ARNOLD SILECTRON CORES

ARNOLD

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INDEX

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SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

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DC Imax. • 2.5V/cell • 1.4 = VA max   600 Cir Mils/A

SILECTRON CORES

PROCESSING

Silectron Cores are manufactured from the highly grain-oriented silicon steel — Silectron. This is a cold-rolled grade of 3% Silicon Steel, manufactured by the Allegheny Ludlum Steel Corporation. It has high saturation flux density and lower core losses and exciting volt-amperes than were previously available from regular silicon steel. The high degree of orientation obtained in Silectron is preserved in both the cut core and gapless construction. This permits operation of the core material at higher inductions, and results in components of lighter weight and smaller size.

The Silectron strip is treated on both sides with a C-10 finish. This finish is an improved chemical and thermal treatment, applied only to Silectron, to provide exceptionally good interlamination resistance with a negligible effect on space factor. The coated strip is slit to the proper width and wound on a mandrel to make a gapless core. The core is then annealed to relieve winding stresses. Gapless cores may be supplied as annealed, or further processed by impregnating with varnish to provide greater rigidity or ease in handling.

Impregnation bonds the core together. In the production of "C" and "E" cores, the annealed and impregnated core is cut so as to produce two core halves. Careful processing of the core and its cut surfaces results in accurately dimensioned core halves whose effective air gap at the butt joint is very small. The total effective air gap length "a" (Formula 4, page 4) will be only .001″ maximum for cores with a gross area of 2¼ square inches or less and a build up of 1″ or less. For larger cores a total effective air gap of .002″ maximum is maintained. Lapped cores may be furnished for applications where the air gap must be reduced to a minimum. The maximum effective air gap of a lapped core is one-half that of the regular guarantee.

Silectron cores are made from strip in standard thickness of 1, 2, 4 and 12 mils. A considerable selection of core sizes is available in each of these thicknesses, as shown in this bulletin. The preferred or stock core sizes, as denoted by asterisks in the tabulations, are recommended for use wherever possible. Cores in non-standard sizes and thicknesses may also be made on special order.

Impregnated Silectron cores are guaranteed for operation at temperatures as high as 300° F under proper conditions of core and coil assembly. In many instances higher operating temperatures may be maintained.

MATERIAL THICKNESS IDENTIFICATION

Identification of each cut core is accomplished by stamping the part number on one side of the core. The part number is located in such a way that the core halves can be readily paired in the same relative position as when cut. For ease in maintaining this relative position during transformer assembly, an identifying mark is also placed on the top side of the core at each end. Each cut core is packaged individually by tying with a loop of colored string and plastic dipping. To indicate tape thickness in mils, the string color follows the EIA color code. The written prefix of the part number is also a code to the thickness of the strip.

MATERIAL THICKNESS	PART NUMBER PREFIX	STRING COLOR
1 mil	AM	Brown
2 mil	AL	Red
4 mil	AH	Yellow
4 mil	AZ	Yellow – Black
12 mil	AA	Brown – Red

PART NUMBER DESIGNATION

The part numbers used for Silectron cut cores are the same as the part numbers established by the Westinghouse Electric Corporation for this type of core, with certain exceptions. All Silectron cut cores are prefixed with the letter "A," indicating manufactured by The Arnold Engineering Company. The second letter of the prefix usually indicates the thickness of the core material, as tabulated above. Thus, a Westinghouse H-1 becomes an Arnold Engineering AH-1. Core numbers which have four digits are cores which are indigenous to The Arnold Engineering Company, or for which there are no known equivalent Westinghouse parts.

Three phase cores are numbered on the same basis, except the letter "T" is used in the prefix. Thus, a typical Arnold Engineering three phase part number would be ATH-1199. An equivalent to the Westinghouse part TH-45 would be ATH-45.

Uncut core part numbers have four or five digits, preceded by the letter "T" to indicate a tape core and followed by the letter "L" to signify Silectron, and a number to indicate the tape thickness in mils. Thus, a typical part number of an uncut, unimpregnated, cased core of four mil Silectron would be T4180-L4. The letter "V" may follow this part number to indicate that the core is impregnated. A more detailed explanation of this nomenclature is found on page 37.

E1250 = 883VA/inch build

POWER HANDLING CAPACITY

It should be noted that the cut core tabulations in this bulletin are in order of increasing power handling capacity as denoted by the product of core cross-section and window area (D×E×F×G). In the case of 12 mil cores, this product times 100 is an approximation to the maximum power in watts that a pair of cores can handle under normal conditions at 60 cps and 15 KB. For cores of other tape thicknesses, and for operation at other frequencies and inductions, this proportionality constant will be different. This system of cataloging cores was suggested by Mr. Herbert French of Newton Engineering Service.

Tabulations of cut core sizes in the past have been made on the basis of their increasing order of core weight, window width, core area or by part number sequence. It is believed that the system described above will assist the transformer designer in his selection of a standard core size which will most closely fit his application. It should help to eliminate from common usage those cores which have a high ratio of weight to power handling capacity.

DESIGN FORMULAE

The testing and design of transformers and reactors utilizing Silectron cores may be based upon the following formulae, which include the calculation of core weight, volts per turn, core loss, exciting current and inductance.

In all of these calculations, the following stacking factors should be used:

12 mil	0.95
4 mil	0.90
2 mil	0.89
1 mil	0.83

Nominal core weight (Wt.) may be calculated by the equation:

$$\text{Wt.} = .276\ S \times D \times E\ (2F + 2G + 2.9E) \qquad (1)$$

Where:
- Wt. = nominal core weight in pounds.
- .276 = density of Silectron in pounds per cubic inch.
- S = stacking factor.
- D = strip width in inches.
- E = build-up in inches.
- F = window width in inches.
- G = window length in inches.

The number of volts per turn (V/N) corresponding to a given value of induction and frequency may be calculated by the equation:

$$\frac{V}{N} = 2.865\ B \times f \times A \times S \times 10^{-4} \qquad (2)$$

Where:
- V = rms volts.
- N = number of turns.
- B = induction in kilogausses.
- f = frequency in cycles per second.
- A = gross core area in square inches (D×E).
- S = stacking factor.

The maximum core loss, P_c in watts may be calculated by the equation:

$$P_c = \text{Wt.} \times \text{W/lb.} \qquad (3)$$

Where:
- P_c = core loss in watts.
- Wt. = nominal core weight in pounds.
- W/lb. = max. design curve value of watts per pound corresponding to the desired frequency and induction. Refer to Figures 7, 9, 10.

The maximum exciting current (I) may be calculated by the equation:

$$I = \frac{\text{Wt.} \times \text{VA/lb.}}{V} + \frac{1.43 \times B \times a \times S \times 10^3}{N} \qquad (4)$$

Where:
- I = rms exciting current in amperes.
- Wt. = core weight in pounds.
- V = rms volts corresponding to B and N.
- B = induction in kilogausses.
- N = number of turns.
- a = effective air gap length in inches.
  - a = .001″ when $D \times E \leq$ 2-1/4 in² or $E \leq 1''$
  - a = .002″ when $D \times E >$ 2-1/4 in² or $E > 1''$
- S = stacking factor.
- VA/lb. = maximum design value of apparent watts per pound corresponding to the desired frequency and induction. Refer to Figures 8, 9, 11.

The exciting current, as calculated by the equation above, is made up of two factors. The first term of the equation gives the exciting current requirement of the core material. The second term gives the exciting current required by the gap. For gapless cores the second term is, of course, omitted.

The inductance of a reactor or choke may be calculated by the equation:

$$L = \frac{3.2 \times N^2 \times A \times 10^{-8}}{a + \frac{l}{\mu_\Delta}}$$

Where:
- L = inductance in henries.
- N = number of turns.
- A = gross core area in square inches (D×E).
- a = effective air gap length in inches.
- l = core length in inches (2F + 2G + 2.9E).
- μ_Δ = incremental permeability under conditions of ac or dc magnetization present in the core.

V/N = 0.245·A C-core   V/N = 0.196·A for E-Lam

N/V = 43/A

0.18 · A = $\frac{V}{N}$ = E Type form.

1 AND 2 MIL "C" CORES

The 1 and 2 mil Silectron "C" cores are used primarily in pulse transformers. However, they also find considerable use in high frequency transformer applications, and in devices such as charging chokes having high frequency components of exciting current.

The use of 1 and 2 mil thicknesses is an advantage only at comparatively high frequencies, since their core loss and excitation characteristics at low frequencies are somewhat poorer than those of the 4 and 12 mil thicknesses. This can be seen by a comparison of the curves on Figures 2, 3, 5 and 6 with those of Figures 7, 8, 10 and 11. As indicated by the dc data on the oriented silicon steels (Figures 13 — 21), the thinner material has higher coercive force than the thicker material. The advantage in using the 1 mil and 2 mil thicknesses results primarily from their lower eddy current losses at high frequencies.

The 1 and 2 mil Silectron "C" cores are normally tested only for pulse permeability since most of the applications are for pulse transformers. The 1 mil type "AM" cores are measured at 0.25 microsecond, 2.5 kilogausses and 1000 pulses per second. Under these conditions, the minimum pulse permeability is 300 for the normal range of core sizes. However, 1 mil cores which are unusually small or large, or made from tape widths exceeding 1″, may have lower pulse permeability. The 2 mil type "AL" cores are measured at 2 microseconds, 10 kilogausses, 400 pulses per second. Under these conditions, the minimum pulse permeability is 600 for the normal range of core sizes. Two mil cores which are unusually small or large, or made from tape widths greater than 2″, may have lower pulse permeability.

It should be pointed out that optimum pulse permeability for larger cores may be realized only by shimming the gap between the core halves with insulating shims. This usually applies only to cores weighing more than 2 or 3 pounds, in which case the ratio of length of iron to length of air path is exceptionally large. This results in a high value of residual induction. The introduction of an air gap reduces the residual induction of the cut core and results in a larger change in incremental induction, ΔB, for the same applied peak pulse magnetizing force, H_m. In cases where a resetting or biasing magnetomotive force is available, it may not be necessary to introduce a gap between the core halves to obtain optimum pulse permeability. By applying a resetting mmf to the core it is possible to use a gapless core in pulse transformers and realize high values of effective pulse permeability.

Pulse testing of 1 and 2 mil cut cores is performed on a 100% basis. To accommodate the wide range of core sizes manufactured, test equipment is used which covers a range of pulse lengths from .05 to 10 microseconds with pulse power as high as 10 megawatts, at repetition rates up to 1000 pulses per second.

In order to determine the volts per turn required for the pulse testing of cores or design of pulse transformers, the following equation is used:

$$\frac{V}{N} = \frac{6.45\ A \times S \times \Delta B}{t \times 10^8} \qquad (6)$$

Where: V = peak voltage at end of pulse in volts.
N = number of turns.
A = gross core area in square inches (D×E).
S = stacking factor.
t = pulse length in seconds.
ΔB = induction change in gausses.

The pulse permeability is calculated as:

$$\mu_e = \frac{\Delta B \times l \times 2.54}{.4\ \pi\ N I_m} \qquad (7)$$

Where: μ_e = effective pulse permeability at end of pulse.
I_m = peak exciting current in amperes.
l = core length in inches (2F+2G+2.9E).

High frequency applications for 1 and 2 mil "C" cores require testing for core loss and exciting current under operating conditions. The standard pulse test given these cores may not be indicative of their core loss or excitation characteristics at other frequencies. Figures 2, 3, 5 and 6 represent typical values of these properties over a frequency range from 60 cps to 100 kc. Guaranteed values under specific operating conditions may be established only after consultation with The Arnold Engineering Company. Core loss and exciting current may be tested up to 20 kc or higher. Equipment for supplying 10 kilowatts up to 10 kc or 5 kilowatts up to 20 kc is available for this purpose. Equipment is also available for supplying 200 watts up to 100 kc for test work.

The 3 mil non-oriented silicon steel which was used in the older pulse transformer designs has now been largely replaced with the newer 2 mil and 4 mil oriented grades. Although not recommended, 3 mil cores will be made to special order.

4 MIL SILECTRON "C" CORES

The 4 mil Silectron "C" cores are made in two different grades of material which carry different type numbers. Both types, the "AH" and "AZ," are generally used at 400 cps in transformer applications. They are also used in filter chokes, reactors and magnetic amplifiers at 400 cps, and in pulse transformers and many other magnetic components at higher frequencies.

The "AZ" type core is preferred for applications in which the core is operated at inductions above 16 kilogausses because of its higher permeability at high inductions. The core loss of the "AZ" type core, however, is practically the same as for the "AH" type.

At lower inductions the 4 mil cores can be used over a wide frequency range. The choice between a 4 mil and a 2 mil or 1 mil core would depend upon the frequency and induction specified. The choice of material thickness may be determined by reference to Figures 5, 6, 7 and 8. In comparing the 2 and 4 mil data, it should be remembered that the 2 mil curves (Figs. 5 and 6) show "typical values," whereas the 4 mil curves (Figs. 7 and 8) show maximum design values. The 2 mil curve values should be increased by approximately 30% in order to make a true comparison with the 4 mil curves.

The high normal and incremental permeabilities at inductions up to 15 kilogausses make 4 mil cores suitable for many types of filter chokes and reactors. These permeabilities are a function of core geometry, as well as the incremental induction and the dc magnetizing force applied to the core. Reference to Figure 12 will indicate how the normal permeability varies as a function of mean length of magnetic path for a peak induction of 10 kilogausses at 60 cps. The permeability shown in Figure 12 is calculated on the basis of the maximum permissible gap at the butt joint. For a comparison of the permeability which might be obtained with other gaps, refer to Figure 23. Smaller gaps may be obtained by lapping and larger gaps may be obtained by the insertion of non-conducting shims.

Magnetic amplifier applications require a core with a rectangular hysteresis loop and with sharp saturation characteristics. The 4 mil Silectron "C" cores meet these requirements and are used in many 400 cps power magnetic amplifiers. Reference to Figs. 17, 19 and 22 shows that the "AZ" type of 4 mil Silectron is the obvious choice for this application. However, the "AH" type may also be used with good results. It is desirable to lap either type of core in this application to reduce the air gap and avoid excessive shearing over of the hysteresis loop, particularly with small cores.

Pulse transformers may use 4 mil cores in many instances with some reduction in incremental inductions. This is particularly true in designs with pulses of long duration (five microseconds or greater), low duty cycle, and where a short rise time is not required.

High frequency application requirements may be satisfactorily met with 4 mil cores. They must be designed, however, for a peak induction which will stay within the core loss and exciting current ratings of the unit. Where a range of frequencies is encountered, the design should be based upon the lowest frequency at which the unit must operate. A paramount reason why Arnold 4 mil Silectron cores may be used successfully at frequencies above 400 cps is the fact that the material does not exceed a maximum thickness of 4 mils. Since the average thickness is somewhat less than 4 mils, improved high frequency operation is possible.

The 4 mil type "AH" cores meet the electrical guarantees shown below when tested at 400 cps and 15 kilogausses. The type "AZ" cores are measured at 400 cps and 17.6 kilogausses. The guaranteed values are based on the nominal core weight as published in this catalog.

TYPE	PEAK INDUCTION AND FREQUENCY	MAXIMUM CORE LOSS—W/lb.	MAXIMUM VOLT AMPERES —MATERIAL PLUS GAP ALLOWANCE
AH	15 Kilogausses, 400 cps	10.0	13.1 × Wt. + 29.9 × A*
AZ	17.6 Kilogausses, 400 cps	15.0	39.5 × Wt. + 41.1 × A**

*When gross core area (A) exceeds 2¼ square inches, or build up (E) exceeds 1", or window width (F) is 1⅝" or more, or window length (G) is 4⅝" or more, use 59.8 × A in place of 29.9 × A.

**When gross core area (A) exceeds 2¼ square inches, or build up (E) exceeds 1", or window width (F) is 1⅝" or more, or window length (G) is 4⅝" or more, use 82.2 × A in place of 41.1 × A.

Arnold 4 mil "C" cores are manufactured to specifications that meet the requirements set forth in EIA Standard RS-217 for wound cut cores.

12 MIL SILECTRON "C" CORES

In shell type transformers the power handling capacity in watts of a pair of cores for normal 60 cps conditions is approximated by the value shown in the last column of the part number tabulation. This column tabulates power handling capacity as denoted by 100 times the product of core cross-section and window area. For example, the AA-519 core, for which this factor is shown as 3080, is a very popular core for a 2.5 kva shell type distribution transformer.

The "AA" cores are used almost exclusively at power frequencies for transformers, filter chokes, reactors and magnetic amplifiers.

In transformer applications inductions as high as 18 kilogausses may be used without excessive core losses. However, exciting currents increase very rapidly above 15 kilogausses, and copper losses rather than core losses will usually be the limiting factor at higher inductions. Allowance for over-voltage characteristics must be made when establishing normal core operating inductions because of the sharper saturation characteristics of Silectron at high inductions.

Filter choke and reactor applications use Silectron cut cores because of their high normal and incremental permeabilities at inductions ranging up to 15 kilogausses. These permeability values are a function of core geometry, as well as of incremental flux change and dc magnetizing force. Reference to figure 12 will indicate the effect of mean core length on normal permeability at 60 cps and 10 kilogausses. Reference to figure 23 will show the effect of other air gaps upon the value of normal permeability.

In magnetic amplifier applications the rectangularity of the hysteresis loop and the high saturation density of Silectron are of major interest. It is necessary in such applications for the core to saturate sharply at a definite value of induction; below this point it must have relatively high permeability. These characteristics are obtained in a Silectron cut core by virtue of the high degree of orientation of the material and by minimizing the effective air gap. Cores with short magnetic path lengths may require lapping to reduce the air gap further and thereby avoid excessive shearing over of the hysteresis loop. The effective air gap becomes less critical in a core with a long magnetic path length because of the smaller ratio of effective air gap length to total magnetic path length.

Twelve mil "C" cores meet the following electrical guarantees when tested at 60 cps and 15 kilogausses:

TYPE	MAXIMUM CORE LOSS W/lb.	MAXIMUM VOLT AMPERES —MATERIAL PLUS GAP ALLOWANCE
AA	0.9	1.70×Wt.+5.0×A*

*When gross area (A) exceeds 2¼ square inches, or build up (E) exceeds 1", or window width (F) is 1⅝" or more, or window length (G) is 4⅝" or more, use 10.0 × A in place of 5.0 × A.

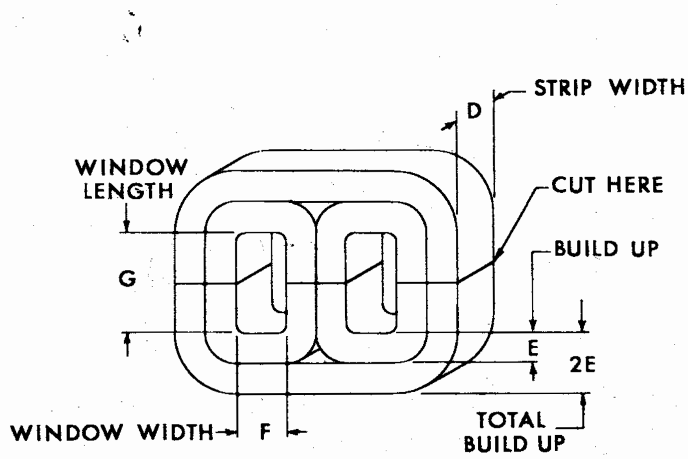
Arnold 12 mil "C" cores are manufactured to specifications that meet the requirements set forth in EIA Standard RS-217 for wound cut cores.

12 MIL AND 4 MIL SILECTRON "E" CORES

Three phase "E" cores are made in 12 or 4 mil Silectron in a wide range of core sizes. The 4 mil cores may be made in either the ATH or ATZ types. "E" cores permit construction of very compact three phase transformers which are smaller in size and weight than similar designs using three single phase cores.

Three phase "E" cores may be operated at the same flux densities as single phase "C" cores of the same strip thickness. Exciting current requirements also are similar to those for "C" cores, with an air gap allowance required for each leg. The core losses, however, will be greater because of third harmonic flux. Therefore, the maximum core loss limit will be 20% greater than for a single phase core.

"E" cores are tested with three phase delta connected excitation. Under this condition they will meet the following guarantees for total core loss and excitation:



TYPE	FREQUENCY CPS	INDUCTION KILOGAUSSES	MAXIMUM CORE LOSS W/lb.	MAXIMUM VOLT AMPERES PER LEG—MATERIAL PLUS GAP ALLOWANCE
ATA	60	15	1.08	1.75 × Wt. + 5.0 × A*
ATH	400	15	12.0	13.1 × Wt. + 29.9 × A**
ATZ	400	17.6	18.0	39.5 × Wt. + 41.1 × A***

*When gross area (A) exceeds 2¼ square inches, or build up (2E) exceeds 1", or window width (F) is 1⅝" or more, or window length (G) is 4⅝" or more, use 10.0 × A in place of 5.0 × A.

**When gross area (A) exceeds 2¼ square inches, or build up (2E) exceeds 1", or window width (F) is 1⅝" or more, or window length (G) is 4⅝" or more, use 59.8 × A in place of 29.9 × A.

***When gross area (A) exceeds 2¼ square inches, or build up (2E) exceeds 1", or window width (F) is 1⅝" or more, or window length (G) is 4⅝" or more, use 82.2 × A in place of 41.1 × A.

AECo. Part Number	Nominal Weight (lb.)	NOMINAL CORE DIMENSIONS D	E	2E	F	G	Gross Area (D×2E)–in.²	Window Area 2(F×G)–in.²	Relative Power Handling Capacity D×2E×F×G×75
ATA-2	1.22	3/8	3/8	3/4	1-1/4	2-1/2	.281	6.25	66
ATA-7	2.30	1-1/8	1/4	1/2	1-1/4	2-5/8	.563	6.56	139
ATA-5	6.96	1-1/2	1/2	1	1-1/4	2-1/2	1.50	6.25	352
ATA-4	9.48	1-3/8	5/8	1-1/4	1-3/8	3	1.72	8.25	533
*ATA-1	9.03	1-3/4	1/2	1	1-3/8	3	1.75	8.25	541
ATA-1097	14.3	3	1/2	1	1	3	3.00	6.00	676
ATA-3	10.2	1-3/4	1/2	1	1-3/8	3-7/8	1.75	10.7	702
ATA-1412	10.9	1-3/4	1/2	1	1-3/4	3-7/8	1.75	13.6	892
*ATA-6	24.0	2-1/2	3/4	1-1/2	1-3/8	3-7/8	3.75	10.7	1503
*ATA-1193	23.5	2-5/8	9/16	1-1/8	2	5-25/32	2.95	23.1	2555
*ATA-1464	32.5	2-1/2	3/4	1-1/2	3	4-7/16	3.75	26.6	3741
ATA-1242	63.9	3	1-1/16	2-1/8	3	5	6.38	30.0	7145
ATA-1300	80.4	2	1-3/8	2-3/4	2-1/8	11	5.50	46.8	9656
ATA-1399	97.9	3-1/2	1-3/16	2-3/8	3-5/16	6-1/2	8.31	43.1	13423
ATA-1504	81.8	2-1/2	1	2	4	12	5.00	96.0	18013

* Preferred core sizes.

TECHNICAL INFORMATION ON UNCUT CORES

Tape wound toroids of Silectron are available in many sizes, shapes and gages. The toroidal or gapless construction utilizes to best advantage the high permeability and low loss characteristics of oriented silicon steel. These cores have been made in round, oval, tubular, rectangular, "D" and other shapes for a large variety of applications. The range of core sizes possible is virtually unlimited, varying from as little as a few grams to as large as several thousand pounds.

Silectron toroids may be supplied uncased, either with or without varnish impregnation, or with various types of cases as required by the core application. All uncut Silectron cores are designated by a basic four or five digit number preceded by the letter "T," which specifies the tape core size. This is preceded by a number indicating the type of core case according to the following table. A letter designation is used as a suffix to indicate the tape material, followed by a number denoting the material thickness in mils. The letter suffix "V" is used if the core is impregnated.

CORE CASE DESIGNATION

NUMBER PREFIX	CASE TYPE
None	Not cased
1	Aluminum (grease type)
2	Aluminum (oil type)
3	Nylon (grease type)
4	Nylon (oil type)
5	Phenolic (Machined — grease type)
6	Aluminum, insulated and hermetically sealed

A T4180 toroidal core size supplied in a nylon grease-type case of four mil Silectron, not impregnated, would be designated as cased core part number 3T4180-L4. This same core, without a core case and impregnated, would be known as part number T4180-L4V.

Toroids are produced in 12, 4, 2 and 1 mil thicknesses in L-Silectron material. Only the 4 mil thickness is available in the Z type Silectron.

The common applications for uncut Silectron toroids include current, potential and low leakage toroidal transformers, magnetic amplifiers and saturable reactors and magnetic shields.

Current transformers and similar applications ordinarily utilize either 12 mil or 4 mil unimpregnated L-Silectron toroids because of the high maximum permeability and low core loss of this material at inductions up to 12 or 15 kilogausses. These cores are used in the varnish impregnated form where greater mechanical rigidity is required, such as for winding with heavy wire, but where a reduction in permeability and an increase in core loss of the order of 25% can be tolerated. Where the best obtainable core properties are required, an unimpregnated but cased core is recommended.

Magnetic amplifier and saturable reactor applications usually require 12 or 4 mil L-Silectron or 4 mil Z-Silectron. The 12 mil material is usually preferred at 60 cps, whereas the 4 mil is preferred at 400 to 1,000 cps. The Z type Silectron has a more rectangular hysteresis loop and better high density characteristics than the L-Silectron. At higher frequencies the 2 or 1 mil material would be required. It should be remembered that both the hysteresis loop rectangularity, and coercive force of oriented Silicon steel depreciates as the material thickness is reduced below 4 mils. Varnish impregnation of the core also reduces the rectangularity of the hysteresis loop. These effects are illustrated by the dc hysteresis loops of Figures 13 through 21.

Transformers and saturable reactors which must operate at very high temperatures can be made with unimpregnated and cased Silectron toroids. In these applications cases from such non-magnetic materials as aluminum, stainless steel, glass or ceramic may be required to withstand the temperatures involved.

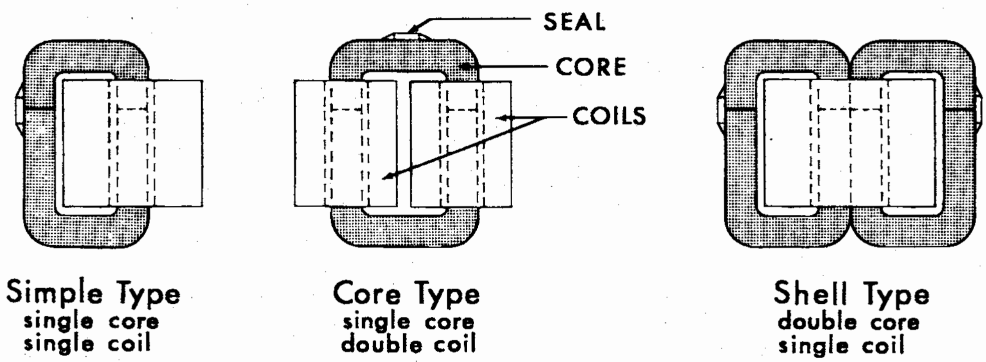
Impregnated and cut toroids with two or more gaps may be provided where the advantage of a gapped toroid is desired, such as for low frequency filters. This construction permits a gapped cut core which can be banded for ease of assembly. Cut cores to fit standard toroidal core cases can readily be provided.

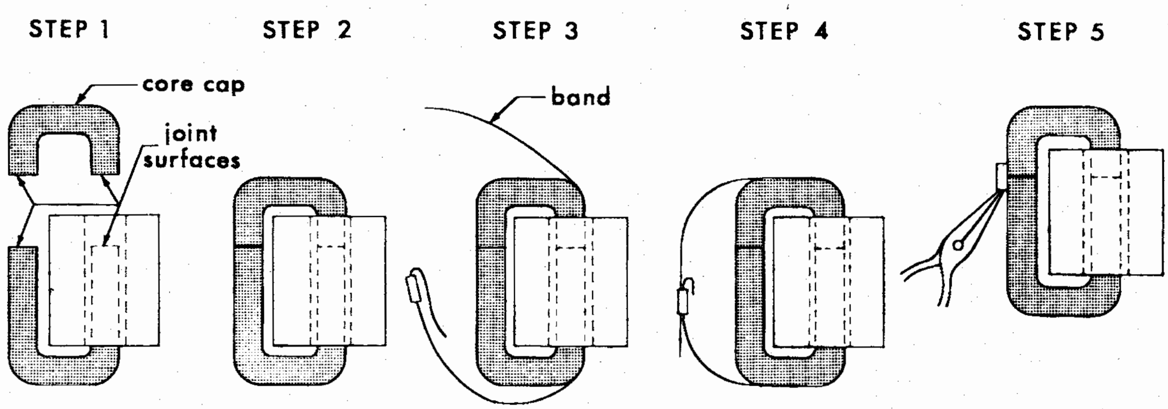
Impregnated Silectron toroids will, in general, meet the same guarantees as the Silectron cut cores, but without the additional volt-ampere requirement allowed for the gap. Unimpregnated and cased Silectron toroids will generally average about 80% of the core loss and exciting volt-ampere limits of the impregnated toroids. This percentage, however, will vary with the material thickness and core size and shape. If specific guarantees are required, they should be referred to The Arnold Engineering Company for evaluation.

In addition to the requirements mentioned above, most Silectron toroids are checked for maximum normal permeability at 60 cps, 10 KB. They may also be checked for permeability at 200 gausses and 60 cps if a low density permeability test is desired. Unimpregnated Silectron toroids with superior low density or high density permeability may be obtained in 12, 4, 2 and 1 mil thicknesses on special order. Specific test limits for these permeabilities have not yet been established.

Additional tests involving various dynamic hysteresis loop parameters of the Silectron core may also be made, as required. Measurement of such parameters may permit grading and matching of cores for magnetic amplifiers and similar applications.

BANDING DATA





Core Strip Width (in.)	Core Cross-Section (D × E)–in²	Band Size (in.)	No. Bands Required	Seal Dimension (in.)	Banding Force (lb.)
Any	.188 or less	3/16 x .006	1	3/16 x 1/4	37.5
3/8 or larger	.188 to .375	3/8 x .006	1	3/8 x 3/8	75
3/8 to 1-1/2	.375 to .75	3/8 x .012	1	3/8 x 3/8	150
1-5/8 or larger		3/8 x .006	2	3/8 x 3/8	75
1/2 to 1-1/8	.75 to 1.5	3/8 x .012	1	3/8 x 3/8	150
1-1/4 or larger		3/8 x .012	2	3/8 x 3/8	150
3/4 or larger	1.5 to 3.0	3/4 x .023	1	7/8 x 1-7/8	600
3/4 or larger	3.0 to 4.25	3/4 x .035	1	7/8 x 1-7/8	900
2 or larger	4.25 to 6.0	3/4 x .023	2	7/8 x 1-7/8	600
3-1/4 or larger	6.0 to 9.0	3/4 x .023	3	7/8 x 1-7/8	600
3-1/4 or larger	9.0 to 13.5	3/4 x .035	3	7/8 x 1-7/8	900

See

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specs