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(54) **ELECTRICAL REACTOR ASSEMBLY HAVING CENTER TAPS**

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(52) **U.S. Cl.** **336/212**; 336/183
(58) **Field of Search** 336/60, 84, 183–185, 336/206–207, 212

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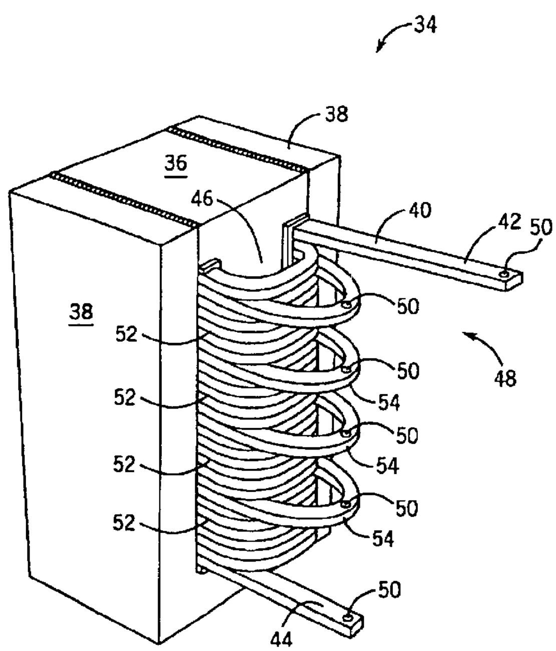
(57) **ABSTRACT**

An electrical reactor assembly and method of assembly is disclosed. The reactor is formed from a combination of a magnetic T-core and a pair of magnetic L-cores. A plurality of comb-like separators is placed over a vertical portion of the T-core. A wire, with a rectangular cross-section, is wound about the vertical portion of the T-core thereby forming a coil. The comb-like separators electrically isolate the wire from adjacent windings and the T-core. The L-cores are attached to the T-core such that they flank two sides of the coil. A plurality of taps is formed on a side of the coil that is not flanked by one of the L-cores. The taps are formed by extending individual windings further from the T-core than other common windings. Preferably, a hole is formed through the rectangular wire at the taps to provide a secure electrical connection to the wire.

23 Claims, 5 Drawing Sheets



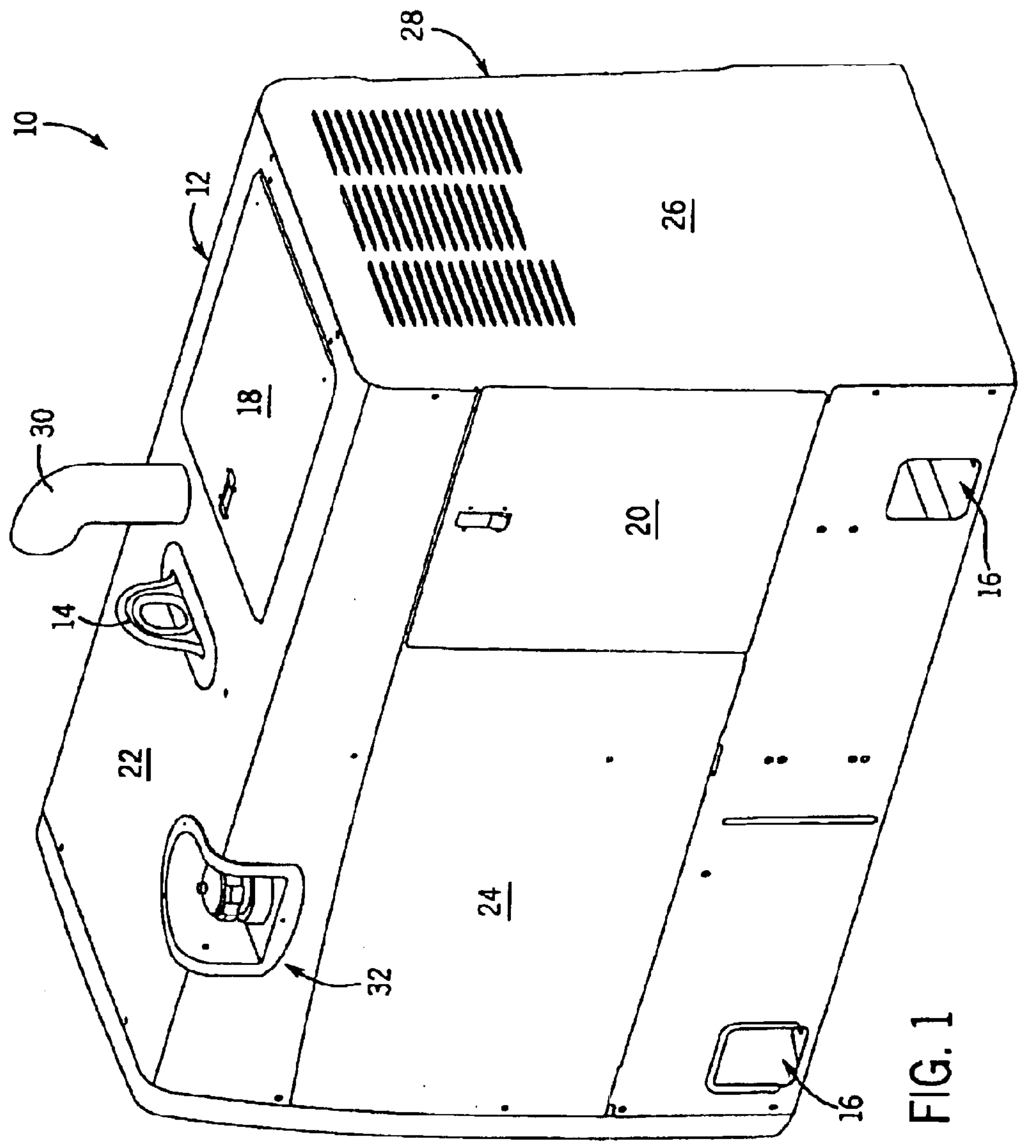


FIG. 1

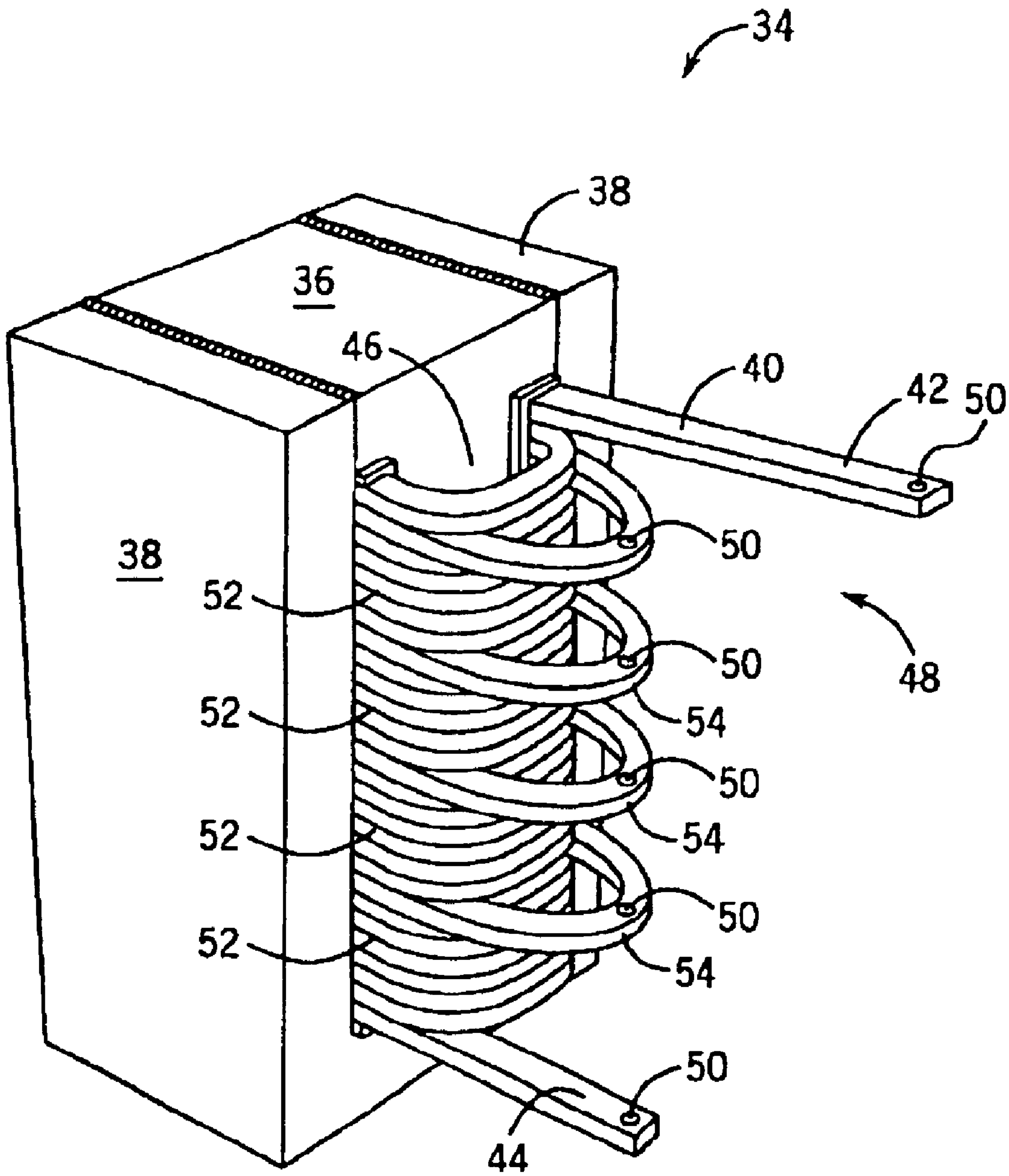


FIG. 2

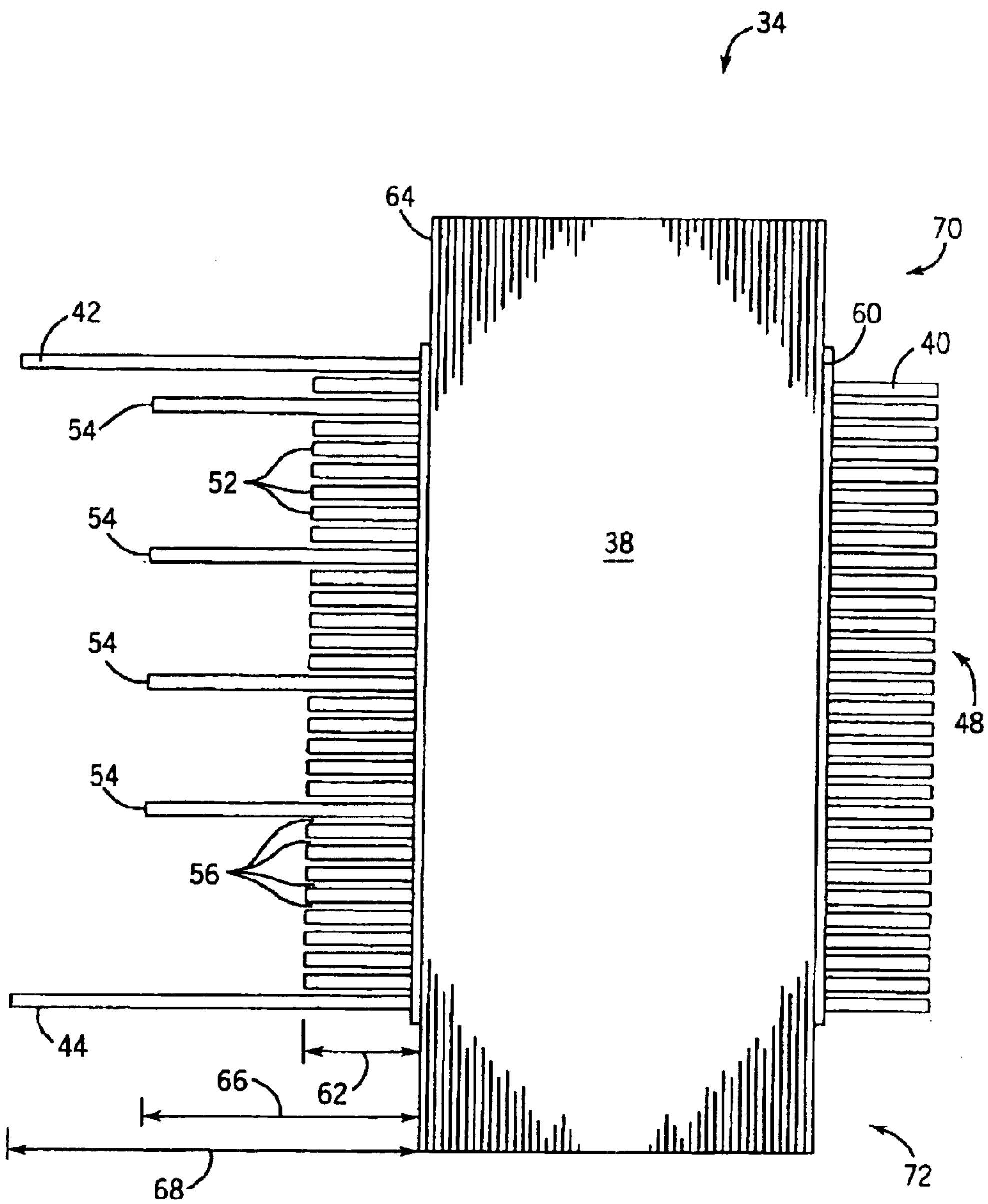


FIG. 3

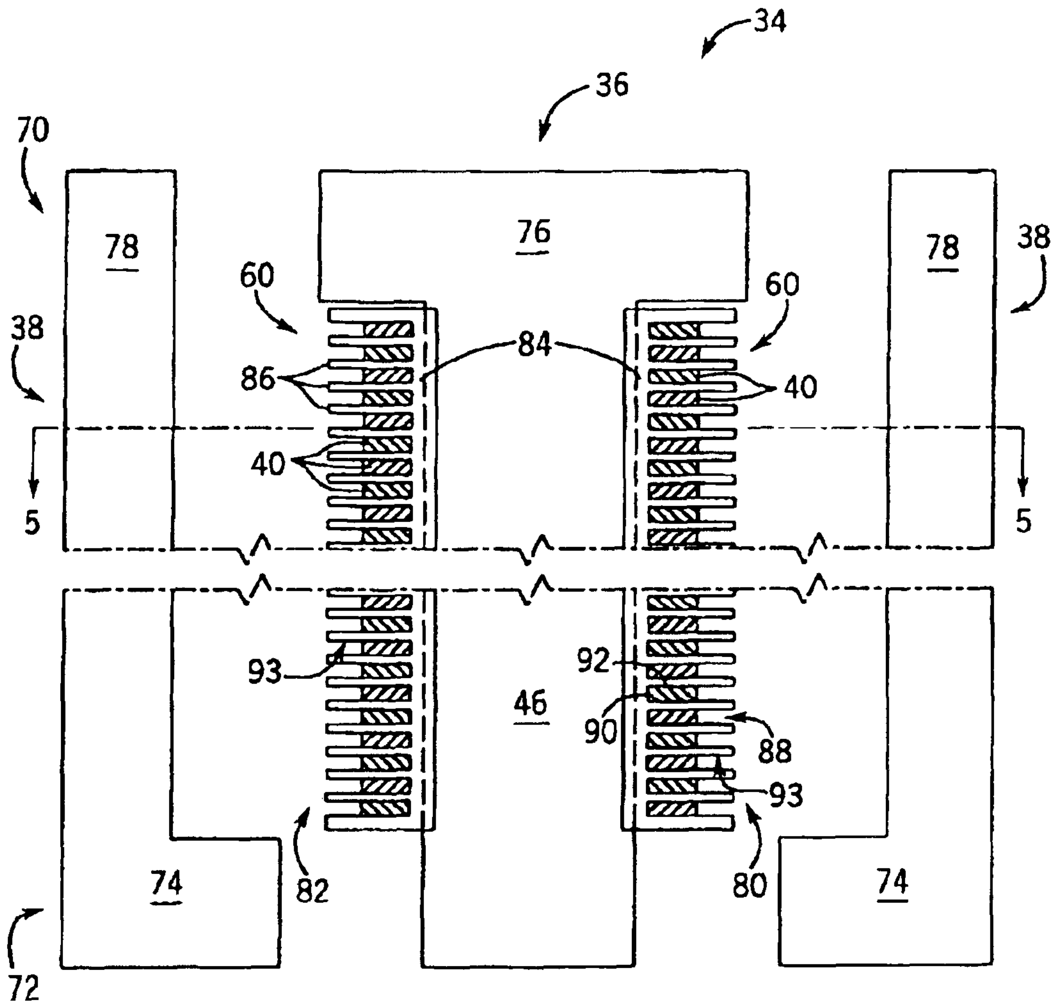

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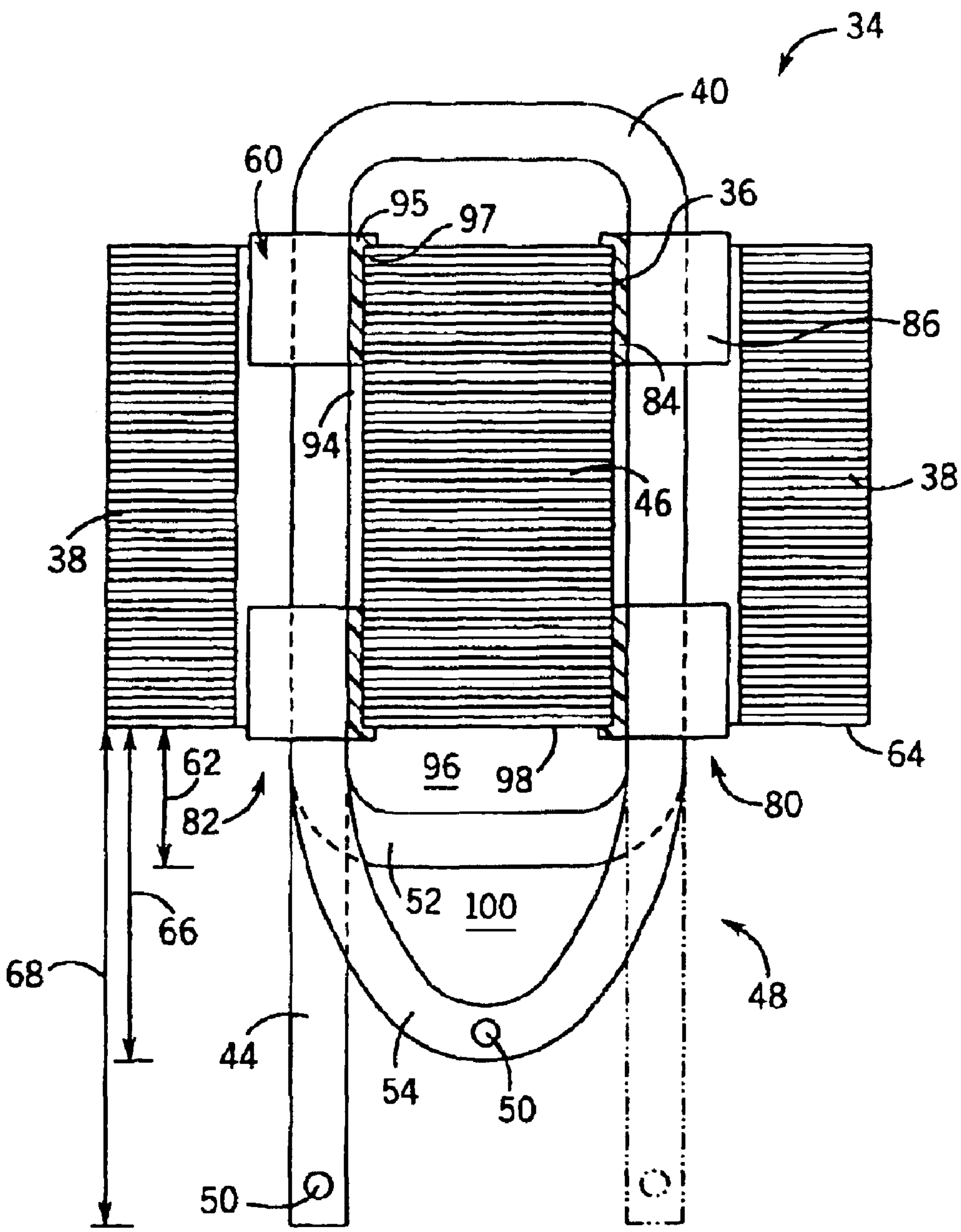
FIG. 4

FIG. 5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ELECTRICAL REACTOR ASSEMBLY HAVING CENTER TAPS

BACKGROUND OF INVENTION

The present invention relates generally to welding-type devices and, more particularly, to an electrical reactor assembly having a plurality of electrical taps formed in the windings of the reactor.

Reactor assemblies are commonly used in welding-type devices to condition and control a power signal so that it may be used in supplying power such as in a welding process. For example, reactor assemblies are often implemented in the electrical circuitry of a welding-type device to control the current provided to the work-piece and supplied by a boost converter assembly. Boost converters are frequently used so that the welding-type device may be operated on a variable voltage source. That is, the boost converter enables the welding-type device to be operable with voltages ranging typically from 115 volts to 230 volts. Typically, the signal is input to a rectifier that in turn outputs the rectified power signal to the boost converter for conditioning whereupon the boost converter outputs a conditioned signal to the inverter of the welding-type device and creates AC power for transformers of the welding-type device.

Additionally, internal combustion engines have often been incorporated into welding-type devices so that the entire device is portable. Welding-type devices that include internal combustion engines as a power supply, generate an electrical signal such that the devices can power both a welding-type device as well as multiple electrical outlets. These devices generally include a generator to supply power for accessories. The combination of the engine to the welding-type device makes the welding device portable and also provides a remote source of power for tools such as grinders, drills, and saws.

Regardless of the source of the power supply, i.e. a wall plug or a portable engine, the electrical signal preferably needs to be conditioned and controlled by passage through a reactor. Typically, the reactor includes of a ferrite core and several turns of magnetic wire. The magnetic wire is generally isolated from the ferrite core through the use of foil insulation around the core or by insulating the wire itself. The reactor needs to electrically insulate individual windings from both adjacent windings and from the ferrite core. The insulation requirement often creates a reactor assembly with a generally closed construction. The closed construction of the reactor assembly inhibits cooling of the reactor. Reactors generally generate a considerable amount of heat due to the relatively high voltages and currents that pass therethrough. The generation of heat signifies electrical losses within the welding device. The closed construction of reactors inhibits cooling of the reactor which in turn increases the inefficiencies of the reactor which in turn reduce the overall efficiency of the welding-type device. The heat generation of the reactor is also detrimental to the reactor itself and can effectively shorten the operating life of the reactor. Additionally, the thermal losses that exist, are generated along the entire length of the wire of the reactor that is utilized to condition and control the electric signal passed through the reactor. These thermal inefficiencies result in increased operating expenses whether from increased fuel consumption by the engine or electrical power consumption.

It would therefore be desirable to design a reactor with multiple taps to limit the length of the reactor that is unnecessarily powered. It is also desirable to design a reactor that is sufficiently cooled during operation to reduce

thermal inefficiencies of the welding-type device and prevent premature failure of the reactor. It would also be desirable to design the reactor that is easily and inexpensively assembled.

BRIEF DESCRIPTION OF INVENTION

The present invention is directed to a reactor for a welder-type device. Preferably the reactor includes a plurality of comb-like structures that provide electrical isolation of a wire wound onto a coil about a T-core. The coil includes a plurality of common windings and a plurality of tap windings. The comb-like structures also provide electrical isolation between adjacent windings. The tap windings extend past the common windings along a common side of the T-core. Additionally, a pair of L-cores is attached to the T-core such that the L-cores flank opposing sides of the coil. All of which overcome the aforementioned drawbacks.

Therefore in accordance with a first aspect of the present invention, an electrical reactor is disclosed. The electrical reactor has a magnetic core. A wire is wound concentric to the magnetic core to form a coil. A plurality of taps is formed integrally in the wound wire by extending a plurality of individual windings beyond adjacent windings.

In accordance with another aspect of the present invention, an apparatus to provide multiple voltages to a welder-type device is disclosed. The apparatus includes a magnetic T-core and a pair of magnetic L-cores. A wire is wound about the T-core multiple times thereby forming a plurality of windings which thereby form a coil. A selected number of the windings are wound with a larger air gap than the air gap formed by a majority of the windings.

In accordance with yet another aspect of the present invention, a reactor includes a T-core with a wire wound about a vertical portion of the T-core to form a coil. The coil has a plurality of common windings and a plurality of tap windings. A pair of L-cores is attached to the T-core and thereby forms a first and a second window. The tap windings are formed by passing a winding from the first window to the second window and extending the tap winding farther from the vertical portion of the T-core than the common windings.

In accordance with yet another aspect of the present invention, a method of assembling a reactor is disclosed. The method comprises the steps of positioning a comb-like separator adjacent a T-core, winding a wire snuggly about the comb-like separator to form a common winding profile about the T-core, forming a plurality of tap windings by leaving a substantial gap between the tap winding and adjacent windings at a predetermined number of turns, and attaching a pair of L-cores to the T-core.

Various other features, objects and advantages of the present invention will be made apparent from the following detailed description and the drawings.

BRIEF DESCRIPTION OF DRAWINGS

The drawings illustrate one preferred embodiment presently contemplated for carrying out the invention.

In the drawings:

FIG. **1** is a perspective view of the welding device according to the present invention.

FIG. **2** is a perspective view of an electrical reactor assembly used in the welding device shown in FIG. **1**.

FIG. **3** is a side elevational view of the electrical reactor assembly shown in FIG. **2**.

FIG. **4** is a cross-sectional exploded side, elevation view of the electrical reactor assembly shown in FIG. **2**.

FIG. **5** is a cross-sectional top view at line **5**—**5** of the electrical reactor assembly shown in FIG. **4**

DETAILED DESCRIPTION

As one skilled in the art will fully appreciate, the hereinafter description of welding devices not only includes welders, but also includes any system that requires high power outputs, such as heating and cutting systems. Therefore, the present invention is equivalently applicable with any device requiring high power output, including welders, plasma cutters, induction heaters, and the like. Reference to welding power, welding-type power, welding device, welder-type device, welder device, or welders generally, includes welding, cutting, or heating power. Description of a welding apparatus illustrates just one embodiment in which the present invention may be implemented. The present invention is equivalently applicable with any power system requiring multiple.

FIG. **1** shows a welding device **10**. Welding device **10** includes a housing **12** which encloses the internal components of the welding device including, a reactor assembly as will be described in greater detail below. Optionally, welding device **10** includes a loading eye **14** and/or fork recesses **16**. Loading eye **14** and fork recesses **16** facilitate the portability of welding device **10**. Optionally, the welding device could include a handle and/or wheels as a means of device mobility. Housing **12** also includes a plurality of access panels **18**, **20**. Access panel **18** provides access to a top panel **22** of housing **12** while access panel **20** provides access to a side panel **24** of housing **12**. A similar access panel is available on an opposite side. An end panel **26** includes a louvered opening **28** to allow for air flow through housing **12**.

Housing **12** of welding-type device **10** also houses an internal combustion engine. The engine is evidenced by an exhaust **30** and a fuel port **32** that protrude through housing **12**. Exhaust **30** extends above top panel **22** of housing **12** and directs exhaust emissions away from the welding-type device **10**. Fuel port **32** preferably does not extend beyond top panel **22** or side panel **24**. Such a construction protects fuel port **32** from damage during transportation and operation of welding-type device **10**. Although shown to include an engine, the present invention is equally applicable to welding-type devices that require an external power source.

Housing **12** protects the internal combustion engine and the internal components of welding-type device **10** or internal generator components. One such component is a reactor assembly **34** as shown in FIG. **2**. Reactor assembly **34** includes a T-core **36** and a pair of L-cores **38**. T-core **36** and L-cores **38** are preferably formed of a ferrite material with desirable magnetic attributes. A wire **40** is wound from a first end **42** to a second end **44** about a vertical portion **46** of T-core **36** to form a coil **48**. First end **42** and second end **44** of coil **48** each include a wire hole **50**. Wire holes **50** provide electrical supply connections to wire **40** of coil **48**. Coil **48** includes a plurality of common windings **52** and a plurality of tap windings **54** formed between first end **42** and a second end **44** of coil **48**. Tap windings **54** provide electrical access to coil **48** at different potentials by extending further from T-core **36** than common windings **52**. Preferably, wire holes **50** provide electrical access to coil **48** at tap windings **54**. Assuming coil **48** is energized from first end **42** through one of the tap windings **54**, that portion of the coil **48** outside of this circuit would not be energized and therefore would not generate thermal losses. That is, no more of the reactor needs to be powered than is necessary for the desired device output. This ability thereby reduces overall losses when compared to a reactor without tap windings.

FIG. **3** shows a side view of the reactor assembly **34** of FIG. **2**. Common windings **52** and tap windings **54** are separated by a distance **56**. Distance **56** is determined by a fin of comb-like separator, as will be addressed in reference to FIG. **4** below. Distance **56** is uniform throughout coil **48**. Additionally, common windings **52** extend a distance **62** from a side surface **64** of L-core **38**. Tap windings **54** extend a distance **66** from side surface **64** of L-core **38** that is farther than common winding distance **52**. In one embodiment, first end **42** and second end **44** of wire **40** of coil **48** extend a distance **68** from side surface **64** of L-core **38** that is still further than tap winding distance **66**. As such, first end **42** and second end **44** extend further from L-core **38** than tap windings **54** which in turn extend further from L-core **38** than common windings **52**. Additionally, coil **48** does not extend into an upper portion **70** and a lower portion **72** of reactor assembly **34**.

FIG. **4** shows upper portion **70** and lower portion **72** of reactor assembly **34** in a broken and partially exploded view. The upper and lower portions **70**, **72** connect a plurality of horizontal portions **74** of L-cores **38** and a horizontal portion **76** of T-core **36**. Horizontal portions **74** of L-cores **38** are attached to vertical portion **46** of T-core **36** at lower portion **72** of reactor assembly **34**. A vertical portion **78** of L-cores **38** is attached to horizontal portion **76** of T-core **36** at upper portion **70** of reactor assembly **34**. This construction, when assembled, forms a first window **80** and a second window **82** through reactor assembly **34**. Positioned in first window **80** and second window **82**, along vertical portion **46** of T-core **36**, are comb-like separators **60**. These comb-like separators **60** each have a longitudinal base **84** adjacent vertical portion **46** of T-core **36**. Extending from longitudinal base **84** of comb-like separators **60** are a plurality of fins **86**. The thickness of fins **86** determines distance **56** between adjacent windings as discussed with respect to FIG. **3** and is generally selected to snuggly retain the windings therein. Referring back to FIG. **4**, wire **40** is snuggly disposed between adjacent fins **86** of comb-like separator **60**. Comb-like separator **60** provides electrical isolation of wire **40** from adjacent windings and from T-core **36**. Additionally, comb-like separator **60** extends past wire **40** toward L-cores **38** to provide the necessary gap between wire **40** and the L-cores **38** of coil **48**.

As shown in FIG. **4**, wire **40** has a rectangular cross section **88** that forms a pair of short sides **90** and a pair of long sides **92**. One of short sides **90** of wire **40** is wound adjacent separator base **84** of comb-like separator **60**. Long sides **92** of wire **40** are parallel to fins **86** of comb-like separator **60**. In effect, wire **40** is edge wound about vertical portion **46** of T-core **36**. An end portion **93** of fins **86** of comb-like separator **60** is not in direct contact with wire **40**. End portion **93**, not only provides the aforementioned gap, but also further protects wire **40** and provides improved cooling of wire **40** by functioning similar to a fin of a heat sink. In effect, end portion **93** dissipates heat from wire **40** to the atmosphere.

FIG. **5** is a top view of the reactor assembly **34** of FIG. **4** broken at line **5**—**5**. Common windings **52** and tap windings **54** of coil **48** surround vertical portion **46** of T-core **36**. Comb-like separators **60** maintain a gap **94** between the coil **48** and vertical portion **46** of T-core **36**. Gap **94** is determined by the thickness of separator base **84** of comb-like separator **60**. Base **84** of comb-like separator **60** also has an L-shaped cross-section **95**. L-shaped cross-section **95** of base **84** of comb-like separator **60** positions comb-like separator **60** on a corner **97** of vertical portion **46** of T-core **36**. Although FIG. **5** shows four independent separators **60**, it is within the scope of the present disclosure and claims that the number of separators can vary so long as isolation is maintained between adjacent coil windings and the magnetic core.

An air space **96** is defined generally by the space enclosed by common winding **52** and a side **98** of vertical portion **46** of T-core **36**. A second air gap **100** is defined as a space generally enclosed by tap winding **54** and side **98** of vertical portion **46** of T-core **36**. Tap windings **54** extend further from side **98** of vertical portion **46** of T-core **36** than common windings **52**. Additionally, tap windings **54** include wire holes **50** for improved electrical connectivity to the reactor assembly **34** at tap windings **54**. The structure of reactor assembly **34** provides access to multiple predetermined electrical parameters of coil **48** while also providing a structure that limits thermal losses of the reactor assembly **34** of the welding device **10**.

Therefore in accordance with an embodiment of the present invention, a magnetic core of an electrical reactor is provided. A wire is wound concentric to the magnetic core to form a coil. A plurality of taps is formed integrally in the wound wire by extending a plurality of individual windings beyond adjacent windings.

In accordance with another embodiment of the present invention, an apparatus to provide multiple voltages to a welder-type device is provided. The apparatus includes a magnetic T-core and a pair of magnetic L-cores. A wire is wound about the T-core multiple times thereby forming a plurality of windings which thereby form a coil. A selected number of the windings are wound with a larger air gap than the air gap formed by a majority of the windings thereby forming electrical taps in the coil of the reactor assembly.

The present invention includes a reactor with a T-core and a wire wound about a vertical portion of the T-core to form a coil. The coil has a plurality of common windings and plurality of tap windings. A pair of L-cores is attached to the T-core and thereby forms a first and a second window. The tap windings are formed by passing a winding from the first window to the second window and extending the winding further from the vertical portion of the T-core than the common windings.

The present invention also includes a method of assembling a reactor. The method includes the steps of positioning a comb-like separator adjacent a T-core, winding a wire snuggly about the comb-like separator to form a common winding profile about the T-core, forming a plurality of tap windings by leaving a substantial gap between the tap winding and adjacent windings at a predetermined number of turns, and attaching a pair of L-cores to the T-core.

The present invention has been described in terms of the preferred embodiment, and it is recognized that equivalents, alternatives, and modifications, aside from those expressly stated, are possible and within the scope of the appending claims.

What is claimed is:

1. An apparatus to provide multiple voltages to a welder-type device comprising:

a magnetic T-core and a pair of magnetic L-cores; and

a wire wound about the magnetic T-core a plurality of times forming a plurality of windings thereby forming a coil, wherein a selected number of windings are wound with a larger air gap between the wire and the magnetic T-core than that formed by a majority of the windings.

2. The apparatus of claim **1** wherein the wire has a rectangular cross-section.

3. The a status of claim **2** further comprising at least one comb-like separator located between the coil end the T-core to electrically insulate the plurality of windings from adjacent windings and from the T-core.

4. The apparatus of claim **1** wherein the majority of the windings are wound to form a defined air gap between the winding mud the magnetic T-core.

5. The apparatus of claim **1** wherein the taps are aligned along one side of the coil.

6. The apparatus of claim **2** wherein the air gap formed by the majority of the windings is larger than a thickness of the wire.

7. The apparatus of claim **3** wherein the comb-like separator has a plurality of uniform recesses that receive the wire and a plurality of uniform fingers located between the plurality of windings.

8. The apparatus of claim **1** wherein the majority of windings have a substantially rectangular cross-section.

9. The apparatus of claim **3** wherein the wire fits snuggly on three sides of the comb-like separator.

10. A reactor comprising:

a center core having a vertical portion and a horizontal portion;

a wire wound about the vertical portion of the center core thereby forming a coil;

the coil having a plurality of common windings and a plurality of tap windings; and

a pair of end cores attached to the center core to form a first and a second window wherein the tap windings are formed by passing a winding from the first window to the second window and extending the wire further from the vertical portion of the center core than the common windings.

11. The reactor of claim **10** wherein the wire has a rectangular cross-section with the longer side of the cross-section parallel to a horizontal portion of the center core.

12. The reactor of claim **10** further comprising a seperator located between the coil and center core to provide separation of adjacent coil windings.

13. The reactor of claim **10** wherein the tap windings are aligned parallel to an axis of the vertical portion of the center core.

14. The reactor of claim **10** wherein the plurality of tap windings include at least two tap windings.

15. The reactor of claim **10** wherein the plurality of tap windings are on a common side of the reactor.

16. The reactor of claim **10** further comprising at least one separator that extends past an end surface of the center core and separates adjacent windings.

17. A method of assembling a reactor comprising:

(A) positioning a comb-like separator adjacent a T-core;

(B) winding a wire snuggly about the comb-like separator to form a common winding profile about the T-core;

(C) winding the wire less snuggly to form a tap winding profile about the T-core;

(D) repeating steps (B) and (C) but winding the wire more often in accordance with step (B) that step (C);

(E) attaching a pair of L-cores to the T-core.

18. The method of claim **17** further comprising welding the L-cores to the T-core.

19. The method of claim **17** wherein positioning a comb-like separator adjacent a T-core is repeated four times.

20. The method of claim **17** wherein the tap windings are coaxially aligned.

21. The method of claim **17** wherein the wire has a rectangular cross-section.

22. The method of claim **21** wherein a short side of the rectangular cross-section is wound parallel to a winding surface of the T-core.

23. The reactor of claim **10** incorporated into a welding-type apparatus.

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