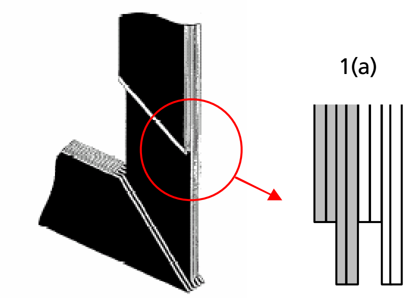
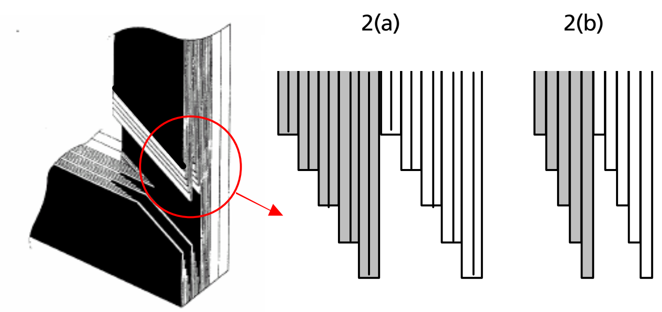
MULTI-STEP LAP CORE
TECHNICAL DATA

Multi-Step Lap Construction
A competitive Tool Offering Low Core Loss and Noise Level

Cogent Power Inc. cuts high quality, multi-step lap cores on its modern GEORG core cutting line, in addition to provi-ding fully assembled cores.

Multi-step lap construction is well established as an industry standard where high efficiency transformers — using stacked cores — are required. It allows manufacturers to produce stacked core transformers with the lowest possible no-load loss, sound level and magnetizing currents while simultaneously reducing core assembly times and simplifying top yoke insertion. In short, it helps you — the manufacturer — to be more competitive.





Note:
One complete set of plates is referred to as a “book” [e.g. in Figure (2a), 1 book = 10 plates]

Figure 1:
Single Step-Lap (2 steps per book, fixed)
(1a) 2 plates per step (optimum)

Figure 2:
Multi-step lap (5 steps per book, shown)
(2a) 2 plates per step (optimum) = 10 plates/book
(2b) 1 plate per step (large cores) = 5 plates/book

How Does It Perform? (comparison with alternative stacked cores)

With multi step-lap jointing, since the number of gaps per sequence is increased, the local flux concentration (flux density) in the joint area, is reduced. Normally, 5 steps/book is adequate.

Multi-step lap cores offer significantly improved performance over other types of stacked cores (i.e. lower WATTS loss, NOISE level and magnetizing VA).

Labour Saving Benefits

Compared to other stacked core types, multi-step lap cores offer multiple labour saving benefits:

- Single piece yoke instead of double (Figures 5 and 6)
- Ability to lay/fit more plates per layer due to number of plates in each book (Figure 6)
- Physically easier to locate and fit groups of plates (books) into top yoke (Figure 6)

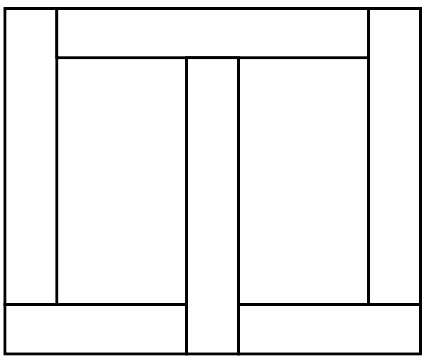


Figure 3: Butt-Lap
(6 pieces/layer)
Cutting scrap=zero

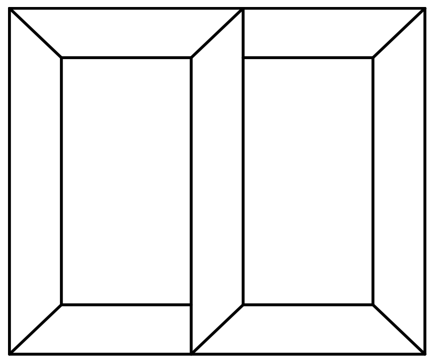


Figure 4: ½ Mitre
(7 pieces/layer)
Cutting scrap = zero

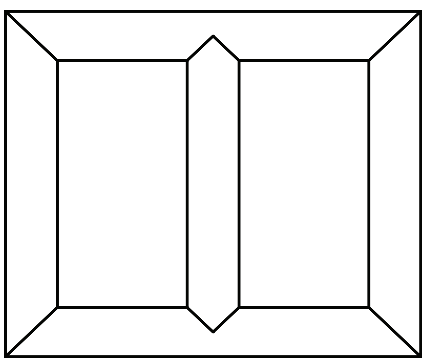


Figure 5: Single Step Lap
(5 pieces/layer)
Cutting scrap = 4 to 8% (due to V-notch)

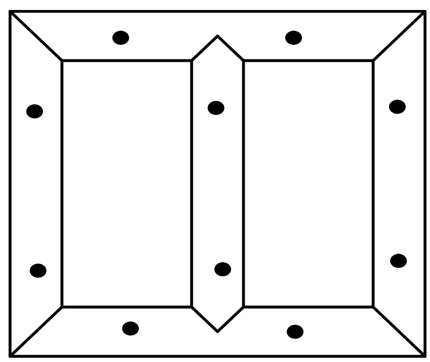


Figure 6: Multi-Step Lap
(5 pieces/layer)
Cutting scrap = 4 to 8% (due to V-notch)

Typically in multi-step lap cores, two small guide pinholes are punched in each plate to facilitate alignment of the plates into the correct stepping sequence (Fig.6). On smaller cores, one hole per plate is adequate. On some larger cores, the hole diameter can be made large enough to accommodate yoke clamping bolts with their associated insulation. Yoke bolts can be used to achieve sufficient clamping pressure on the centre leg, without the need for (expensive), heavily stiffened clamps.

The following table illustrates the improvements possible for dimensionally identical, 3-phase, 3-limb, stacked cores with various corner-jointing methods (same steel grade):

Corner Joint Type	Butt-Lap (2 steps)	Half Mitre (2 steps)	Single Step Lap (2 steps)	Multi-Step Lap (5 steps)
Watts	Reference	94%	91%	87%
Noise (dbA)	Reference	-4dbA	-6dbA	-9dbA
VA	Reference	70%	50%	35%

Values apply to a core of average proportions (1.0MVA, corner volume = 35%, B = 1.65 tesla).

At flux densities higher than 1.65 tesla, the % reduction in Watts/VA, gained through using step-lap is greater (i.e. maximum step-lap benefit, at highest flux densities).

Reduced Total Ownership Cost (of transformer)

Multi step-lap cores are highly effective in transformers where a high no-load loss evaluation is attached, particularly on 3-phase units. Here, the end user adds the transformer running costs to the initial purchase price, to calculate the Total Ownership Cost (TOC), rather than simply purchasing a transformer based on lowest first cost.

Typically, the payback period for the additional costs associated with high efficiency core designs is short, less than 5 years. When compared with the expected lifetime of a transformer, which is typically between 20 and 40+ years, it is clear that significant financial savings can be made over the transformer lifetime.

Typical Design Options (utilizing benefits of multi step-lap)

The lower destruction factor achieved with a multi step-lap construction can provide an improved core perfor mance for an existing design. It also allows a lower material cost to be achieved with a new/re-designed transformer. The main design options are:

Option (1):
Direct Substitution of a multi step-lap core into an existing design (i.e. retaining same winding design, volts/turn etc.)

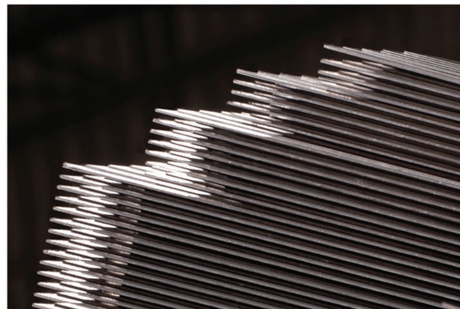
(a) Same no-load loss, with a lower grade steel
(b) Lower no-load loss, with original steel grade
(c) Substantially lower no-load loss, with a better grade steel

Option (2):
Redesign to take full advantage of multi step-lap performance (re-proportion active materials in core & windings, i.e. steel & copper/aluminim — consider volts/turn change)

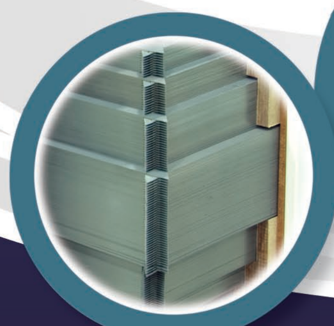
(a) Same no-load loss, in a higher induction design, with original grade of steel
(b) Reduced no-load loss, in a higher induction unit using original steel grade
(c) Reduced no-load loss, in a higher induction unit using Hi-B steel

Typically, re-designed transformers will be more compact with fewer active materials, particularly those originally designed at low flux densities.

Precision cut joint



440 mm in-house Georg



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