the twine tension **and**, any effect they do have stays the same during machine operation.

Many binders have quite a large, unsupported run of twine between the last guide near the Twine Box and the next guide near the Needle. On some machines *(e.g. Deering)* the twine runs through a tube in this location, to support the twine run and prevent unwanted 'looping' & tangling during Needle operation.

On machines where this feature is absent, some binder operators have made a simple & effective modification *(Fig.5.4)*: a piece of plastic trunking downpipe serving as an effective twine support tube.



Fig.5.4 D.I.Y. plastic twine support tube *(arrowed)* installed between the Twine Box & Needle on a McCormick binder

Threading the Knotter with Twine *(see Fig.5.5)*

Before work can begin, the twine must be threaded up into the binder's Knotter Unit: it's not enough simply to thread it through the Needle eye.

This can be done quite quickly & easily, **BUT** it is important to take care when doing so, because you will be very close to sharp, unforgiving, moving machine components.



SAFETY WARNING

Threading the Knotter – Steps

- **ENSURE** the tractor's parking brake is applied, the p.t.o. is disengaged, the engine is stopped **and** *(ideally)* the ignition key is removed
- **Pull** the twine end through the Needle eye & down the binder's Deck and hold it firmly just below the edge of the Deck *(Fig.5.5 (left))*
- **Trip** the Knotter Trip Clutch *(lift the Stop Arm up off the Drive Pawl)*
- **Turn** the Knotter Shaft through one complete revolution **by hand**, by lifting & turning one of the Discharge Arms *(Fig.5.5)*:
  - This causes the Needle to deliver the twine into the Knotter Unit and the knotter's Twine Disc / Retainer to rotate & grasp it
- **Pull** the resulting knot or short length of twine out of the Knotter Unit
- **You're now ready to go**

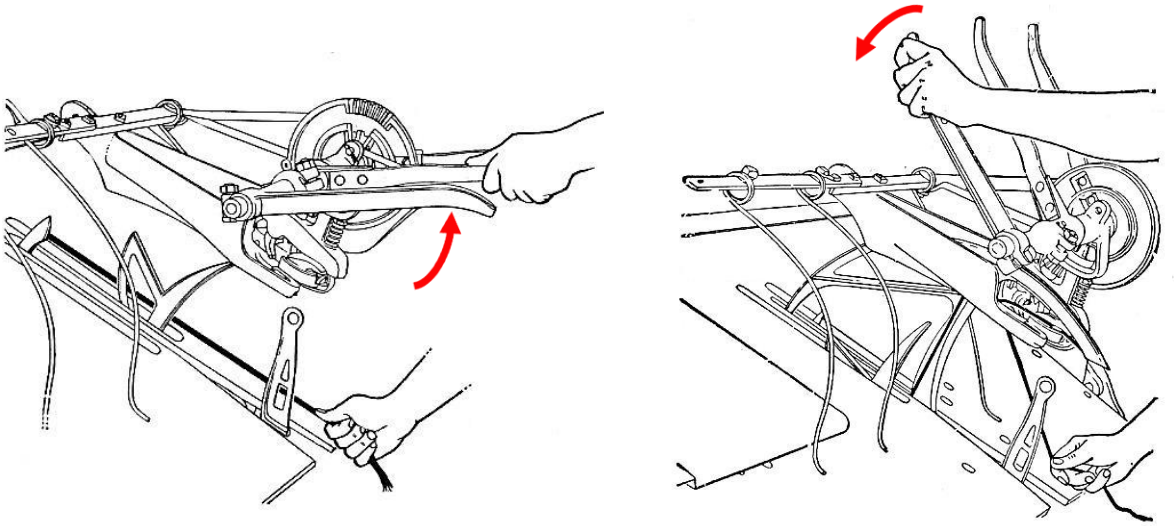


Fig.5.5 Threading the Knotter of a (McCormick) binder - Starting the process *(left)* and with the Knotter Shaft rotated halfway *(with the Needle at full travel - (right)) – (see Text Box for description)*

(courtesy IHC)

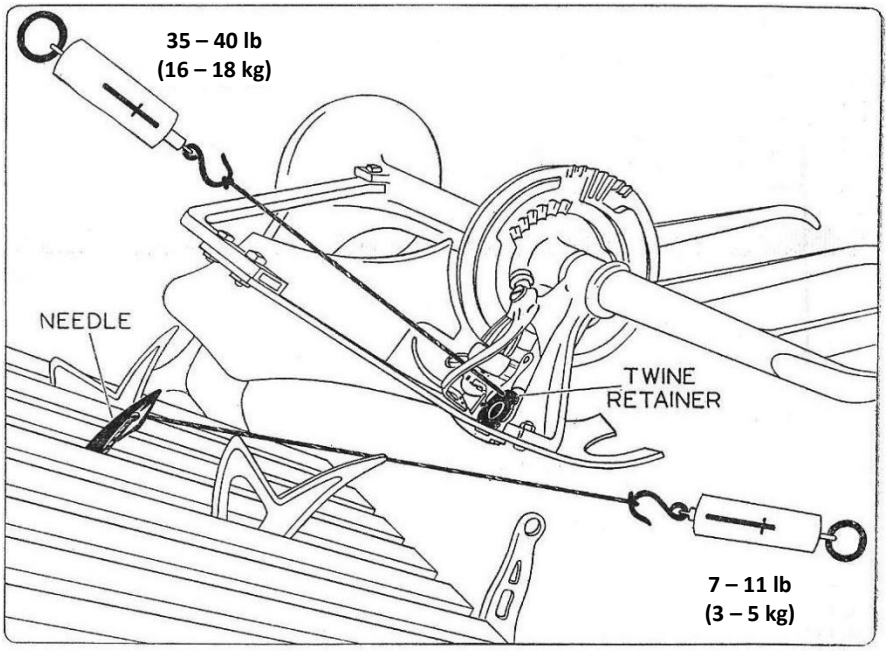


Fig.5.6 Recommended twine *(pre-)* tension when measured at the Needle's 'eye' *(bottom)*

N.B. Top-mentioned value(s) concern the Twine Retainer's clamping pressure setting – See the Knotter technical guide for further information

Twine Tension Setting

The binder's Twine Tensioner should be adjusted so that a force of 7 – 11 lb (3 – 5 kg) is required to pull the twine through the *(partly raised)* Needle's eye, down along the binder's Deck *(Fig.5.6).*

This setting is important – Consider investing in a small spring balance to get it right. Twine Tension can be adversely affected by accumulations of crop debris, variable-quality twine and, **importantly,** by wear grooves in the Twine Guides, the Needle eye or the Twine Tensioner. Always inspect the twine path, and seek out & address any signs of possible trouble.

See Section 4.2.1 of the Knotter Technical Guide for more information regarding the Twine Retainer's clamping pressure setting.

5.5 Machine Lubrication

Generally, the type & frequency of lubrication a moving component requires depends on the:

- Loading it carries
- Speed with which it moves
- Type of supporting bearing used
- Environment in which the component operates.

That may sound like it's straight out a textbook, but there's good reason for highlighting these points.

Early binders mainly used open gear & chain drives, with shafts running on oil-lubricated plain bearings. Over 100 'oil holes' required daily lubrication and faster-moving components needed attention up to 3 times / day.

Binders produced from the ~1930s onwards, particularly those intended for tractor operation, made greater use of ball & roller bearings, with gear drives in enclosed grease or oil-filled casings. The majority of bearings were pressure-lubricated through conventional grease nipples, although some oil-holes remained.

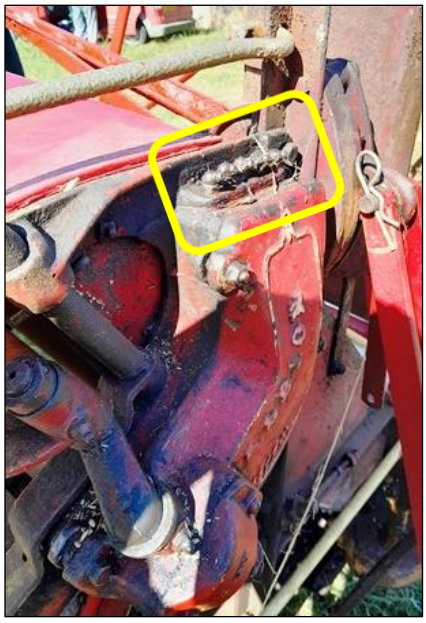


Fig.5.7 Grouped grease nipples *(highlighted)* on a 1947-model Albion binder

The specific requirements of individual machines differ, but as a general rule:

- Unless it requires particular attention, lubricate everything on the machine at least once a day:
  - Give each grease nipple one or two of squirts of grease *(after first cleaning the nipple)*
  - Check the oil or semi-fluid grease levels in any enclosed gear cases *(if not lubricated externally)*
- Faster moving and/or harder working components should be lubricated 3 times / day; examples being:
  - Knife drive shaft, crank pin & connecting rod
  - Packers & associated crankshaft
  - Buttor
- The lubrication of older-type machines, which use oil holes & plain bearings, should be more frequent – probably 2 times / day rather than daily
- Chain drives should generally be lubricated *(see Section 4.1.5)*, but not too frequently and **NOT** if operating in dust arising from abrasive soils. Some drive chains on higher-specification binders were fitted with automatic oilers: small oil reservoirs which could be adjusted to periodically drip oil onto the chain(s). However, depending on the operating conditions, too much lubrication can be counter-productive
- **DON'T** be tempted to lubricate the Cutter Bar / Knife, other than during initial installation. Most of the lubricant will be wiped-off by the passing crop & that which isn't will form a grinding paste with soil, causing far greater wear than if the components were run 'dry'.

6 In-Field Operation

6.1 Machine Safety

From a safety viewpoint tractor-driven *(and particularly p.t.o.-driven)* binders potentially fall into the 'less-than-ideal' category because:

- They are probably not be guarded to modern standards
- Unlike most modern field machinery, there is a second *(remote)* operator on the binder, who probably is unable to disengage the drive to the machine in an emergency *(see Section 8.2.5)*.



Fig.6.1 P.t.o.-driven binder at work

Consequently, extra care is required, both on the part of the tractor driver and also the binder operator. Particular things to be careful of include:



- **ALWAYS** ensure that the Binder Operator is in a safe position **and** ready for work to commence **BEFORE** engaging drive to the machine **and/or** starting work
- **ENSURE** that the Tractor Driver and Binder Operator can easily communicate with each other when the binder is operating
- **The Tractor Driver must be particularly vigilant at all times:**
  - Look out for potential in-field hazards
  - Drive carefully over rough ground / ruts / tramlines
- **ALWAYS** disengage the drive to a machine **and** ensure its components are in a safe, stationary position **BEFORE** opening guards and/or attempting to clean, maintain or adjust it. **Follow the SAFE STOP procedure:**
  - **Disengage the tractor p.t.o.**
  - **Apply** the parking brake
  - **Stop the tractor engine**
- **ALWAYS** ensure that all the required safety guards are in good condition **and** in place whenever the binder is under power / in use
- **ALWAYS** replace safety guards following machine adjustment(s).

6.2 In-Field Machine Settings

6.2.1 Cutting Height



Fig.6.3 Stubble cutting height – How low should you go?

This is usually a compromise because:

- It's desirable to cut as low as possible to maximise the length of the harvested straw, **BUT;**
- Cutting low-down seriously increases the risk of stone damage & general wear & tear to the binder's Cutter Bar, **and;**
- It's best to cut above any 'green' *(weed)* material in the base of the crop, **and;**
- In a damp season, leaving a slightly longer stubble will help the Butt ends of the sheaves dry out quicker.

Some things can & should be addressed well before harvest. The crop seedbed should be as level as possible. It should be rolled in the spring, to suppress any stones *(if present)*. Vehicles used for early-season crop spraying & fertiliser application(s) should be fitted with wide tyres, to avoid creating deep, rutted tramlines: but of course you can't prevent this in a wet year.

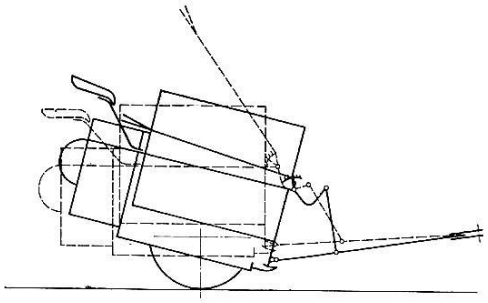


Fig.6.4 Adjusting binder cutting height by tilting the platform / main frame *(courtesy Heyde)*

Selection & Adjustment of Cutting Height

Generally a minimum cutting height of 4 inches (100 mm) is recommended. Otherwise *(depending on soil type)* the risk of stone damage increases dramatically.

All binders have both a 'Coarse' and 'Fine' means of cutting height adjustment:

- **Coarse Adjustment:** The Bull and Grain Wheels are raised or lowered relative to the binder's main frame via individual screw adjusters *(see Section 5.2).* It's important that both wheels are adjusted equally, to keep the cutter bar level, left-to-right
- **Fine Adjustment:** Made by tilting the binder's Platform *(in fact the entire machine)* forwards / backwards relative to the drawbar via a hand lever from the binder's seat *(see Figs 3.11 & 6.4).* Tilting the Platform further forward lowers the cutter bar / reduces cutting height and vice-versa.

It's normal practice to:

- Set the 'Coarse' *(Wheel Height)* adjustment at the beginning of a field and then make any further in-field cutting height adjustments by tilting the Platform
- Cut crop with the Platform tilted slightly down / forwards. Slightly greater forward tilt can also be helpful if the crop is partly laid *(see Section 6.3.4)*

- Move the Platform back to 'level' when reversing or when travelling idle across the field
- Set the binder's drawbar *(vertical)* adjusting stays so that the Platform reaches the desired tilt / cutting height position when the Operator's control level is at the end of its travel. This permits quick & accurate return to the chosen cutting height following any temporary change.

6.2.2 Reel Position

A binder's 'bat'-type reel is a simple design which works well in a good, upright standing crop. However, if the crop has suffered from wind & weather damage and is partly laid, the limitations of a 'bat' reel over a combine's 'pick-up'-type reel soon become very noticeable. **However:**

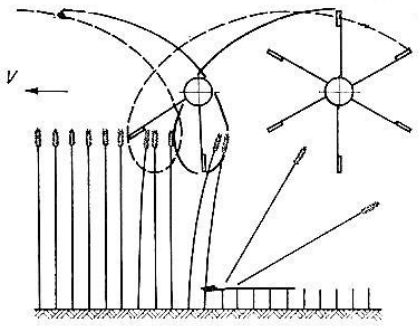


Fig.6.5 Reel height & fore-aft position in a standing crop *(courtesy Heyde)*

- Skilful use of the binder's Reel and correct adjustment of its height & fore-aft position to suit the prevailing conditions, are very important. It can make a big difference to the evenness of crop feed into the machine and the subsequent uniformity of the sheaves
- Adjustment(s) should be made to suit crop height and any direction of lean, **BUT:**
  - **DON'T** attempt to do too much with the Reel, other than to obtain an even feed of crop onto the Platform Canvas
  - **BEWARE** of running the Reel too fast *(relative to the forward speed of the binder)*. It's best practice to thresh-out the crop later-on



Fig.6.6 Reel height setting for a standing crop

- **Reel Height:** In a standing crop, the Reel should ideally reach down into the crop to a point ⅔ - ¾ up the plant *(from ground level) (Figs 6.5 & 6.6)*.

  It will need to be set lower in a part-laid crop, **BUT** don't put it any lower than absolutely necessary. If occasional *(cut)* crop stems get carried over / around by the Reel, it's set too low
- **Reel Fore-Aft Position:** In a standing crop, set the Reel's centre approx. 12 inches (300 mm) in front of the Cutter Bar *(Fig.6.5)*. The Reel should gently sweep the crop rearwards, very slightly bending it over the Platform, just as the stems are cut.

  In a part-laid / leaning crop, different settings will be required depending on whether it is leaning towards or away from the Cutter Bar.

6.2.3 Binder Operating Speed

So, are we talking about binder forward speed or component *(rotational)* speed? The answer depends on whether it's a ground wheel-driven or a p.t.o.-driven machine *(see Section 3.1).* However, before getting into the detail, there's one important point to bear in mind *(see Box)*.

Dealing with Today's Thicker Crops

In many instances, the cereal crops grown for thatching straw today are far thicker / of greater plant density than those which the binders were originally designed to harvest. So, for a given cutting width, the volume and flowrate of crop the binder has to deal with are also greater.

This places bigger demands on the machine's conveying system *(mainly the elevator canvases)*, but especially on the packaging & tying mechanism(s).

What can be done to compensate?

- **P.T.O.-driven binder:** Can be driven at a slower forward speed, **BUT** this may then result in the Reel speed being faster than ideal. Alternatively, only a part-width cut can be taken
- **Ground-driven binder:** Reducing forward speed will also reduce the speed of the binder's mechanisms, so no advantage is gained. Taking a part-width cut is the only option in a really thick crop.

So, with these & other limitations in mind, the general recommendations are as follows:

Ground-driven Binders

- **Adjust** forward speed to suit crop *(density)* and field *(surface roughness)* conditions:
  - Don't forget that the Binder Operator is riding on a steel-wheeled machine!
- **Remember** that Cutter Bar, Reel, Canvas *(conveyor)* & Packer speeds will all be linked to machine forward speed. Fortunately, this ensures that the Reel Speed is always correct for the forward *(travel)* speed
- Binder manufacturers generally recommended not to exceed 2½ - 2¾ mph (~4 – 4.4 km/h) forward speed, but it is important to maintain forward momentum.

P.T.O.-driven Binders

- Again, **adjust** forward speed to suit crop *(density)* and field *(surface roughness)* conditions
- Generally, don't exceed 3 mph (~5 km/h) forward speed, but may have to be slower
- **BEWARE** of high p.t.o. speed causing excessive component speeds. Binders were designed to be operated at ~540 p.t.o. rpm, **BUT** they are getting older:
  - **DON'T** use a dual-speed p.t.o. tractor in '1000 p.t.o. rpm' gear at anything more than engine 'tick-over' speed: you might well exceed 540 rpm. If available, a '540E' p.t.o. setting is fine
- **Beware** that if forward speed is reduced to suit a heavy crop, the Reel speed may become too high & cause crop damage. Consider changing the Reel drive ratio if this is a frequent problem.



Binder Reel setting & operation



Binder in-field operation

Click on the image or scan the adjacent QR codes to view the videos

6.2.4 Sheaf Size, Appearance & Twine Band Tightness

The binder's packaging & tying mechanism *(see Sections 3.4 & 4.5)* incorporates a number of adjustments to ensure that neat, well-formed sheaves are produced, that suit the harvesting conditions and the particular requirements of subsequent handling & storage methods.

Sheaf size & density *(twine band tightness)* should be adjusted to suit the crop, the *(immediate & forecast)* weather conditions and the expected method of crop handling *(i.e. individual sheaves or larger packages)*. The potential adjustments and their various pros & cons are as follows. The method(s) of adjustment are described subsequently.

- **Sheaf Size (diameter):**
  - **Smaller Sheaves:** Dry out quicker. Best in a greener *(less-ripe)* crop or if green material *(weed)* is present, **BUT** produces more sheaves to handle. They are also likely to be easier for a baler to pick up *(if used)*
  - **Larger Sheaves:** Good for clean, dry crops. Fewer sheaves to handle & uses less twine, **BUT** will restrict crop ripening in the centre of the sheaf & delay drying-out if it gets wet.

Overall: Unless it's a hot, dry year & the crop is ripening fast, a greater number of slightly smaller / lighter sheaves is likely to be a better approach.

- **Twine Band Tightness (Sheaf Density):**
  - **Loose Sheaves:** Dry-out quicker, but *(following shrinkage)* may be more difficult to handle. Better in a greener *(less-ripe)* crop or if green material *(weed)* is present
  - **Tighter Sheaves:** Good in a clean, dry crop **OR** if the crop is expected to shrink significantly during drying / ripening. Will be more stable to handle **and** make more stable / robust larger packages.

Remember: If the Twine Band is tighter, more crop will have been packed into the same size of sheaf: so the sheaf will be both denser & heavier **AND** the binder's packaging / tying mechanism will have had to work harder.

- **Sheaf Band Position *(see also Section 3.4 & Fig.3.10)*:**

  The fore-aft position of the binder's Deck & Tying Mechanism should be adjusted *(according to variations in crop height)* to place the twine band as close to the middle of the sheaf as possible *(i.e. halfway up)*. Most growers advise that any variation should be towards the Butt end rather than the Ears. The reasoning being that:

  - **Twine Band in Middle:** Will let the Butt end splay-out slightly, aiding in-field ripening. The sheaf will also be more balanced & handle better
  - **Twine Band Too High:** Will allow excessive Butt end splay, leading to poor stability of both the sheaves & subsequent stacks.

    Perhaps this is not so much of an issue if the sheaves are to be made into larger packages *(e.g. bales or bundles)* prior to storage.



Fig.6.7 Sheaf band position – Correct *(left)* and too low *(right)*

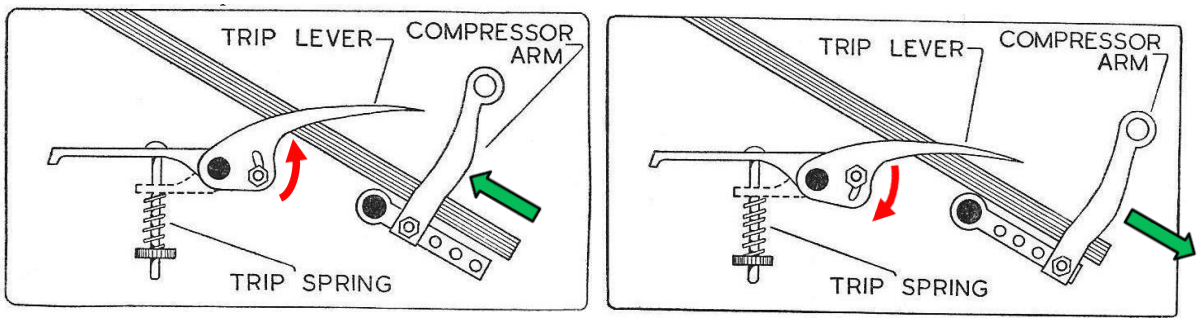
  However, some growers prefer the Twine Band to be placed very slightly above the middle of the sheaf, to improve handling characteristics. It's really a matter of personal preference!

- **Butt End Shape:**

  The Buttor Board *(see Fig.3.8)* may be adjusted to produce sheaves with either a square or an angled Butt end. A slightly angled Butt end is desirable because it can be used to advantage to improve Stook stability *(see Section 6.4).* Also, if particular stooking techniques are used, it can enable less of the Butt end to be in contact with the ground, improving crop drying in difficult conditions *(see Fig.6.16)*.

  NEVER attempt to adjust the Buttor to try & vary Sheaf Band Position, **unless** the crop is very short: in which case it probably won't be suitable for thatching straw.

Sheaf Size & Twine Band Tightness - Adjustment *(see also highlighted Box)*



Smaller Sheaf **Larger Sheaf**

Fig.6.8 Binder settings to adjust Sheaf Size on machines fitted with a separate Trip Lever *(e.g. an Albion, Hornsby or Massey-Harris / Sunshine)*

- Smaller sheaf *(left)* and larger sheaf *(right)*
- Trip Spring may act on the Trip Lever *(above)* or the Trip Clutch Stop Arm *(see Section 4.6)*

Adjusting Sheaf Size & Twine Band Tightness

- Adjustment method depends on whether the binder's tying mechanism is tripped by:
  - A separate Trip Lever protruding through the Deck *(e.g. Albion, Hornsby & Massey-Harris / Sunshine) – (Figs 6.8 & 6.9)*
  - Pressure of the forming sheaf pushing on the Compressor Arm *(e.g. Deering & McCormick) – (Fig.6.10)*
- **ALWAYS adjust Sheaf Size and Band Tightness separately:**
  - **First** adjust to get the desired Sheaf Size
  - **Then** adjust the Band Tightness to the desired level
- **NEVER attempt to vary Band Tightness by adjusting the Twine *(supply)* Tension**. You'll just create mis-tying problems

Sheaf Size Adjustment

- **Binders with a separate Trip Lever:**
  - **For a Smaller Sheaf** *(Fig.6.8 (left))*:
    - Move the Compressor Arm **in, closer** to the Packers / Needle **and,**
    - **Raise** the Trip Lever
  - **For a Larger Sheaf** *(Fig.6.8 (right))*:
    - Move the Compressor Arm **out, away** from the Packers / Needle **and,**
    - **Lower** the Trip Lever
  - **DON'T** adjust the Trip Spring setting **unless** the Band Tightness is incorrect.
- **Binders without a Trip Lever** *(i.e. Compressor Arm trip – Fig.6.10)***:**
  - **For a Smaller Sheaf:**
    - Move the Compressor Arm **in, closer** to the Packers / Needle **and,**
    - Slightly **loosen** the Trip Spring
  - **For a Larger Sheaf:**
    - Move the Compressor Arm **out, away** from the Packers / Needle **and,**
    - Slightly **tighten** the Trip Spring

Twine Band Tightness Adjustment

- Procedure is the same for all binder types:
  - **For a Looser Band *(a less dense Sheaf)*:**
    - Loosen the Trip Spring
  - **For a Tighter Band *(a denser Sheaf)*:**
    - Tighten the Trip Spring

N.B. Depending on machine design, the Trip Spring may act on the Trip Lever *(Massey-Harris)*, the Trip Clutch Stop Arm *(Albion, Deering)* or on the Compressor Arm *(McCormick) (see Section 4.6 and Figs 6.9 & 6.10).*

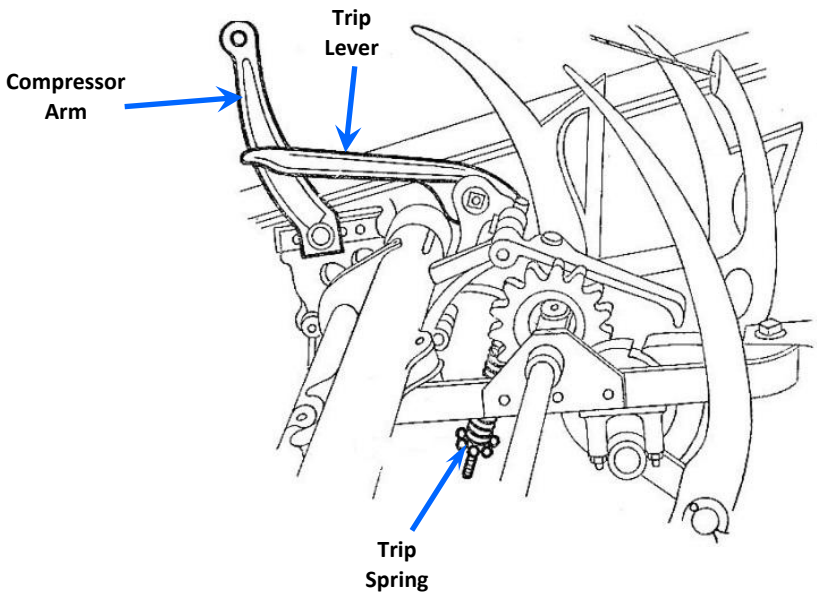


Fig.6.9 Sheaf Size and Band Tightness adjustment on a Massey-Harris binder *(with separate Trip Lever)*

- **Smaller Sheaf:** Move the Compressor Arm in & raise the Trip Lever
- **Larger Sheaf:** Move the Compressor Arm out & lower the Trip Lever
- Trip Spring compression *(tightness)* adjusts the Twine Band Tightness

(courtesy Massey-Harris)

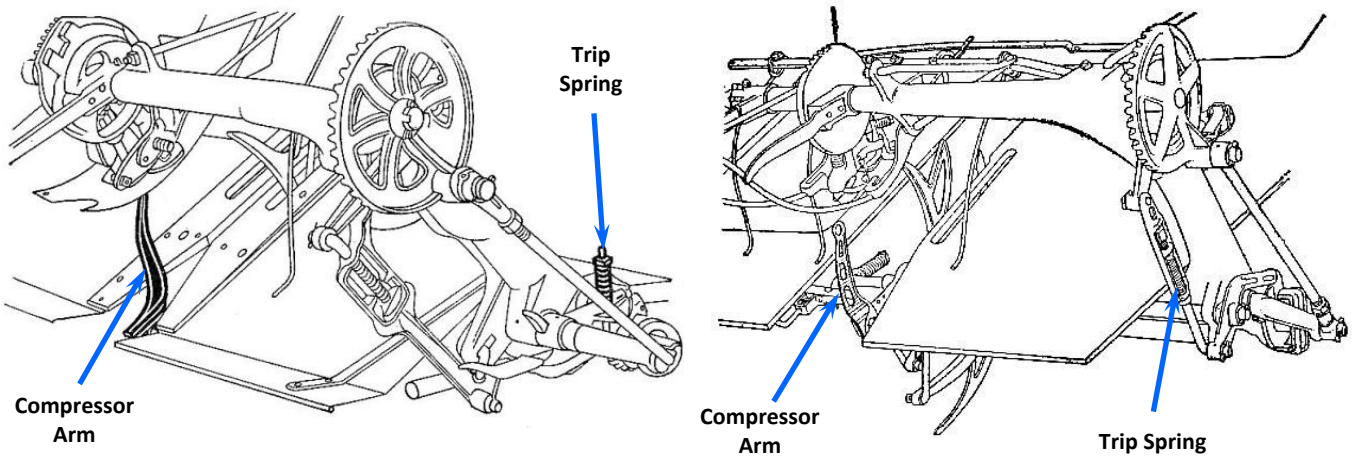


Fig.6.10 Sheaf Size and Band Tightness adjustment on Deering and McCormick binders *(both are Compression Arm trip)*

- **Smaller Sheaf:** Move the Compressor Arm in & slightly loosen the Trip Spring
- **Larger Sheaf:** Move the Compressor Arm out & slightly tighten the Trip Spring
- Trip Spring compression *(tightness)* adjusts the Twine Band Tightness

N.B.

- The Trip Spring location on McCormick machines is unique
- The coil spring in the Compressor Arm operating linkage of Deering **and** certain other binders **IS NOT the Trip Spring**
- A McCormick binder should require a force of 18 – 24 lbs (8 – 11 kg) on the Compressor Arm to trip.

(courtesy IHC)

6.3 Binder Operating Techniques

6.3.1 Starting the Field

Due to the offset arrangement of a binder's Cutter Bar & Platform *(see Figs 3.1 & 3.2)*, unless there's an uncropped or grass margin around the outer edge of the field, the first 'opening-out' pass has to be made with the tractor running over a portion of the crop. Historically, it was normal practice to mow a swath around the outside of the field by hand, for the *(horse-drawn)* binder to follow whilst cutting the first 'opening' round. The field would then be harvested by successive 'round & round' passes.

The same general approach is followed today, but hand-mowing was consigned to the history books long before binders stopped being used for harvesting commercial cereal crops. Instead the first 'opening' round would be cut with the tractor running as close as possible to the field boundary, with the Cutter Bar towards the centre of the field. The outermost 'Back' Swath, over which the tractor & binder had travelled, would then be cut later, at a convenient time, by travelling around the field in the opposite direction.

When best to cut the outside 'Back' swath is a matter of personal preference. The crop there is likely to be thinner, but probably less ripe / greener than the rest of the field. It may also contain binder-damaging debris from the field margins. Also, the Back Swath cannot be cut until at least two or three 'normal' rounds have been completed and the sheaves moved *(or more usually Stooked)* to provide a clear path for the tractor. Lack of available labour to Stook and the desire to press on with cutting, may mean that the Back Swath isn't cut until later-on. It may be wise to delay this until just before exchanging the 1st Knife for a re-sharpened replacement: that way any possible damage will be experienced by the 'used' Knife prior to its resharpening *(assuming you sharpen your knives)*.

Given that virtually all modern fields will feature 'tramline' wheel marks left by the passage of sprayers & fertiliser spreaders, it could be argued that the first 'opening' pass could be made with the tractor & binder travelling along the headland tramline: the outer portion of the headland then being cut as a series of back swaths. However, given the operating widths of modern chemical application equipment, it's conceivable that this headland tramline could be 6, 9, 12 or even 18 metres in from the field boundary. For this reason if no other, perhaps the accepted harvesting approach remains preferable.

6.3.2 Turning Corners *(see Fig.6.11)*

The technique for turning corners with a binder when in-work differs little between ground-driven & p.t.o.-driven machines: the only real distinction is how tightly you can turn, this often being limited by the turning circle of the towing tractor rather than features of the binder.

During the first few passes or 'rounds' around a field, the tractor & binder must be driven around each corner in an arc, which must not be too tight if damage to a p.t.o.-driven binder's driveline is to be avoided. This leads to a certain loss of crop because the binder's Outer Divider *(see Fig.3.4)* presses some of the crop down during each turn & this is then missed by the Cutter Bar.

This can be avoided by adopting the cornering technique shown in Fig.6.11, once a few rounds have been cut.

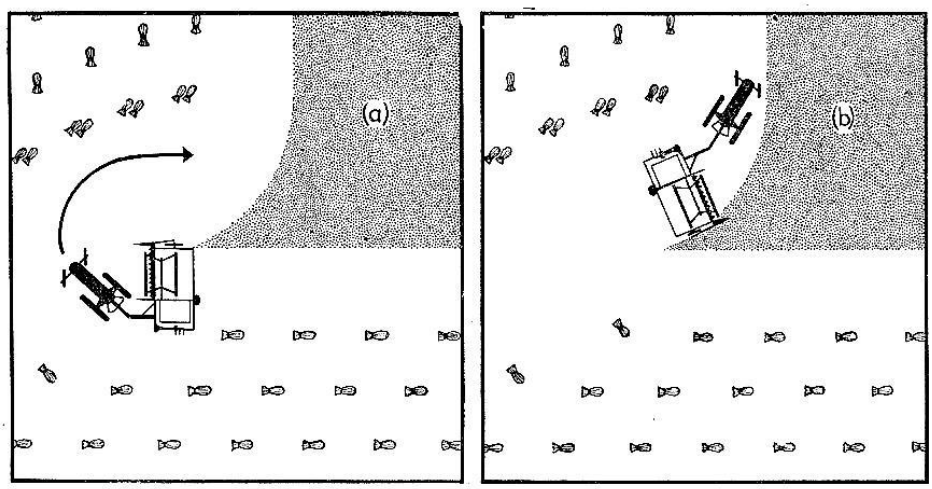


Fig.6.11 Cornering technique with a right-hand cut binder

(courtesy Hawkins)

On each corner the tractor is driven straight until the binder's Cutter Bar exits the crop *(Fig.6.11(a))*. A sharp turn is then made so that the Cutter Bar re-enters the crop after the corner, the turn being made with the binder out of the crop *(Fig.6.11(b))*. This creates a pointed corner *(which is cut on the next round)*, with a curve on the following side.

This may seem rather untidy, but it has proven to be the quickest & most efficient method of cornering and it maximises overall workrate. However, there are a few things to bear in mind:

- It's important to keep the 'turning area' at each corner clear of sheaves, to prevent them being run-over & damaged during subsequent passes of the tractor & binder:
  - A Corner Sheaf Carrier *(see Fig.3.14)* can be used to good effect for this purpose
  - Alternatively, it may be possible to run a p.t.o.-driven binder 'empty' before making the turn, thereby avoiding sheaves being discharged in the turning area. This, together with the time lag between re-entering the crop & the next sheaf being discharged, may create enough clear space for turning. However, today's thicker crops may make this difficult to achieve.

    Perhaps the *(Corner)* Sheaf Carrier has merit after all, whether triggered either by the Binder Operator *(if present)* or remotely by the Tractor Driver?
- Given the absence of a damage-prone p.t.o. driveshaft & Universal Joints, this cornering technique presents no problems for a Ground-driven binder. The same technique can also be used with p.t.o.-driven machines, **BUT it's important not to turn too tightly:**
  - Disengaging the p.t.o. drive when turning is highly advisable if you want to turn tightly. A tractor fitted with a hydraulically engaged 'independent' p.t.o. *(i.p.t.o.)* may be really handy.

    Although many growers use older tractors to tow binders, hydraulically-engaged i.p.t.o. systems have been available for over 60 years, so perhaps it's now time to use something slightly newer *(but not necessarily bigger)* up-front, if only to protect the binder?

    However, remember to **reduce tractor engine speed prior to both disengagement & re-engagement of the p.t.o.** when cornering.
  - Some operators of Ground-driven binders also advise the disengaging of the drive to the machine when turning, by means of the clutch control provided *(see Fig.3.13)*.



Fig.6.12 Keep a sufficient sideways clearance between the tractor's rear wheel and the edge of the crop – This is easier when using a smaller, narrower tractor *(left)* than a larger, wider example *(right)*.

- If necessary, offset the tractor's swinging drawbar towards the uncut crop to compensate

6.3.3 Width of Cut

Modern agricultural machinery seems to follow a trend of ever-increasing working widths, whereas if anything, binders seem to do the opposite. The reason? As previously discussed *(see Section 6.2.3),* today's cereal crops are often far thicker than those which binders of the mid-20th century were designed to harvest. The limiting factor is usually the ability of the binder's conveying, packaging and tying mechanisms to cope with the sheer volume of crop.

In particularly thick crops, the forward speed of p.t.o.-driven binders can be lowered to reduce the amount of crop material being presented to the Tying Mechanism. Alternatively, a narrower *(part)* width of cut can be taken *(with either p.t.o. or ground-driven binders)* to achieve the same effect.

Binders of the 1930s, 40s and 50 were produced with cutting widths of 5, 6, 7 and even 8 feet: however, today a 6 foot (~1.8 m) cut machine is regarded by many growers as more than adequate.

The tractors that tow binders today may well be larger & wider than those used in the 1940s & 50s. If crop conditions permit a full width of cut to be taken, lack of sideways clearance between the tractor's rear wheel & the uncut crop may be a nuisance *(Fig.6.12)*. This can be addressed either by adjusting the tractor's wheels to a narrower track setting or offsetting the tractor's swinging drawbar slightly towards the uncut crop. However, if offsetting the drawbar, be conscious that the p.t.o. shaft's universal joints will be moved through a greater *(less favourable)* angle when the tractor turns in a particular direction.

6.3.4 Rescuing a Part-Laid Crop

A weather-beaten, partly laid crop is everyone's worst fear. Not only will the quality of the straw be affected; the crop will also be considerably more difficult to harvest. If a cereal crop is really badly laid, the straw is unlikely to be of sufficient quality for thatching and so, the crop may well be 'salvaged' by combining.

The capabilities of a binder are rather limited, **BUT** if the crop is only partly laid, there are a number of approaches that may be taken to rescue it for use as thatching straw.

P.T.O. or Ground Wheel-Drive?

A p.t.o.-driven binder will always be more effective than a ground-driven machine in these circumstances. The ability to vary tractor-binder forward speed to suit the prevailing crop conditions, whilst maintaining the operating speed of the binder's components, is of great value.

Direction of Cutting

A binder can usually cut most effectively when the crop is either standing upright or leaning towards the Cutter Bar / Platform. With skilful use of the Reel, it may be possible to pull crop which is leaning slightly away from the Cutter Bar, back towards the Platform, but the scope for this is limited *(see 'Reel Adjustment' below)*. It's also usually possible to cut a crop that leans towards the binder's Outer Divider, but it's much more difficult if the crop leans towards the Inner Divider or *(badly)* away from the Cutter Bar.

In such instances it may only be possible to cut along one or two sides of the field *(where the crop leans in a more favourable direction)*, running idle back to the starting point after each pass. This obviously reduces overall workrate by a significant degree and requires that some sheaves are cleared to form a path for the binder's frequent 'return trips'. However, this approach can at least enable the crop to be harvested.

Reel Adjustment *(see also Section 6.2.2)*

As previously discussed, although the physical position of a binder's Reel may be readily adjusted, its plain, 'bat'-type construction means it is far less able to recover a laid crop than the 'pick-up'-type design which became commonplace on combines from the 1960s onwards. Additionally, most combines from the 1970s onwards enabled Reel speed to be adjusted from the Operator's Seat, to suit the machine's forward speed, further enhancing its effectiveness & adaptability.

Even without these facilities at his/her disposal, the Binder Operator can still do a great deal to help capture a part-laid crop by simply adjusting Reel position. The Reel should always be maintained at the correct height to 'encourage' the crop flow onto the Platform, with least damage; and also in the best fore-aft position for the direction of lean of the crop. However, remember that the Reel can only aid / encourage crop to flow onto the Platform: it can't work miracles.

Grain Lifters *(see Fig.6.13)*

Far from being an invention of the 'combine-era', spring steel Grain Lifters were always available as optional extras for binders when new: however, it seems that market uptake was low.

Still readily available, these clip-on components fit onto the end of the cutter bar's Fingers: usually spaced on every 3rd or 4th Finger. In work they run lightly along the ground surface and any laid crop rises up their leading edge, enabling it to be cut by the Knife, rather than run-over and missed. They also permit the Cutter Bar to be held at a safe height above the ground, to avoid damage when, otherwise, it may be tempting to tilt the Platform further forward in an attempt to retrieve the crop.

Grain Lifters can be very effective: there's little disadvantage *(other than wear)* to them being fitted permanently, even though they serve little purpose in a good, standing crop. However, there's often a part-laid area in any field, whether caused by a fertiliser application overlap or shading from a tree. In any event, the Lifters can be easily removed when they are not required.



Fig.6.13 Grain Lifters on a binder's Cutter Bar – They are normally fitted to every 3rd or 4th Finger

6.4 Stooking

Although not an aspect of machine operation, the process of 'Stooking', 'Stitching' or 'Shocking' is directly linked to the use of binders. Crops harvested by binder are cut when partly ripe and are then left in-field for a period to fully ripen & dry, prior to further packaging and/or transport to store.



Fig.6.14 Stooking sheaves of wheat previously cut with a binder

(courtesy P. Watkin)

To encourage this, groups of sheaves are arranged upright in 'stooks' to improve exposure to the sun & wind and to provide some resistance to adverse weather

During hot & very dry summers, some growers have found stooking to be unnecessary and instead have allowed sheaves to ripen whilst laying on the ground, perhaps turning them over once in the process. However, this practice requires very favourable weather conditions and *(ideally)* slightly smaller sheaves, so it tends to be the exception rather than the rule.

Many growers have their own preferred technique(s) for stooking, often developed to suit the local weather & field conditions, crop varieties or the harvesting and subsequent crop packaging & transportation methods employed. However, it is usual to work around the field **opposite to the direction of binder travel,** so that the discharged sheaves are approached from their Butt ends. This enables the sheaves to be picked up and placed *(Butt ends down)* in stooks without the need to first rotate them, saving valuable time & effort over a working day.

Aspects of binder setup *(e.g. sheaf size, Butt end shape, twine band position & tightness)* and sheaf distribution in the field will also affect the efficiency of the stooking process.

Some of the potential variations in the Stooking process include the:

- **Number of Sheaves per Stook:** Usually 8 or 10 sheaves, arranged in pairs
- **Arrangement of Sheaves in the Stook:** In opposing pairs, working outwards each way along the stook centreline. Each additional pair of sheaves is leant **both** towards each other **and** also slightly towards the middle of the stook, to improve stability *(Fig. 6.15)*

  The ends of the stook are usually left open to encourage through flow of drying air
- **Sheaf Butt End Shape & how this is used in Stooking:** The Buttor can be adjusted to produce sheaves with a slightly angled Butt end. This can be used to advantage, both to improve stook stability and also to reduce the proportion of the Butt end which is in ground contact *(Fig.6.16)*.

  In a wet year when the soil is moist, this will discourage moisture absorption from the ground & help the sheaves dry-out more rapidly
- **Position of the Knot side of the Sheaf in the Stook:** The cross-section of a sheaf is not circular; rather it is a 'squashed oval'. Also, the knot is not located on the middle of a sheaf's side, but rather on the upper corner of the 'oval', on the side compressed by the Packers & Needle *(Fig.6.17)*.

  Some growers consider that, due to the way in which the sheaf is formed, the Packer or 'Knot' side is likely to be less weatherproof. They therefore recommend that in difficult weather conditions, stooks are constructed with the knot side of the sheaves innermost *(Fig.6.18)*.

  N.B. The Knot 'side' of the sheaf rather than the actual knot location on the sheaf *(Fig.6.17)*.
- **In-field Orientation of the Stooks:** Relative to sunrise / sunset and/or the prevailing wind direction? Few growers seems to worry about this
- **Use of a Sheaf Carrier:** Can improve stooking efficiency in a thin crop, **BUT** in a modern, thick crop, where the sheaves almost touch each other *(see Fig.3.15)*, it is unlikely to deliver significant benefits. **However,** they can be used to advantage to reduce crop damage caused by the machines running over sheaves when turning on corners *(see Section 6.3.2).*



Fig.6.15 Side view *(left)* and end view *(right)* of a wheat stook formed of 10 sheaves *(5 pairs)*

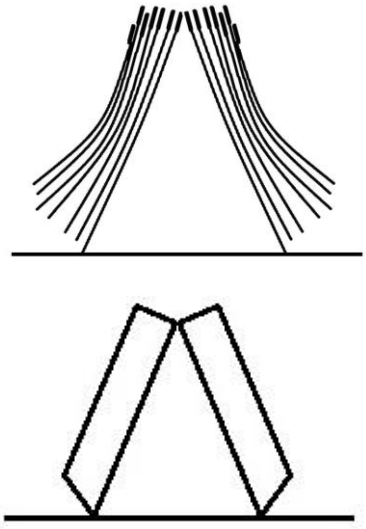


Fig.6.16 Schematic representations of sheaves in a stook, with angled Butt Ends arranged to reduce ground contact and improve stook stability

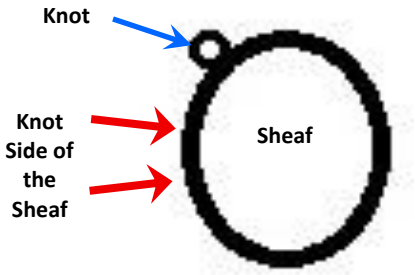


Fig.6.17 Sheaf cross-section showing the knot location and the knot side

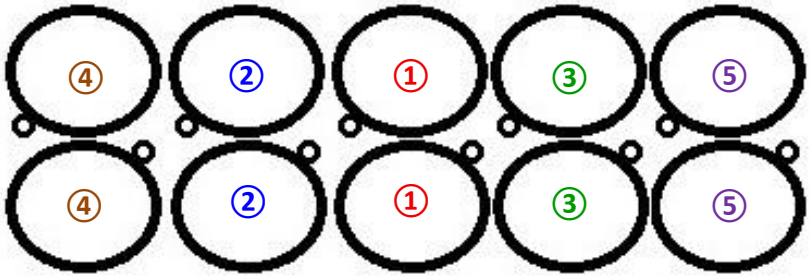


Fig.6.18 Plan view of a 10-sheaf stook showing the arrangement of sheaves and order of construction – Sheaves are placed with their knot sides innermost to resist rainfall penetration

Click on the adjacent image or scan the QR code to view video of Stooking



Fig.6.19 Stooking sheaves of Squareheads Master wheat

6.5 In-Field Maintenance *(see also Section 5.5)*

If the machine has been well-prepared pre-season *(see recommendations in Section 4)*, in-field maintenance should be limited to:

Lubrication

Follow the *(general)* recommendation given in Section 5.5 and any specific instructions given in the Operator's Manual for your binder. If in doubt, depending on the length of the working day:

- Lubricate all moving parts *(with grease or oil)* at least once a day
  - Faster-moving and/or more heavily loaded components should be lubricated up to 3 times / day
  - Any plain bearings, lubricated via oil holes, should probably be oiled twice / day.
- **DON'T** lubricate the Cutter Bar Knife Sections, other than during initial installation
- Contrary to the recommendations of some Binder Operator's Manuals, *(modern)* greases are ideal for lubricating most bearings on a binder. The 'grease' the manuals warn against is the thick, fibrous material that was used for lubricating wagon axle bearings. Today's Lithium-based greases are comparable to the 'solidified oil' lubricants recommended by some binder manuals.

Knife Sharpening / Exchange / Replacement *(see Section 4.2)*

Possible requirements include:

- Knife removal, re-sharpening & replacement **OR** exchange for a pre-sharpened 'spare' Knife
- Replacement of any broken/damaged Knife Sections *(e.g. Due to stone damage).*

The sharpening of binder knives fitted with 'plain' sections is less of a requirement if the base of the crop is clean / weed free. It was normal practice to swap for a newly sharpened Knife at least twice a day. If the Cutter Bar has been upgraded & fitted with self-sharpening, serrated *(Combine)* Knife Sections *(see Section.9.1)*, little or no sharpening is required.

Nonetheless, efficient, clean cutting is important: more so than in commercial cereal crops, so it is important to keep the Knife and Cutter Bar components in tip-top condition. To that end, **always remember that there have to be two sharp cutting edges for a clean cut:** the Knife Section **AND** the Finger / Ledger Plate. It's no good if only one is maintained in good condition.

Canvases

- Keep the Canvases adequately *(**BUT** not over-)* tensioned
- Monitor them for wear and development of any holes & tears. Address any damage sooner rather than later; it will only get worse
- Remember to slacken the Canvases at the end of each day. Otherwise damage may be caused not only to the Canvases, but also to the Drive & Idler Rollers.

6.6 Troubleshooting and Fault-Finding

Apart from major mechanical breakdowns, operating problems can only really occur in the mechanisms responsible for cutting, conveying or packaging & tying. Considering each of these in turn:

6.6.1 Crop Cutting

If the Cutter Bar was prepared properly, pre-season *(see Section 4.2)*, problems are likely to be limited to:

- **Blunt, worn or damaged Knife Sections**
    - Remember that the Knife Sections only provide half of the cutting action; the Fingers provide the other half *(see above)*
- **Damaged or mis-aligned Fingers** *(probably due to stone contact)*
    - Also check the Knife's clearance(s) & cutting action with the Inner & Outer Shoes on the Cutter Bar
- **Worn Connecting Rod and/or Knife drive bearings**
- **Incorrectly adjusted Knife Register.**

6.6.2 Crop Conveying

Potential problems in this area are likely to be limited to:

- **Damaged Canvases:** Repair as soon as possible to prevent further damage
- **Incorrect Canvases Tracking:** Tell-tale signs include the Slats not appearing to be parallel to the drive & idler Rollers as the Canvases rotate. Check & correct drive & idler roller alignment *(see Section 4.4)*
- **Canvases Slipping under Load**
    - Canvases may become slack during work, particularly if they dry-out during the day. Re-tension if necessary, **BUT** be careful not to over-tighten them
    - May be caused by a *(wooden)* Drive Roller slipping on its shaft or failing in some other way. Make sure this isn't the root cause of the problem before tightening the canvas.
- **Crop Travels Diagonally on the Canvases *(see Section 3.3 & Fig.3.5)***
    - Weight of the Ears causes the Platform Canvas to move them sideways more effectively than the lighter Butt ends. This creates a diagonal feed of crop into the Elevators and the Packaging & Tying mechanism, resulting in the formation of badly-shaped sheaves. It also places a greater load on the Packers *(as they attempt to re-align the crop into the sheaves)*
    - Consider making & fitting a Grain Retarder over the Platform Canvas. Make it so that its fore-aft position can be adjusted, to allow for different crop heights *(the Ears need to fall onto the Retarder rather than the Canvas).*

6.6.3 Crop Packaging & Tying

Problems here are likely to fall into one of two distinct categories:

a) Failure to secure / tie sheaves correctly *(i.e. loose, mis-tied crop is discharged)*

b) Failure to process the crop properly or even at all *(i.e. Packaging mechanism mis-behaviour or simple blockages / overloading)*.

Considering each of these in turn:

Mis-Tying / Knotter Issues

These problems, their likely causes and potential remedies are covered in the dedicated 'Knotter' technical guide, produced as part of this publication series *(see below & Section 13)*.

Click on the adjacent image or scan the QR code to access the Knotter Guide



However, before you start to try & correct a mis-tying issue, pause & ask yourself:

- **Is There Really a Problem?**
  - 1 or 2 mis-tied sheaves, particularly at the start of the season, doesn't mean there is, **BUT** 3 or 4 mis-ties in a row suggests that action needs to be taken
  - Before doing anything, check that every component on the Twine Path is shiny, rust-free & smooth. Pay particular attention to the surfaces of the Twine Tensioner, the Twine Guides, the Needle eye and the Bill Hook.

    Unfortunately, the Old Hand's trick of squirting some oil into the centre of the Twine Spool is an imperfect solution, just as likely to cause issues elsewhere in the binder's tying mechanism. Instead of masking it, it's better to find the real source of the problem & sort it

- **Is the Knotter Unit Actually to Blame?** It may well be at fault, **BUT** there are a number of more likely causes to discount first, including:
  - **Twine Supply:** Debris accumulation, rusty twine guides, poor quality twine and/or incorrect twine threading? Insufficient 'give' in the twine supply system as the Needle deploys?
  - **Twine Tension:** Incorrect or variable tension setting *(see Section 5.4)*? Failure to 'tweak' the setting as conditions change during the day? ***(N.B.** Do so with care!)*
  - **Incorrect Twine Placement:** Incorrect Needle travel and/or position relative to the Knotter's components
  - **Simple overloading of the Tying Mechanism:** Expecting it to deal with too much crop?



Fig.6.20 Knotter Trip Clutch *(highlighted)* on a McCormick binder

Click on the above image or scan the QR code to view video of Knotter Trip Clutch operation

Crop Packaging Issues

With a few exceptions, most problems here are likely to arise from the incorrect setup or operation of either the Knotter Trip Mechanism or the Knotter Trip Clutch *(see Section 4.6.2 & Table 2)*.

Both of these items work very hard during binder operation *(see Video Clip & Fig.6.20)* and, inevitably, long working lives will eventually result in component wear and, in time leading to unreliable operation.

Table 3 *(overleaf)* lists the issues which may be experienced, their possible causes & the likely remedies.

Table 3 Packaging mechanism problems, possible causes and likely remedies

(Click on Section No. or see relevant Figure for further info.)

Issue No	Problem / Symptom	Possible Cause(s)	Likely Remedy *(see Section and/or Fig. No.)*
1	**Sheaf Size is Too Large or Too Small**	• Incorrect Trip Mechanism adjustment and/or Compressor Arm position	• Adjust & re-position components **Beware –** Adjustment procedure is machine brand-specific **Section 6.2.4** ***(Figs 6.8, 6.9 & 6.10)***
2	**Twine Band is Too Tight** ***(Sheaf Too Dense)***	• Trip Spring set too tight	• Adjust Trip Spring **Section 6.2.4** ***(Figs 6.8, 6.9 & 6.10)*** **Beware –** Trip Spring location is machine brand-specific
	Twine Band is Too Loose ***(Sheaf Too Loose)***	• Trip Spring set too loose	
3	**Occasional Small Sheaf Produced**	• Knotter Trip Clutch engages prematurely on occasion Caused by worn or mis-aligned components	• Rebuild worn components to original profile or replace • Re-bush any worn pivot points **Section 4.6.2**
4	**Packing / Tying Mechanism Jams, seemingly due to Overload** ***(Machine 'Chokes Down')***	**Tying Mechanism Fails to Trip** • Incorrectly adjusted Trip Mechanism • Worn Trip Clutch components	• Inspect & re-adjust Trip Mechanism **Section 6.2.4** • Rebuild worn components to original profile or replace **Section 4.6.2**
		Needle Unable to fully-Compress Sheaf during Tying Cycle • Excessive volume of crop • Sheaf too large and/or Twine Band too tight	• Take narrower width of cut **or** reduce forward speed *(p.t.o.-driven binder)* • Reduce Sheaf Size **and/or** loosen Twine Band **Section 6.2.4**
		• Needle travel excessive / incorrect	• Reduce Needle travel slightly *(lengthen Needle Connecting Rod)* **Section 4.5** ***(Figs 4.18 & 4.22)***
5	**Discharge Arms & Tying Mechanism Fail to Start, or Revolve part-way & Stop**	• Weak, broken or missing Trip Clutch Drive Pawl Pivot Spring **N.B.** Ensure that the Tying Mechanism isn't being overloaded ***(Issue No.4)***	**Sections 4.6.1 & 4.6.2** **and** **Table 2**

Table 3 Packaging mechanism problems, possible causes and likely remedies *(continued)*

(Click on Section No. or see relevant Figure for further info.)

Issue No	Problem / Symptom	Possible Cause(s)	Likely Remedy *(see Section and/or Fig. No.)*
6	**Discharge Arms Revolve with a Jerky Motion** - Drive slips whenever the load increases	• Trip Clutch drive components are badly worn or mis-aligned • Weak Trip Clutch Drive Pawl Spring	• Rebuild worn components to original profile or replace • Replace Spring **Sections 4.6.1 & 4.6.2** **and** **Table 2**
7	**Discharge Arms & Tying Mechanism Revolve Continuously** - Knotter Trip Clutch fails to disengage	• Trip Clutch Stop Arm and Drive Pawl are badly mis-timed	• Carefully re-time the driveline components between the Packer & Knotter Shafts **Section 4.6.2** ***(Figs 4.25 & 4.26 and Table 2)***
8	**Knotter Trip Clutch 'Taps' or 'Clicks' during Normal Machine Operation**	• Trip Clutch Drive Pawl not being disengaged / held back sufficiently by the Stop Arm - Stop Arm – Drive Pawl clearance *(when Drive Pawl pulled back manually)* is excessive	• Adjust Trip Clutch mechanism **Section 4.6.2** ***(Figs 4.23 & 4.24 and Table 2)***
9	**Knotter Trip Clutch components 'Pound' each other during Normal Machine Operation** ***(and Discharge Arms vibrate)***	• Stop Arm adjustment incorrect • Knotter Shaft (non-return) Lock adjustment incorrect • Knotter Shaft driveline incorrectly timed • Knotter Shaft (non-return) Lock loose or broken	• Adjust, re-time, repair or replace components **Sections 4.6.1 & 4.6.2** **and** **Table 2**

7 Out-of-Season Maintenance

We all know what it's like. You finish cutting the crop, then it needs to be carted before the weather turns, then perhaps some needs to be threshed for seed and then it needs to be put back into the ground for next season.

With so much to be done in such a short space of time, there's a danger that the binder will get forgotten about which, for such a critical piece of equipment, is almost certainly a very bad idea. A couple of hours spent now could set things up for winter and avoid a great deal of grief next year.

Leaving a binder covered in dust & debris following harvest creates a haven for vermin & a recipe for machine deterioration. So instead, **here's what you should do BEFORE the autumn arrives:**

- **Remove Canvases**
  - These should already have been slackened immediately following last use of the machine
  - Brush or blow them down to remove dust / debris
  - Examine them for wear / damage – **Make a note to remind you if they need attention!**
  - Treat the *(leather)* straps with suitable oil, to prevent them from drying-out, cracking & then breaking when next used. Neatsfoot Oil is generally recommended
  - Store them in a dry, vermin-free place.

- **Remove all debris & crop material**
  - Blow the binder down with an airline or a Leaf Blower - **Don't wash it down!**

- **Remove Knife, sharpen & re-fit:** Also sharpen the spare knife *(if you have one)*

- **Remove, clean & re-lubricate Drive Chains**
  - Exposed drive chains will have accumulated dust & dirt in-work
  - Remove and soak & clean them in diesel. Drain, re-lubricate with oil & re-fit

- **Inspect for worn/damaged parts:** This will help avoid any nasty surprises come next season
- **Protect against corrosion**
  - Grease / oil / lubricate all grease nipples & oil holes *(ensure these aren't blocked)* and any sliding surfaces which are usually lubricated
  - Coat the Knotter Bill Hook and Twine Guides & Twine Tensioner with grease or rust preventative ***(N.B. This must be removed before putting the binder back to work)***
  - Spray the rest of the machine (***EXCEPT*** *the Canvas drive & idler rollers)* with a 60:40 mix of diesel & *(clean-ish)* oil - ***(N.B. NOT waste engine oil*** *– Old gearbox oil is ideal**)***

- **Remove weight from the wheels:** If it's fitted with pneumatic tyres *(not too common)*. It really will prolong their life
- **Store the binder undercover:** Keep the machine dry. Ideally in a shed, but at least under a decent sheet.

Before next Season, find time to work through the **Pre-Season Preparation** steps recommended in **Section 4 of this Guide**.

8 Machine Safety (Guarding)

OK, so perhaps this is the section that you'd prefer to gloss over? That may be understandable **BUT** if you spare a few moments, read the next few pages with an open mind and implement a few, inexpensive, practical measures, your wife/partner & family may just end up be very grateful **AND** you may also avoid physical injury and/or a hefty fine. **ENOUGH SAID!**

8.1 Binder (Legal) Safety and Guarding Requirements

As mentioned in Section 1, when Binders were originally manufactured *(1880s–1950s)*, Workplace Health & Safety was not a particular priority, especially in agriculture. Few, if any, of the driveshafts, gears, chains, sprockets or other dangerous moving parts on these machines were guarded in any way. Then the introduction of new, dedicated safety requirements for these machines in the early 1960s virtually coincided with their withdrawal from use in mainstream agriculture.

(continued)

Binder Health & Safety Myths



SAFETY WARNING

1) ***"It's an Old Machine. It was never guarded to modern standards when it was originally built, so it doesn't need to satisfy them now ……"***

   - **NO -** Specific safety regulations were introduced in the early 1960s. **All binders** being used commercially at that time were legally obliged to meet them; not just new machines.

2) ***"It's only me that uses the machine, so it doesn't need to meet all the safety (guarding) requirements …."***

   - **NO -** If used for commercial purposes *(i.e. not Vintage Machinery demonstrations)*, binders are regarded as 'Work Equipment' and fall under associated Safety Regulations ***(PUWER 98** -see Section 1**)***
   - **PUWER 98 applies to all Work Equipment,** whether the machine user is an employer, an employee or is self-employed: it makes no difference. They require that any equipment provided for use for work must always:
     - Be safe for use
     - Be suitable for the intended use
     - Be properly maintained in a safe condition
     - Feature suitable safety control measures *(i.e. guards, markings & warnings)*

     Also, the machine user must be adequately trained / instructed and be provided with appropriate information to enable the safe use of the machine.

So there's no doubt that the requirements apply to your binder. It's really just a case of what you choose do to meet them

Unfortunately, this meant that not many binders were fitted with appropriate guarding back in the 1960s and today, other than p.t.o. shaft guards on p.t.o.-driven machines, there is little evidence of appropriate guarding or other safety measures on many such machines used for harvesting thatching straw. **This is a needlessly dangerous situation and could have very serious consequences for you, your staff & your business.**

What Can You Do?

There's no doubt that modern health & safety requirements apply to your binder(s) *(see 'Binder Health & Safety Myths' box)*, so what can you do meet them without breaking the Bank or making the machine more difficult to use?

In reality, quite a lot; and it needn't be too difficult or expensive. This Section reviews some of the potential hazards on binders which probably should be addressed: Section 8.2 goes on to look at some practical safety solutions which could perhaps be used.

General Approach

Modern Health & Safety legislation requires that all equipment used in a workplace must satisfy Essential Health & Safety Requirements (EHSRs). To do this you must assess the possible safety risks posed by a machine and try *(wherever possible)* to reduce them. Previous legislation used to identify what potential dangers existed and specify how they should be addressed.

The modern way is to follow a 'Risk Assessment' approach, identifying what the potential hazards of machine operation might be, the likelihood of them occurring and the potential seriousness of any resulting incident. A combination of these three elements determines the seriousness of each safety risk & the priority of the safety measure(s) necessary to 'control' *(prevent)* it.

It may seem a bit obvious, but the accepted, general approach to make a machine as safe as practicable to use is to follow these three *(sequential)* steps:

- **Eliminate the Risk by Machine Design:** If there's a hazard, change the design of the machine to eliminate it. That's all very well, but you didn't design the Binder and it has to operate in a certain way to do its job: so this probably isn't an option.

  However, it may not be so far-fetched. For example, if the Binder's controls were removed / adapted so that they could be operated remotely by the Tractor Driver, the need for anyone to ride on the machine *(and their exposure to potential safety hazards)* would be removed *(see Section 9.3)*

- **Reduce the Remaining Risk(s) by appropriate Protective / Safety Control Measures:** A typical example being the fitting of appropriate safety guards

- **Warn of any Remaining / Residual Risks:** If guarding or other accepted safety measures aren't feasible *(e.g. perhaps due to the way crop has to enter or leave the machine)*, provide appropriate safety warnings on the machine, in its operating instructions **and also** identify any specific operator training requirements.

So that's the 'textbook' approach, **BUT** it is actually based on common sense. **Importantly,** if an accident ever does occur and you end up being investigated or even prosecuted, you will be expected to provide evidence of having taken these steps.

So, this is the right 'general' approach to follow and it may be fine for a trained machine designer but, for someone trying to deal with vintage farm machinery in a farm workshop, a few machine-specific clues regarding what best to do would probably be handy.

Fortunately, **The Agriculture (Field Machinery) Regulations (1962)**[1] specified some very sensible safety requirements for binders and some particular safety control measures to implement. These regulations have since been superseded by modern *(less machine specific)* general safety legislation *(PUWER 92 & PUWER 98)*, but the overall requirements didn't change.

However, the requirements of the previous safety regulations are still appropriate today and, if applied properly *(with a few updates & appropriate safety warnings)*, they will help to ensure that a binder satisfies Essential Health & Safety Requirements (EHSRs).

REMEMBER



SAFETY WARNING

- It isn't enough to rely on someone not coming into contact with a dangerous part of a machine, simply because there's no reason for them to do so, or they shouldn't normally be near the hazard
  - **You must protect against Inadvertent Contact.** Unplanned exposure to a hazard resulting from a person's action's during the normal operation or servicing of the machine
  - People to consider might not actually be the binder or tractor operator, but also anyone who might foreseeably be in the vicinity *(e.g. part of the Stooking team?)*
- So ask yourself the question. What measures are in place, either to prevent contact occurring or, as a last resort, to clearly warn of the dangerous consequences of contact?

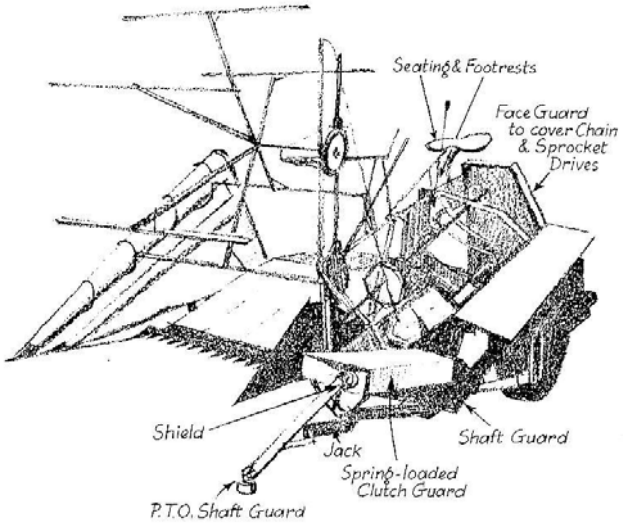


Fig.8.1 Examples of some of the additional safety features required on both new and existing binders by the Agriculture (Field Machinery) Regulations (1962)

(courtesy Practical Power Farming magazine)

[1] **Statutory Instruments 1962 No.1472** – The Agriculture (Field Machinery) Regulations 1962

The Agriculture (Field Machinery) Regulations – 1962 *(see also Fig.8.1)*

These Regulations were applicable to a whole range of different mounted, towed and self-propelled field machinery *(not stationary machines).* However, the key requirements relating to binder safety were:

- **Drawbar Jack**
    - If the downward force on the drawbar hitch point exceeds 56 lbs (25 kg), a suitable drawbar jack must be fitted
- **Towing Coupling (Drawbar Hitch) Pin:** Must be firmly secured in position
- **Cutter Bar Fingers**
    - Must be guarded when not in use **UNLESS** the Reel extends at least 12" (300 mm) in front of the Fingers, which it would on virtually all Binders. So probably not an issue.
- **Operator's Seat**
    - Must be of adequate strength **AND** be fitted with a backrest **or** otherwise shaped to prevent the operator from slipping from the seat

  This would no longer be deemed adequate. Current safety requirements are likely to be more demanding *(see Section 8.2.1)*.
- **Operator's Footrests**
    - Machine must be fitted with adequate & convenient footrests to prevent the Operator's feet from slipping & coming into contact with any moving parts of the machine

  This would no longer be deemed adequate. Any footrests must now:
    - Be at least 300 mm wide and have non-slip surfaces
    - Be fitted with lateral stops at each end, to prevent feet from slipping off.
- **Mounting Devices *(steps & handrails/handholds)***
    - Must provide the Operator with a safe & convenient means of mounting & dismounting from the machine *(i.e. a series of steps)*:
        - The 1st / lowest step must be no more than 21" (550 mm) above ground level
        - A handrail or handholds must be provided

  These are very similar to current requirements, except that today:
    - Any mounting means must permit **three-point contact** to be maintained *(i.e. to permit a person to simultaneously use two hands & a foot or two feet & a hand)*, when boarding & dismounting from a machine
    - Handrails or handholds must be provided on both sides of the steps
    - Steps must be at least 300 mm wide & have non-slip surfaces
    - Be fitted with lateral stops at each end, to prevent feet from slipping off
    - Be spaced 125 – 300 mm apart *(vertically)*
    - Be shielded to their rear **IF** there's a risk that a protruding hand or foot could contact a hazardous part of the machine. **N.B.** You can't assume that the Operator will only mount / dismount when the machine is at-rest / not under power.

- **Power Transmission Components**
    - Any *(rotating or reciprocating)* shafting, pulley, flywheel, gearing, crank, sprocket, belt or chain must be guarded *(or located)* to protect a worker *(or their clothes)* from coming into contact with it

  Current requirements are very similar except:

    - Any opening / hinged safety guard *(as opposed to a fixed / bolted guard)* must require a tool to open it *(e.g. a key, spanner or screwdriver)*, to prevent unintentional opening
    - When shut, the guard must lock automatically without use of a tool.

- **Moving Parts Involved in the Machine's Work Process**
    - For example conveyor belts / canvases for the movement of materials. Must at least be guarded at their run-on points *(onto drive or idler rollers)*
    - However, if there is a risk that a worker will be so close to these components as to be exposed to risk of injury, the side of the *(conveyor)* belt must also be guarded to prevent contact.

  Current safety requirements accept that:

    - Due to operational requirements, it may not be possible to use guards to prevent inadvertent contact with moving parts which are involved in the machine's work process
    - In such instances, other appropriate safety measures should be used *(e.g. safety distance guarding by use of a barrier)*

- **Stopping Devices *(Emergency Stop)***
    - In the case of a power-driven, towed machine which is manned *(e.g. a Binder)*, the machine operator must be able, from the normal operating position, to either:
        - Directly stop / control the engine which is supplying power to the machine, **or**
        - Have access to an easily reached drive disengagement device to disconnect power to the machine in an emergency situation.
    - It is not acceptable to have to signal to someone else before the power supply can be stopped.

  This is quite a far-reaching requirement: a consequence of the operator being present on the machine whilst it is in-work. It would appear that this and many of the other abovementioned binder-related safety requirements, were never actually implemented in practice.

  However, an equivalent 'Emergency Stop' requirement exists in current agricultural machinery safety standards[2] and so, like it or not, it can't be ignored. Potentially it provides significant justification for reviewing whether or not a dedicated operator is still required on a binder, or whether the machine may be controlled solely by the tractor driver *(see Section 9.3)*

(continued)

[2] **BS EN ISO 4254-1** Agricultural machinery – Safety – Part 1: General requirements

All these basic safety requirements from the 1962 Regulations still make a lot of sense today **BUT**, as indicated, in some cases it is now necessary to do slightly more to satisfy current machine safety requirements. Still, in most instances, meeting these requirements isn't too onerous and appropriate safety measures can be designed, constructed & installed in most farm workshops.

Very good, detailed guidance regarding how to do this is provided by the PD 5304:2019 – 'Guidance on Safe Use of Machinery' publication produced by British Standards, but it is very expensive to purchase. Alternatively, Section 8.2 indicates **some** of the guarding & safety control measures which should be implemented on binders which are in commercial use today.

8.2 Potential Guarding / Safety Control Measures

PLEASE REMEMBER, the following suggestions are intended to be a guide regarding possible safety control measures, rather than a definitive list. Ultimately you must perform your own Risk Assessment and satisfy yourself that the hazards present on your machine have been either eliminated or adequately controlled.

8.2.1 Operator Access & Seating

Firstly, are you going to have an Operator on the binder? If not, this entire range of requirements may be discounted, **BUT** remember to remove the existing seat & access steps so there can be no possibility of anyone riding on the machine when it is in-work.

If an Operator is going to be present on the machine, it's time to identify the potential hazards and do something to remove or control them. Necessary or highly desirable measures include:

- **Access Steps & Handrails / Handholds:** Not particularly challenging to engineer in the farm workshop. See Section 8.1 for the specific dimensional & constructional requirements

- **Operator Seating:** This area can be improved quite easily & cheaply and also provide partial solutions to certain other problems:

    - **Operator *(bodily)* Support:** The seat must provide sufficient bodily support to the Operator while the binder is in-work. A backrest is essential: aftermarket, replacement 'tractor' seats of 'wrap-round' design *(Fig.8.2)* can provide *(highly desirable)* lateral support to the Operator
    - **Seat Belt:** This may at first seem unnecessary, but think about it. Many, simple, aftermarket, 'tractor' suspension seats can either be supplied or subsequently fitted with a 'lap-type' seat belt for a few extra £s. Wearing of a seat belt is likely to ensure the Binder Operator remains in his working position and doesn't accidentally fall into the moving parts of the machine, which are probably in close proximity.

      So, **if a seatbelt is worn,** you will have taken certain measures to control an identified hazard. **This doesn't remove the need for component guarding, BUT** it does go some way to address the hazards posed by other parts of the machine *(e.g. the Reel & Canvases)* which, because of their *(Work Process)* function, cannot be totally guarded.

(continued)

- **Seat Suspension:** At the time of writing, aftermarket, mechanically suspended 'tractor' seats *(Fig.8.2)* are readily available for around £100.

  Installation of a suspended seat is no more challenging than a fixed seat pan, **BUT** it will give the binder operator a much more comfortable ride and simultaneously address / control a more recently identified safety hazard: worker exposure to Whole Body Vibration.

  However, if purchasing a replacement seat online, ensure the selected version actually incorporates a suspension system. Many don't!



Fig.8.2 Aftermarket 'wrap-round'-type replacement tractor suspension seat

8.2.2 Power Take-Off (p.t.o.) and Other Driveshafts

P.T.O. Shaft Guarding

The requirements for guarding of p.t.o. shafts, and the potentially fatal consequences of not doing so, are well-documented and understood. The entire power input shaft driveline, from the tractor's p.t.o. stub shaft to the implement's inner component's, must be fully protected by a series of non-rotating guards, to prevent physical contact with the underlying *(rotating)* parts.

Particular attention should be paid to any Universal Joints (U.J.s) and/or support bearings in the driveline. In all locations it must not be possible to make finger contact with any of the moving components. The guarding must also be adequately robust.

The 'tractor end' of the shaft should be protected by the tractor's own p.t.o. 'master' guard, whereas the implement end of the shaft must be guarded until it reaches a point where it is either protected by other guarding present on the machine, or by the presence of other *(static)* components which prevent access.

Fig.8.3 shows a relatively well-guarded binder p.t.o. shaft. A very good effort has been made, but the rearmost U.J. *(arrowed)* still requires some additional guarding. This could be achieved by the use of proprietary 'extended' p.t.o. shaft 'cone' guards *(Fig.8.4)* or by installation of an additional, fixed guard over the immediate hazard area.

Other Driveshafts

Unless other guarding or the presence of other static or non-hazardous machine components prevents the possibility of physical contact, all other rotating shafts on the binder must be guarded.

In practice, such shafts will often be driving other power transmission components *(e.g. gears or chains & sprockets)* which will also require guarding *(see Section 8.2.3)*. So satisfying that requirement may often prevent contact with the rotating shaft(s).



Fig.8.3 Relatively well-guarded binder p.t.o. shaft **BUT** some additional / revised guarding is required at the rearmost Universal Joint *(arrowed)*



Fig.8.4 Implement fixed 'power input connection' guard *(left)* and extended p.t.o. shaft cone guard *(right)* for Universal Joint assemblies

8.2.3 Other Power Transmission Components *(Chains & Sprockets, Gears, Rods & Belts)*

Assuming that the p.t.o. / power input shaft is already adequately guarded, the binder's other power transmission components are probably the most important / urgent area to address; particularly if the machine is typically used with an Operator on-board. Fortunately, thanks to the layout of most binders *(see Fig.3.2)*, the majority of drive chains, sprockets & shafts are located in the area under the Elevator(s) and Deck, which themselves provide some degree of physical protection.

However, there remain a number of key areas where accidental / inadvertent contact with rotating / moving power transmission components is possible and, without question, these require guarding. D.I.Y. manufacture & installation of fixed *(hinged)* guards constructed either from sheet steel or steel mesh fitted over a skeleton farmwork is a simple, effective solution.

(continued)

REMEMBER, when constructing & fitting a guard to any field machine:

- Access will probably be required at times, for servicing & replenishing or re-threading twine, so design / build guards so they may be opened easily & shut securely afterwards. Otherwise they are likely to be removed & discarded and no longer serve their intended purpose
  - Remember that current regulations require that safety guarding can only be opened by use of a tool *(e.g. a spanner, screwdriver or simple key)*, and it must lock shut *(without use of a tool)* when closed. Spring-loaded locking catches are readily available to permit this
- **Ensure** the guard doesn't permit a person to reach around its sides and make contact with the hazardous component(s) to which you are trying to prevent access
- It may be desirable to see through the guard, to check on component operation, but how important is this? The guard could be made of steel mesh, **BUT** this may introduce other problems such as undesirable accumulation of crop debris
- If constructing a steel mesh guard, don't use anything larger than 25 mm (1") mesh size and ensure the guard is at least ~125 mm (5") away from any component you're attempting to guard. If a part of the guard needs to be closer, use a smaller mesh size or sheet steel for that particular section.

Specific areas on a binder in which power transmission components require guarding include:

- **Area under the Elevator(s) & Deck:** Guarding is required to prevent inadvertent access *(and risk of entanglement)* from the rear of the machine *(Fig.8.5)*. This can probably best be achieved by a one or two-piece hinged guard, as service access with be required for twine re-threading & machine lubrication. It may be necessary to move the Twine Box slightly, or even attach it to the outer surface of the guard. It's important to ensure that the guard prevents *(hand / limb)* contact with the drive components from around its sides
- **Reel Drive *(Fig.8.6, Item 1)*:** May be via chain & sprocket or vertical shaft *(see Fig.4.15)*. Both require guarding, but the chain & sprocket-type presents a greater design challenge and a greater risk of entanglement. Consideration should be given to guarding of the Universal Joint at the base of the driveshaft on shaft-driven Reels
- **Buttor Drive / Crank Arm *(Fig.8.6, Item 2)*:** Can potentially be enclosed / guarded on all but its rear side, so long as provision is made for access for lubrication
- **Knotter Trip Clutch, Knotter Shaft Drive Gear and Needle & Compressor Arm Connecting Rods *(Fig.8.6, Item 3)*:** These components revolve / move whenever the Knotter is tripped & a sheaf is discharged. Some binders use an exposed chain & sprocket drive rather than an enclosed bevel gear & shaft arrangement *(see Figs 4.25 & 4.26).* In either case the entire area indicated in Fig.8.6 should be enclosed by a suitable guard, much as recommended in Section 6.2.3 of the Trusser Knotter Replacement Guide *(see Section 13)*
- **Knife Driveshaft *(Fig.8.7)*:** This usually runs from rear to front of the binder, under the Deck, on the outside of the Bull Wheel. Inadvertent access to it is discouraged, but unfortunately not prevented, by the lower edge of the Deck. It is therefore advisable to enclose the shaft in a guard **unless** access will be prevented by other safety control measures on the machine, such as a stand-off barrier installed to prevent inadvertent contact with the *(rotating)* Discharge Arms.



Fig.8.5 Binder main drive *(apron)* and knife drive chains – Chain & sprocket drives in the area under the Elevator(s) & Deck *(highlighted)* require guarding to protect against inadvertent contact. Enclosure of the whole area is probably the best solution

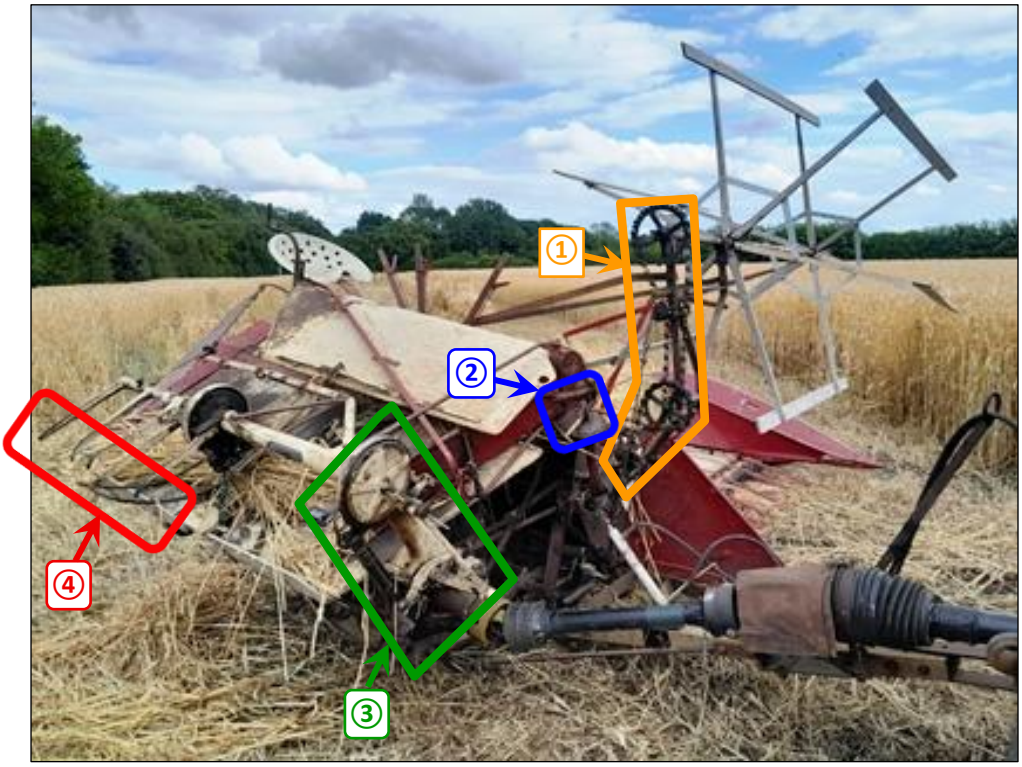


Fig.8.6 Additional areas on a binder which require guarding or other safety control measures to protect against inadvertent contact:

(1) Reel drive mechanism
(2) Buttor *(board)* drive / crank arm
(3) Knotter Trip Clutch, Knotter Shaft Drive Gear, Needle & Compressor Arm Connecting Rods
(4) Discharge Arms



Fig.8.7 Knife Driveshaft and rotating Discharge Arms & Knotter Shaft require guarding **UNLESS** inadvertent access to this area is prevented by other means *(e.g. a safety distance barrier)*

8.2.4 Moving Parts Involved in the Work Process

As indicated in Section 8.1, machine safety standards accept that certain parts of the machine cannot be completely guarded and also perform their intended job. A binder's cutter bar & the front of the reel cannot be guarded or protected by a safety barrier without impeding crop flow.

Consequently, whilst the machine safety / guarding requirements for power transmission components are very strict, those for components involved in a machine's 'work process' are slightly more flexible. This doesn't mean that safety control measures aren't required or that actions needn't be taken to prevent inadvertent contact with moving parts; but rather that a wider range of options other than fixed guarding may be considered.

One option is a safety distance barrier, positioned so as not to restrict the machine's operation, but still able to prevent a person from inadvertently contacting potentially hazardous moving parts. Like many agricultural field machines, a binder has to take crop in, process & discharge it without restriction, **BUT** if it's reasonably foreseeable that someone could be in the vicinity and make contact with unguarded, moving parts, something must be done to try & prevent it.

(Rotating) Discharge Arms *(see Figs 8.6 & 8.7)*

Considering these as an example, do they represent a hazard? Is there a need to implement measures to protect against inadvertent contact? Is it practicable to do so?

- They protrude beyond the edge of the binder's Deck, beyond the tractor's rear wheel, at the height of a person's torso. They rotate *(intermittently)* whenever a sheaf is tied & discharged

(continued)

(Rotating) Discharge Arms *(continued))*

- Their action is triggered automatically, without warning. It cannot be controlled by the binder operator
- Other *(farm machinery)* safety regulations of the 1960s[3] required the Discharge Arms of straw trussers to be guarded to prevent human contact, but the regulations for binders did not. Perhaps the risk of making contact with a moving field machine was considered less than with a stationary machine, **BUT** the physical nature of hazard is identical in both instances
- Whilst the binder operator & tractor driver wouldn't be in the vicinity for the Discharge Arms to pose a hazard, is it reasonably foreseeable that other workers *(e.g. inexperienced members of the stooking team)* **could** be in the harvest field & accidentally get too close to the discharge side of the binder as it works?

  This may sound far-fetched, but is it possible? Would a person simply have to be in the wrong place at the wrong time? What is there to warn them of the potential hazard, other than perhaps the binder operator, who may be looking the other way?

So, given that this is a potential *('drawing-in' & 'entanglement')* hazard, which was deemed important enough to be mentioned in mandatory safety requirements on similar machines over 65 years ago, it would seem unwise not to implement some form of safety control measure to address it on binders in use today.

Many straw trussers have been retro-fitted with hinged, wire mesh guards over the discharge arm area. These prevent inadvertent access & don't restrict crop flow, but are bulky and perhaps an over-engineered solution for a *(mobile)* binder and the risk that its Discharge Arms represent.

An alternative & perhaps more appropriate safety measure for binders may be the installation of an appropriate 'stand-off' Safety Distance Barrier *(Guard Rail)* immediately beyond the Discharge Arm / sheaf discharge area *(Fig.8.8)*. This may also prevent inadvertent access to other components in the area, removing the need to guard them individually *(Fig.8.7).*

Small diameter, tubular steel safety distance barriers are often used to provide a degree of protection in the vicinity of the moving, crop-engaging parts of agricultural machines such as mowers, hay tedders and pick-up balers. The current recommended guarding requirements for baler pick-up reels, by use of a safety distance barrier, potentially provide useful guidelines for the construction & installation of a barrier to guard the Discharge Arm area of a binder *(Fig.8.9)*.

In light of these recommendations, any Safety *(distance)* Barrier should be:

- Positioned at least:
  - 300 mm (12") beyond the outermost tips of the Discharge Arms
  - 150 mm (6") beyond the sides of the Discharge Arms
- Adequately constructed & rigidly mounted *(see 'Safety Distance Barriers' box)*
- Mounted to move forwards / backwards with the binder's Deck & Tying Mechanism, as this is moved to adjust sheaf twine band position *(see Fig.3.10)*.

[3] **Statutory Instruments 1960 No.1199** – The Agriculture (Threshers and Balers) Regulations, 1960



Fig.8.8 Potential location of a Safety Distance Barrier *(blue line)* to prevent inadvertent bystander contact with the Discharge Arms ***(N.B.** May not be required if a Sheaf Carrier is fitted)*

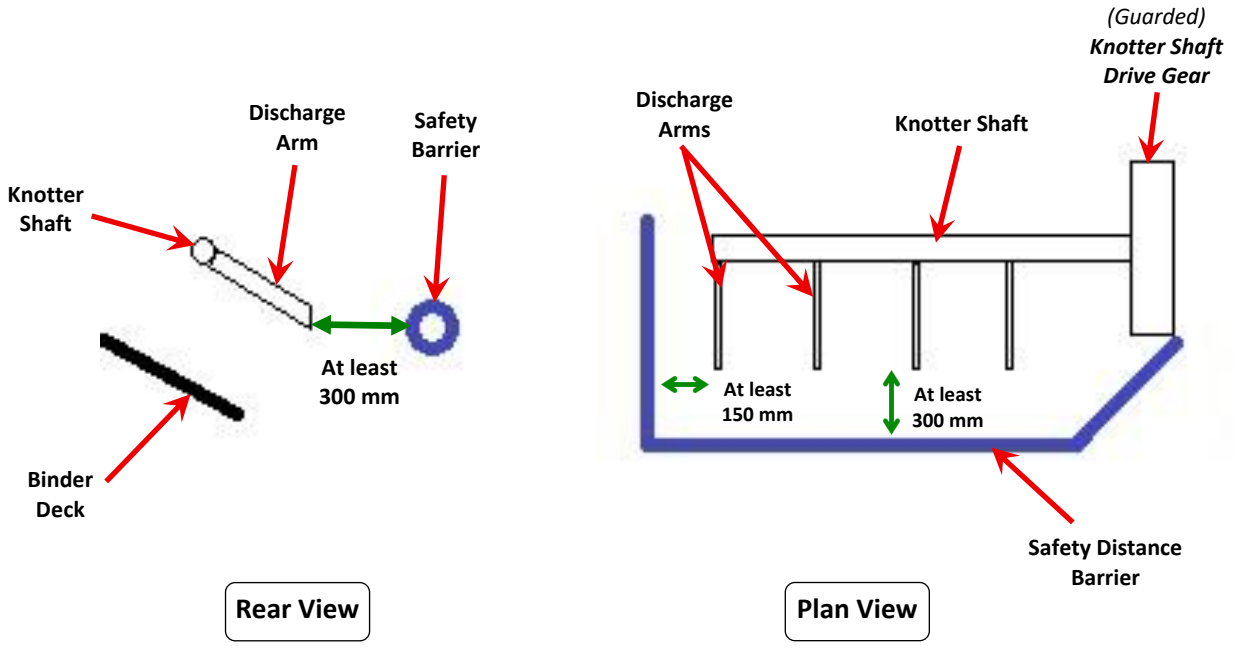


Fig.8.9 Potential arrangement of a Safety Distance Barrier to prevent inadvertent bystander contact with a binder's Discharge Arms

- **Note minimum clearance dimensions**
- A similar, simple *(tubular?)* distance barrier could also be installed across the rear of the Reel / Platform area if desired *(see example binder in Fig. 3.4)*

Safety Distance Barriers – Use on Binders

If because of specific operational limitations of the binder, you choose to install a 'stand-off' safety *(distance)* barrier instead of fixed guard, **ENSURE that:**

- There are good reasons why the use of a guard would not be practicable
- The proposed Barrier is:
  - Located a sufficient distance away from the hazard to prevent inadvertent contact in reasonably foreseeable circumstances
  - Sufficiently strongly constructed & mounted on the machine:
    - Current standards require Barriers to withstand *(separate)* horizontal & vertical loadings of 100 kg *(if installed up to 400 mm from the ground)* or 60 kg *(if above 400 mm)* without fracture or more than 10 mm permanent deformation
  - If possible, constructed & installed in line with recommendations for safety measures to protect similar 'working process' components on similar field machines *(e.g. combine harvesters or pick-up balers)*

8.2.5 Stopping Devices / Emergency Stop

Although a safety requirement for manned field machines such as a binder *(see Section 8.1)*, this would not be particularly easy to satisfy on existing machines. Three options come to mind, but there may well be more. Ignoring the issue and doing nothing isn't an option.

- **Operator Remains on Binder – Drive Disengagement 'Clutch' Installed**

  Sounds complicated & costly, but need it be? Modify the binder's input driveline & install a simple lever-operated 'throw-out' clutch. V-belt & tensioner pulley clutches are widely used on harvesting machinery. Ground-driven binders already incorporate a disengagement clutch *(see Fig.3.13),* but will this type disengage easily if under load? Any control must be easy to use and be readily accessible in an emergency

- **Operator Remains on the Binder – Additional Safety Measures Implemented**

  If an emergency stopping device isn't fitted, at least some steps must be taken to reduce the risk of the Binder Operator accidentally becoming entangled with moving parts of the machine. These could possibly include:

  - More comprehensive guarding of moving parts in the vicinity of the Operator's *(Working)* Station. This could be both complex & costly
  - Taking steps to ensure the Operator is less able to slip or fall from the Working Station and contact dangerous parts *(e.g. Provision of shielded footrests and a seat belt)*

- **Remove Operator from Binder – Control the Machine from the Tractor Seat *(see Section 9.3)***

  This removes the need to install an emergency stopping device on the machine. Whilst not without some difficulty & cost, it would completely eliminate the potential safety risk *(by revised machine design)* and also reduce the *(labour)* cost of operating the binder. Also, it's a viable concept, as proven by the Bisset semi-mounted binder *(see Fig.2.5)* and others.

Ultimately you must decide which approach to take: the issue cannot really be ignored.

8.2.6 Warning Signs / Decals

Don't underestimate the potential usefulness of ***(and the legal requirement for)*** warning signs on agricultural field machinery; particularly power-driven machinery.

Just because a machine may be adequately guarded, doesn't mean that you don't need to warn people of the potential hazards which lie behind the guards; and especially why they should never open the guards when the machine is under power / in-motion.

Warning Signs are not a substitute for effective safety guarding, BUT they:

- Should always be used to complement guarding
- May be used, as a 'fall-back' measures in instances where there is no other practicable solution *(e.g. Guarding or safety distance barriers are not feasible)*. **However,** strong evidence & a thorough risk assessment would be required to support such a choice.

Remember, harvesting thatching straw in sheaves is a labour-intensive activity: it's likely that you will need extra hands to help. But also remember that these *(Casual?)* staff may not be so familiar with potential machine hazards as yourself.

Unless you take demonstrable steps to train your staff, and inform them of & protect them from these hazards, legally you are at fault. This includes people working in the same field as the binder, even though they aren't actually operating it.

It's not possible to make a potentially hazardous machine idiot-proof, **BUT** you must take demonstrable steps to try.



Fig.8.10 Example Warning Decals potentially suitable for use on a binder

A wide variety of self-adhesive vinyl warning decals are readily available from eBay & other online sellers for a few £s *(Fig.8.10)*. Some suppliers will even produce warning signs featuring your own, bespoke wording. It really is a no-brainer!

Assess which hazards are present on your machine, choose the appropriate warning decals & place them in locations on the binder where they can be clearly seen *(e.g. on the surfaces of the new guards you've recently installed).* **However,** don't use too many signs in one place, otherwise they might tend to be ignored!

9 Upgrading Your Binder

The following examples are modifications which may be made to any binder of conventional design. They may improve its performance & in-field reliability or enable use of readily available *(replacement)* wearing parts, in place of those originally fitted to the machine. Alternatively, modifications may simply be to improve the usability of the binder. There are undoubtedly other useful modifications which can also be made. Please share your suggestions with other growers.

9.1 Cutter Bar

The Knife Sections and Fingers of a binder's reciprocating cutter bar are wearing parts, so sooner or later they will need to be replaced. Unfortunately, with very few exceptions, these parts for binders are no longer available from mainstream agricultural spare parts suppliers, partly because stocks have long since been exhausted *(see Section 10)* and also because there's insufficient demand to justify their re-manufacture. Consequently, even if you happen to find some 'old stock' parts at an agricultural dealer's or a farm sale, sourcing spare parts is likely to become increasingly challenging.

Fortunately, reciprocating knife cutting systems didn't go out of fashion: they continued to be used on grass mowers *(for a period)* and on combine harvesters up to the present day.

In many instances, both Knife Sections & Fingers were manufactured to agreed dimensional standards *(e.g. BS 1562-2)*, to enable parts from one manufacturer / supplier to be interchangeable with those from others.

As shown *(Fig.9.1)*, the 'standard' dimensions were originally in Imperial units, based on a 3 inch section width & a 2 inch fixing hole spacing. So, you may just find that Knife Sections from an old Massey Ferguson mower or a vintage New Holland combine can still be purchased and, by coincidence, will fit your binder.

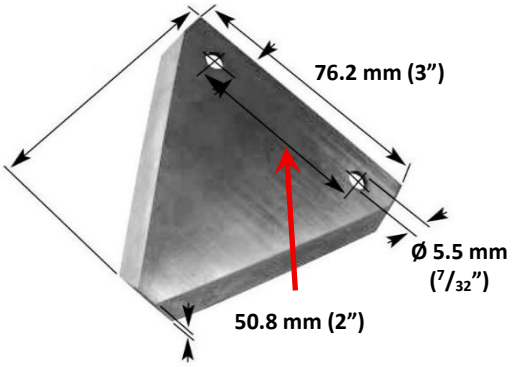


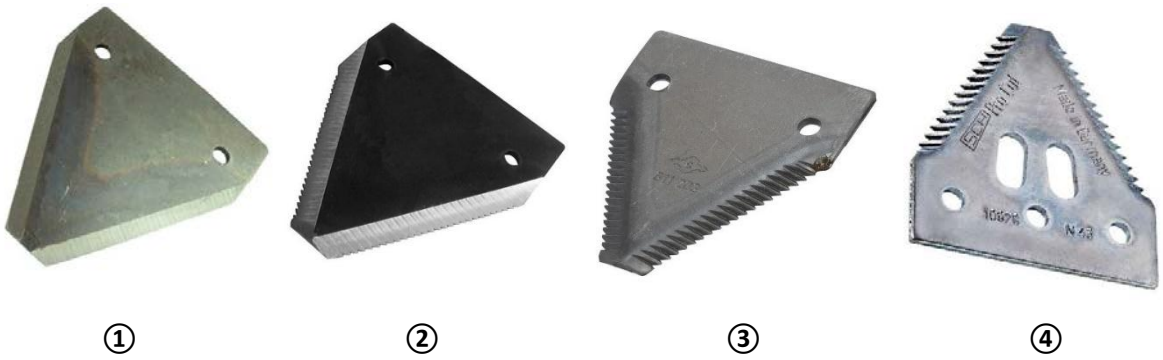
Fig.9.1 British Standard dimensions for Knife Sections
(courtesy Sparex)

Unfortunately, not all manufacturers of *(binder, mower or combine)* followed this standard and, over time, more & more departed slightly from it. Fixing hole dimensions & locations have changed. So the chances of current replacement parts fitting your binder are gradually becoming slimmer.

Knife Section design has also progressed: 'plain' edged sections being replaced with serrated sections of various designs which require little or no sharpening *(Fig.9.2)*. Modern Knife Sections are often secured with bolts rather than rivets, frequently with three rather than two fixings per Section.

Over the same period, Knife Finger design has moved on from the single / individual Fingers found on binders, mowers & older combines, to more robust double or even triple Finger units used on current combine cutter bars *(Fig.9.3)*. Today it is not easy to source new, 'single'-type Knife Fingers.

In order to work effectively, Knife Sections are specifically designed to suit the requirements & dimensions of the matching fingers *(and vice-versa)*. So, if faced with a very worn Knife & Fingers on your binder, the inevitable solution chosen & successfully implemented by a number of growers, is to replace all the original Cutter Bar components with new parts as used on modern-(ish) combine harvesters *(Fig.9.4)*.



① ② ③ ④

Fig.9.2 Cutter Bar Knife Section development – Left to Right: (1) Plain section, (2) Under-serrated section, (3) Over-serrated section & (4) Modern over-serrated section with additional fixing hole

(courtesy Sparex)



① ② ③ ④

Fig.9.3 Cutter Bar Finger development – Left to Right: (1) Conventional single finger, (2) Conventional double finger, (3) Updated double finger & (4) Modern double finger design

(courtesy Sparex)



Fig.9.4 Modern (Biso) combine cutter bar fingers & (over)-serrated knife sections fitted to a McCormick binder

(courtesy J. Carter)

Upgrading a Binder's Cutter Bar

Whilst it's not a cheap exercise & will require some *(farm workshop)* engineering effort, this modification will improve your binder's cutting performance **and** also permit ready access to replacement parts for the foreseeable future. In many instances, it's one of the few ways by which to refurbish a binder's Cutter Bar **and** it will potentially eliminate the need for knife sharpening.

When planning the job, it may be useful to give some thought to the following aspects:

- **Replacement Components - Dimensions**
  - Remember that you are trying to mate brand new parts of different design(s) to your existing machine. Some parts types may fit more readily / require less modification to the binder than others. It's worth doing your homework
  - **Imperial rather than Metric?** All modern parts will be specified in metric dimensions, **BUT** look carefully. Many are still manufactured to the metric equivalent of imperial dimensions. These are much more likely to fit your machine with little or no modification
  - **Inner & Outer Shoes:** While the Knife Sections & Fingers do the majority of the cutting, the Knife still has to pass *(and fit)* through the cutter bar's existing Inner & Outer Shoes: so choose your new components carefully.

- **Knife Drive Mechanism**
  - The existing Knife Back *(the rectangular bar to which the Knife Sections are fitted)* will almost certainly be worn & require replacement. You may be able to purchase & modify a suitable off-the-shelf replacement. If not you'll have to make a new one – accurately
  - The new Knife will need to accept the existing Knife *(drive)* Head in order to attach to the Connecting Rod *(see Fig.4.9)*. Some modification(s) or remanufacturing may be required
  - Don't forget the *(connecting rod)* drive connection to the knife drive flywheel & Crank Pin. These need to:
    - Be in alignment with the new Knife: hopefully they should already be
    - Provide the correct Knife stroke *(throw)* and register *(see Fig.4.14)*

    These components move fast & work hard, so any shortfalls will need to be addressed. 'Close Enough' probably won't be 'Good Enough'.

9.2 Knotter Unit

Every binder relies entirely on the correct functioning of its Knotter Unit and few things can cause as much angst as a mis-behaving Knotter in the middle of a harvest field. Its therefore not surprising that many growers have found that poor knotter reliability can seriously reduce binder output during crop harvesting.

That's not to say that a worn or poorly-adjusted Knotter can be the sole cause of tying problems: poor or variable twine quality can also be to blame. However:

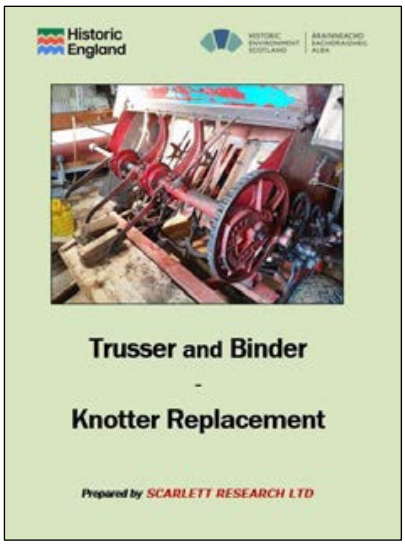
- Twine can still be sourced from many alternative suppliers
- Incorrectly adjusted knotters can be corrected, **BUT:**
- Unfortunately, there are few options available by which to deal with a Knotter Unit when it's finally worn-out.

The dedicated *'Knotter Setup'* technical guide, prepared as part of this publication series *(see Section 13)* details the scope for knotter adjustments & replacement of worn components. However, ultimately, this approach is severely limited by lack of available replacement parts.

When faced with wear-related problems and absence of replacement parts to correct them, some users have successfully replaced the original Knotter(s) on their binders *(and trussers)* with current, Deering-type knotters, as intended for Conventional Balers. This 'upgrade' approach incurs some engineering time, effort & cost, but it:

- Future-proofs the machine in terms knotter *(replacement)* parts availability
- Permits more precise adjustment of the Knotter Unit *(newer knotter designs have greater scope for adjustment)*
- Almost certainly leads to more reliable tying performance.

A dedicated *'Knotter Replacement'* technical guide in this publication series provides full details of this process *(see right & Section 13)*



Click on the adjacent image or scan the QR code to access the Knotter Replacement Guide

9.3 Remote Controls

Don't worry: we're not suggesting remote, radio control of the binder from the field gateway. Rather the scope to modify the binder to enable one-person operation from the tractor seat. As discussed in Section 8.2.5, whilst this is not a trivial task, this modification could deliver both:

- **Safety Benefits:** By removing the Binder Operator from the proximity of potentially hazardous, moving components
- **Economic Benefits:** By halving the labour required to operate the machine.

Yes, irrespective of the technical challenges, there are pros & cons of trying to do this. Riding on the binder is seen by many as one of the more enjoyable aspects of harvesting thatching straw by the 'conventional' method. Conversely, many growers regularly use 'standard' binders without an operator on-board, especially in uniform crop conditions *(see front cover)*.

However, binder remote controls are not a new concept. 'One-man controls' were offered as an optional extra on many U.S.-manufactured binders from the 1930s onwards. The control levers were simply repositioned to extend along the drawbar and be within the reach of the tractor driver *(Fig.9.5)*. Later tractor-mounted binders from J.F. and Bisset *(see Fig.2.5)* were also operated solely by the tractor driver.

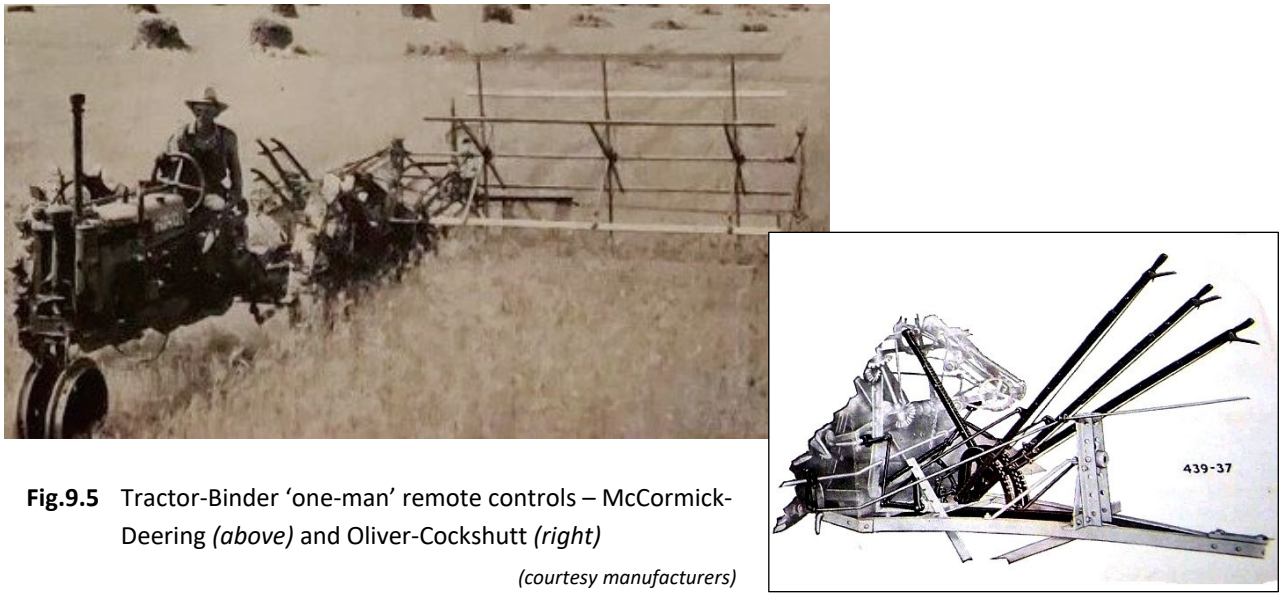


Fig.9.5 Tractor-Binder 'one-man' remote controls – McCormick-Deering *(above)* and Oliver-Cockshutt *(right)*

(courtesy manufacturers)

So, remote controls are entirely feasible, but they need bringing up to date. However, before reaching for the spanners & angle grinder, give the matter a little bit of thought & determine:

- Which controls the tractor driver actually needs to operate during work?
- How best to enable their *(remote)* adjustment?
- How to ensure they can be adjusted with sufficient:
  - Speed, to respond to changing field / crop conditions?
  - Accuracy, so as not to adversely affect the quality of work? This particular aspect probably depends on the rate of *(control)* adjustment required & also whether the operator is able to monitor the effect of adjustment as it is made.



Fig.9.6 Binder fitted with double-acting hydraulic ram *(arrowed)* to adjust cutting height *(platform tilt)* from the tractor seat

(courtesy J. Carter)

The binder controls which are likely to require adjustment from the tractor seat are:

- Platform tilt *(cutting height)*
- Reel height *(lift / lower)* and Reel tilt *(fore-aft position)* – **N.B.** Two separate adjustments
- Twine band position on the sheaf *(i.e. binding mechanism fore-aft position)*
- Sheaf carrier operation *(if fitted).*

The manner in which the remote controls are installed on a binder depends partly on user preference and partly on the type of control actuator(s) used. It may be possible to retain the existing control linkages and simply replace each original control lever *(see Fig. 3.11)* with a compact actuator. Alternatively, it may be preferable to replace both the lever & linkage with an appropriate actuator which acts both as a structural item and a source of force / movement *(Fig.9.6).*

Regarding choice of actuators, there are two main options: hydraulic rams or 12 volt electrical linear actuators. Each has advantages & disadvantages:

Hydraulic Rams

- Common on agricultural machinery. Readily available & well-understood
- Powerful; perhaps almost too powerful? Therefore select ram diameter with care
- Robust – Can act as semi-structural members
- Need to be double-acting to provide controlled movement / adjustment in each direction
- Require a separate spool valve *(slice)* to control each ram, located within reach of the tractor driver, **BUT not exposed inside the tractor's cab**. The tractors normally used to tow binders may not be equipped with multiple *(four)* spool valves
- Can extend / retract relatively quickly. Flow restrictors may be required to limit speed of movement of certain items. These devices can also be adjustable
- Not particularly cheap to install, once the rams, pipework, fittings & control valves are all taken into consideration.



Fig.9.10 Example 12 volt electrical linear actuators for remote *(mechanical)* control applications

(courtesy manufacturers)

(12 volt) Electrical Linear Actuators

- Not uncommon on agricultural machinery *(e.g. combine harvester controls, forage harvester spouts)*
- Inexpensive and readily available in a range of sizes *(i.e. stroke lengths and force capacities)*
- Simple to install. Requires a 12 volt fused supply via a two-way, momentary switch
- Unable to extend/retract particularly quickly: 5 mm/sec being a typical max. speed
- More suited to providing fine control, unless actuator movement is amplified via a linkage
- Probably not so structurally robust as a hydraulic ram
- Cheaper to install than a hydraulic ram, pipework & control valve. Relatively easy to build a simple in-cab control box.

Binder Remote Controls - Summary

- It may be appropriate to use hydraulic rams for certain, more demanding tasks *(e.g. Cutter Bar & Reel height control)* and use linear actuators where more precise control is required and a slower rate of adjustment is acceptable *(e.g. twine band position)*
- Consider fitting removable limit stops to the Cutter Bar height control ram, so the binder can be quickly returned to the same setting when entering work
- Consider installing graduated position indicators to items whose *(adjusted)* position isn't readily visible from the tractor seat, to help the driver see the item's position and/or the extent of the actuator's extension / retraction.

10 Binder Spare Parts Availability

Like it or not, binders are old machines: the vast majority which are currently used to harvest thatching straw were manufactured before 1960. Given the number that were originally on UK farms *(approx. 99,000 in 1958)*, it's not surprising that many are still in existence. However, those that are will have suffered wear & tear and, as they continue to be used commercially, will require replacement parts.

Limited availability of replacement / spare parts is probably one of the biggest problems facing continued commercial operation of binders. Unfortunately, today, any remaining dealer-held parts stocks have long since been exhausted. You may be lucky and come across an occasional 'find' at a farm sale, but what are the chances of it actually fitting your particular machine?

Depending on machine make / model, there may be limited availability of certain newly manufactured replacement parts from the U.S.A. *(Fig.10.1)*, but shipping & import costs need to be considered. Another option may be to cannibalise a scrap machine for parts. However, there's a strong chance that if a part is worn on your machine *(as opposed to being broken by accident)*, it will also be worn on the scrap 'donor' machine. Also, is the donor machine identical to your own?

So is the picture really that bleak? Not necessarily: it really depends which part(s) you're after.

Wearing vs Non-Wearing Parts

Wearing or 'consumable' parts of a binder are those which would be expected to wear out and require replacement as a result of the machine's normal operation. They would include items such as cutter bar components, the canvases, knotter components, drive chains, sprockets, gears, universal joints, bearings / bushes and other critical drive components *(e.g. Knotter Trip Clutch)*. Some may be expected to wear more quickly / require more frequent replacement than others, but all would expect to succumb sooner or later.

Non-wearing parts are virtually everything else. Parts of the binder's frame & structural members, driveshafts, its wheels, controls, & all the other bits & pieces. These would not normally be expected to wear out, but may be damaged accidentally or simply deteriorate over many decades.

Repair / Replacement Options

For non-wearing parts the options are limited to component repair or remanufacture *(either of which may be difficult and/or expensive)* or cannibalising a scrap machine. Depending on the component type, a much wider range of options exists for wearing parts:

- Cutter Bars can be upgraded to accept *(readily available)* combine cutter bar parts *(see Section 9.1)*
- New, replacement drive chains, bearings & bushes can usually be obtained
- Gear & sprocket teeth and other components can be built-up *(with bronze welding)* & filed back to their original profiles
- Knotter parts may possibly be available **BUT** *(more likely)* will require rebuilding **OR** the entire knotter unit must be replaced with one for which parts are available *(see Section 9.2)*
- Knotter Trip Clutches are critical, bespoke parts: they will require repair / rebuilding
- Canvases can be repaired or replacements made by specialists.

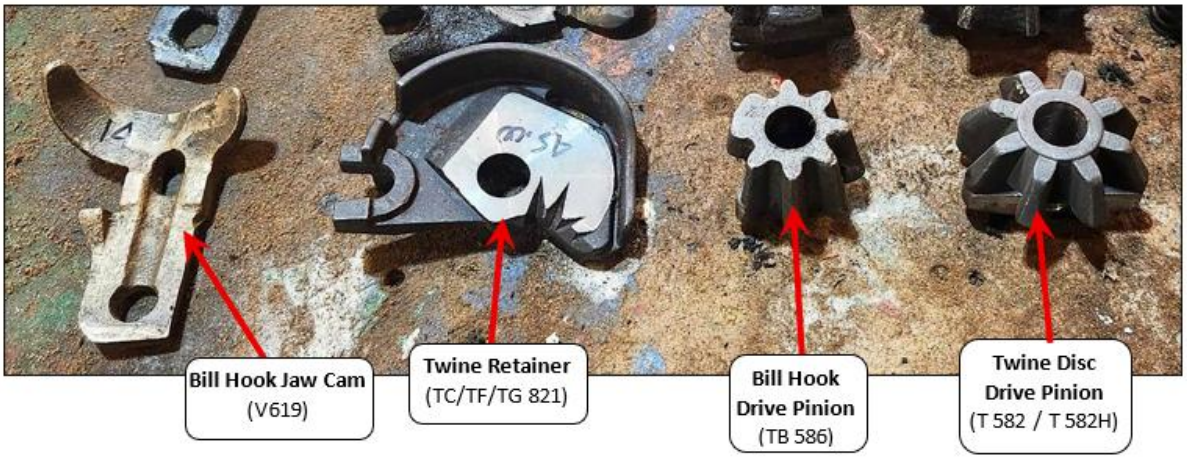


Fig.10.1 Selection of McCormick binder knotter parts available from a U.S. supplier

(courtesy B.W. Macknair & Son)

Known suppliers of replacement parts include the following. **Please note,** this is not an exhaustive list. **Other parts suppliers are available**. There are almost certainly various local sources of 'old stock' and second-hand parts but *(perhaps understandably)*, such information may not always be shared too readily between machine owners. After all, once it's gone, it's gone!

Farm & Rural Past *(Graham Kirk)*
Aylsham
Norfolk

Tel: +44 (0)1263 732 287

Mob: 07795 511 777

graham@farmandruralpast.co.uk

(Specialist manufacturer of new binder canvases & supplier of second-hand binder parts)

B.W. Macknair & Son
3055 US Highway 522 North
Lewistown
Pennsylvania *(U.S.A.)*
PA 17044

Tel: +1 717 543 5136

norman@macknair.com

www.macknair.com

(Specialist ag. machinery repairer & supplier of parts for McCormick & Deering (grain) binders)

Cottage Craft Works
P.O. Box 771
Brookshire
Texas *(U.S.A.)*
77423

Tel: +1 281 638 0055

info@cottagecraftworks.com

www.cottagecraftworks.com/mccormick-deering-grain-binder-parts

(Supplier of certain new/remanufactured parts for McCormick & Deering (grain) binders)

These U.S. sources can supply certain *(knotter & other)* parts for McCormick and Deering *(grain)* Binders. They will deal direct, either via email, website or phone, **BUT** shipping & other import costs must be taken into consideration. **Also, remember** that in U.S. terminology, these machines are **Grain Binders**: a **Corn Binder** is something completely different!

UK suppliers of spare parts for modern agricultural machinery include Agri-Linc, Granit Parts Ltd, Kramp UK Ltd, Spaldings Ltd, Sparex Ltd. Some may well stock items which can be useful.

11 Sourcing Your Binder

This guide provides a host of useful information regarding how to setup and operate a binder. Great! But what if you don't yet have a binder? Where can you obtain one from?





Fig.11.1 Example 'barn find' binders for sale during 2026

- *(Top)* - Not for the faint-hearted
- *(Bottom)* - Very straight: has potential

Obtaining a Secondhand Binder

Although there may have been ~99,000 binders on UK farms back in 1958, since then most have either been scrapped or simply allowed to rot away. Fortunately a number remain: occasionally in an old barn, but more likely either preserved & perhaps used by vintage machinery enthusiasts or working museums, or used commercially by growers of specialist crops such as thatching straw.

Binders are still out there, examples do come up for sale and often are not very expensive, **BUT be VERY wary of their physical condition.**

Remember that these machines:

- Will be at least 70 years old
- Will probably have seen considerable use; so examine them thoroughly for wear
- May have deteriorated in 'storage' over many decades *(Fig.11.1 (top))*. Some parts may be rotten or missing: mechanisms may be seized.

So, when considering the purchase of a secondhand binder:

- Budget for the cost of repairs & replacement parts *(if available)*. This will far exceed the initial purchase price. A 'barn find' may seem cheap, but consider the cost *(and time)* required to return it to reliable working order
- Check out the availability of replacement parts for the binder. If it's a real museum piece or something obscure, it may well be uneconomic to return to commercial operation
  - The majority of machines in current commercial use are likely to have been manufactured by either Albion, Bisset, Deering, Lanz, McCormick, Massey-Harris or Sunshine
- Remember that p.t.o.-driven binders are generally more effective & convenient to use than ground-driven machines. Therefore they are likely to be more sought-after & command a higher price. However, historically, ground-driven machines were sold over a longer period and so may be more numerous on the secondhand market
- Always check the mechanical condition of a newly painted, 'restored' machine very carefully. It may well be exactly as described, but verify what lies beneath its pretty exterior.

OK, so exactly where should you search for a secondhand binder? Any of the following sources may prove fruitful:

- (UK) farm machinery sales / auctions, particularly in thatching straw growing areas *(i.e. South West, South, South East & East Anglia)*
- (UK) specialist, vintage farm machinery auctions *(e.g. Cheffins, Cambridge)*
- Thatching straw grower websites & social media pages *(i.e. The National Thatching Straw Growers Association (NTSGA), Thatching Straw Growers Buy & Sell)*



Fig.11.2 A 'promising' Massey-Harris *(Sunshine)* ground-driven binder offered for sale

- Other related social media pages *(e.g. Threshing & Harvesting Machinery)*
- Farm machinery magazine classified ads *(e.g. Classic Tractor, Heritage Tractor, Tractor & Machinery, Farmer's Guide Farm Ads)*. Some are also accessible online
- Internet and social media selling sites *(e.g. eBay & Facebook/Meta Marketplace)*.
  N.B. Use 'Grain Binder' or 'Reaper Binder' as search terms. The term 'Binder' will generally throw up devices intended for the packaging of multiple sheets of paper
- 'Word of Mouth' enquiries to thatching straw growers & vintage farm machinery preservation enthusiasts *(e.g. National Vintage Tractor & Engine Club (NVTEC) & numerous others)*.

So secondhand binders do come up for sale and can be acquired, **BUT remember:**

- **DON'T** be rushed into buying a machine which is in very poor condition. You may later regret it
- **ALWAYS** budget for a **considerable materials and labour cost** to bring any new purchase back into reliable working order. You would expect to do the same for any other 70+ year-old piece of power-driven farm machinery. Don't expect a binder to be any different.

What About a Brand-New Binder?

Similar designs of tractor rear/side-mounted & front-mounted reaper-binders are manufactured in India, Turkey & elsewhere and appear to be popular in those markets. Attempts to import these machines into the UK have met with limited commercial success, primarily because:



Fig.11.3 Tractor-mounted reaper-binder *(courtesy BCS – Alvan Blanch)*

- The potential market size is limited
- The position of the binding mechanism is fixed, so sheaf band position cannot be adjusted
- Without additional guarding, the machines **DO NOT satisfy UK Health & Safety Requirements.** They therefore require physical modification & re-certification to permit their legal sale & use
- The cost of the *(new)* machine is considerably higher than that of a good, secondhand binder.

12 Summary

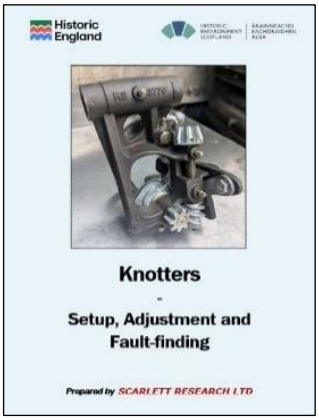
This technical guide provides an informative overview of:

- Binder setup, adjustments & operating techniques, to help improve their efficiency of operation
- Important safety control measures which *(unless already in place)* should be implemented to allow the continued safe & legal operation of these machines in the 21st century.

It has been prepared both to guide the novice user and also to assist experienced binder operators. Some content may appear rudimentary & unnecessarily simplistic, whilst other parts may seem excessively detailed. Covering this range of material has resulted in a rather lengthy, but nonetheless comprehensive document. Hopefully it will be of use to all potential readers.

Subject areas covered by the guide have included:

- How Binders actually work
- Machine Pre-season Preparation
- Procedures to follow to prepare a Binder for work
- In-field operating procedures & troubleshooting
- Out-of-Season Maintenance
- Machine Safety & Guarding
- Binder Upgrading
- Sourcing of Spare Parts.



The binder's knotter & twine tying mechanism is considered so important that a separate technical guide has been prepared, covering all aspects of knotter setup, adjustment & fault-finding *(see Section 13.)*

Messages to Take Home

- Binders are both complex and increasingly old & precious machines, **BUT** are expected to perform commercial work
- They will experience wear and, unless preventative action is taken, will eventually become unreliable or breakdown
- **Thorough Pre-Season Preparation is essential:**
  - Don't expect to pull the machine from the shed, fit the canvases, grease-up and for all to be well. It might be for a while, but like it or not, the clock will be ticking!
- Budget for and expect to undertake preventative maintenance & repairs:
  - Your binder might be a cheap bit of vintage kit, picked up online or at a farm sale, **BUT** it's also an important part of your harvesting machinery and it needs to be reliable

(continued)

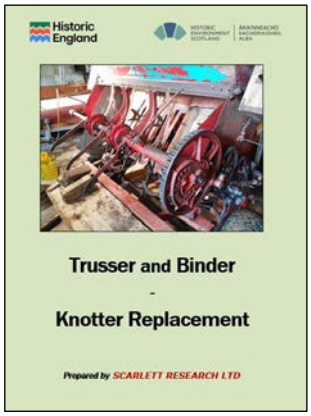
Messages to Take Home *(continued)*

- Machine Safety measures on most binders are woefully inadequate and need to be improved:
  - It doesn't matter if you are an employer, an employee or self-employed. If the machine is used commercially *(i.e. it's Work Equipment)* then it must be safe
  - Safety guards & other appropriate safety control measures can be constructed & installed in the farm workshop. It needn't be a big deal

- The availability of bespoke / dedicated replacement parts *(as opposed to generic parts)* is now very limited, **BUT** the situation isn't hopeless:
  - Gear & sprocket teeth and other components can be built-up *(with bronze welding)* & filed back to their original profiles
  - New, replacement drive chains can usually be obtained
  - Bushes can be made and inserted into worn housings
  - At a last resort, components can potentially be remade *(at a cost)*

- 'Upgrades' can be made to improve binder performance, reliability, ease of use and operating safety. All can be undertaken in the farm workshop for moderate cost. Examples include:
  - Cutter Bar component replacement with combine cutter bar parts
  - Knotter Unit replacement *(see below)*
  - Installation of remote controls to permit binder operation from the tractor seat

- When faced with a very worn Knotter Unit and an absence of replacement parts, some users have replaced the knotter with one from a Conventional Baler. This 'upgrade' incurs some engineering time, effort & cost, but it solves the problem of replacement parts availability and delivers much more reliable tying performance
- A dedicated Technical Guide in this series provides full details of this *'Knotter Replacement'* process *(see right and Section 13)*



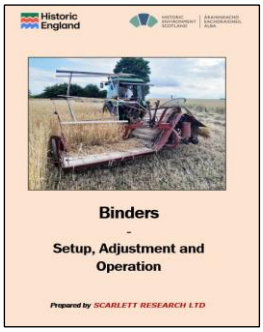
13 Thatching Straw Harvesting Machinery – Technical Guides

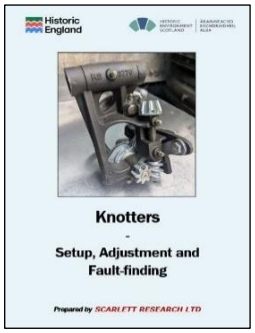
This publication is one of a series of technical guides prepared by Scarlett Research Ltd, on behalf of Historic England and Historic Environment Scotland. These guides are intended to illustrate machine adjustments, modifications & operating techniques which are likely to improve the efficiency & productivity of certain types of equipment when used for harvesting of cereal straw for thatching.

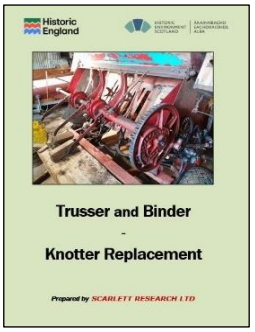
Technical Guides in this series include:

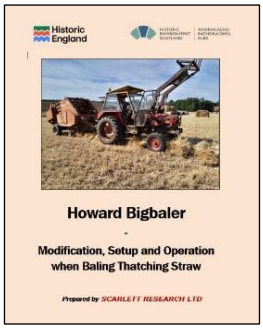
- **Binders – Setup, Adjustment & Operation**
- **Knotters – Setup, Adjustment & Fault-finding**
- **Trusser and Binder – Knotter Replacement**
- **Howard Bigbaler - Modification, Setup & Operation when Baling Thatching Straw**

The guides may be downloaded by scanning the relevant QR code *(above)*, 'clicking' on the relevant image *(below)* or from the Historic England website.









Historic England
The Engine House
Fire Fly Avenue
Swindon
SN2 2EH

Tel: 01793 445050
Email: conservation@HistoricEngland.org.uk

Historic Environment Scotland | Àrainneachd Eachdraidheil Alba
Longmore House
Salisbury Place
Edinburgh
EH9 1SH
Tel: 0131 668 8600
www.historicennvironment.scot

Historic England

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

© Historic England, 2026 All rights reserved

No part of this publication may be reproduced by any means without prior permission