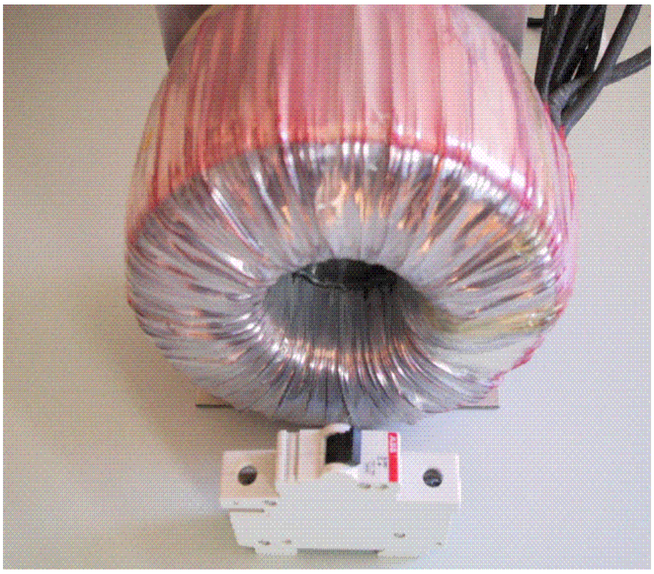
An improperly pair ??

-A Toroidal transformer and a fast acting line protector switch with nominal current of the transformer.-
Yes its true, but only at first sight.
Picture 1.



The picture 1 shows an 1 kVA, 230 V toroidal core transformer and a C 4 A automatic cut out. The toroidal core transformer has low losses, a nominal current of 4,3 Aeff. but an inrush current of 56 times of nominal current = 240 Aeff. The C 4 A line protector switch trips when a 6 times of nominal current flows = 24 Aeff. The inrush current of the transformers is 10 times higher.
Conclusion: The toroidal core transformer and the automatic cut out are not to combined.

It´s a pity, that both mismatch. Each of them has opportunities for himself. The low loss transformer is energy saving, stays cold and has a very low idle running current of only 25 Milliamps.
The C 4A line protector switch is able to protect the transformer together with long wires behind him.
(When a short circuit occurs at the end of the long wires behind the transformer, then the short circuit currents are low and must although trip the line protector switch).
In a factory area or inside of large buildings are such long wires commonly. They are feeding any actors with 24V AC for example. Up to now big wire sizes must spent the low resistance to enable the short current flowing is high enough to trip the fuse in a short time before the cable is burning.
Additionally for that must be spent a secondary side fusing.
But thick cables are expensive. For this reason, when a so called soft short circuit occur, the inner resistance of the transformer should be as low as possible.
This allows again thinner wires after the transformer.

– But this raises the inrush current, when the inner resistances inside of the transformer are low.-

Because the sum of all resistances in the circuit between fuse and short circuit **limits the short circuit current, who must trip the fuse in a short time less than 200 milliseconds.**

But with a low inrush transformer it is paradox. The copper was economized inside of the transformer must be spent many times fort he cables after the transformer, when they are longer as 100 m and more. And the customer pays the bill.

However, when a so called „Transformer-switching-relay“ is placed between the both in the picture 1, then the transformer and the line protect switch are agree.
The Transformer switching relays avoids the inrush current in all circumstances better than normally used inrush current limiters.

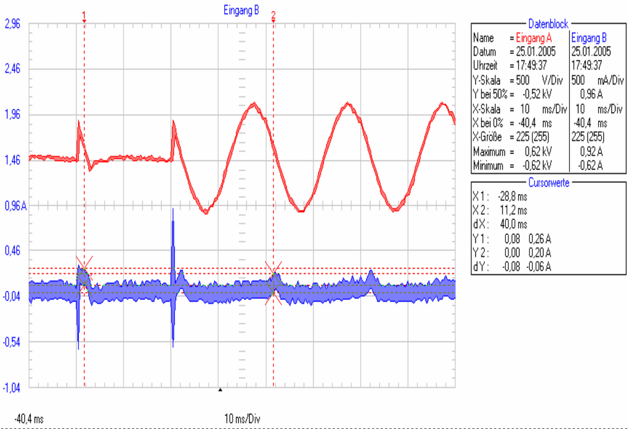
Some times used so called Inrush current limiters, cannot limit the inrush current in all circumstances.
They don't like short circuits and a switching on after a short pause.
Mostly they consist of an bridged NTC or fix resistor.
After a short Power line interruption they cannot limit the inrush currents, when the power line voltage comes back.

Normally used EI core control-Transformers runs hot also in no load state.
The reason is laying in the construction.
--Either a transformer has low losses or he has a low inrush current. Both together is not possible with normally costs.--
With the argument for Transformers with low inrush currents on correspond the argument of an easy to fuse of the transformer. That´s often published. But nobody tells about the higher warming up and the higher current losses of this kind of low inrush transformers.

Alternatively we think it is better to use a low loss transformer together with a Transformer switching relay to save energy and costs.

A so called transformer switching relay, TSR, fullfills all the needed criterions to withstands the rough industrial environment. He avoids the inrushes of transformers and allows it to use transformers with low losses. The fuse select is then very easy. The Transformer fuse can be a fast blowing type with a value of nominal current or less.

The switching on procedure of an 1kVA Toroidal core transformer together with the TSRL is seen above. **After a short time of premagnetising the transformer is switched full on.**
Picture2



TSRL-plus-Trafo-1, einschalten von 1kVA Ringkern-Trafo

The graph in picture 2 shows:

Ahead the voltage on the transformer and above the current into the transformer.
The transformer was in no load state while switching on. Only 80 Milli-Amps are flowing.
(Softstart procedure is Patented with EP 0575715)
Since more than 8 jears **this Inrush avoiders are on the european market. More and more they are used inside of medical separation transformers or in traffic control lights and so on. A transformer fullfill together with a TSR the tests conform to EN 61000-4-11, with fast voltage dips. No fuse is blowing than, when missing one half wave of the feeding voltage.**

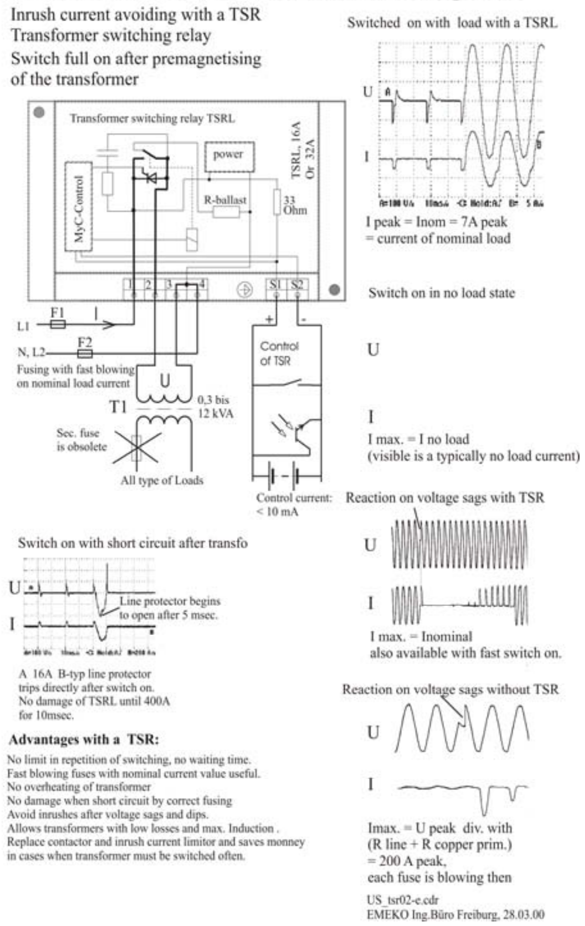
A TSR, can switch on and off over 5 Million times in his life, with no long pause between the switchings.
A TSR brings together with a toroidal core transformers many advantages.

Only at toroidal core transformers is the no load current so little, that he d´ont care for warming up the transformer.
This kind of transformer are in future important as energy saving transformers, when the only bad habit is eliminated, the high Inrush current.

Also a bigger size of transformer is recommended when the losses must decrease to a minimal value, when the transformer must stay cool when loaded. The higher no load losses can neglected but the load losses are only a ¼ when the power of the transformer is doubled. A 2kVA Transformer can also be fused to 0,5kVA when the load is not bigger.
In the right picture 4, a Bloc schematic is showed. With the measuring curves of the switch on procedure and so on.

The bottom picture 3 shows a low loss control transformer with 1kVA, 400V to 230V, together with a TSRL and the 2A B line breaker on a top hat rail.
Picture 3.

Picture 4.
Transformer switch on without inrush current peaks



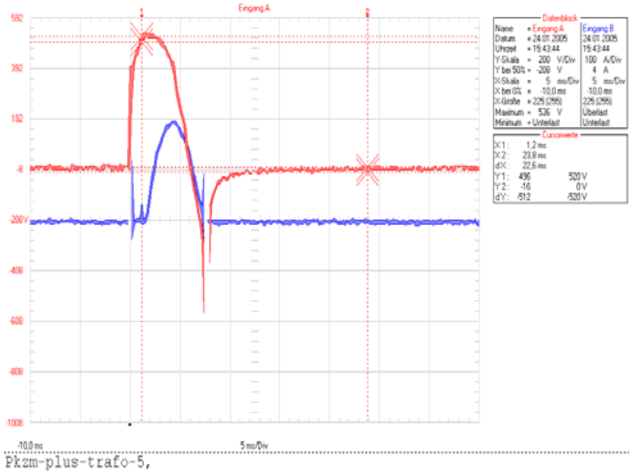
How it runs switching on without a TSRL?

The Graph in the bottom shows the switch on Voltage and current, when a 1kVA toroidal core transformer is switched on by a electro-mechanical contactor. He is fused with a PKZM0-4-T line breaker especially for transformers.

Picture 5.

(Switch on directly.)

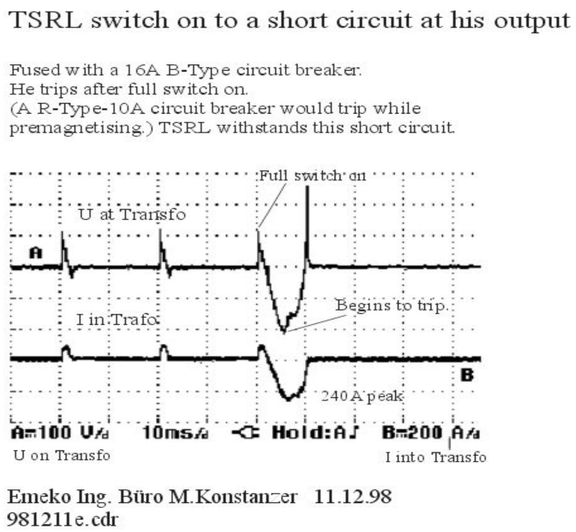
Input A, top= Voltage at the transformer, Input B, bottom = current into the transformer.



The line protector trips within 10 Milliseconds. The low loss Transformer has an air gap-less Iron core. He produce a inrush current of 200A peak, thats 140Aeff. (Thats the 56 times of nominal current.)
Line protector switches who have a short circuit breaker current of more then 22 times of the nominal current are not available. They´d not be able to protect the wires when a so called soft short circuit occurs.

Picture 6.

When between circuit breaker and 1kVA transformer a TSRL is placed:



Channel A shows the voltage on the transformer, channel B shows the Amps into the transformer. The circuit breaker start to trip in the peak of the current after 5 msec. Only 240Amps peak are flowing. The TSRL withstands 1000Amps peak for 10 msec.
Switch on onto short circuits is no problem for the TSRL.

When the TSR switches on to a short circuit **after the transformer he gets no damage, when the fusing is correct.**

Other inrush current limiters failed this test.

Additionally: A TSRL with the option for fast recognition of so called fast voltage dips can avoid inrushes and fuse tripping when tested the equipment with EN 61000-4-11. This TSRL has also a switch off threshold from 170Veff and a switch on threshold from 185Veff.
When voltage sags occurs, no jitter with mechanical contactors is induced when a TSRL is in front of a control transformer.
A separately voltage Supervisor relay is no more needed than.

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Word-texte/fzartik/einunmögl-paar-k-e.doc