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DYNAMO-ELECTRIC MACHINE

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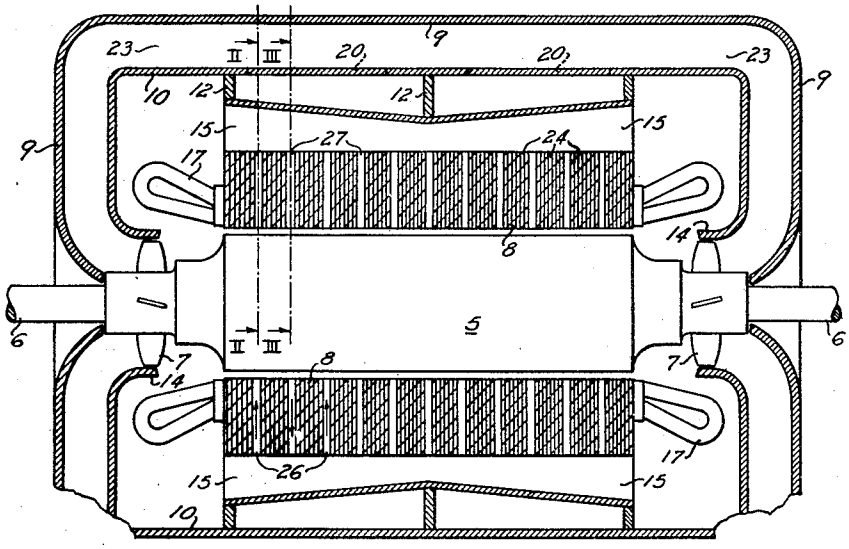


Fig. 1

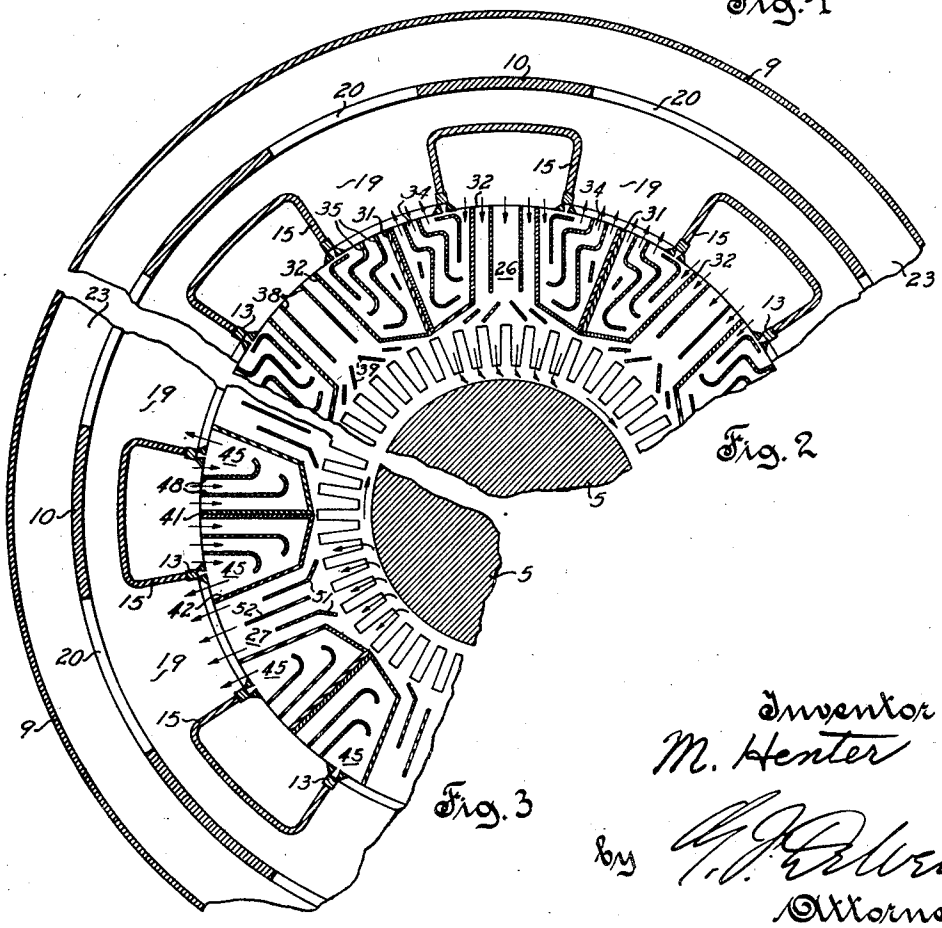


Fig. 2

Fig. 3

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DYNAMOELECTRIC MACHINE

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8 Claims. (Cl. 171—252)

This invention relates in general to dynamo-electric machines, and it has more particular relation to features of design and construction of such machines contributing to effective cooling of interior portions of the core and windings of such machines, and more particularly the stator elements thereof.

Particularly in high speed dynamo-electric machines of the turbo-generator, induction and synchronous motor types, where a machine of relatively small overall dimensions produces or consumes a relatively large amount of electrical power, it is a very considerable problem to effectively ventilate the stator core and windings, embedded in slots of the core, at interior portions of the machine. Various efforts toward effective solution of the problems involved have been offered in the past, the ordinary arrangement including dividing the stator laminations in axially separated groups or bundles, the radial spaces between adjacent groups or bundles being used as paths in which air is circulated between the outer and inner peripheries of the stator and in the air gap. However, while the various prior art arrangements for ventilation are effective to certain degrees, they have the defect that cooling effects on the core and winding embedded therein are uneven, leaving certain portions of the embedded winding and adjacent portions of the core at temperatures considerably higher than is desirable.

The present invention contemplates the provision of features of design and construction of the stator element of a ventilated dynamo-electric machine to provide more effective dissipation of heat from and cooling of the stator core and windings, and more uniform cooling effects on the several conductors of the stator winding; and it contemplates in a preferred embodiment of the invention features of design and construction in accordance with which ventilating air travels through only certain of the radial ventilating spaces of the stator core in a radially inward direction past the core portions adjacent the air gap throughout the entire circumference thereof, and such air, in returning, travels in other radial ventilating spaces radially outward past the core portions adjacent the air gap throughout the entire circumference thereof, and another portion of the available ventilating air passes radially inward and thence outward in both groups of radial ventilating spaces, through segments thereof not utilized as active portions of the through radially inward and outward paths of the ventilating air to and from the air gap through these spaces. Such an arrangement supplements heretofore known ventilating schemes to a very considerable extent, in more effectively subjecting all portions of the core to the cooling effects of the ventilating air, and provides more generally effective and efficient cooling, with resultant reduction of heat losses or increase in permissible loading.

It is an object of the present invention to provide an improved design and construction of dynamo-electric machine affording extremely effective ventilating and cooling of the core and windings embedded therein.

It is a further object of the present invention to provide an improved design and construction of dynamo-electric machine having a stator comprising axially spaced groups of laminations, providing ventilating spaces between such groups, with provisions associated with the radial ventilating spaces for insuring the passage of ventilating air radially inward through the winding-occupying portions of such ventilating spaces, throughout the entire inner periphery thereof and the return of such ventilating air through adjacent radial ventilating spaces, throughout the entire inner periphery thereof, with additional provisions for circulating ventilating air radially inward and outward through those outer portions of the radial ventilating spaces not utilized for the through passage of ventilating air to and from the inner periphery of the radial ventilating spaces.

These and other objects and advantages are attained by the present invention, various novel features of which will be apparent from the description herein and the accompanying drawing, disclosing an embodiment of the invention, and will be more particularly pointed out in the annexed claims.

In the accompanying drawing:

Fig. 1 is a broken view in vertical section of a dynamo-electric machine embodying features of the present invention;

Fig. 2 is a vertical section in the plane of the line II—II of Fig. 1; and

Fig. 3 is a vertical sectional view in the plane of the line III—III of Fig. 1.

As shown in the drawing, a dynamo-electric machine of the turbo-generator type includes a rotating field element **5** having a conventional form of cylindrical core mounted on a shaft **6**, the latter being carried in bearings in a conventional manner, and the core being provided with an energizing winding mounted in slots at the outer periphery of the core. Ventilating fans **7**

are mounted on the shaft beyond the ends of the field element 5.

A stator core 8 is mounted in position radially outside of the field element, being spaced from the latter by the usual air gap, and being supported in an enclosing housing or shell 9 through the intermediary of an inner housing 10 spaced from and held in position relative to the enclosing shell 9. This housing 10 is provided with a plurality of annular supporting plates 12 mounted on and extending inwardly from the housing, and with longitudinally extending ribs 13 secured to the inner periphery of the annular plates. The stator core laminations are built up on the ribs 13 and clamped in position through suitable end plates. The axially outer ends of the housing 10 are provided with radially inwardly extending flanges whose inner edges are turned axially inward and constitute, with adjacent portions of the enclosing shell 9, casings or housings, as indicated at 14, for the fans 7.

Welded or otherwise secured in cutaway portions of the annular supporting plates 12 are a plurality of supply ducts 15 for air or other cooling fluid, the edges of said ducts extending radially inward to the outer periphery of the stator core laminations or the longitudinal ribs 13 on which the laminations are mounted. These ducts 15 are open at their ends to the space within the housing 10 and axially outside the stator core and into which the end extensions of the stator winding 17 project, this winding being secured in position in slots at the inner periphery of the stator core.

The spaces or chambers 19 within the housing 10 and between adjacent air inlet ducts 15 communicate, through openings 20 in the housing 10, with the extended space or passage 23 between the housing 10 and the enclosing shell 9, this passage communicating at its ends with the inlets to the housings 14 of the fans.

The stator core consists of a number of groups 24 of laminations, the several groups being spaced from adjacent groups when the laminations are clamped together in operative condition, so as to provide radial ventilating spaces or passages between the groups of laminations, these spaces extending from the outer to the inner periphery of the core, and alternate ones of these radial ventilating spaces being designated as 26 and the other such spaces as 27. The radial ventilating spaces 26 provide for the passage of ventilating air currents radially inward therethrough to the inner periphery of the stator core, and the radial ventilating spaces 27 provide for passage of ventilating air currents radially outward from the inner to the outer periphery of the core.

As indicated more particularly in Fig. 2, the radial ventilating spaces 26 have relatively heavy spacing ribs or elements 31 therein, preferably welded to the end laminations of one of the adjacent groups, these spacers extending radially inward from the outer periphery of the core at mid-points between adjacent air ducts 15, to a point adjacent the radially outer end of the adjacent winding slots. Spacers 32 extend from the outer periphery of the core opposite each air duct 15, at a point removed some distance from the adjacent side wall of the air duct, inwardly to the inner end of the adjacent spacer 31. The position of these spacers 32 is such as to permit passage of some cool ventilating air from each air duct 15 along each side of the two spacers 32 associated with air duct 15. These spacers 32 are preferably curved or bent, as indicated; and the inner end of each spacer 31 is preferably welded to the inner end of the two spacers 32, one at each side of the spacer 31, to form pocket-like spaces 34 in the radial ventilating space 26 and into which cool air may be supplied from the side edge portions of the cooling air ducts 15, and from which this air, after coming in contact with the end laminations of adjacent groups and the spacers 31 and 32, is discharged outwardly into the chambers 19. Preferably, intermediate spacers or heat-dissipating fins 35, attached to one of the end laminations, and preferably angle-shaped or curved and hence of extended length, are provided to insure extended paths through the pockets 34 and insure the dissipation of further heat to the air passing therethrough.

The air fed to the radial ventilating spaces 26 from the intermediate portion of the cooling ducts, between the spacers 32, travels radially inward to the air gap, radial guiding spacers or fins 38 and angularly disposed fins 39, secured to an end lamination, cooperating to insure a substantially uniform distribution of this air past the sides of all of the winding elements disposed in the core slots within the arc included between the radial spacers 31.

The greater portion, preferably at least two-thirds, of the air fed from the air ducts 15 passes radially inward past the winding in the core slots and to the air gap, this air then moving axially along the air gap to the adjacent ventilating spaces 27 through which it is discharged radially outward to the periphery of the core, and into the chambers 19, as more particularly shown in Fig. 3. The remainder of the air fed from air ducts 15 to the radial ventilating spaces 26 passes into, and serves to cool the walls, spacers and fins of the pockets 34, and is discharged outwardly to the chambers 19.

As indicated in Fig. 3, the radial ventilating spaces 27 have radial spacing elements 41 therein, disposed substantially in alinement with the center lines of the air ducts 15, these spacers 41 being preferably welded to an end lamination of one of the adjacent groups, and extending from the outer periphery of the core to a point adjacent the radially outer end of the adjacent core slots. Spacing elements 42, preferably welded to one of the end laminations, extends inwardly from the outer periphery of the core opposite the chambers 19 to the radially inner end of the adjacent radial spacers 41, with the inner ends of the spacers 42 preferably welded to the inner end of such spacers 41, to thereby form two pockets 45 in position to receive ventilating air from each air duct 15 and permit the discharge of such air to the outer periphery of the core into the side edge portions of the adjacent chambers 19. That portion of the periphery of the core over which air is discharged radially outward from each pocket 45 into a chamber 19 represents approximately one-sixth of the peripheral width of the chamber 19. Light spacers or guiding fins 48, bent or curved at their inner ends, are preferably attached to one of the end laminations in the pockets 45 to insure circulating paths of extended length and reaching the inner part of such pockets, to increase the heat extracted by the air.

The ventilating air entering the radial ventilating spaces 27 from the air gap, as referred to hereinabove, is received into all portions of these ventilating spaces throughout the full inner pe-

riphery of the core. The spacers 42 act as guides or baffles to collect and guide the air drawn outwardly from the air gap at the side portion of the space defined by the arc included between adjacent radial spacers 41. Guiding and heat-dissipating fins attached to an end lamination and disposed angularly, as indicated at 51, and radially, as indicated at 52, may be provided in these portions of the ventilating space 27 through which the ventilating air passes radially outward from the air gap, to uniformly distribute such air and increase the extraction of heat thereby. The portions of the ventilating spaces 27, as measured at the outer periphery of the core, through which the ventilating air from the air gap passes outwardly to the chambers 19, preferably amount to about two-thirds of the exposed periphery of the core between adjacent air ducts 15.

In the operation of the machine hereinabove described, ventilating air is forced by the fans 7, at both ends of the machine, to pass radially outward over the end turns of the stator winding 17 and thence axially through the air supply ducts 15. The air is forced or drawn from the air ducts 15 into the radial ventilating spaces 26, the major portion of this air, as indicated in Fig. 2, passing radially inward to the air gap over the full inner periphery of the core, to cool the core and windings in and adjacent the path of this ventilating air. And a smaller portion of the air from each air duct 15, at the side edges thereof, passes radially inward into the pockets 34, whence it is discharged radially outward into the chambers 19, after absorbing heat from the core. And at the same time, air from the ventilating ducts 15 passes into the radial ventilating spaces 27, as shown in Fig. 3, this air passing radially into the pockets 45 and being discharged therefrom to the chambers 19, after cooling outer portions of the core. And the air passing inwardly through the ventilating spaces 26 to the air gap, and along the latter in an axial direction, and probably with a small circumferential component due to the rotation of the rotor, is drawn or forced into the ventilating spaces 27, as indicated in Fig. 3, along the full inner periphery of the core; and after absorbing heat from the windings and core, such air is discharged radially outward into the chambers 19.

Probably due to the fact that the area of the discharge from the pockets 45 in the radial ventilating spaces 27 is considerably smaller than the area of the inlet from the ducts 15 to these pockets, the discharge from these pockets into the chambers 19 exerts something of an ejector action in assisting the discharge of the body of air passing outwardly from the air gap through the ventilating spaces 27, to the chambers 19.

Instead of causing all of that portion of the ventilating air passing inwardly from the central portion of each air duct 15, and through the ventilating spaces 26, to pass into the air gap, a part of such air may be by-passed through axial ports in the teeth or the body of the core near the inner periphery thereof and opening into the ventilating spaces 27, thus permitting this part of the ventilating air, in its axial passage from one radial ventilating space to another, to contact and further cool interior portions of the core immediately adjacent the windings.

The air discharged into the chambers 19 is drawn outwardly, through the openings 20 in the housing 10, into the passage 23 between such housing and the enclosing shell 9, from which it is drawn by the fans 7 and recirculated through the machine, it being considered that the shell 9 is sealed to provide for circulation of the air in a closed path within the shell. And the shell, with or without the assistance of one or more coolers of conventional form in the space between the shell 9 and the housing 10, serves to extract heat from the circulating air after passage thereof through the core. While air has been referred to as the ventilating medium, it will be apparent that other suitable ventilating gas, such as hydrogen, may readily be used in a suitably enclosed machine, of this type. Likewise, the machine may be cooled with air taken from outside the enclosing shell, such ventilating air, after passage thereof radially outward from the housing 10, discharging through the shell to the surrounding atmosphere, or if the enclosing shell 9 should be omitted, the air may be discharged directly through the openings 20 in the housing 10, to the atmosphere.

It should be understood that the invention disclosed herein is not limited to the exact details of design and construction herein described and illustrated, for various modifications, within the scope of the appended claims, may be made without departing from the invention.

It is claimed and desired to secure by Letters Patent:

1. In a dynamo-electric machine, a laminated stator core provided with winding slots along its inner periphery, said core being provided with radial ventilating spaces between adjacent groups of core laminations, circumferentially spaced and axially extending ducts for supplying ventilating fluid to certain of said radial ventilating spaces, outlet chambers between adjacent ducts and open to said radial ventilating spaces, means for directing a portion of the ventilating fluid from said supply ducts to cause it to pass radially inward through said radial ventilating spaces along the entire circumference of the slotted inner portion of said core, and means for directing another portion of the ventilating fluid from said ducts to cause it to pass therefrom radially inward and thence outward in said radial ventilating spaces and to discharge into said chambers.

2. In a dynamo-electric machine, a laminated stator core mounted within said housing and provided with winding slots along its inner periphery, said core being provided with radial ventilating spaces between adjacent groups of core laminations, a rotor mounted to operate within said stator with a gap therebetween, circumferentially spaced and axially extending ducts for supplying ventilating fluid to certain of said radial ventilating spaces and providing outlet chambers between adjacent ducts open to said radial ventilating spaces, means for directing a portion of the ventilating fluid from said supply ducts to cause it to pass radially inward through certain of said radial ventilating spaces along the entire circumference of the slotted inner portion of said core, and means for directing another portion of the ventilating fluid from each of said supply ducts to cause the same to pass radially inward and thence outward in said radial ventilating spaces and to discharge into said chambers at each side of said duct, and means for directing ventilating fluid to cause it to pass radially outward through others of said radial ventilating spaces from the air gap between said rotor and stator along the entire circumference thereof and to discharge from said latter radial ventilating spaces into said outlet chambers.

3. In a dynamo-electric machine, a laminated stator core provided with winding slots along its inner periphery, said core being provided with radial ventilating spaces between adjacent groups of core laminations, a rotor mounted to operate within said stator with a gap therebetween, circumferentially spaced and axially extending ducts for supplying ventilating fluid to certain of said radial ventilating spaces with chambers between said ducts and open to others of said radial ventilating spaces, means for directing ventilating fluid to cause it to pass radially outward through said latter radial ventilating spaces from the gap between said stator and rotor along the entire circumference thereof and to discharge through said latter radial ventilating spaces into said chambers, and means for directing ventilating fluid from said supply ducts to cause it to pass radially inward in said latter radial ventilating spaces toward the slotted portion of said core and to discharge radially outward from said ventilating spaces to said chambers.

4. In a dynamo-electric machine, a laminated stator core provided with winding slots along its inner periphery, said core being provided with radial ventilating spaces between adjacent groups of core laminations, a rotor mounted to operate within said stator with a gap therebetween, circumferentially spaced and axially extending ducts for supplying ventilating fluid to certain of said radial ventilating spaces and providing outlet chambers between adjacent ducts, said chambers being open to said radial ventilating spaces, means for directing a portion of the ventilating fluid from said supply ducts to cause it to pass radially inward through certain of said ventilating spaces to the gap between said stator and rotor along the full circumference thereof, means for directing said ventilating fluid to cause it to pass radially outward through certain others of said radial ventilating spaces from said gap along the entire circumference thereof and to discharge through said latter radial ventilating spaces into said chambers, and means for directing another portion of the ventilating fluid from said supply ducts to cause it to pass radially inward in said latter radial ventilating spaces toward the slotted portion of said core and to discharge radially outward in said latter ventilating spaces to said chamber.

5. In a dynamo-electric machine, a laminated stator core provided with winding slots along its inner periphery, said core being provided with radial ventilating spaces between adjacent groups of core laminations, a rotor mounted to operate within said stator with a gap therebetween, circumferentially spaced and axially extending ducts for supplying ventilating fluid to said radial ventilating spaces and providing outlet chambers between adjacent ducts, said chambers being open to said radial ventilating spaces, means for directing ventilating fluid from said supply ducts to cause it to pass radially inward through one group of said ventilating spaces to the gap between said stator and rotor over the entire circumference thereof, means for directing ventilating fluid to cause it to pass radially outward through a second group of said radial ventilating spaces from said gap along the entire circumference thereof and to discharge outwardly into said chambers, and means for directing ventilating fluid from each of said supply ducts to cause it to pass radially inward in said second group of radial ventilating spaces toward the slotted portion of said core and to discharge radially outward therefrom in said latter ventilating spaces at each side of said supply duct without coming into contact with the ventilating fluid discharging outwardly in said latter ventilating spaces from said gap.

6. In a dynamo-electric machine, a laminated stator core provided with winding slots along its inner periphery, said core being provided with radial ventilating spaces between adjacent groups of core laminations, a rotor mounted to operate within said stator with a gap therebetween, circumferentially spaced and axially extending ducts for supplying ventilating fluid to all of said radial ventilating spaces and providing chambers between said ducts, said chambers being open to said radial ventilating spaces, means for directing a portion of the ventilating fluid from said supply ducts to cause it to pass radially inward through one group of said radial ventilating spaces along the entire circumference of the slotted inner portion of said core, means for directing another portion of the ventilating fluid from said ducts to cause it to pass radially inward and thence outward in said radial ventilating spaces and to discharge into said chambers, means for directing ventilating fluid to cause it to pass radially outward through another group of said radial ventilating spaces from the slotted portion of said stator along the entire circumference thereof and to discharge to said chambers, and means for directing a further portion of the ventilating fluid from said supply ducts to cause it to pass radially inward in said second group of radial ventilating spaces toward the slotted portion of said core and to discharge radially outward in said ventilating spaces to said chambers without appreciable intereference with the ventilating fluid discharging outwardly in said ventilating spaces from the slotted portion of said core.

7. In a dynamo-electric machine, a laminated stator core provided with winding slots along its inner periphery, said core being provided with radial ventilating spaces between adjacent groups of core laminations, a rotor mounted to operate within said stator with a gap therebetween, circumferentially spaced and axially extending ducts for supplying ventilating fluid to said radial ventilating spaces, chambers between said ducts and open to said radial ventilating spaces, means for directing a portion of the ventilating fluid from said supply ducts to cause it to pass radially inward in alternate ones of said radial ventilating spaces to the gap between said stator and rotor, means for directing ventilating fluid to cause it to pass radially outward in the other ventilating spaces from said gap over the full circumference thereof to said chambers, and means for directing ventilating fluid from said supply ducts to cause it to pass radially inward in all of said radial ventilating spaces toward but not reaching the slotted portion of said core and to discharge radially outward in said ventilating spaces to said chambers.

8. In a dynamo-electric machine, a stator including a housing, a laminated stator core mounted within said housing and provided with winding slots along the inner periphery of the core, said core being provided with radial ventilating spaces between adjacent groups of core laminations, a rotor mounted to operate within said stator with a gap therebetween, said housing supporting circumferentially spaced and axially extending ducts for supplying ventilating fluid to said radial ventilating spaces and providing outlet chambers between adjacent ducts, said chambers being open

to said radial ventilating spaces, means for directing a portion of the ventilating fluid from said supply ducts to cause it to pass radially inward through one group of said radial ventilating spaces to the gap between said stator and rotor along the full circumference thereof, means for directing ventilating fluid to cause it to pass radially outward from said gap along the full circumference thereof through a second group of said radial ventilating spaces and to discharge therefrom to said chambers, and means for directing ventilating fluid from said supply ducts to cause it to pass radially inward in both groups of said radial ventilating spaces to a point adjacent the slotted portion of said core and to discharge said ventilating fluid radially outward in said ventilating spaces to said chambers without substantially interfering with the ventilating fluid passing through said spaces from one periphery to the other periphery of said core.

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