IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Atty. Dkt. No:	6757-35500	§	Title: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME
Application No:	09/798511	§	Examiner: Compton, Eric B.
Patent No:	7,036,207	§	Group/Art Unit: 3726
Filing Date:	03/02/2001	§	
Inventor(s):	Griffith D. Neal	§	

STATEMENT REGARDING CHANGE FROM SMALL ENTITY STATUS

Patentee is no longer entitled to small entity status in the above-referenced patent.

No fees are believed necessary; however if any fees are required, the Commissioner is hereby authorized to immediately charge the fees or credit any overpayment to Meyertons, Hood, Kivlin, Kowert & Goetzel, P.C. Deposit Account No. 501505/6757-35500/DMM.

Respectfully submitted,

Date: January 7, 2013

By: /Dean M. Munyon/
Dean M. Munyon
Reg. No. 42,914

Meyertons, Hood, Kivlin, Kowert & Goetzel, P.C.
P. O. Box 398
Austin, Texas 78767
(512) 853-8800

Electronic Acknowledgement Receipt

EFS ID:	14628313
Application Number:	09798511
International Application Number:	
Confirmation Number:	9388
Title of Invention:	STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME
First Named Inventor/Applicant Name:	Griffith D. Neal
Customer Number:	35690
Filer:	Dean M. Munyon/Danielle Kramer
Filer Authorized By:	Dean M. Munyon
Attorney Docket Number:	6757-35500
Receipt Date:	07-JAN-2013
Filing Date:	02-MAR-2001
Time Stamp:	13:02:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	small-entity-change-form.pdf	16835 cdd275b40baa0573d8c07c5895acead5c912b3d9	no	1

Warnings:

Information:

Total Files Size (in bytes):	16835

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/798,511	03/02/2001	Griffith D. Neal	8864/20

CONFIRMATION NO. 9388

POA ACCEPTANCE LETTER

OC000000058312978

35690
MEYERTONS, HOOD, KIVLIN, KOWERT & GOETZEL, P.C.
P.O. BOX 398
AUSTIN, TX 78767-0398

Date Mailed: 12/24/2012

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/03/2012.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/sharris/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/798,511	03/02/2001	Griffith D. Neal	8864/20

CONFIRMATION NO. 9388

POWER OF ATTORNEY NOTICE

OC000000058312955

757
BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610

Date Mailed: 12/24/2012

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/03/2012.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/sharris/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

[x] Practitioners associated with the Customer Number: **35690**

OR

[ ] Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

[x] The address associated with Customer Number: **35690**

OR

[ ] Firm or Individual Name					
Address					
City		State		Zip	
Country		Telephone		Email	

Assignee Name and Address:

Intellectual Ventures Holding 88 LLC
7251 W Lake Mead Blvd
Ste 300
Las Vegas, Nevada 89128

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	29 OCT 2012
Name	Jeanne Suchodolski	Telephone	
Title	Authorized Person for Intellectual Ventures Holding 88 LLC		

DECLARATION REGARDING AUTHORITY TO SIGN
ON BEHALF OF A LEGAL ENTITY
37 C.F.R. 3.73(b)(2)(i)

I, Jeanne Suchodolski (whose title is supplied below), hereby declare that I am authorized to sign documents on behalf of Intellectual Ventures Holding 88 LLC.

Jeanne Suchodolski
Authorized Person for Intellectual Ventures Holding 88 LLC

24 OCT 2012

Date

Electronic Acknowledgement Receipt

EFS ID:	14373018
Application Number:	09798511
International Application Number:	
Confirmation Number:	9388
Title of Invention:	STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME
First Named Inventor/Applicant Name:	Griffith D. Neal
Customer Number:	757
Filer:	Dean M. Munyon/Dawn DeLuca
Filer Authorized By:	Dean M. Munyon
Attorney Docket Number:	8864/20
Receipt Date:	03-DEC-2012
Filing Date:	02-MAR-2001
Time Stamp:	20:35:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Assignee showing of ownership per 37 CFR 3.73.	373b.pdf	39702 cee548d0e93bd1c081aca3f6cdd2f7e6f36764e4	no	3

Warnings:

Information:

2	Power of Attorney	POA.pdf	967342 875449c23023d37e5da46803aa55a6ac615df8c8	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	1007044	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
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National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Intellectual Ventures Holding 88 LLC

Application No./Patent No.: 7036207 Filed/Issue Date: 05/02/2006

Titled: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME

Intellectual Ventures Holding 88 LLC, a LIMITED LIABILITY COMPANY
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is ________ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. [ ] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel ____________, Frame ____________, or for which a copy therefore is attached.

OR

B. [X] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Griffith D. Neal To: Encap Motor Corporation
The document was recorded in the United States Patent and Trademark Office at
Reel 012135, Frame 0350, or for which a copy thereof is attached.

2. From: Encap Motor Corporation To: Encap Merger Co., Inc.
The document was recorded in the United States Patent and Trademark Office at
Reel 018524, Frame 0001, or for which a copy thereof is attached.

3. From: Encap Merger Co., Inc. To: Encap Technologies, Inc.
The document was recorded in the United States Patent and Trademark Office at
Reel 018524, Frame 0039, or for which a copy thereof is attached.

[X] Additional documents in the chain of title are listed on a supplemental sheet(s).

[X] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Dean M. Munyon/ 12/3/2012
Signature Date

Dean M. Munyon Reg. No. 42,914
Printed or Typed Name Title

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Supplemental Sheet

A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee continues as follows:

4. From: Encap Technologies Inc. To: Intellectual Ventures Holding 88 LLC
The document was recorded in the United States Patent and Trademark Office at
Reel 029228 , Frame 0379 , or for which a copy thereof is attached.

5. From: ____________ To: ____________
The document was recorded in the United States Patent and Trademark Office at
Reel ____________ , Frame ____________ , or for which a copy thereof is attached.

6. From: ____________ To: ____________
The document was recorded in the United States Patent and Trademark Office at
Reel ____________ , Frame ____________ , or for which a copy thereof is attached.

7. From: ____________ To: ____________
The document was recorded in the United States Patent and Trademark Office at
Reel ____________ , Frame ____________ , or for which a copy thereof is attached.

8. From: ____________ To: ____________
The document was recorded in the United States Patent and Trademark Office at
Reel ____________ , Frame ____________ , or for which a copy thereof is attached.

Applicant or Patentee: Griffith D. Neal
Serial or Patent No: 7,036,207
Filed or Issued: May 2, 2006 Case No.: 8864-20
For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) and 1.27(c)) - SMALL BUSINESS CONCERN

I hereby declare that I am

☐ the owner of the small business concern identified below:

☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN: ENCAP TECHNOLOGIES, INC.
ADDRESS OF CONCERN: 1334 Bay Street, Alameda, California 94501

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME by inventor(s) Griffith D. Neal described in:

☐ the specification filed herewith.

☐ application serial no. _____, filed _____.

☒ patent no. 7,036,207, issued May 2, 2006.

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e). *NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME
ADDRESS

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

NAME
ADDRESS

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

SIGNATURE: G. D. Neal DATE: 11-22-11
NAME OF PERSON SIGNING: Griffith D. Neal
TITLE OF PERSON OTHER THAN OWNER: CEO
ADDRESS OF PERSON SIGNING: 1334 Bay Street, Alameda, California 94501

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
Chicago, Illinois 60610
(312) 321-4200

Electronic Acknowledgement Receipt

EFS ID:	11703033
Application Number:	09798511
International Application Number:	
Confirmation Number:	9388
Title of Invention:	STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME
First Named Inventor/Applicant Name:	Griffith D. Neal
Customer Number:	757
Filer:	Steven P. Shurtz/Kristin Hooper
Filer Authorized By:	Steven P. Shurtz
Attorney Docket Number:	8864/20
Receipt Date:	23-DEC-2011
Filing Date:	02-MAR-2001
Time Stamp:	15:57:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Petition for review by the Office of Petitions.	8864-20_Verified_Statement_Claiming_Small-Entity.pdf	105855 53e8f7b5206719feb45d4985d743705a8fda0428	no	1

Warnings:

Information:

Total Files Size (in bytes):	105855

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New International Application Filed with the USPTO as a Receiving Office
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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIBDATASHEET

Bib Data Sheet

CONFIRMATION NO. 9388

SERIAL NUMBER	FILING OR 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/798,511	03/02/2001 RULE	029	3726	8864/20

APPLICANTS

Griffith D. Neal, Alameda, CA;

** **CONTINUING DATA** *************************

** **FOREIGN APPLICATIONS** ********************

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 05/15/2001

		STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed	☐ yes ☐ no	CA	6	29	5
35 USC 119 (a-d) conditions met	☐ yes ☐ no ☐ Met after Allowance				
Verified and Acknowledged	Examiner's Signature Initials				

ADDRESS

00757

TITLE

STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME

FILING FEE RECEIVED		
843	FEES: Authority has been given in Paper No. _________ to charge/credit DEPOSIT ACCOUNT No. _________ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other ________________ ☐ Credit

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571) 273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

00757 7590 12/15/2005

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610

O I P E IAP74
FEB 0 2 2006
PATENT & TRADEMARK OFFICE

02/02/2006 MGEBREM2 00000045 09798511

01 FC:1501 1400.00 OP
02 FC:1504 300.00 OP

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

Steven P. Shurtz (Reg. No. 31,424) (Depositor's name)
Steven P. Shurtz (Signature)
1/27/06 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

TITLE OF INVENTION: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	~~YES~~ No	~~$700~~ $1,400	$300	~~$1000~~ $1,700	03/15/2006

EXAMINER	ART UNIT	CLASS-SUBCLASS
COMPTON, ERIC B	3726	029-596000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Brinks Hofer Gilson & Lione
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Encap Motor Corporation

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Alameda, CA

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are enclosed:

☒ Issue Fee
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☐ A check in the amount of the fee(s) is enclosed.
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☒ The Director is hereby authorized by charge the required fee(s), or credit any overpayment, to Deposit Account Number 23-1925 (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
☒ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.
NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature: Steven P. Shurtz Date: 1/27/06

Typed or printed name: Steven P. Shurtz Registration No. 31,424

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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NOTICE OF ALLOWANCE AND FEE(S) DUE

00757 7590 12/15/2005

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610

EXAMINER	
COMPTON, ERIC B	
ART UNIT	PAPER NUMBER
3726	

DATE MAILED: 12/15/2005

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

TITLE OF INVENTION: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$700	$300	$1000	03/15/2006

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE REFLECTS A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE APPLIED IN THIS APPLICATION. THE PTOL-85B (OR AN EQUIVALENT) MUST BE RETURNED WITHIN THIS PERIOD EVEN IF NO FEE IS DUE OR THE APPLICATION WILL BE REGARDED AS ABANDONED.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL should be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). Even if the fee(s) have already been paid, Part B - Fee(s) Transmittal should be completed and returned. If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail** **Mail Stop ISSUE FEE**
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or Fax **(571) 273-2885**

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

00757 7590 12/15/2005

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I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

TITLE OF INVENTION: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME

APPLN. TYPE	SMALL ENTITY	ISSUE FEE	PUBLICATION FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$700	$300	$1000	03/15/2006

EXAMINER	ART UNIT	CLASS-SUBCLASS
COMPTON, ERIC B	3726	029-596000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 ____________________
2 ____________________
3 ____________________

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

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5. **Change in Entity Status** (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
- ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

The Director of the USPTO is requested to apply the Issue Fee and Publication Fee (if any) or to re-apply any previously paid issue fee to the application identified above.
NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature ____________________ Date ____________________

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

00757 7590 12/15/2005

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610

EXAMINER	
COMPTON, ERIC B	

ART UNIT	PAPER NUMBER
3726	

DATE MAILED: 12/15/2005

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571) 272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (703) 305-8283.

PTOL-85 (Rev. 07/05) Approved for use through 04/30/2007.

Notice of Allowability	Application No.	Applicant(s)	
	09/798,511	NEAL, GRIFFITH D.	
	Examiner	**Art Unit**	
	Eric B. Compton	3726	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *an amendment filed September 26, 2005*.

2. ☒ The allowed claim(s) is/are *1,3-15,17,19-26 and 30-35*.

3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

DETAILED ACTION

Remarks

1. Applicant's amendment and arguments in support thereof, dated September 26, 2005, have been found persuasive.

2. The following is an examiner's statement of reasons for allowance: the prior art of record does not teach or suggest a stator assembly (and method of making), comprising: "a plurality of individual stator arc segments forming a toroidal core wherein each stator arc segment has two end surfaces and a plurality of poles with wire around said poles forming the toroidal core; and a monolith body of injection molded thermoplastic material substantially encapsulating the stator are segments and the wire wound around the poles, wherein said thermoplastic material bonds the arc segments together to hold the arc segments in a toroidal shape," in combination with the other claimed subject matter.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

3. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

U.S. Pats. 6,265,804 & 4,990,809; EP 0938181 & DE 26 53 387 disclose segmented core stator assemblies. However, the stator assembly is not encapsulated.

JP 06-327208 discloses a method for forming stator in which a plurality of stator iron core sections is encapsulated. However, the reference does not teach or suggest "each stator arc segment has two end surfaces and a plurality of poles with wire around said poles forming the toroidal core."

U.S. Pats. 6,509,665; 6,359355; 5,212,419; & 5,134,327 discloses a segmented stator assembly. However, each stator segment only has a single pole.

U.S. Pat. 6,362,553 discloses a stator strip which is bent to form the stator.

Contact Information

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eric B. Compton whose telephone number is (571) 272-4527. The examiner can normally be reached on M-F 9-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Bryant can be reached on (571) 272-4526. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Eric B. Compton
Primary Examiner
Art Unit 3726

ebc

Notice of References Cited

Application/Control No.	Applicant(s)/Patent Under Reexamination
09/798,511	NEAL, GRIFFITH D.

Examiner	Art Unit	
Eric B. Compton	3726	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-4,128,527	12-1978	Kinjo et al.	310/43
*	B	US-4,990,809	02-1991	Artus et al.	310/192
*	C	US-5,134,327	07-1992	Sumi et al.	310/43
*	D	US-5,212,419	05-1993	Fisher et al.	310/254
*	E	US-5,859,486	01-1999	Nakahara et al.	310/254
*	F	US-6,049,153	04-2000	Nishiyama et al.	310/156.53
*	G	US-6,265,804	07-2001	Nitta et al.	310/259
*	H	US-6,359,355	03-2002	Hartsfield et al.	310/89
*	I	US-6,362,553	03-2002	Nakahara et al.	310/254
*	J	US-6,509,665	01-2003	Nishiyama et al.	310/215
*	K	US-6,844,636	01-2005	Lieu et al.	310/43
*	L	US-6,856,065	02-2005	Suzuki et al.	310/218
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N	2653387	06-1978	DE	INTERMADOX	
	O	01-138936	05-1989	JP	SHIBAURA	
	P	04-029536	01-1992	JP	NIPPON	
	Q	06-327208	11-1994	JP	SEIKO	
	R	10-243595	09-1998	JP	KK ARON	
	S	0938181	08-1999	EP	SIEMENS	
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	G.D. Neal et al. "Ceramic Filled Thermoplastic Encapsulation as a Design Feature for a BLDC Motor in a Disk Dirve" IEEE 2000
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

DERWENT-ACC-NO: 1978-E4108A

DERWENT-WEEK: 197823

TITLE: Stepping motor with permanent magnet rotor - has stator comprising laminated sheet metal segments combining together in peripheral direction to form circular ring

PATENT-ASSIGNEE: INTERMADOX AG[INTEN]

PRIORITY-DATA: 1976DE-2653387 (November 24, 1976)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
DE 2653387 A	June 1, 1978	N/A	000	N/A

INT-CL (IPC): H02K037/00

ABSTRACTED-PUB-NO: DE 2653387A

BASIC-ABSTRACT:

The stepping motor has permanent magnet rotor and a stator comprised of stamped sheet-metal parts axially laminated together to carry the excitation windings bedded into slots. To avoid the high costs of mfg. the stamped sheet-metal component parts, which in itself requires an expensive stamping machine tool, according to the invention, the stator comprises sheet-metal segments that combine together in the peripheral direction in circular ring fashion to form a laminated structure.

The sheet-metal segment specif. have pole teeth on their edge(s) facing the rotor, the pole teeth serving to specif. fix or establish the step(ping) angle of the rotor.

TITLE-TERMS: STEP MOTOR PERMANENT MAGNET ROTOR STATOR COMPRISE LAMINATE SHEET METAL SEGMENT COMBINATION PERIPHERAL DIRECTION FORM CIRCULAR RING

DERWENT-CLASS: V06 X11

⑤¹ Int. Cl. ²: H 02 K 37/00

⑲ BUNDESREPUBLIK DEUTSCHLAND

DEUTSCHES PATENTAMT

DE 26 53 387 A 1

⑪ Offenlegungsschrift 26 53 387

㉑	Aktenzeichen:	P 26 53 387.9
㉒	Anmeldetag:	24. 11. 76
㊸	Offenlegungstag:	1. 6. 78

㉚ Unionspriorität:

㉜ ㉝ ㉛ –

㊹	Bezeichnung:	Schrittmotor
⑦¹	Anmelder:	Intermadox AG, Zug (Schweiz)
⑦⁴	Vertreter:	Liska, H., Dr.-Ing., Pat.-Anw., 8000 München
⑦²	Erfinder:	Nichtnennung beantragt

DE 26 53 387 A 1

⊖ 5 78 809 822/86 7/60

P a t e n t a n s p r ü c h e

1. Schrittmotor, mit einem Permanentmagnetrotor und einem aus Blechstanzteilen axial geschichteten Stator, der in Nuten eingelegte Erregerwicklungen trägt, dadurch g e k e n n z e i c h n e t , daß der Stator aus in Umfangsrichtung kreisringförmig zusammensetzbaren Blechsegmenten (1) geschichtet ist.

2. Schrittmotor nach Anspruch 1, dadurch g e k e n n z e i c h n e t , daß die Blechsegmente (1) auf ihrer dem Rotor zugekehrten Kante Polzähne (2) aufweisen, die den Schrittwinkel des Rotors festlegen, daß die Polzähne (2) um einen halben Zahnabstand oder ein ganzzahliges Vielfaches davon in Umfangsrichtung gegen den das Blechsegment (1) halbierenden Segmentradius versetzt sind und daß die Blechsegmente (1) in Umfangsrichtung abwechselnd auf der Blechvorderseite bzw. der Blechrückseite liegend kreisringförmig zusammengesetzt geschichtet sind.

3. Schrittmotor nach Anspruch 1 oder 2, dadurch g e k e n n z e i c h n e t , daß die Blechsegmente (1) an ihren in Umfangsrichtung einander zugekehrten Stirnkanten Ausnehmungen oder Ansätze aufweisen, die bei geschichtetem Stator miteinander fluchten und daß in die miteinander fluchtenden Ausnehmungen oder auf die miteinander fluchtenden Ansätze axial sich erstreckende Verbindungsstangen (5) eingesetzt bzw. aufgesetzt sind.

4. Schrittmotor nach Anspruch 3, dadurch g e k e n n z e i c h n e t , daß die Querschnittsform der Verbindungsstangen (5) der Form der geschichteten, miteinander fluchtenden Ausnehmungen bzw. Ansätze angepaßt ist.

5. Schrittmotor nach Anspruch 4, dadurch gekennzeichnet, daß die Ausnehmungen oder die Ansätze Schwalbenschwanzform haben.

6. Schrittmotor nach Anspruch 4, dadurch gekennzeichnet, daß die Ausnehmungen Trapezform haben.

7. Schrittmotor nach einem der Ansprüche 3 bis 6, dadurch gekennzeichnet, daß an den Enden der Verbindungsstangen (5) Motorabdeckungen (7) angeschraubt sind, die in den Rotorraum des Stators eingreifen.

8. Schrittmotor nach Anspruch 7, dadurch gekennzeichnet, daß an den in den Rotorraum eingreifenden Teilen der Motorabdeckungen (7) Lager (8) für den Rotor gehalten sind.

9. Schrittmotor nach Anspruch 7, dadurch gekennzeichnet, daß eine der Motorabdeckungen (7) einen Klemmenkasten (1o) für den elektrischen Anschluß des Schrittmotors trägt.

1o. Schrittmotor nach einem der voranstehenden Ansprüche, dadurch gekennzeichnet, daß die Anzahl der in Umfangsrichtung aufeinanderfolgenden Blechsegmente (1) gleich der Phasenzahl des Schrittmotors ist.

11. Schrittmotor insbesondere nach einem der voranstehenden Ansprüche, mit einem Rotor, welcher wenigstens zwei axial nebeneinander angeordnete, in axialer Richtung magnetisierte und mit Polschuhen versehene Permanentmagnete aufweist, dadurch gekennzeichnet, daß in axialer Richtung des Rotors aufeinanderfolgende Permanentmagnete (2o) jeweils in entgegengesetzter axialer Richtung magnetisiert sind, so daß sich gleiche Magnetpole (19) axial gegenüberliegen.

12. Schrittmotor nach Anspruch 11, dadurch g e k e n n - z e i c h n e t , daß die Polschuhe (21) axial aufeinanderfolgender Permanentmagnete (2o) aneinander anliegen.

13. Schrittmotor insbesondere nach einem der voranstehenden Ansprüche, dadurch g e k e n n z e i c h n e t , daß jede Erregerwicklung aus mehreren, parallel in die Nut bzw. Nuten der Erregerwicklung eingebrachten Einzelwicklungen besteht.

14. Schrittmotor nach Anspruch 13, dadurch g e k e n n - z e i c h n e t , daß die Enden der Einzelwicklungen getrennt aus jeder Erregerwicklung herausgeführt sind und daß die Einzelwicklungen außerhalb der Erregerwicklung insbesondere mittels einer Steuerschaltung zueinander in Serie oder zueinander parallel schaltbar sind oder in zueinander parallel geschalteten Einzelwicklungsgruppen in Serie schaltbar sind oder in zueinander in Serie geschalteten Einzelwicklungsgruppen parallel schaltbar sind.

15. Schrittmotor nach Anspruch 14, dadurch g e k e n n - z e i c h n e t , daß die Einzelwicklungen derselben Erregerwicklung in Serie und/oder parallel geschaltet sind.

16. Schrittmotor nach Anspruch 14, dadurch g e k e n n - z e i c h n e t , daß Einzelwicklungen verschiedener Erregerwicklungen in Serie und/oder parallel geschaltet sind.

17. Schrittmotor nach einem der Ansprüche 13 bis 16, dadurch gekennzeichnet, daß jeder Einzelwicklung oder jeder Einzelwicklungsgruppe eine eigene, der Einzelwicklung bzw. der Einzelwicklungsgruppe einen Erregstrom bzw. eine Erregerspannung zuführende Steuerschaltung zugeordnet ist.
18. **Schrittmoter nach einem der Ansprüche 13 bis 17, dadurch gekennzeichnet, daß jede Erregerwicklung aus mehreren, parallel gewickelten Einzeldrähten besteht, von denen jeder eine Einzelwicklung bildet.**

3 Blatt Zeichnungen gegen 2 Blatt neue ausgetauscht. L 14.7.77

DR.-ING. HORST LISKA
PATENTANWALT

NIGERSTRASSE 4
8000 MÜNCHEN 80
TELEFON 089/4704893

5

2653387

INTERMADOX AG Hochhaus I, Fridbach
CH-63oo Zug / Schweiz

Schrittmotor

Es ist bekannt, Schrittmotoren-Statoren aus gestanzten Blechen zu schichten, wobei das Statorblech einen geschlossenen Kreisring mit den entsprechenden Aufnahmeöffnungen für die Wicklung und die erforderlichen Polteilungen enthält. Es ist weiterhin bekannt, den Stator für Schrittmotoren so aufzubauen, daß die Pole aus U-förmig gebogenem Blech gebildet werden, welche ineinandergelegt werden, wodurch der gewünschte Zahn-Lücke-Abstand erreicht wird und welche U-förmigen Blechen die Wicklungen aufnehmen.

Während das erstbeschriebene Verfahren ein sehr kostenintensives Stanzwerkzeug erfordert, ist beim zweiten Verfahren der Herstellungsaufwand relativ hoch.
Demgegenüber besitzt nachfolgend beschriebenes Verfahren diese Nachteile nicht.

Der Stator wird hier aus Segmenten 1 aufgebaut, die aus gestanzten und geschichteten Blechen bestehen. Die Segmente sind entsprechend Fig. 1 so ausgelegt, daß z.B. für einen Vierphasen-Schrittmotor vier gleiche Segmente gestanzt werden. Jedes Segment beinhaltet die für den Schrittmotor charakteristische Zahnausbildung 2 sowie den Raum 3 zum Einlegen der Wicklungen.

Fig. 2 zeigt ein derartiges Segment. Die Zähne 2' sind um einen halben Zahnabstand in Umfangsrichtung gegen die Winkel-Halbierende der Segmente 1 versetzt. Die Segmente 1 werden in Umfangsrichtung des Stator abwechselnd auf der Blechvorderseite bzw. der Blechrückseite liegend zusammengesetzt. Für einen Vierphasenmotor werden jeweils zwei Bleche auf der Vorderseite liegend und zwei Bleche auf der Rückseite liegend angeordnet.

809822/0088

Die Herstellungskosten für ein derartiges Stanzwerkzeug sind vergleichsweise gering zu denen für ein kreisringförmiges Statorstanzwerkzeug. Dies ist insbesondere deshalb der Fall, weil das Segment nur einen Teil des Bearbeitungsaufwandes beinhaltet wie der für den Kreisring erforderliche. Weiterhin läßt sich das Segmentwerkzeug z.B. durch Drahterodieren in einem geschlossenen Kurvenzug herstellen. Der Kreisring dagegen besteht aus zwei Kurvenzügen. Da beim Stanzen der Segmente kaum Stanzabfälle entstehen im Vergleich zum Kreisring, sind die Materialkosten für einen segmentweise aufgebauten Stator günstiger. Für einen Vierphasen-Motor besteht der Stator aus vier identischen Segmenten. Die erforderliche Stückzahl an Teilen vervierfacht sich daher zum Kreisringstator. Dies bedeutet eine weitere Rationalisierungsmöglichkeit bei der Herstellung des Segmentstators.

Um aus den Einzelsegmenten einen kreisringförmigen Stator (Fig.3+4) zu erhalten, sind die Segmente 1 an ihren Enden 4 so ausgebildet, daß ein geeignet geformtes, z.B. schwalbenschwanzförmig gestaltetes Verbindungsstück 5 aus magnetisch nichtleitendem Material die Verbindung der Segmente untereinander herstellt. Die Länge dieses Verbindungsstückes entspricht dabei der Statorlänge. Gleichzeitig trägt dieses Verbindungsstück an seinen Enden Stehbolzen 6. Über diese Stehbolzen wird das Statorblechpaket durch zusammenschrauben zusammengepreßt und ist somit gegen Verschiebungen gesichert. Gleichzeitig bieten diese Stehbolzen die Möglichkeit der Befestigung der vorder- und rückseitigen Motorabdeckungen 7, die die Aufnahme 8 für die Lager der Rotorwelle sowie den Flansch 9 zur Motorbefestigung und einen Klemmkasten 10 zum elektrischen Anschluß des Motors enthalten. Diese Motorabdeckungen 7 sind so ausgebildet, daß sie gleichzeitig durch Hineinragen in den Rotorraum des Stators eine mechanische Abstützung 11 bilden und für die Einhaltung des gewünschten Luftspaltes zwischen Rotor und Stator sorgen.

Der Rotor von Schrittmotoren ist für Motoren höherer Leistung üblicherweise aus Permanentmagneten aufgebaut, die axial magnetisiert sind und auf deren Polflächen jeweils ein Polrad aus geschichteten Blechen oder aus einem Sinterteil aufgebracht ist.

Zur Leistungssteigerung der Motoren werden dabei auch zwei und mehr Magnete mit Polrädern verwendet. Aus Gründen der Magnetisierbarkeit werden diese Magnete jedoch alle in derselben Richtung magnetisiert. Dies erfordert dann zwischen jedem Magnetsystem einen Luftspalt von einigen Millimetern zur magnetischen Entkopplung der Systeme. Trotz des Luftspaltes tritt noch ein Streufluß zwischen den Magnetsystem auf. Dieser geht der Motorleistung verloren und zur Erzielung eines bestimmten Drehmomentes sind entsprechend größere oder bessere Magnete zu verwenden. Dadurch entstehen erhöhte Kosten und eine größere Bauform. Die hier beschriebene Magnetanordnung vermeidet diese Nachteile. Entsprechend Fig.5 wird der Rotor so aufgebaut, daß die Polarität 19 der Magnete 20 an ihren zusammenliegenden Stirnseiten gleichgerichtet ist, z.B. Südpol auf Südpol trifft. Durch diese Magnetanordnung kann der sonst erforderliche Luftspalt zwischen dem System entfallen und die gegenüberliegenden Polräder 21 der beiden Systeme dürfen zusammengeschoben werden. Falls noch weitere Systeme folgen, wird nach der selben Regel verfahren. Die Vorteile sind offenkundig. Ein Streufluß zwischen dem System tritt nicht mehr auf. Die Bauform kann durch Verwendung kleinerer Magnete bei gleicher Leistung und durch Wegfallen des Luftspaltes reduziert werden.

Die Wicklungsausführung bei Schrittmotoren ist üblicherweise so gestaltet, daß für jede vom Strom durchflossene Wicklung ein der Belastung entsprechender Drahtdurchmesser gewählt wird. Insbesondere bei hohen Erregerströmen ist deshalb ein relativ starker Drahtquerschnitt erforderlich. Da Schrittmotoren jedoch mit Rechteckimpulsen betrieben werden und die Wicklung üblicherweise so ausgelegt wird, daß eine große Stromanstiegsgeschwindigkeit erreicht wird und andererseits Schrittmotoren bis zu einigen 10 kHz Schrittfrequenz betrieben werden, beinhaltet das Frequenzspektrum des Ansteuerstromes sehr hohe Frequenzkomponenten. Aufgrund des Skineffektes steigt jedoch der wirksame Widerstand eines runden Cu-Drahtleiter von 1mm Durchmesser z.B. bei einer Frequenz von 1 MHz auf das Fünffache des Gleichstromwiderstandswertes. Wird der Motor, wie häufig üblich, mit Konstantstrom betrieben, so erwärmt sich die Wicklung dadurch auf unzulässig hohe Temperaturen. Betreibt man den Motor mit Konstantspannung, so nimmt der Wicklungswiderstand entsprechend zu, was zu einer Minderung der Leistungsabgabe führt. Um die Nachteile dieses Effekts zu vermeiden, wird nun erfindungsgemäß jede Wicklung des Schrittmotors aus mehreren gegeneinander isolierten parallel aufgebrachten Wicklungen ausgeführt, so daß sich der Skineffekt entsprechend reduziert. Gleichzeitig ist eine Wicklung aus vielen dünnen Drähten geschmeidiger und somit leichter in den zur Verfügung stehenden Wickelraum einzulegen als eine Wicklung aus weniger dicken Drähten. Die Aufspaltung der Wicklung in mehrere Einzelwicklungen hat jedoch noch weitere Vorteile. Das dynamische Verhalten von Schrittmotoren hängt in weiten Grenzen von der Wicklungsausführung und der Art der elektrischen Bestromung ab. Da den zum Einsatz gelangenden höchsten Spannungen und höchsten Strömen aus wirtschaftlichen und technischen Gründen Grenzen gesetzt sind, ist diese Wicklungsausführung des Motors ein wesentlicher Punkt für dessen Laufeigenschaften. Man unterscheidet insbesondere hochohmige Motoren mit hohem Anfangsdrehmoment und niedriger Lauffrequenz und niederohmige Motoren mit kleinerem Anfangsdrehmoment und konstantem Drehmomentverlauf bis zu höchsten Drehzahlen. Hat man nun die Wicklung aus mehreren Einzelwicklungen ausgeführt, so ergeben sich vielseitige Kombinationsmöglichkeiten. Bei Serienschaltung der Einzelwicklungen erhält man die höchstohmige Ausführung. Für sie ist das hohe Anfangsdrehmoment charakteristisch. Führt man eine gemischte seriell/parallel-Schaltung aus, so sind die Zwischenwerte zur Anpassung des Motors an die verschiedensten Anforderungen möglich. Bei Parallelschaltung aller Einzelwicklungen erhält man die niederohmigste Ausführung. Sie liefert ein konstantes Drehmoment bis zu höchsten Drehzahlen.

Da es aus wirtschaftlichen Gründen häufig nicht möglich ist, die bei der niederohmigen Verschaltung erforderliche Stromstärke für dieselbe magnetische Erregung wie bei der hochohmigen Verschaltung zu erreichen, ist das Drehmoment in der niederohmigen Ausführung meistens kleiner. Ist die Wicklung jedoch aus Einzelwicklungen aufgebaut, so besteht die Möglichkeit, jede Einzelwicklung mit einer einfachen Standardelektronik anzusteuern. Die Summe der Einzelströme kann dann so gesteigert werden, daß die Drehmomentkurve des Motors sowohl ein hohes Anfangsmoment als auch gute Linearität über der Drehzahl bis zu höchsten Frequenzen aufweist.

Die Kombinationsmöglichkeiten sollen an einer aus 16 Einzelwicklungen bestehenden Wicklung erläutert werden. Die Einzelwicklung besteht aus n_1 Windungen. Eine Wicklung habe die Induktivität L_1 und den Widerstand R_1. Für die maximale Durchflutung dieses Pols seien W_1 Amperewindungen erforderlich. Die zur Verfügung stehende Konstantstromquelle zum Betrieb des Motors liefert $I_1 = \frac{W1}{16} n_1$ Ampere, so daß bei Serienschaltung aller Windungen das maximal mögliche Drehmoment abgegeben wird. Die Konstantstromquelle soll den Konstantstrom bis zu einer Spannung U_1 abgeben können. Dann ergibt sich die Stromanstiegsfunktion zu $I\ (t) = \frac{U}{R}\ (1 - \exp(- \frac{t}{\tau}))$ mit $\tau = \frac{L}{R}$ und $I\ (t)_{max.} = I_1$. Solange die Zeit bis zum Erreichen von I_1 klein ist im Vergleich zur Umschaltzeit der Wicklungen, kann der Motor nahezu sein volles Drehmoment abgeben. Bei höheren Drehzahlen wird jedoch die in die Stromanstiegszeit eingehende Spannung U gleich $U_1 - U_{ind}$, wobei U_{ind} die durch die Rotordrehung induzierte Gegenspannung ist. Dadurch vergrößert sich die Stromanstiegszeit nochmals. Mit steigender Drehzahl sinkt der in die Wicklung fließende Strom, wodurch sich das Drehmoment reduziert. Je nach Wicklungsart erfolgt diese Reduzierung schneller oder langsamer.

Für Serienschaltung aller 16 Wicklungen ergibt sich eine Induktivität von $L_{16} = 256\ L_1$. Der Wicklungswiderstand steigt auf $R_{16} = 16\ R_1$. Damit wird die Zeitkonstante $\tau = \frac{256\ L_1}{16\ R_1} = 16\ \frac{L_1}{R_1} = 16\ \tau_1$. Die durch die Drehung des Rotors in der Wicklung induzierte Gegen-EMK wird $U_{16\ ind} = 16\ U_{1\ ind}$. Beides führt zu einem sehr schnellen Abfall des Drehmomentes. Das andere Extremum ist die Parallelschaltung aller 16 Wicklungen. Die Induktivität bleibt hierbei L_1; der Widerstand wird zu $\frac{R_1}{16}$. Daraus ergibt sich eine Zeitkonstante von $16\ \tau_1$. Die induzierte Gegenspannung bleibt jedoch bei U_{1ind}, so daß insgesamt die Stromanstiegszeit kleiner wird und damit das Drehmoment bis zur höheren Drehzahl nutzbar bleibt. Allerdings wird es durch die geringe Amperewindungszahl von nur $n_1 \cdot I_1 = \frac{W_1}{16}$ auf $\frac{1}{16}$ reduziert gegenüber der Serienschaltung aller Wicklungen. Analog können alle Kombinationsmöglichkeiten zwischen Serien- und Parallelschaltungen betrachtet werden.

Nun bietet sich aber die Möglichkeit, mehrere Einheitskonstantstromquellen und Ansteuerelektroniken parallel, aber getrennt zu verwenden. Bei beispeilsweise 16 solcher Einheiten bleibt die Zeitkonstante τ wie bei einer Wicklung, also $\tau_1 = \frac{L_1}{R_1}$. Die induzierte Gegenspannung bleibt U_{1ind} und das Drehmoment wird genau so groß wie bei der Serienschaltung; also maximal. Diese Anordnung bietet die Vorteile des maximalen Drehmomentes bei gleichzeitiger guter Linearität des Drehmoments über einen weiten Drehzahlbereich.

11
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Fig.1

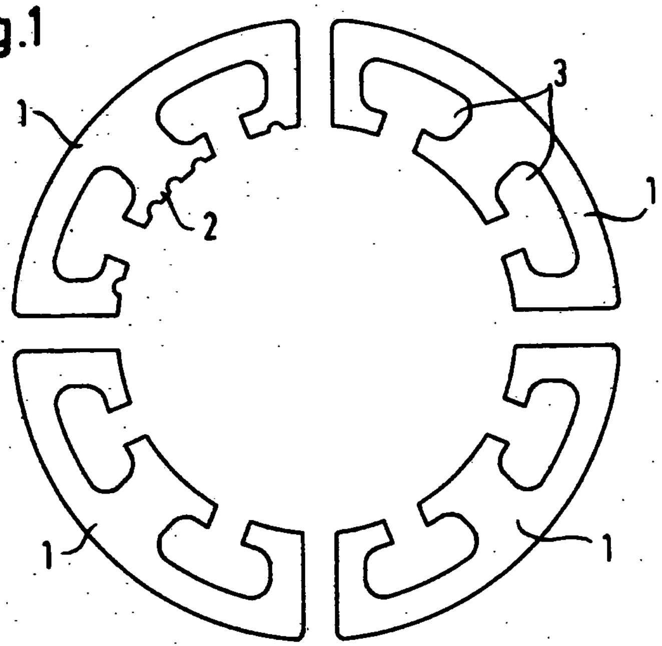


Fig.2

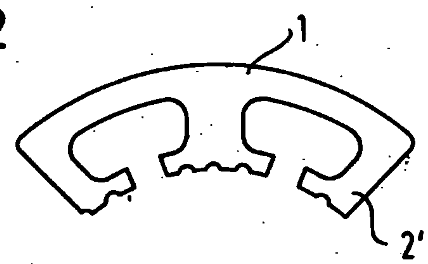
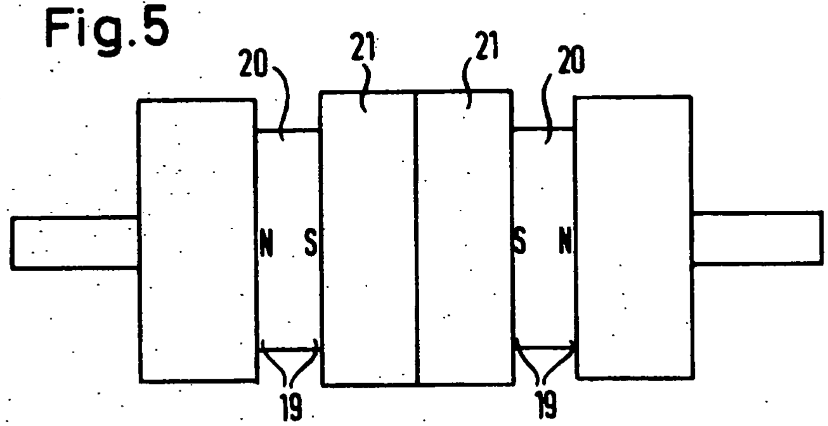


Fig.5



809822/0086

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Fig.3

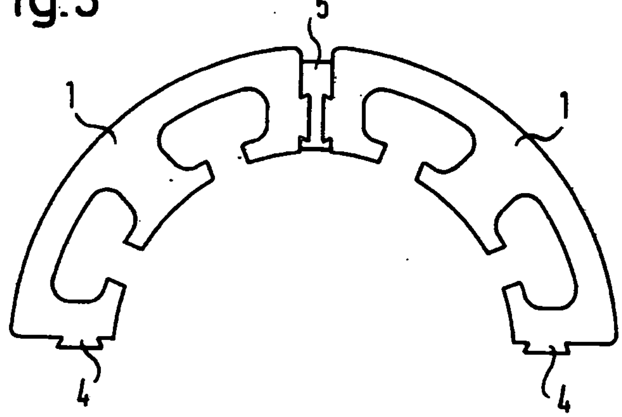
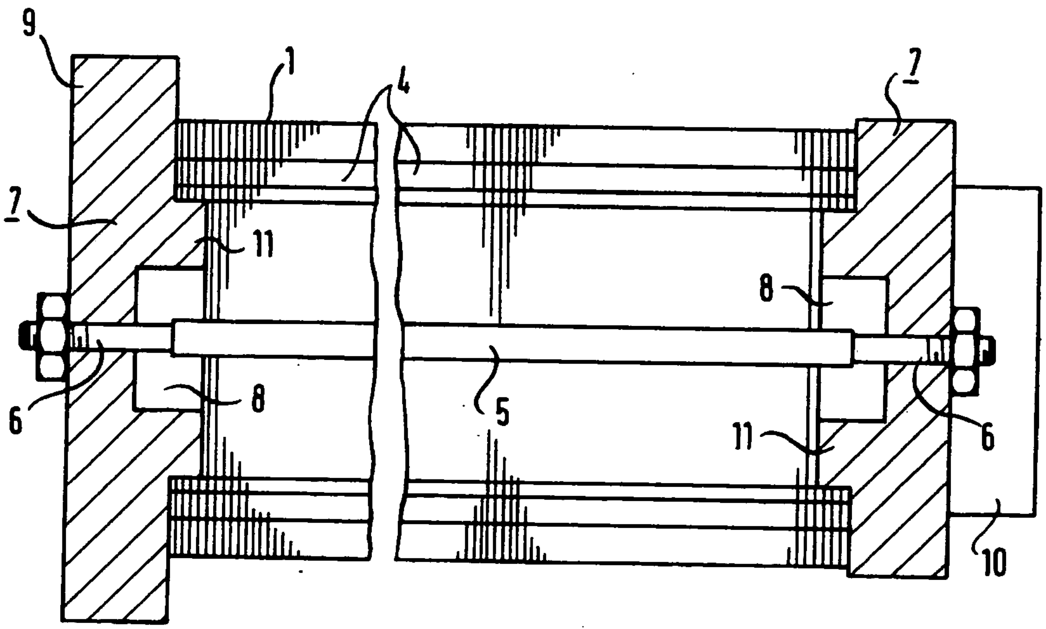


Fig.4



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INTERMADOX AG

PAT-NO: JP401138936A

DOCUMENT-IDENTIFIER: JP 01138936 A

TITLE: MANUFACTURE OF INDUCTION MOTOR STATOR

PUBN-DATE: May 31, 1989

INVENTOR-INFORMATION:
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APPL-NO: JP63213277

APPL-DATE: August 27, 1988

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US-CL-CURRENT: 29/596

ABSTRACT:

PURPOSE: To prevent the deformation and damage of a winding by resin mold forming a stator core from the outside in the manner of embedding said winding while leaving the tooth part inner peripheral end face forming an opposed face at least to a rotor.

CONSTITUTION: A toroidal winding 15, which winds a yoke part 14 via an insulating means for every slot 11, is applied to a stator core 10. Then, the whole stator core 10, to which said winding 15 has been applied, is molded into an integral body by injection of a molded material 18 composed of synthetic resin material to the outside in the manner of embedding said winding 15 while leaving the tooth part 13 inner peripheral end face of the stator core 10 forming an opposed face at least to a rotor. In this manner, there is no possibility of the winding coming off or being damaged at the time of resin mold forming.

⑲日本国特許庁（JP）　⑪特許出願公開
⑫公開特許公報（A）　平1－138936

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㊹発明の名称　誘導電動機の固定子の製作方法

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明　細　書

1．発明の名称　誘導電動機の固定子の製作方法

2．特許請求の範囲

1．内周に歯部によって隔設された多数のスロットを有する固定子コアの各スロット毎に継鉄部を巻回するトロイダル状の巻線を施しておいて、少なくとも回転子との対向面をなす歯部内周端面を残して巻線を埋め込むように樹脂モールド成形することを特徴とする誘導電動機の固定子の製作方法。

3．発明の詳細な説明

本発明は、誘導電動機の固定子の製作方法に関するものである。

従来より、誘導電動機の固定子は、通常固定子コアの回転子との対向面側に形成されたスロットに巻線が収納されているもので、スロットからスロットへの渡りの部分である所謂コイルエンド部分が固定子コアの両側面よりはみ出した状態となっている。

また近年、電動機の小型軽量化および製造工程の短縮化の目的から、この種の電動機において、巻線が施された固定子コアを、注入型や射出成形等の手段により樹脂モールド成形して、成形一体化した固定子を製造することが行なわれてきている。

ところが、前記のように巻線を固定子コアのスロットに収納する従来の巻線収納方式では、樹脂モールド成形の際の注入圧力によって巻線が流されて変形したり傷が付いたり、また巻線がモールド樹脂表面に露出する等のおそれがある。これを防止するためにはモールド材料である樹脂材の注入圧力を低くすればよいが、そうすると、前記樹脂材の粘度によっては固定子コア内側のスロット部分等に樹脂材が充分に流れ込まない不具合が生じることになるので、あまり粘度の高い樹脂材を用いることができない。

特にこの樹脂モールドに使用される合成樹脂

材は、一般にポリエステル系やエポキシ系等の熱硬化性樹脂にガラス繊維や各種フィラーを混合したものが多く、かなりの粘性を有するものが普通であり、そのためあまり注入圧力を低くすることはできないもので、前記のような問題が生じ易いものであった。

本発明は、上記に鑑み、誘導電動機の小型軽量化および製造工程の短縮を目的として、巻線が施された固定子コアを樹脂モールド成形する場合において、注入圧力を高くしてかつ巻線が流れたり傷が付く等のおそれなく確実に成形でき、比較的粘度の高い樹脂材を用いることも可能にする固定子の製作方法を提供しようとするものである。

すなわち、本発明の誘導電動機の固定子の製作方法は、内周に歯部によって隔設された多数のスロットを有する固定子コアの各スロット毎に継鉄部を巻回するトロイダル状の巻線を施しておいて、少なくとも回転子との対向面をなす歯部内周端面を残して巻線を埋め込むように樹脂モールド成形することを特徴とする。

次に本発明の実施例を第1図～第6図に基いて説明する。

第1図は本発明により製造された固定子を示し、第6図は前記固定子を使った誘導電動機の概略を示す。図において、(1) は固定子、(2) は回転子、(3)(3)は回転子(2) の軸(4) を支承する軸受、(5) はフレーム部分を示す。

そして、前記固定子(1) の製造においては、まず第2図に示すように回転子(2) と対向する内周側において軸方向の多数のスロット(12)を隔設する歯部(13)と継鉄部(14)とからなる固定子コア(10)に対して、各スロット(12)毎に絶縁手段を介して継鉄部(14)を巻回するトロイダル状の巻線(15)を施す。この場合、歯部(13)と継鉄部(14)とが一体形成された環状をなす固定子コア(10)に直接トロイダル状巻線装置をもって巻線するほか、前記固定子コア(10)を2分割等の周方向複数に分割形成しておき、その分割コアの各スロット毎に絶縁手段を介して巻線したあと、分割コア同士を接合することもできる。環状の固定子コア(10)に巻線するよりも分割コアに巻線するほうが能率的である。

また前記巻線(15)と固定子コア(10)の間の絶縁手段(16)としては、固定子コア(10)あるいは分割コアのうち少なくとも巻線(15)が施される部分に絶縁材料を塗装して形成するか、または合成樹脂等の絶縁材料により歯部(13)および継鉄部(14)のコア形状に略対応した第5図〔a〕および〔b〕のような形状の割形の絶縁体(16a)(16b) を両側より被着しておくもので、特に前記絶縁体(16a)(16b)には、巻線状態を良好にするつば(16c) を設けておくことができ、さらにつば(16c) に口出線用の導電部材を設けておくことができる。

前記のような絶縁体(16a)(16b)を固定子コア(10)に被着するものの場合でも、巻線(15)がトロイダル状に巻装されることによって、絶縁体(16a)(16b)が内方向へ締めつけられて固定子コア(10)に対して強く密着し、その結果巻線(15)と固定子コア(10)との間に空隙を生じさせることなく、密に巻装できることになる。

次に前記のように巻線(15)が施された固定子コア(10)を、周知の樹脂モールド法によって、固定子コア(10)の少なくとも回転子(2) との対向面をなす歯部(13)内周端面を残して前記巻線(15)を埋め込むように合成樹脂材よりなるモールド材料(18)を外側に注入して全体を成形一体化する。すなわち第3図に示すように巻線(15)が施された固定子コア(10)をモールド型(20)内にセットしておき、このモールド型(20)内にモールド材料(18)である樹脂材を圧入し、外側をこの樹脂材により包被し成形固定するもので、これによって第1図および第4図のごとき固定子(1) を得る。なおこの樹脂モールドによって電動機のフレーム部分(5) も一体形成する。

前記の樹脂モールド法としては、例えば特開昭52-98909号公報や特開昭53-107605号公報等にも見られるように、インジェクションモールド等の周知のモールド法を利

用すればよく、またモールド材料(18)としても、この種の合成樹脂製電動機等において一般に使用されている合成樹脂材、例えばポリエステル系やエポキシ系の熱硬化性樹脂にガラス繊維や各種フィラー等を混合した合成樹脂材料が用いられる。なお、前記モールド材料(18)の注入圧力は、モールド材料の粘度等によっても異なるが、通常10kg／cm²程度に設定する。

しかして、前記樹脂モールド成形の際、巻線(15)が固定子コア(10)の各スロット(12)毎の継鉄部(14)にトロイダル状に巻装されて、固定子コア(10)に対して強く密に巻着した状態に保持されているため、モールド材料(18)が比較的粘度の高い樹脂材よりなるものであっても、またその注入圧力が比較的高いものであっても、巻線(15)がモールド材料(18)によって流されたり傷が付く等の不良が生じない。またトロイダル状に巻装された巻線(15)が絶縁手段を介して固定子コア(10)に対してコンパクトに巻着し、巻線とコアとの間に空隙が生じず、コア径方向や外側方向へのはみ出し寸法が小さくなるため、モールド樹脂部分の厚みを小さくしても、巻線がモールド樹脂表面に露出するおそれがなく、それだけモールド樹脂材量を少なくして成形できる。

上記のように本発明は、固定子コアの各スロット毎に継鉄部を巻回するトロイダル状の巻線を施しておいて、少なくとも回転子との対抗面をなす歯部内周端面を残して巻線を埋め込むように外側より樹脂モールド成形することとしたので、樹脂モールドの際の注入圧力を高くしてかつ巻線を変形、損傷させるおそれなく成形できるとともに、少ないモールド樹脂材量で巻線を露出させることなく確実に包被できてその保護を良好になし、外形のコンパクトな固定子、延いてはフレーム部分を一体成形した小型化した誘導電動機を得ることができる。

しかも、前記のように注入圧力を高くできることで、その注入成形に要する時間を短縮でき、また巻線が固定子コアに締め付けられていることとも相俟って、粘度の高い樹脂材料を用いることが可能となり、モールド樹脂強度の高い電動機を得ることができる。

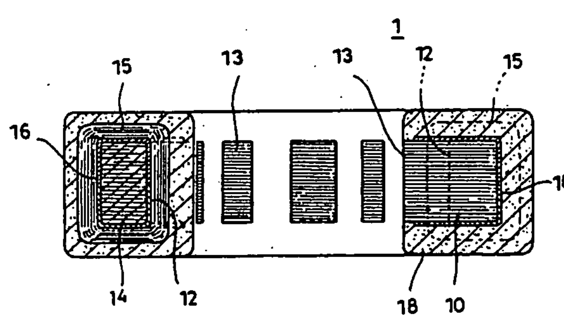
4、図面の簡単な説明

第1図は本発明により製造された固定子の縦断面図、第2図は固定子の巻線構造を示す略示正面図、第3図はモールド状態を示す縦断面図、第4図は製造された固定子の一部欠截斜視図、第5図〔a〕〔b〕は絶縁被嵌体を例示する一部の斜視図、第6図は本発明による誘導電動機を示す縦断面図である。

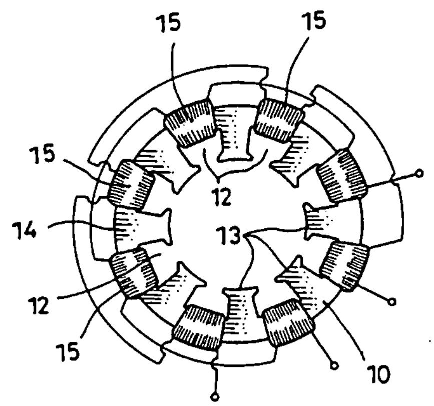
(1)…固定子、(2)…回転子、(10)…固定子コア、(11)(11)…分割コア、(12)…スロット、(13)…歯部、(14)…継鉄部、(15)…巻線、(18)…モールド材料、(20)…モールド型。

特許出願人　株式会社芝浦製作所
代理人　蔦田璋子
ほか1名

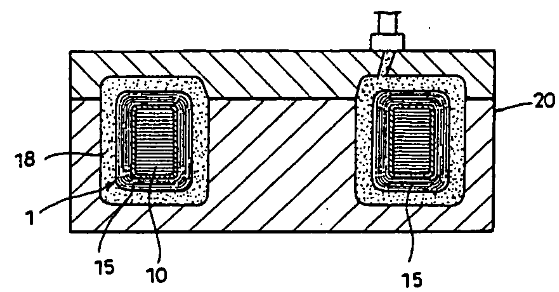
第1図



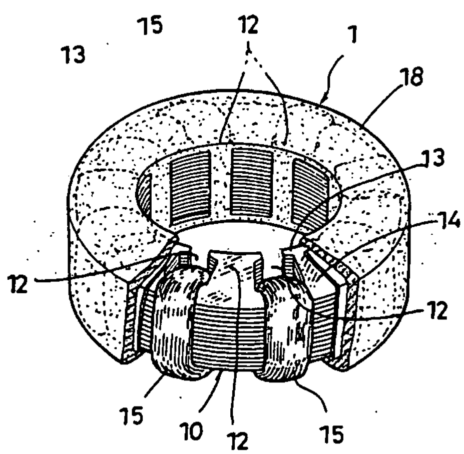
第2図



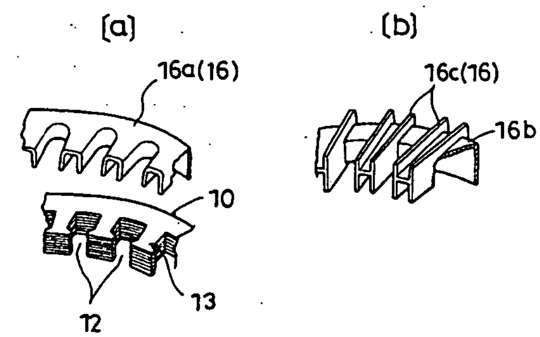
第3図



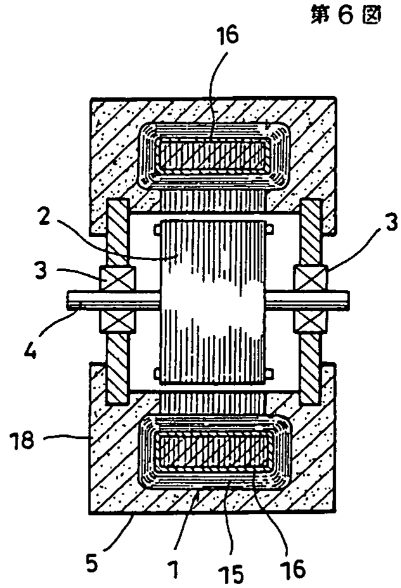
第4図



第5図



第6図



PAT-NO: JP404029536A

DOCUMENT-IDENTIFIER: JP 04029536 A

TITLE: STATOR CORE

PUBN-DATE: January 31, 1992

INVENTOR-INFORMATION:
NAME
IWASAKI, KUNIYASU

ASSIGNEE-INFORMATION:

NAME	COUNTRY
NIPPON DENSAN CORP	N/A

APPL-NO: JP02136649

APPL-DATE: May 25, 1990

INT-CL (IPC): H02K001/16, H02K015/02 , H02K029/00

ABSTRACT:

PURPOSE: To obtain an easy-to-assemble stator core and to reduce the diameter of brushless motor without reducing the diameter of bearing by forming a plurality of fan-type segments, provided with ties to be applies with a coil, in tubular.

CONSTITUTION: The length of a board body 5, provided with externally projecting ties forming pieces 6..., is differentiated at the opposite edges in the circumferential direction. Board bodies having same profile are then stacked alternately back to back and vertically opposed board bodies 5 are shifted form each other in the circumferential direction. Consequently, no gap is made between joint faces 7 thus eliminating gap from a magnetic path. Each segment 2... comprises a plurality of stacked board bodies 5... having approximately fan-type profile and a stator core 1 is formed into an approximately tubular shape where a plurality(three in the embodiment) of segments 2... are arranged in the circumferential direction. Since the stator core 1 can be fixed to a small diameter section 9c, stator core 1 having relatively small diameter can be employed without requiring bearings 11, 11 having small diameter.

⑲日本国特許庁（JP）　⑪特許出願公開

⑫公開特許公報（A）　平4－29536

⑤Int.Cl.⁵　識別記号　庁内整理番号　㊸公開　平成4年(1992)1月31日

H 02 K 1/16　Z　7254－5H
15/02　A　8325－5H
29/00　Z　9180－5H

審査請求　未請求　請求項の数　1　（全4頁）

⑭発明の名称　ステータコア

㉑特　願　平2－136649
㉒出　願　平2(1990)5月25日

⑫発明者　岩崎　邦保　京都府中郡峰山町荒山壱番谷225　日本電産株式会社峰山工場内
⑪出願人　日本電産株式会社　京都府京都市中京区烏丸通御池上ル二条殿町552番地
⑭代理人　弁理士　中谷　武嗣

明　細　書

1．発明の名称

ステータコア

2．特許請求の範囲

1．コイル3が巻設されるティース4…を備えると共に平面的に見て略扇形状とされた複数個のセグメント2…を、円周方向に沿って配設して全体略円筒形状に形成したことを特徴とするステータコア。

3．発明の詳細な説明

〔産業上の利用分野〕

本発明はステータコアに関する。

〔従来の技術と発明が解決しようとする課題〕

従来、ブラシレスモータ等においては、第6図と第7図に示すようなステータコアaが使用され、このステータコアaは、ティースb…が突設された全体略円筒体からなり、ブラケットcの円筒部dに外嵌固着される。即ち、ステータコアaの孔部eに円筒部dを挿入固定していた。また、この場合、円筒部dには回転軸fが軸受g，gを介して挿入され、該回転軸fの一端部にロータhが固着されている。

従って、このブラシレスモータの小型化を図ろうとすれば、円筒部dを小径としてステータコアaを小径とする必要があるが、円筒部dの小径化を図れば、軸受g，gを小径とせねばならず、軸受g，gの耐久性等の問題から軸受g，gを小径のものにするのは好ましくない。即ち、従来のステータコアではこの種のブラシレスモータ全体の小型化をあまり図ることができなかった。

そこで、本発明では、ブラシレスモータ等に使用する場合に、軸受を小径とすることなしに該ブラシレスモータの小径化を図ることができ、しかも、その際極めて組み立て易いステータコアを提供することを目的とする。

〔課題を解決するための手段〕

上述の目的を達成するために本発明に係るステータコアは、コイルが巻設されるティースを備えると共に平面的に見て略扇形状とされた複数個のセグメントを、円周方向に沿って配設して全体略

円筒形状に形成したものである。

〔作　用〕

複数個のセグメントからなるので、このステータコアを円筒部に組付ける際、各セグメントを外方から径方向に沿って組付けることができ、該円筒部をこのステータコアが対応する部位のみを小径とし、他の部分、即ち、軸受に対応する部位を大径とすることができる。

また、各セグメントを合わせて全体略円筒形状とする前に、各セグメントごとにティースにコイルを巻設しておくこともできる。

〔実施例〕

以下、実施例を示す図面に基づいて本発明を詳説する。

第1図は本発明に係るステータコア1を示し、このコアは、複数個（実施例では3個）の略扇形状のセグメント2…を円周方向に沿って配設して全体略円筒形状に形成したものであり、各セグメント2…は、コイル3（第2図参照）が巻設されるティース4…を備えている。

しかして、各セグメント2…は、略扇形状のケイ素鋼等からなる複数枚の平板体5…が積層されてなり、各平板体5…には、第4図に示すように、ティース形成片部6…が外方向に突設されている。さらに、第4図に示す如く、該平板体5の周方向部の両端縁5a，5bの周方向長さに長短差を設け、同一形状のこのような平板体5…を表て向きと裏向きに交互に積層してゆくことによって、第3図に示すように、対面する上下の平板体5の両端縁5a，5bは夫々周方向に沿って僅かにずれを生じ、各セグメント2…を略円筒形状に組み付けた場合、対向する接合面7，7はギヤの凹凸歯の如く嵌合し、隙間を生じさせない。つまり、磁路のすきまが生じない。

そして、上述の如く構成されるステータコア1は第2図に示すブラシレスモータ8に使用されるが、このブラシレスモータ8は、円筒部9を有するブラケット10と、該ブラケット10の円筒部9に軸受11，11を介して回転自在に挿通される回転軸12と、該回転軸12の一端部12aに固着されるロータ13と、該円筒部9に外嵌されるステータ14と、を備えたものである。また、ロータ13は、ロータホルダ15と、該ロータホルダ15の周壁内周面にバックヨーク16を介して取付けられるロータマグネット17と、からなる。

また、この場合、ブラケット10の円筒部9は、両端部に大径部9a，9bが形成され、その間は小径部9cとされる。従って、ロータマグネット17と小径部9cとの間に比較的大きなスペースが設けられ、このスペースにステータ14が設けられる。

ここで、ステータ14は、上述の如く構成されるステータコア1と、コア1のティース4…に巻設されるコイル3と、からなり、ステータコア1が小径部9cに取付けられる。また、大径部9a，9bには軸受11，11が内嵌され、該軸受11，11にて回転軸12がこの円筒部9に回転自在に枢支されている。

従って、この場合、軸受11，11を小径とすることなしに、比較的小径のステータコア1を使用することができ、ステータ14の外周部を円筒部9の大径部9a，9bより外周側へ突出させないようにすることができる。実施例では、ステータ14の外径寸法Dと円筒部9の大径部9aの外径寸法Daと略同一に設定している。つまり、小径部9cの外径寸法Dcと、ステータコア1の肉厚寸法Aの2倍と、の和を、外径寸法Daと略同一としている。

即ち、各セグメント2…を外方から径方向に沿ってこの小径部9cに組み付けることができるので、円筒部9の一端部に（軸受11を保持するために）大径部9aが形成されていても、この大径部9aに関係なくステータコア1を小径部9cに組み付けることができるからである。

また、セグメント2を組み付ける際には、ステータコア1に巻設されるべきコイル3を、各セグメント2のティース4…に予め巻設しておくことができ、コイル3の巻設作業が極めて容易なものとなる。

次に、第5図は他の実施例を示し、インナーロ

ータ型ステータであり、この場合、内径側にティース4…が形成されたものであるが、上述の実施例と同様、各セグメント2…は、複数枚の略扇形状の平板体5…が積層されてなり、各セグメント2…の接合面7…は、合わされた際には、ギヤの凹凸歯の如く嵌合している。

なお、本発明は上述の実施例に限定されず、発明の要旨を逸脱しない範囲で設計変更自由であり、例えば、1つのステータコア1のセグメント2の数は任意であり、また、各セグメント2に設けられるティース4の数も自由であると共に、各セグメント2に補極となる小ティースを設けるも自由である。

〔発明の効果〕

本発明は上述の如く構成されているので、次に記載する効果を奏する。

本発明に係るステータコアを組み付ける場合、各セグメント2…を外方から径方向に移動させて組み付けることができるので、従来のステータコアでは組み付けることができなかった例えば第2図に示すような形状の円筒部9に簡単に組み付けることができ、内部に無駄なスペースを形成することのない極めて小型のブラシレスモータを形成することができる。つまり、このステータコアを使用すれば、モータ構造の設計の自由度が大となる。

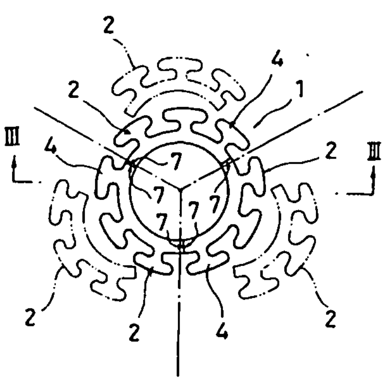
また、組み付ける前に各セグメント2…のティース4…に予めコイル3を巻設することができ、その巻線作業が容易となり、全体の組立作業が極めて容易となる。

4．図面の簡単な説明

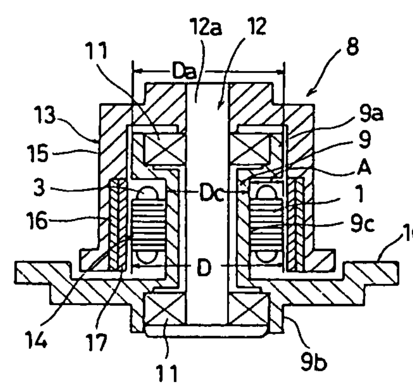
第1図は本発明の一実施例の平面図、第2図は本発明に係るステータコアが使用されたブラシレスモータの断面図、第3図は第1図のIII－III線拡大断面図、第4図は平板体の平面図、第5図は他の実施例の斜視図である。第6図は従来例の平面図、第7図は従来例のステータコアが使用されたブラシレスモータの断面図である。

2…セグメント、3…コイル、4…ティース。

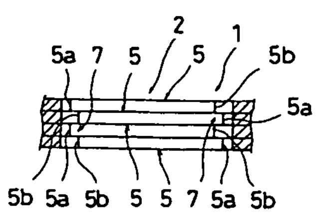
第1図



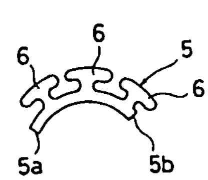
第2図



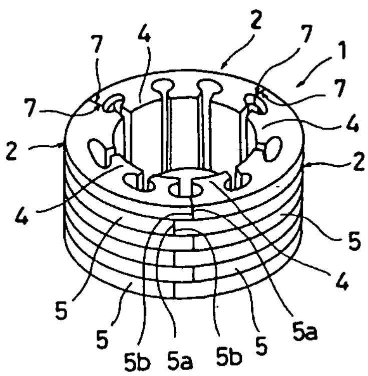
第3図



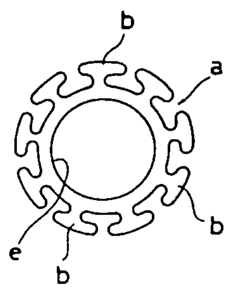
第4図



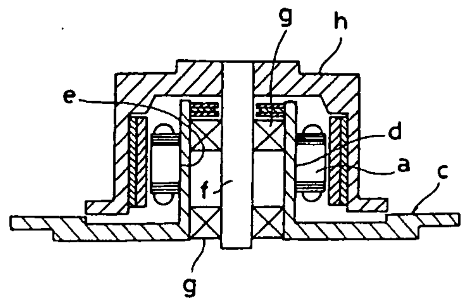
第 5 図



第 6 図



第 7 図



PAT-NO: JP406327208A

DOCUMENT-IDENTIFIER: JP 06327208 A

TITLE: STATOR OF DC BRUSHLESS MOTOR

PUBN-DATE: November 25, 1994

INVENTOR-INFORMATION:

NAME
SATO, MICHIRO
SETO, TAKESHI

ASSIGNEE-INFORMATION:

NAME	COUNTRY
SEIKO EPSON CORP	N/A

APPL-NO: JP05107934

APPL-DATE: May 10, 1993

INT-CL (IPC): H02K029/00, H02K003/04 , H02K015/12

ABSTRACT:

PURPOSE: To provide a DC brushless motor which excels in radiation and is small in size and high in output, efficiency and performance by sealing a stator block with a resin in one body to increase the mechanical strength and reliability of the stator.

CONSTITUTION: Stator blocks 10, each having a coil 11 on an iron core 12, are radially arranged around the center of rotation of a motor. The gap between an external case 20 and an internal case 30 is sealed with a resin 40 to constitute an integrated stator. The resin 40 may be either thermoplastic or thermosetting and also to the manufacturing method are applicable various methods of injection molding, potting, die-casting and the like. As a result, the stator blocks 10 are sealed with the resin 40, so that the strength and rigidity of the stator may be increased, thereby being able to increase durability and reliability against vibration and external force. Also, the heat generated in the stator blocks 10 is transferred into the external case 20 through the resin 40 of excellent thermal conductivity to increase radiation with heat-transfer to outside air.

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The stator of DC brushless motor characterized by uniting said stator block with the iron core which consists of column-like soft magnetic materials by the resin seal between the rotators of the pair which fixed the permanent magnet in the stator of the shaft-orientations gap mold DC brushless motor which allotted two or more stator blocks which rolled the coil.
[Claim 2] The stator of DC brushless motor characterized by the heat conductivity of the main filler of said resin being more than ten (W/m-K) in the stator of DC brushless motor according to claim 1.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the stator of DC brushless motor for power used for an electric vehicle drive etc.
[0002]
[Description of the Prior Art] There is an example indicated by JP,4-26350,A as a stator of the shaft-orientations gap mold DC brushless motor for the conventional power. As shown in drawing 2 , this motor uses a permanent magnet 51 for a rotator, and has structure which allotted two or more stator blocks 10 constituted by rolling a coil 11 between the rotators 50 of the pair which fixed the permanent magnet 51 by the iron core 12 which consists of column-like soft magnetic materials. As shown in drawing 3 , a stator arranges the stator block 10 to a radial to a revolving shaft, and has the structure of making an end plate 60 fixing in the both-ends surface part of shaft orientations.
[0003]
[Problem(s) to be Solved by the Invention] The stator block 10 of the shaft-orientations gap mold DC brushless motor of JP,4-26350,A has the uniform path cross-section configuration of a coil 11, as shown in drawing 4 , and it has the structure of performing a coil concentrically to the column-like iron core 12 further. Therefore, a coil is easy, and further, since it is possible to enlarge a coil space factor very much by considering as the coil structure of a straight angle line or one apparatus etc., as compared with DC brushless motor of the direction gap mold of a path, joule heat loss can be reduced sharply. That is, generation of heat at the time of high torque generating is able to constitute few efficient high performance motors. However, conventionally which fixes and arranges stator block 10 like drawing 3 to the end plate 60 in the both-ends side of the direction of a revolving shaft of a motor, with structure, if a metal is used for members for fixing, such as an end plate 60 or ****, the eddy current loss by field fluctuation will become remarkably large. Therefore, end plates 60 must be resin and an insulator like a ceramic, and fixing with the stator block 10 did not have a means in addition to adhesion. With this structure, since the reinforcement of a stator and rigidity were inadequate, vibration was large, and it was easy to transform it according to external force, and the problem was in endurance or dependability.

[0004] Furthermore, since the interior of the direction of the diameter of a motor of the stator block 10 which are the main sources of generation of heat is insulated with the opening section, the temperature of a there rises remarkably. Therefore, at the time of large torque, although there is little calorific value, since sufficient heat release was not obtained, practical use operation had the technical problem that it was impossible and high power could not be generated in fact.
[0005]
[Means for Solving the Problem] The stator of DC brushless motor of this invention is characterized by having the structure which unified said stator block by the resin seal in the stator of the shaft-orientations gap mold DC brushless motor which allotted the stator block which is what wound the coil around the iron core which consists of column-like soft magnetic materials, and is constituted between

the rotators of the pair which used the permanent magnet for the rotator and fixed the permanent magnet.

[0006] As a means which furthermore raises the heat dissipation engine performance, it is characterized by the thermal conductivity of the main filler of said resin being the quality of the material more than ten (W/m-K).

[0007]

[Example] A drawing is used for below and the example of this invention is explained to it. Drawing 1 is the path sectional view of the stator of DC brushless motor of this invention. In drawing 1 , 11 is a coil, 12 is an iron core, and, as for an outside case and 30, 20 is [an inside case and 40] resin. The stator block 10 consists of those by which the coil 11 was wound around the iron core 12, and are arranged to the center of rotation of a motor at the radial. [two or more] The closure of the gap with the outside case 20 and the inside case 30 is carried out by resin 40, and the stator of integral construction is constituted. Thermoplastic or thermosetting any are sufficient as the resin 40 in this case, and its various approaches, such as injection molding, potting, casting, and transfer molding, are possible also for a process. For example, in the case of drawing 1 , when liquefied thermosetting resin is used, it is potting, and in the case of powdery thermosetting resin, the closure is performed by transfer molding. Moreover, when there is not the outside case 20, the inside case 30, or both sides, it can close by casting. Therefore, drawing 1 R> 1 and its explanation are what showed one example, and are not what limited the component part of the stator of DC brushless motor of this invention, and the manufacture approach.

[0008] Thus, by carrying out the closure of the stator block 10 by resin 40, the reinforcement of a stator and rigidity increase and the endurance and dependability over vibration or external force improve remarkably.

[0009] Moreover, compared with air, heat transfer of the heat generated with the stator block 10 is carried out to the outside case 20 through thermally conductive good resin 40, it is performing heat exchange by the outside case 20 and the open air, and its heat dissipation nature also improves.

[0010] In addition, although the thermal conductivity of the epoxy resin that to the closures generally used is 0.1 to 0.2 (W/m-K) extent, in the epoxy resin which uses as a principal component the ceramic in which thermal conductivity, such as oxidation aluminum and nitriding aluminum, has 10-200 (W/m-K), and a large value as a bulking agent, and a metal powder, by about 10 times, thermal conductivity becomes large and its heat dissipation nature improves still by leaps and bounds. [many]

[0011] Therefore, as compared with the conventional motor, there are few temperature rises of a stator, it is small and it is possible to constitute the motor of high power. If the above-mentioned high ceramic of electric insulation is especially used as the main bulking agent of resin, insulating processing of a coil 10 is unnecessary, and since a man day is reducible, cost reduction of a motor can be planned.

[0012]

[Effect of the Invention] In the stator of the shaft-orientations gap mold DC brushless motor which allotted two or more stator blocks which are what wound the coil around the iron core which consists of column-like soft magnetic materials, and are constituted between the rotators of the pair which used the permanent magnet for the rotator and fixed the permanent magnet, small [which the mechanical strength of a stator and small dependability improved and is excellent in heat-dissipation nature], high power, and an efficient highly efficient DC brushless motor can consist of having the structure which unified the above-mentioned stator block by the resin seal.

[0013] Moreover, if thermal conductivity uses the thing more than ten (W/m-K) for the main filler of the above-mentioned resin, since heat dissipation nature improves still by leaps and bounds, it can be made more into small and high power DC brushless motor.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The path sectional view of the stator of DC brushless motor of this invention.
[Drawing 2] Drawing of longitudinal section of the conventional DC brushless motor.
[Drawing 3] The perspective view of the stator of the conventional DC brushless motor.
[Drawing 4] The perspective view of a stator block of the conventional DC brushless motor.
[Description of Notations]
10 Stator Block
11 Coil
12 Iron Core
20 Outside Case
30 Inside Case
40 Resin
50 Rotator
51 Permanent Magnet

[Translation done.]

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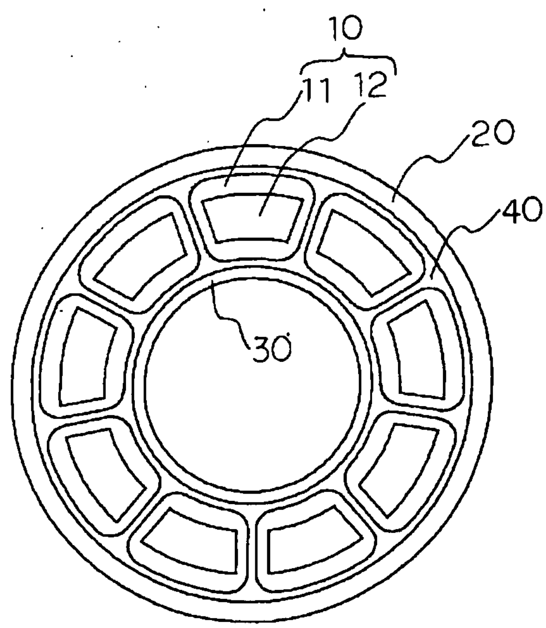
(54)【発明の名称】　ＤＣブラシレスモータの固定子

(57)【要約】
【目的】　回転子に永久磁石を用い、永久磁石を固着した一対の回転子の間に、柱状の軟磁性材料からなる鉄心にコイルを巻いた固定子ブロックを配した軸方向ギャップ型ＤＣブラシレスモータは、固定子コイルの高占積率化が可能であるため、固定子内での発熱が少ない高効率なモータとすることができるが、従来の構造では、機械的強度が不十分で、耐久性や信頼性に問題があり、また、放熱性が悪いため固定子内部の温度上昇が著しく、高いトルクを維持することができなかった。本発明では、このような問題点を解決した小型・高出力で高効率の高性能なＤＣブラシレスモータの固定子を提供する。
【構成】　固定子ブロックを樹脂封止で一体化することで、固定子の強度、信頼性が向上し、また、固定子ブロックで発生する熱の放熱効果を高められる。



【特許請求の範囲】
【請求項1】　永久磁石を固着した一対の回転子の間に、柱状の軟磁性材料からなる鉄心にコイルを巻いた固定子ブロックを複数個配した軸方向ギャップ型ＤＣブラシレスモータの固定子において、前記固定子ブロックを樹脂封止により一体化したことを特徴とするＤＣブラシレスモータの固定子。
【請求項2】　請求項１記載のＤＣブラシレスモータの固定子において、前記樹脂の主充填材の熱伝導率が10(W/m·K)以上であることを特徴とするＤＣブラシレスモータの固定子。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】この発明は、電気自動車駆動等に用いられる動力用ＤＣブラシレスモータの固定子に関する。
【０００２】
【従来の技術】従来の動力用の軸方向ギャップ型ＤＣブラシレスモータの固定子として、特開平４－２６３５０に記載された例がある。このモータは、図２に示すように、回転子に永久磁石５１を用い、永久磁石５１を固着した一対の回転子５０の間に、柱状の軟磁性材料からなる鉄心１２にコイル１１を巻いて構成される固定子ブロック１０を複数個配した構造となっている。固定子は、図3に示すように、固定子ブロック１０を回転軸に対して放射状に配置し、軸方向の両端面部において端板６０を固着させる構造になっている。
【０００３】
【発明が解決しようとする課題】特開平４－２６３５０の軸方向ギャップ型ＤＣブラシレスモータの固定子ブロック１０は、図4に示すようにコイル１１の径断面形状が一様で、さらに柱状の鉄心１２に対して同心状に巻線を行う構造をもつ。そのため、巻線が容易で、さらに、平角線や一体型のコイル構造とすることなどでコイル占積率を非常に大きくすることが可能であるため、径方向ギャップ型のＤＣブラシレスモータと比較して、ジュール熱損失を大幅に低減できる。すなわち、高トルク発生時の発熱が少ない高効率な高性能モータを構成することが可能である。しかしながら、図3のような、固定子ブロック１０をモータの回転軸方向の両端面にある端板６０に固着して配置する従来構造では、端板６０あるいは、ねじ等の固着用部材に金属を用いると、磁界変動による渦電流損失が著しく大きくなる。そのため、端板６０は樹脂やセラミックのような絶縁体でなければならず、固定子ブロック１０との固着は接着以外に手段がなかった。この構造では、固定子の強度や剛性が不十分であるため、振動が大きく、また外力によって変形しやすく、耐久性や信頼性に問題があった。
【０００４】さらに、おもな発熱源である固定子ブロック１０のモータ径方向の内部は空隙部で断熱されるため、そこでの温度が著しく上昇する。したがって、大トルク時には、発熱量は少ないものの、十分な放熱量が得られないため、実用運転は不可能で、実際には大出力を発生できないという課題を持っていた。
【０００５】
【課題を解決するための手段】本発明のＤＣブラシレスモータの固定子は、回転子に永久磁石を用い、永久磁石を固着した一対の回転子の間に、柱状の軟磁性材料からなる鉄心にコイルを巻いたもので構成される固定子ブロックを配した軸方向ギャップ型ＤＣブラシレスモータの固定子において、前記固定子ブロックを樹脂封止により一体化した構造を持つことを特徴とする。
【０００６】さらに放熱性能を向上させる手段として、前記樹脂の主充填材の熱伝導率が10(W/m·K)以上の材質であることを特徴とする。
【０００７】
【実施例】以下に本発明の実施例を図面を用いて説明する。図1は、本発明のＤＣブラシレスモータの固定子の径断面図である。図1において、１１はコイル、１２は鉄心で、２０は外側ケース、３０は内側ケース、４０は樹脂である。固定子ブロック１０は、鉄心１２にコイル１１が巻かれたものから構成され、モータの回転中心に対して放射状に複数個配置されている。外側ケース２０および内側ケース３０との間隙は樹脂４０で封止され、一体構造の固定子が構成されている。この場合の樹脂４０は、熱可塑性あるいは、熱硬化性のいずれでもよく、製法も射出成形、ポッティング、キャスティング、トランスファ成形等種々の方法が可能である。例えば、図1の場合、液状の熱硬化性樹脂を用いた場合にはポッティングで、また、粉状の熱硬化性樹脂の場合にはトランスファ成形で封止を行う。また、外側ケース２０と内側ケース３０のいずれか、または双方がない場合には、キャスティングにて封止することができる。したがって、図1およびその説明は、一実施例を示したもので、本発明のＤＣブラシレスモータの固定子の構成部品、製造方法を限定したものではない。
【０００８】このように、固定子ブロック１０が樹脂４０で封止されることにより、固定子の強度や剛性が高まり、振動や外力に対する耐久性、信頼性が著しく向上する。
【０００９】また、固定子ブロック１０で発生した熱は、空気に比べて熱伝導性の良い樹脂４０を介して外側ケース２０に伝熱され、外側ケース２０と外気とで熱交換を行うことで、放熱性も向上する。
【００１０】なお、一般に封止用に多く用いられるエポキシ樹脂の熱伝導率は、0.1～0.2(W/m·K)程度であるが、充填剤として酸化アルミや窒化アルミなど熱伝導率が10～200(W/m·K)と大きい値を持つセラミックや金属粉を主成分とするエポキシ樹脂では、熱伝導率は１０倍程度大きくなり、放熱性がさらに飛躍的に向上する。

【0011】そのため、従来のモータと比較して、固定子の温度上昇が少なく、小型で高出力のモータを構成することが可能である。特に、電気絶縁性の高い上記セラミックを樹脂の主充填剤にするとコイル10の絶縁処理が不要で、工数が削減できるためにモータのコスト低減を図ることができる。

【0012】

【発明の効果】回転子に永久磁石を用い、永久磁石を固着した一対の回転子の間に、柱状の軟磁性材料からなる鉄心にコイルを巻いたもので構成される固定子ブロックを複数個配した軸方向ギャップ型DCブラシレスモータの固定子において、上記固定子ブロックを樹脂封止により一体化した構造を持つことで、固定子の機械的強度、信頼性が向上し、かつ放熱性に優れた小型、高出力、高効率の高性能なDCブラシレスモータを構成できる。

【0013】また、上記樹脂の主充填材に熱伝導率が10(W/m·K)以上のものを用いると放熱性は、さらに飛躍的に向上するので、より小型、高出力なDCブラシレスモータとする事ができる。

【図面の簡単な説明】

【図1】 本発明のDCブラシレスモータの固定子の径断面図。

【図2】 従来のDCブラシレスモータの縦断面図。

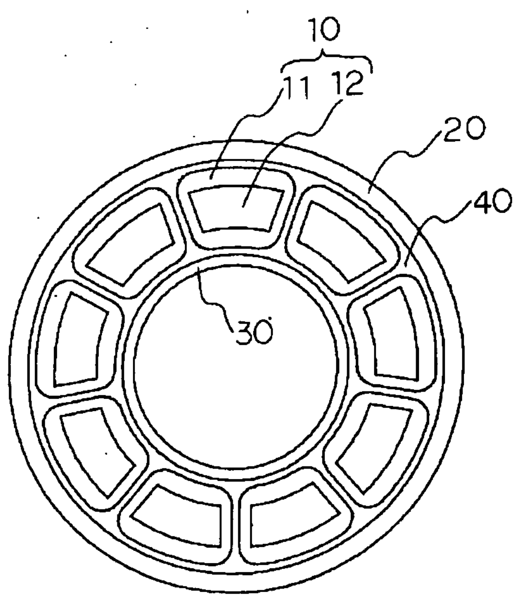
【図3】 従来のDCブラシレスモータの固定子の斜視図。

【図4】 従来のDCブラシレスモータの固定子ブロックの斜視図。

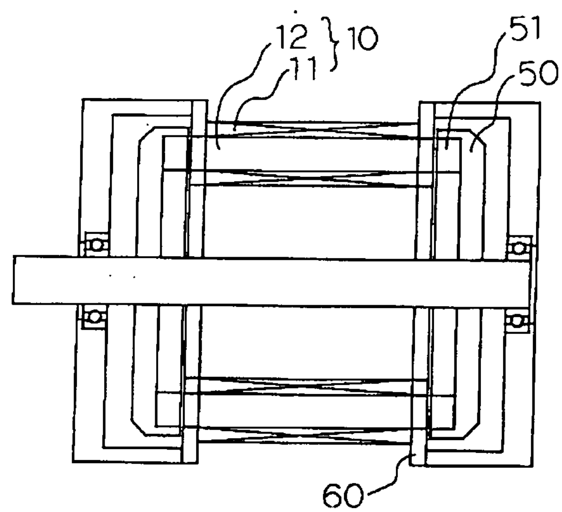
【符号の説明】

10 固定子ブロック
11 コイル
12 鉄心
20 外側ケース
30 内側ケース
40 樹脂
50 回転子
51 永久磁石

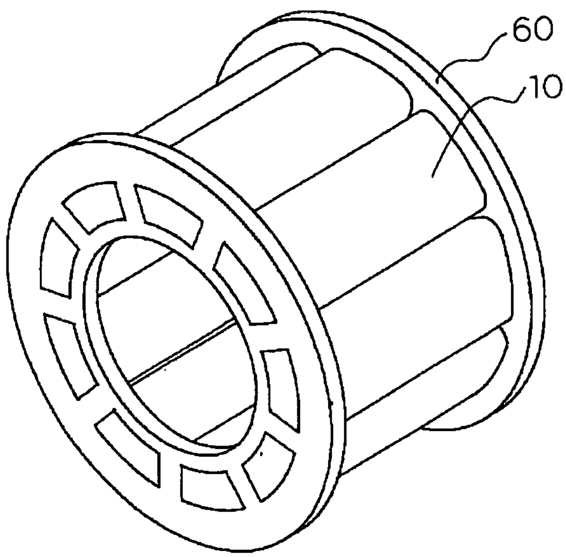
【図1】



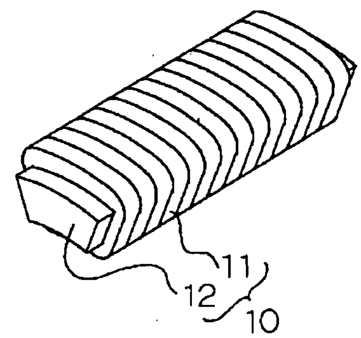
【図2】



【図3】



【図4】



PAT-NO: JP410243595A

DOCUMENT-IDENTIFIER: JP 10243595 A

TITLE: SEALED STATOR FOR SMALL MOTOR AND ITS MANUFACTURE

PUBN-DATE: September 11, 1998

INVENTOR-INFORMATION:
NAME
NAKATSUKA, GINZOU

ASSIGNEE-INFORMATION:

NAME	COUNTRY
KK ARON	N/A

APPL-NO: JP09052512

APPL-DATE: February 21, 1997

INT-CL (IPC): H02K003/44, H02K003/34 , H02K015/12

ABSTRACT:

PROBLEM TO BE SOLVED: To manufacture a sealed stator by injection molding easily without damaging a winding by a method wherein the winding is applied to the core of a stator on which an insulator made of high fluidity thermoplastic synthetic resin is formed by insert-molding and the core is covered with the same system thermoplastic resin by injection molding.

SOLUTION: A layer-built core 1 is inserted into the mold of an injection molder and an insulator is molded with high fluidity thermoplastic synthetic resin as raw material to form an undermold. A winding 10 is applied to the tooth 9 of the layer-built core 1 covered with the undermold 8 to form a stator. Then the gate of the mold is positioned so as not to have the injected resin applied directly to the winding 10 of the stator and the high fluidity thermoplastic resin of the same system as the insulator is applied to the stator to cover the winding 10 as an overmold 12. With this constitution, the winding 10 is not exposed to the outside directly, so that the leakage of contaminants from the winding 10 of an operating motor can be avoided.

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3/34		3/34	C
15/12		15/12	E

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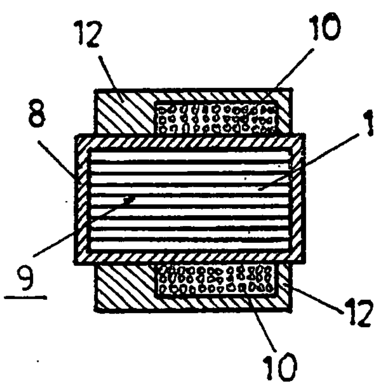
(54)【発明の名称】　小型モータ用封止型ステーター及びその製造方法

(57)【要約】

【課題】　巻線に損傷を与えることなく、射出成形により封止型のステーターやローターを製造する。

【解決手段】　鋼板を必要枚数積み重ね積層鉄心とし、積層鉄心を射出成形機の金型内にインサートし、絶縁性高流動性熱可塑性合成樹脂を原料としてアンダーモールドし積層鉄心の両端面とスロットに樹脂膜を被覆するとともに鉄心の上面を被覆する樹脂膜には同時に巻線加工用のフックを成形してインシュレーターとし、インシュレーターを被覆した積層鉄心にフックを利用して細い被覆銅線を巻線加工し、次に射出成形機の金型内で、このステーターの巻線に射出した樹脂が当たらない位置にゲートを設け、アンダーモールドに使用した樹脂と同系統を原料とし、充填圧力を基準値の２０～６０％の低圧、射出速度を基準値の２倍以上の高速とし、射出成形によりステーターにオーバーモールドした。



【特許請求の範囲】

【請求項１】絶縁性を有する高流動性の熱可塑性合成樹脂製のインシュレーターがインサート成形してある鉄心に巻線をしたステーターに、射出成形により同系統の熱可塑性樹脂が被覆してあることを特徴とする小型モータ用封止型ステーター。

【請求項２】所望形状に打ち抜いた鋼板を必要枚数積み重ねてカシメ加工して積層鉄心とし、

この積層鉄心を射出成形機の金型内にインサートし、絶縁性を有する高流動性の熱可塑性合成樹脂を原料としてアンダーモールドし、少なくとも積層鉄心の両端面とスロットに薄肉の樹脂膜を被覆するとともに鉄心の上面を被覆する樹脂膜には同時に巻線加工用のフックを成形してインシュレーターとし、

このインシュレーターを被覆した積層鉄心に前記フックを利用して細い被覆銅線をコイル状に巻線加工し、

次に射出成形機の金型内で、このステーターの巻線に射出した樹脂が直接当たらない位置に金型のゲート位置を設け、

前記アンダーモールドに使用した樹脂と同系統の合成樹脂を原料とし、

使用する射出成形機の基準値に対し、充填圧力を基準値の２０～６０％の低圧とし、射出速度を基準値の２倍以上の高速とし、射出成形により前記ステーターにオーバーモールドして被覆するようにしたことを特徴とする小型モータ用封止型ステーターの製造方法。

【請求項３】射出成形用の金型に、射出圧力を吸収するための圧力調整機構を設けたものを使用する請求項２記載の小型モータ用封止型ステーターの製造方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、スピンドルモータやサーボモータ等の小型の薄肉成形モータのステーターに関するものであり、特にハードディスク駆動装置に適するものである。

【０００２】ハードディスクの記憶容量は近年ますます大容量化が要求されており、記憶容量の向上とともに駆動部のクリーン度の要求レベルも高いものになっている。ハードディスク駆動装置となるモータの部品となるステーターの鉄心及び巻線部から発生する埃りやガスを封じ込めることは、ハードディスクの性能向上に大きな効果をもたらす。本発明のステーターはかかるニーズに対応するクリーンな環境での使用に適する小型精密モーター用のステーターである。

【０００３】

【従来の技術】近年、各分野において小型や薄型の各種モータが使用されるようになってきており、それにつれてステーター及びインシュレーターの小型化や薄型化も要求されるとともに、製造工程の簡略化や信頼性の向上が要求されるようになってきている。

【０００４】特に、市場要求としてモータの小型化、薄型化のニーズが高くなっており、鉄心との絶縁性がキープできればインシュレーターの肉厚が薄い程、巻き線量も大きくなり、モータの起動力やパワー等の性能も向上することになる。また、絶縁物が薄い程モータに発生する熱の放散がしやすくなる等の作用効果もある。

【０００５】一方、ハードディスク装置に使用されるスピンドルモータの場合、上記小型化と薄型化に加え、磁気ヘッドやハードディスクに微小な埃等が付着すると、ノイズやヘッドクラッシュの原因となるので、モータから埃やガスが発生しないようにする必要がある。

【０００６】モータからは主にパーティクル，有機物質，イオン性物質，ガスが発生する。特に、ステーターやローターの巻線同士が擦れたりすることにより生じる汚染物質の飛散を防止する必要があり、このことはハードディスク装置の耐久性を高めるためにも重要である。また、ハードディスク装置の性能向上のためには、電流パルスにより発生する振動，ノイズを防止する必要もある。

【０００７】

【発明が解決しようとする課題】ところで、従来ステーターを製造するためには、形に打ち抜いた薄い鋼板を複数枚カシメて積層鉄心とし、これを防錆処理した後塗装により絶縁処理をしていた。そして、これに巻線ガイドを接着した後、巻線を行っていた。

【０００８】しかし、打ち抜いた薄い鋼板を積層するために、積層面が露出することとなる外周やスロット等が完全な平面とはならないで凹凸が生じるのは避けられなかった。インサート上の大きな問題は、積層した鉄心の厚みの変動があることである。そのため、インサート成形には①積層の厚みで分類するか又は②型内で調整コアを作動させる等の多大な費用を要した。且つまた、従来のインサート方式の①積層厚分類方式、②型内調整移動コア方式では双方ともにバリが発生するため、多大な費用をかけてバリとりをする必要があった。

【０００９】そして、このような凹凸面を絶縁処理するためには５０～８０μｍ位の厚さで塗装を行う必要があった。塗装は前工程としてバリ取りのショットブラスト又はバレル工程を必要とするため、費用が高くなるとともに、ピンホール等が生じやすくなるために絶縁不良となりやすく、エッジ部の剥離がおき、従って歩止まりが悪かった。その上、塗装後に巻線ガイドを接着する必要があり、製造工程が複雑となっていた。

【００１０】また、特開昭６３－３６３６号公報や特開昭６３－３６３７号公報に示されるように、鉄心の一番外側となる鋼板に熱可塑性の合成樹脂層が予め貼り合わせてあるラミネート鋼板を使用し、鋼板を積層後この合成樹脂層を加熱して熱変形させて絶縁する方法もあるが、積層した鋼板の中間部まで完全に合成樹脂で被覆するためにはこれらの部分へ熱変形させるためにラミネー

ト鋼板の合成樹脂層の厚さに余裕をもたせておく必要があり、あまり合成樹脂層を薄くすることができず、また、鉄心全体を均一な厚さで被覆するのもなかなか困難であった。

【0011】すなわち、上記課題を解決するためには、簡単な製造工程により絶縁処理した鉄心を欠陥品の発生を防いで製造し、且つインシュレーターも同時に成形するとともに、抵抗値やインダクタンスの値を向上させたものができればよいことになる。

【0012】一方、ステーターやローターの巻線同士が擦れたりすることにより生じる汚染物質の飛散を防止したり、電流パルスにより発生する振動，ノイズを防止するためには、巻線を合成樹脂等で封止密封し、巻線が外部に直接露出しないような状態にする必要がある。

【0013】そこでこれを解決することを目的として巻線を合成樹脂で封止するものが各種提案されている。但し、合成樹脂で封止するに際しては、巻線の被覆を熱や圧力により損傷させることなく、且つ巻線コイルに乱れを生じさせないようにすることが重要である。

【0014】従来一般に合成樹脂で封止するのは、熱硬化性樹脂を使用して低温（１２０℃以下）、低圧で行われている。樹脂材料は主としてバルクモールディングコンパウンド（ＢＭＣ）によるものである。この方法では、樹脂温度は低温であるが、製造時間は数分を要した。

【0015】一方、巻線を合成樹脂で被覆するのに射出成形法を用いる方法も各種提案されている。例えば、特公平６－５９７７号公報に示すものは、コイル状に巻回した巻線を金型内に挿入し、金型温度を１２０～１５０℃とし、向き充填物が２０～４０ｗｔ％含有してポニフェニレンサルファイド（ＰＰＳ）を用いて、樹脂温度３００～３５０℃、射出圧力８００～１０００ｋｇ／ｃ㎡で射出成形して巻線を被覆するものである。これは従来巻線の封止に使用されていた熱硬化性のエポキシ樹脂では成形に長時間要して生産性が悪かったので、熱可塑性樹脂を用い射出成形により比較的短時間で成形できるようにしたものである。しかしながら、溶融している高温の樹脂を高い圧力で射出しており、巻線のコイル径が太く且つコイルの被覆膜が厚い場合は問題ないが、コイル径が細く且つ被覆膜が薄い巻線の場合には、巻線コイルの乱れや被覆膜の損傷が発生し実用的でない。

【0016】また、特開平３－７０４４１号公報に示すものは、複数このスロットを有する鉄心に巻線をし、整流子を備えたローターの鉄心と巻線の外周を絶縁性封止部材（ガラス繊維入りのポリアセタール）で射出成形で封止する際、樹脂の射出位置を整流子の反対側の端面でローターの回転軸と平行に射出するようにしたものである。射出は２段射出で行い、最初の射出圧力は２２０ｋｇ／ｃ㎡、２段目は５０ｋｇ／ｃ㎡で行う。これはローターに関するものであり、本願のステーターとは対象物を異にするとともに、これの技術ポイントは樹脂の射出方向を特定し、巻線の乱れを防ぐことと、射出圧力を２段にして射出時間を短くし、樹脂の冷えを防ぎ、皺やひけ等の成形不具合をなくすことである。樹脂の射出時間は２．５秒と短いが、この短時間でも小型精密モータ用ステーターの巻線は被覆膜が薄いので、高温の溶融樹脂により損傷を受けてしまう。また、最初の射出圧力が２２０ｋｇ／ｃ㎡と高く、射出される樹脂の影響で巻線コイルが乱れてしまうことになる。

【0017】更に、特開平６－３２７２０８号公報に示すものは、永久磁石を固着した一対の回転子の間に、柱状の軟磁性材料からなる鉄心にコイルを巻いた固定しブロックを複数個配した軸方向ギャップ型ＤＣブラシレスモータの固定子の固定子ブロックをステーターとして組立固定し、主充填材の熱伝導率が１０（ｗ／ｍ・ｋ）以上の樹脂で固着するものである。使用する樹脂は熱可塑性，熱硬化性の両種類の樹脂が対象となっているが熱硬化性樹脂を主体としている。また成形方法として射出成形も記載されているが、液状の熱硬化性樹脂はポッティングで、粉状の熱硬化性樹脂はトランスファー成形を用い、更に形状によってはキャスティングを使用することが提案されており、射出成形による具体的な方法については記載がない。なお、使用する樹脂としては酸化アルミや窒化アルミ等の熱伝導率のよい充填材を主成分とするエポキシ樹脂であり、流動性についての言及はない。

【0018】

【課題を解決するための手段】そこで、この発明に係る小型モータ用封止型ステーターとは上記課題を解決するために、絶縁性を有する高流動性の熱可塑性合成樹脂製のインシュレーターがインサート成形してある鉄心に巻線をしたステーターに、射出成形により同系統の熱可塑性樹脂が被覆してあるものである。

【0019】また、この発明に係る小型モータ用封止型ステーターの製造方法は上記課題を解決するために、所望形状に打ち抜いた鋼板を必要枚数積み重ねてカシメ加工して積層鉄心とし、この積層鉄心を射出成形機の金型内にインサートし、絶縁性を有する高流動性の熱可塑性合成樹脂を原料としてアンダーモールドし、少なくとも積層鉄心の両端面とスロットに薄肉の樹脂膜を被覆するとともに鉄心の上面を被覆する樹脂膜には同時に巻線加工用のフックを形成してインシュレーターとし、このインシュレーターを被覆した積層鉄心に前記フックを利用して細い被覆銅線をコイル状に巻線加工し、次に射出成形機の金型内で、このステーターの巻線に射出した樹脂が直接当たらない位置に金型のゲート位置を設け、前記アンダーモールドに使用した樹脂と同系統の合成樹脂を原料とし、使用する射出成形機の基準値に対し、充填圧力を基準値の２０～６０％の低圧とし、射出速度を基準値の２倍以上の高速とし、射出成形により前記ステーターにオーバーモールドして被覆するようにしたものであ

る。

【0020】

【発明の実施の形態】次に、この発明に係る小型モータ用封止型ステーター及びこれらの製造方法の実施例について説明する。

【0021】まず、インシュレーターをインサート成形した鉄心及びその製造方法の一実施例を、ハードディスク装置で使用するスピンドルモータ用のステーターのものについて図1～図5に基づいて述べる。1は薄い鋼板を複数枚カシメて形成した積層鉄心である。そして、この積層鉄心1を射出成形機の金型内にインサートし、高流動性の熱可塑性合成樹脂を原料としてインシュレーター2をアンダーモールドして成形する。アンダーモールドしたインシュレーター2の肉厚は望ましくは0．2mm以下とする。

【0022】インシュレーター2は積層鉄心1の両端面3，スロット4及び外周5を被覆するように成形する。すなわち、ローター挿入部となる内径側面6も含め全周を被覆するように薄い絶縁性合成樹脂製のインシュレーター2をアンダーモールドする。7はインシュレーター2の端面3に形成した巻線ガイドである。なお、インシュレーター2は内径側面6を含め、肉厚0．2mm以下で全周を被覆するようにすることが望ましい。

【0023】また、使用方法によっては外径側面を除く全周を被覆してもよい。そして図5に示すように、インシュレーター2は積層鉄心1の両端面3とスロット4を被覆するように成形し、インシュレーター2の端面3に巻線ガイド7を形成する。薄肉成形インサート品（肉厚0．2mm以下）で、同時に巻線ガイドを成形した画期的なものである。なお、巻線ガイド7の形状としては図示した逆L字形に限定されるものではなく、垂直や斜めにI型のものでもよい。

【0024】インシュレーター2を成形する合成樹脂としては、絶縁性を有する高流動性の熱可塑性を使用するが、例えば66ナイロンやPBT樹脂，LCP樹脂，PPS樹脂等を使用することができる。なお、本発明において高流動性樹脂と称するものは、樹脂が成形に必要な温度で溶融された状態でシアーレート（せん断速度）が10^2(1／秒)の時の溶融粘度が7×10^3 ポイズ以下、シアーレートが10^3(1／秒)の時の溶融粘度が3×10^3 ポイズ以下のものをいう。

【0025】次に、上記した積層鉄心1を利用して小型モータ用封止型ステーターの製造方法について説明する。なお、以下の説明においてはインシュレーター2をアンダーモールド8と称す場合もある。

【0026】まず、アンダーモールド8をした積層鉄心1の歯9に巻線10をしてステーター11とする。これは通常の方法により巻線10をすればよい。そして、このステーター11の巻線10に射出した樹脂が直接当たらない位置に金型のゲート位置を設け、上記インシュレーター2と同系統の高流動性の熱可塑性樹脂を射出成形により前記ステーターにオーバーモールド12をして巻線10を被覆する。これにより、巻線10が外部に直接露出せず、樹脂によりオーバーモールド12された状態の本発明の封止型ステーターが製造される。

【0027】なお、オーバーモールド12をするに際しては、射出成形時の樹脂の充填ピーク圧は、原料樹脂や製品の形状等により異なるが、通常使用する充填ピーク圧を基準とし、この値の20～60％の低圧で、射出速度を通常速度の2倍以上の高速とする必要がある。

【0028】一般の射出成形では通常70kg/cm²～150kg/cm²の充填ピーク圧が使用されている。本発明のオーバーモールドの際の充填ピーク圧は、通常の成形で70kg/cm²程度の充填ピーク圧を必要とする場合（原料や製品に対して）は、15kg/cm²～40kg/cm²とする。また、通常成形で150kg/cm²程度の充填ピーク圧を必要とする場合は30kg/cm²～90kg/cm²の充填ピーク圧とする。

【0029】またオーバーモールドの際、金型キャビティの中に背後にバネを備えた複数個の圧力調整用の可動ピンを設け、樹脂の射出圧力が加わるとこの樹脂圧でピンが一旦押し込まれてダンパーとして働いて金型内の急激な圧力上昇を防止し、樹脂の射出圧力によって巻線が乱れることをより確実に防止することができる。この圧力調整機構は、樹脂の充填ピーク圧が高い場合に効果的なものとなる。

【0030】一方射出速度は、例えば基準となるなる通常の射出速度が135mm/secであれば、これの2倍以上となる270mm/sec以上とする。なお、最近の射出成形機においては性能的には1000mm/secも可能となっている。射出速度を2倍とすれば、射出充填時間は1／2となる。

【0031】本発明で使用する巻線10は、例えば線径（直径）が0．13mmの銅線であり、被覆材はポリウレタン樹脂（耐熱温度155℃）であり、被覆膜の厚さは0．01mmである。このようなものでも上記条件（充填圧力と射出速度）とすることにより被覆材の損傷を防止できる。

【0032】なお、金型温度が高過ぎるとアンダーモールド8が変形する恐れがあるとともに、巻線10に伝わる熱量を小さくするため、金型温度は30℃～80℃の間、好ましくは50℃以下とする。

【0033】また、ゲート位置を巻線10を直撃しない位置とすることにより、射出圧力による巻線の乱れを防止できる。実際のゲート位置としては、例えばスロット4内、より具体的にはステーター11の巻線10加工をした相隣接する歯9の間とする。また、ゲート数は短時間に射出成形を完了するためには多いほど望ましいが、これはステーターの大きさや極数により適当に選択すればよい。

【００３４】オーバーモールド１２に使用する高流動性の熱可塑性樹脂は、アンダーモールド８とのなじみをよくするために、同系統の樹脂を使用する。なお、これらの樹脂を使用すると成形温度は３００℃位となるが、このような耐熱温度の高い樹脂を使用して封止成形をしておくことにより、耐久性に優れたモータとすることができる。

【００３５】

【発明の効果】以上述べたように、本発明の小型モータ用封止型ステーターによれば、モータ運転中の巻線からの汚染物質の流出を防止でき、また電流パルスにより発生する振動やノイズを押えることができる。

【００３６】また、本発明の小型モータ用封止型ステーターの製造方法によれば、巻線に損傷を与えることなく、射出成形によって簡単に封止型のステーターを製造することができ、小形且つ高性能なスピンドルモータを製造することができる。

【図面の簡単な説明】

【図１】本発明で使用するインシュレーターをインサート成形した積層鉄心の平面図である。

【図２】本発明で使用するインシュレーターをインサート成形した積層鉄心の正面図である（巻線ガイドについては一部図示を省略した）。

【図３】図１のＡ－Ａ線端面図である。

【図４】図１のＢ－Ｂ線端面図である。

【図５】本発明で使用するインシュレーターをインサート成形した積層鉄心の他例を示す正面図である（巻線ガイドについては一部図示を省略した）。

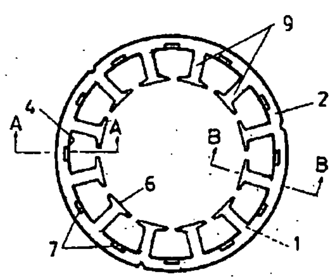
【図６】本発明の封止型ステーターの平面図である。

【図７】図６のＣ－Ｃ線拡大端面図である。

【符号の説明】

１　積層鉄心
２　インシュレーター
３　端面
４　スロット
５　外周
６　内径側面
７　巻線ガイド
８　アンダーモールド
９　歯
１０　巻線
１１　ステーター
１２　オーバーモールド

【図１】



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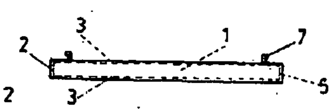

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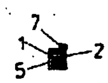
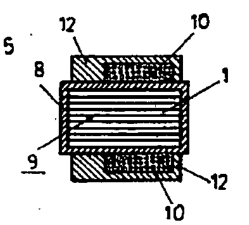
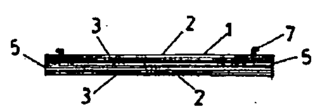


【図４】

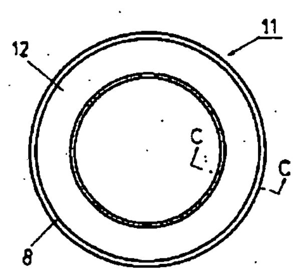
【図７】



【図５】



【図６】



A.C. motor

Patent number: EP0938181

Publication date: 1999-08-25

Inventor: KLAUS GEORG DIPL-ING (DE); HUTH GERHARD PROF (DE); SCHUELLER UWE DR (DE)

Applicant: SIEMENS AG (DE)

Classification:

- international: H02K1/14

- european: H02K1/16

Application number: EP19990101656 19990205

Priority number(s): DE19981005981 19980213

Also published as:

DE19805981 (A1)
EP0938181 (B1)

Cited documents:

US5057733
GB2123318
DE2653387

Abstract of **EP0938181**

The motor has a stator. Segmented partial sheet metal laminations (1) are provided around the circumference of the stator and/or in the axial direction of the motor. The laminations have at least one stator tooth (2) and means for fastening in a recess (6) with a cylindrical or polygonal inner contour. The stator teeth (2) are mounted with pre-fabricated coils (4). The coils (4) are formed as toothed coils (4) and can be switched to form a pure phase breach-hole winding. The coils (4) are fixed with the tooth head elements (3) which can be fastened to the stator teeth (2).

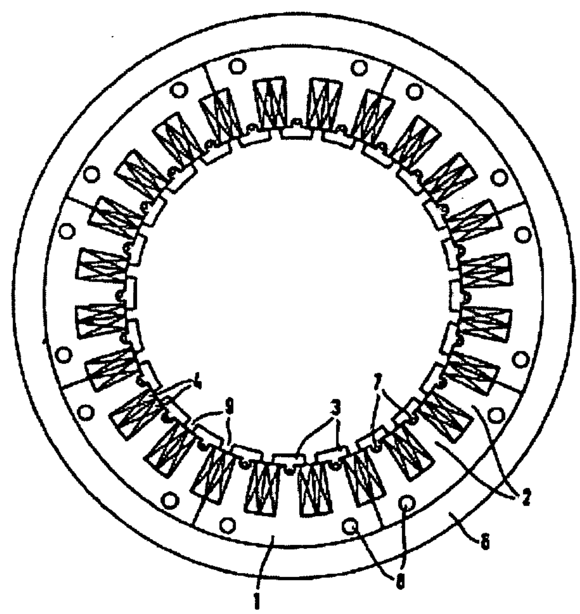


FIG 2

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-095193

(43)Date of publication of application : 06.04.2001

(51)Int.Cl. H02K 5/08
H02K 13/00
H02K 15/12

(21)Application number : 11-270508

(22)Date of filing : 24.09.1999

(71)Applicant : HONDA MOTOR CO LTD

(72)Inventor : MURATA TERUYA
NEGISHI SHOICHIRO
MURAOKA HIDETO

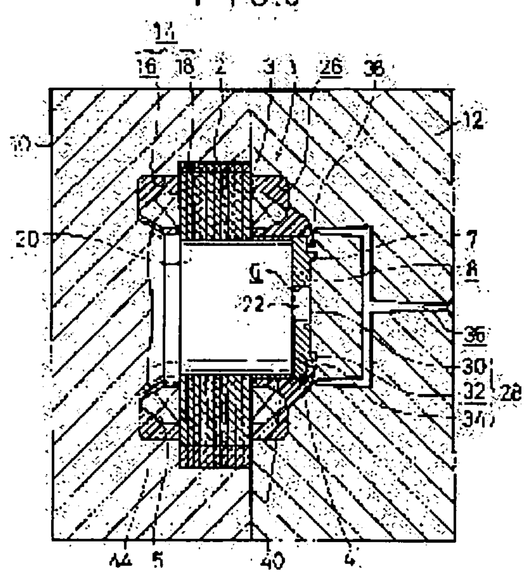
(54) STATOR ASSEMBLY, AND METHOD AND EQUIPMENT FOR ITS INJECTION MOLDING

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a stator assembly whose production efficiency can be increased by simplifying a molding process and which can prevent the deterioration of a commutator caused by the friction or vibration due to the rotation of a rotor, and to provide a method and equipment for molding the stator assembly.

SOLUTION: A stator core 3 with its teeth 46 wound with windings 5 is positioned and fixed in a movable metal mold 10. Then, the movable metal mold 10 is drawn close to a fixed metal mold 12. Into a cavity formed by joining these metal molds, molten material is injected through an injection hole 38 of the fixed metal mold 12. A part of a commutator installed in the stator core 3 is shielded by a shielding section 28 provided in the fixed metal mold 12, and so the resin material does not attach to that part of the commutator 4 shielded by the shielding section 28, Then, the molten material is solidified on the outer surface of the commutator, integrally fixing the commutator 4 and the stator core 3.

FIG.3



Issue Classification	Application/Control No. 09/798,511	Applicant(s)/Patent under Reexamination NEAL, GRIFFITH D.	
	Examiner Eric B. Compton	Art Unit 3726	

ISSUE CLASSIFICATION

ORIGINAL					CROSS REFERENCE(S)							
CLASS				SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)						
29				597	29	596	606					
INTERNATIONAL CLASSIFICATION					310	45	218					
H	0	2	K	15/00								
H	0	2	K	1/14								
				/								
				/								
				/								

(Assistant Examiner) (Date)	Eric Compton 12/09/2005	Total Claims Allowed: 29	
(Legal Instruments Examiner) (Date)	(Primary Examiner) (Date)	O.G. Print Claim(s) 18	O.G. Print Fig. 4, 5

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	25	31		61		91		121		151		181
	2	26	32		62		92		122		152		182
2	3	27	33		63		93		123		153		183
3	4	28	34		64		94		124		154		184
4	5	29	35		65		95		125		155		185
5	6		36		66		96		126		156		186
6	7		37		67		97		127		157		187
7	8		38		68		98		128		158		188
8	9		39		69		99		129		159		189
9	10		40		70		100		130		160		190
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11	12		42		72		102		132		162		192
12	13		43		73		103		133		163		193
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21	24		54		84		114		144		174		204
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23	26		56		86		116		146		176		206
	27		57		87		117		147		177		207
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	29		59		89		119		149		179		209
24	30		60		90		120		150		180		210

Search Notes

Application/Control No.	Applicant(s)/Patent under Reexamination	
09/798,511	NEAL, GRIFFITH D.	
Examiner	**Art Unit**	
Eric B. Compton	3726	

SEARCHED

Class	Subclass	Date	Examiner
310	218	12/9/2005	EC

INTERFERENCE SEARCHED

Class	Subclass	Date	Examiner
29	**597**	12/9/2005	**EC**

SEARCH NOTES (INCLUDING SEARCH STRATEGY)

	DATE	EXMR
updated search	12/9/2005	EC

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Bib Data Sheet

CONFIRMATION NO. 9388

SERIAL NUMBER	FILING DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/798,511	03/02/2001 RULE	029	3726	8864/20

APPLICANTS

Griffith D. Neal, Alameda, CA;

** CONTINUING DATA *************************

** FOREIGN APPLICATIONS ********************

IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** SMALL ENTITY **
** 05/15/2001

Foreign Priority claimed ☐ yes ☑ no 35 USC 119 (a-d) conditions met ☐ yes ☐ no ☐ Met after Allowance Verified and Acknowledged — Examiner's Signature — Initials	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
	CA	6	29	5

ADDRESS
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BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO , IL
60610

TITLE
Stator assembly made from a plurality of toroidal core segments and motor using same

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
543	No. _________ to charge/credit DEPOSIT ACCOUNT No. _________ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other ______________

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L87	2	(stator and "segments" and encapsulating and poles).clm.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2005/12/08 18:51

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SEP 2 6 2005
PATENT & TRADEMARK OFFICE

CERTIFICATE OF MAILING

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September 22, 2005
Date of Deposit

Steven P. Shurtz, Reg. No. 31,424
Name of Applicant, Assignee or Registered Representative

/Steven P. Shurtz/
Signature

September 22, 2005
Date of Signature

Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Griffith D. Neal

Serial No.: 09/798,511

Filing Date: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: Stephen J. Kenny

Group Art Unit No.: 3726

AMENDMENT

Mail Stop: Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office Action mailed April 22, 2005, please enter the following amendment and consider the following remarks.

Amendments to the claims are reflected in the listing of claims which begins on page 3 of this paper.

Remarks begin on page 8 of the paper.

Amendments to the Claims

Please cancel claim 16 and amend claims 1, 3-9, 19-21 and 31-32. The changes in these claims from their immediate prior version are shown with ~~strikethrough~~ or [[double brackets]] for deleted matter and <u>underlines</u> for added matter. A complete listing of the claims with proper claim identifiers follows. This listing replaces all previous listings and versions of claims in the application.

<u>Listing of Claims</u>

1. (Currently amended) A stator assembly, comprising:

a) a plurality of individual stator arc segments forming a toroidal core, wherein each said stator arc segment has two end surfaces and a plurality of poles with wire wound around said poles forming the toroidal core; and

b) a monolithic body of injection molded [[phase change]] <u>thermoplastic</u> material substantially encapsulating the stator arc segments and the wire wound around the poles, wherein said [[phase change]] <u>thermoplastic</u> material bonds the arc segments together to hold the arc segments in a toroidal shape<u>, the monolithic body of thermoplastic material being the sole structure functioning to secure the arc segments in the toroidal shape</u>.

2. (Canceled)

3. (Currently amended) The stator assembly of claim [[3]] <u>1</u> wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

4. (Currently amended) The stator assembly of claim 1 wherein the [[phase change]] <u>thermoplastic</u> material has a coefficient of linear thermal expansion of less than 2×10^{-5} in/in/ºF throughout the range of 0-250°F.

5. (Currently amended) The stator assembly of claim 1 wherein the [[phase change]] <u>thermoplastic</u> material has a coefficient of linear thermal expansion of less than 1.5×10^{-5} in/in/ºF throughout the range of 0-250°F.

6. (Currently amended) The stator assembly of claim 1 wherein the [[phase change]] thermoplastic material has a coefficient of linear thermal expansion of between about $0.8x10^{-5}$ in/in/ºF and about $1.2x10^{-5}$ in/in/ºF throughout the range of 0-250°F.

7. (Currently amended) The stator assembly of claim 1 wherein the [[phase change]] thermoplastic material has a thermal conductivity of at least 0.7 watts/meterºK at 23°C.

8. (Currently amended) The stator assembly of claim 1 wherein the [[phase change]] thermoplastic material comprises polyphenyl sulfide.

9. (Currently amended) A method of making a stator assembly for a motor comprising:

a) providing at least two individual stator arc segments each having a first end surface and a second end surface and a plurality of poles with wire wound around said poles;

b) aligning said stator arc segments to form a toroidal core; and

c) substantially encapsulating said toroidal core, including said windings, with a monolithic body of injection molded [[phase change]] thermoplastic material to form said stator assembly, wherein said [[phase change]] thermoplastic material has a coefficient of linear thermal expansion of less than $2x10^{-5}$ in/in/ºF throughout the range of 0-250°F and bonds the arc segments together to hold the arc segments in a toroidal shape.

10. (Previously presented) The method of claim 9 wherein the poles extend inwardly from a base of each of said stator arc segments.

11. (Original) The method of claim 10 wherein prior to said step of aligning, the wire is wound around said poles of said stator arc segments.

12. (Original) The method of claim 11 wherein said stator arc segments are placed in a carrier that holds and supports said stator arc segments while the wire is wound around said poles.

13. (Original) The method of claim 12 wherein said carrier has a plurality of cavities to hold and support said stator arc segments.

14. (Original) The method of claim 13 wherein said cavities are spaced apart a distance X, wherein X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

15. (Previously presented) The method of claim 9 wherein said windings provide multiple conductors that create a plurality of magnetic fields when electrical current is conducted through the conductors.

16. (Canceled)

17. (Original) The method of claim 9 wherein prior to said substantially encapsulating, said toroidal core is clamped in an injection mold cavity to maintain the toroidal shape.

18. (Canceled)

19. (Currently amended) The method of claim 9 wherein said [[phase change]] <u>thermoplastic</u> material is injected into a mold at temperature of between about 200ºF and about 700ºF.

20. (Currently amended) The method of claim 9 wherein said [[phase change]] <u>thermoplastic</u> material is injected into a mold at a temperature of between about 550ºF to about 650ºF.

21. (Currently amended) A method of making a motor comprising:

a) providing [[four]] <u>a plurality of</u> individual stator arc segments, wherein each stator arc segment has a first end surface and a second end surface and [[a plurality of]] <u>three</u> poles with wire wound around said poles;

b) aligning said stator arc segments to form a toroidal core;

c) substantially encapsulating said toroidal core, including said windings, with a monolithic body of [[phase change]] <u>thermoplastic</u> material, wherein said substantially encapsulating is by injection molding said [[phase change]] thermoplastic material around said toroidal core to form a stator assembly, wherein said [[phase change]] thermoplastic material bonds the arc segments together to hold the arc segments in a toroidal shape, the monolithic body of thermoplastic material structurally functioning to secure the core in the toroidal shape; and

d) constructing the stator assembly into a motor.

22. (Original) The method of claim 21 wherein each of said stator arc segments comprise a plurality of steel laminations.

23. (Previously presented) A motor comprising the stator assembly of claim 1.

24. (Previously presented) The motor of claim 23 wherein said motor comprises said stator assembly, a shaft, a base, bearings, a rotor, at least one permanent magnet and a hub.

25. (Previously presented) An electronic device including the motor of claim 23.

26. (Previously presented) A motor and disc assembly including the motor of claim 23.

27-29. (Canceled)

30. (Previously presented) The method of claim 11 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

31. (Currently amended) The method of claim [[9]] 21 wherein the [[phase change]] thermoplastic material has a coefficient of linear thermal expansion of less than 2×10^{-5} in/in/ºF throughout the range of 0-250°F.

32. (Currently amended) The method of claim 9 wherein the [[phase change]] thermoplastic material has a thermal conductivity of at least 0.7 watts/meterºK at 23°C.

33. (Previously presented) The stator assembly of claim 1 wherein said end surfaces of adjacent stator arc segments are in contact with one another.

34. (Previously presented) The method of claim 9 wherein said end surfaces of adjacent stator arc segments are in contact with one another.

35. (Previously presented) The method of claim 21 wherein said end surfaces of adjacent stator arc segments are in contact with one another.

REMARKS

The amendment does not involve new matter. The limitation relating to thermoplastic material added to claims 1, 3-9, 19-21 and 31-32 is found in original claim 16. Claim 9 is also amended to include the limitation from claim 31. The other amendments to claims 1 and 21 are supported by the disclosure.

The objection to claim 3 in the outstanding Office Action is overcome by the change in dependency of claim 3.

In the outstanding Office Action, claims 1, 4-17, 19-26 and 31-35 were rejected under 35 U.S.C. § 103(b) as being unpatentable over U.S. Patent No. 5,592,731 (Huang) in view of U.S. Patent No. 4,015,154 (Tanaka). This rejection is respectfully traversed. Claim 1 is directed to a stator assembly, and requires a plurality of stator arc segments forming a toroidal core, with each arc segment having two end surfaces and a plurality of poles with wire wound around the poles. Claim 1 also calls for a monolithic body of injection molded thermoplastic material substantially encapsulating the stator arc segments, including the windings, wherein the thermoplastic material bonds the arc segments together to hold the arc segments in a toroidal shape. The monolithic body is formed by an injection molding operation, preferably in which a plurality of stator arc segments are clamped in a mold, and thermoplastic material is injection molded around them to form the monolithic body. Injection molding naturally requires the molten thermoplastic to be injected into the mold cavity at high pressures. One of the problems overcome by the present invention is the fact that when the core is made of individual arc segments, the high pressure encountered during the injection molding tends to disrupt and move the individual arc segments apart from one another. However, in the preferred method of the present invention, described on page 12 of the specification and depicted in Figs. 6a and 6b, moveable pins 61 are used to hold the segments in shape while the thermoplastic is being injected, but then are removed as the thermoplastic solidifies, holding the arc segments in the toroidal shape.

Huang discloses stator arc segments, but those arc segments are not substantially encapsulated by a monolithic body of thermoplastic material as called for by claim 1. In Huang, individual particles of iron powder (each with an iron phosphate layer thereon) have a coating of thermoplastic material on them, and the thermoplastic material allows the particles to be compacted together. Thus, in Huang, the iron particles are encapsulated in a thermoplastic, rather than the stator arc segments being encapsulated as called for by claim 1. These particles are then compacted in a die to form a stator arc segment, but these stator arc segments are not thereafter encapsulated. Rather, a metallic ring 62 is used to hold the arc segments together. See column 8, line 61 to column 9, line 10 of Huang.

Huang does not disclose the monolithic body of thermoplastic material substantially encapsulating stator arc segments and bonding the arc segments together to hold the arc segments in a toroidal shape, nor would it have been obvious to modify Huang to include this element.

Tanaka discloses a motor made with a conventional laminated toroidal core, rather than a core made of stator arc segments. Such a laminated toroidal core is then placed in an injection molding machine and a specific combination of thermosetting and thermoplastic materials is used to form a casing around the core. Tanaka goes to great lengths in choosing the right combination of thermosetting and thermoplastic materials, and notes that significant problems surround molding cores for electric motors using these materials. Column 4, lines 29-51 describe these problems, which include contraction and shrinkage, cracks, cave-ins, lack of high fidelity reproduction, etc.

There is nothing in either Tanaka or Huang that would suggest that stator pieces such as those in Huang could or should be overmolded with the specific composition of Tanaka. The Tanaka injection molding is for laminated cores that form a complete annular ring, not a core made from pieces. Further, from the problems addressed in Tanaka with injection molding cores in general, it would go against Tanaka to try to mold a stator core made of individual pieces, especially where the segments are then held together by the injection molded material. Hence claims 1 and the claims that depend thereon are patentable over Huang and Tanaka.

Claim 1 requires that the monolithic body of thermoplastic material substantially encapsulating the stator arc segments and the wire wound around the poles also bonds the arc segments together to hold the arc segments in a toroidal shape, the monolithic body of thermoplastic material being the sole structure functioning to secure the arc segments in the toroidal shape. Even if the combined thermosetting/thermoplastic material of Tanaka was added to the structure formed by Huang, it would be after the stator pieces were already held together by the metallic ring 62. The thermosetting/thermoplastic material would thus not constitute a monolithic body of thermoplastic material that bonds the arc segments together to hold the arc segments in a toroidal shape.

Claims 9 and 21 also require individual stator arc segments each having a plurality of poles with wire wound around said poles, and also require substantially encapsulating the toroidal core formed of aligned stator arc segments with a monolithic body of thermoplastic material, with the thermoplastic material bonding the arc segments, and windings, together to hold the arc segments in a toroidal shape. As noted above, these features are not found in Huang and Tanaka. Claims 1, 9 and 21, and claims 3-8, 10-15, 17, 19-20, 22-26 and 31-35 dependent thereon, are thus not obvious in view of Huang and Tanaka.

Claims 3 and 30 were rejected in the outstanding Office Action under 35 U.S.C. § 103(a) as being unpatentable over Huang and Tanaka in view of U.S. Patent No. 5,729,072 (Hirano). (The Office Action twice refers to "Huang/Trago", but since Trago was not used in the primary rejection, it is believed that this was intended to be "Huang/Tanaka".) This rejection is respectfully traversed. Claim 3 is ultimately dependent on claim 1, and claim 30 is ultimately dependent on claim 9. Hirano discloses a stator made of arc segments, but the arc segments do not each include a plurality of poles, and there is no suggestion of substantially encapsulating the arc segments in the stator of Hirano with a monolithic body of thermoplastic material. Rather, the segments are held together by "welding, bonding or applying an annular member." (Column 2, lines 47-48.) Thus even if Huang, Tanaka and Hirano were somehow combined, and arc segments such as those disclosed in Hirano were used in the motor of Tanaka, the stator segments would be bonded together by some other means before the wire was wound around the poles. Just as with Tanaka, any thermosetting/thermoplastic material added to fill in gaps would not constitute an injected molded monolithic body of thermoplastic material which acts to hold the arc segments in a toroidal shape as required by claims 1 and 9. Neither Huang, Tanaka nor Hirano disclose a monolithic body of injection molded thermoplastic material substantially encapsulating stator arc segments with wire windings on multiple poles on each segment, and bonding the arc segments together to hold the arc segments in a toroidal shape. Thus, even if the art were somehow combined, the resulting device would not have all of the elements called for by claims 1 and 9, and hence by claims 3 and 30 dependent thereon. These claims are thus patentable over Huang, Tanaka and Hirano.

Since each of the rejections has been overcome, an early notice of allowance is respectfully requested.

Respectfully submitted,

/Steven P. Shurtz/
Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant

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TC 3626

CERTIFICATE OF FACSIMILE TRANSMISSION UNDER 37 C.F.R. §1.8
I hereby certify that this correspondence is being sent via facsimile to 1-703-872-9306 to Examiner Kenny at the United States Patent & Trademark Office on the below date:
Date: September 22, 2005 Name: Steven P. Shurtz Signature: /Steven P. Shurtz/

Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Griffith D. Neal

Serial No: 09/798,511

Filed: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: Stephen J. Kenny

Group Art Unit: 3726

PETITION AND FEE FOR A TWO MONTH EXTENSION OF TIME (37 CFR § 1.136(a))

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is a petition for an extension of the time to respond to an Office Action dated April 22, 2005 for a period of two months.

☒ Applicant:

☒ claims small entity status. See 37 C.F.R. §1.27.

☐ is other than small entity

	Extension Months	Other Than Small Entity	Small Entity
☐	One Month	$120.00	$60.00

09/27/2005 ZJUHAR1 00000031 09798511
01 FC:2252 225.00 OP

☒	Two Months	$450.00	$225.00
☐	Three Months	$1,020.00	$510.00
☐	Four Months	$1,590.00	$795.00
☐	Five Months	$2,160.00	$1,080.00

Fee Payment

☐ Attached is a check for $_____ for the Petition fee.

☒ Attached is a credit card authorization form for $225 for the Petition fee.

☐ Charge Petition fee to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

☒ Charge any additional fee required or credit for any excess fee paid to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

Respectfully submitted,

Dated: September 22, 2005

/Steven P. Shurtz
Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant

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CHICAGO, IL 60610
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Date: September 22, 2005 Name: Steven P. Shurtz Signature: /Steven P/ Shurtz/

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Appln. of: Griffith D. Neal

Appln. No.: 09/798,511

Filed: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Attorney Docket No: 8864/20

Examiner: S. J. Kenny

Art Unit: 3726

Mail Stop Amendment
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL

Sir:

Attached is/are:

☒ Amendment; Petition for Extension of Time

☒ Return Receipt Postcard

Fee calculation:

☐ No additional fee is required.

☒ Small Entity.

☒ An extension fee in an amount of $225 for a 2-month extension of time under 37 C.F.R. § 1.136(a).

☐ A petition or processing fee in an amount of $_____ under 37 C.F.R. § 1.17(_____).

☐ An additional filing fee has been calculated as shown below:

	Claims Remaining After Amendment		Highest No. Previously Paid For	Present Extra		Small Entity Rate	Small Entity Add'l Fee	or	Not a Small Entity Rate	Not a Small Entity Add'l Fee
Total		Minus				x $9=			x $18=	
Indep.		Minus				x 43=			x $86=	
First Presentation of Multiple Dep. Claim						+$145=			+ $290=	
						Total	$		Total	$

Fee payment:

☐ A check in the amount of $_____ to cover the above-identified fee(s) is enclosed.

☐ Please charge Deposit Account No. 23-1925 in the amount of $. A copy of this Transmittal is enclosed for this purpose.

☒ Payment by credit card in the amount of $225 (Form PTO-2038 is attached).

☒ The Director is hereby authorized to charge payment of any additional filing fees required under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17 associated with this paper (including any extension fee required to ensure that this paper is timely filed), or to credit any overpayment, to Deposit Account No. 23-1925.

Respectfully submitted,

September 22, 2005
Date

/Steven P. Shurtz/
Steven P. Shurtz (Reg. No. 31,424)

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2000

Application or Docket Number: 09798511

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS		
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	29 minus 20=	*
INDEPENDENT CLAIMS	3 minus 3 =	*
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	355.00	OR	BASIC FEE	710.00
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL		OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875
(Rev. 8/00)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
*U.S. GPO: 2000-460-703/30103

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

757 7590 04/22/2005

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610

EXAMINER	
KENNY, STEPHEN	

ART UNIT	PAPER NUMBER
3726	

DATE MAILED: 04/22/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No. 09/798,511	Applicant(s) NEAL, GRIFFITH D.	
	Examiner Stephen J Kenny	Art Unit 3726	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 February 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3-17,19-26 and 30-35* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-17,19-26 and 30-35* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

Claim 3 is objected to because of the following informalities: Claim 3 incorrectly depends from itself. Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 4-17, 19-26, 31-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang et al.(US Patent No 5592731) ion view of Tanaka et al. (US Patent No 4015154).

Regarding claims 1, 9, 10, Huang discloses a stator assembly, and method of manufacturing, comprising a plurality of individual stator arc segments (22), wherein each segment has a plurality of inwardly directed poles (24) with wire wound around (37) forming a toroidal core.

Huang does not explicitly disclose injection molding a material to encapsulate and bond the segments and wire into a toroidal shape.

Tanaka discloses injection molding a phase change material to encapsulate a stator and winding to bond the components and fill any voids in the stator assembly (column 5, lines 1-5). The use of such injection mold is advantageous in that it fills any voids (or air gaps) between the stator laminations which is widely known to adversely affect the performance of the motor (see US Patent No 4365180 column 1, lines 43-50 for further discussion).

Regarding claims 4, 5, & 31, Huang discloses a coefficient of linear thermal expansion of less than $2*10^{-5}$in/in/°F & $1.5*10^{-5}$in/in/°F (column 9, lines 10-14) for a molding material of the stator segments.

Regarding claims 6-8, & 32, Huang/Tanaka discloses the claimed invention except for the specific values of Coefficient of Linear Thermal Expansion; thermal conductivity; and material composition. It would have been an obvious matter of design choice to use the specific values claimed, since applicant has not disclosed that such values solves any stated problem or is for any particular purpose, and it appears that the invention would perform equally well with alternative values as disclosed by Huang/Tanaka. Therefore, these specific values do not carry any patentable weight.

Regarding claim 11, Huang discloses prior to the aligning step, the wire is wound around said poles of said stator arc segments (column 8, lines 34-35).

Regarding claims 12 & 13, Huang discloses stator segments placed in a carrier that holds said stator segments while wire is wound around said poles (column 8, lines 36-37) wherein said carrier has a plurality of cavities to hold and support said segments (Figure 5).

Regarding claim 14, Huang discloses spacing apart segments by a distance X, where X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core (Figure 6).

Regarding claim 15, Huang discloses multiple conductors (37) that create a plurality of magnetic fields when electrical current is conducted through said conductors (Figure 6).

Regarding claim 16, Huang discloses said phase change material selected from the group of thermoplastics & thermosetting materials (column 5, lines 13-15).

Regarding claims 17, 21-26, Tanaka discloses clamping (column 3, line 64) a stator core in a mold cavity and subsequently injection molding a thermosetting resin substantially encapsulating said core (column 5, lines 1-5). Injection molding is a technique old and well established for effectively encompassing components of dynamoelectric machines in order to provide improved vibration & noise characteristics as well as heat dissipation. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the stator disclosed by Huang whereby the thermosetting material is injection molded as taught by Tanaka in order to realize the advantages discussed above. In further regards to claims 23-26, Huang & Tanaka each disclose a motor/electronic device employing a stator, which inherently provides a shaft, base, bearings, etc.

Regarding claims 19 & 20, it is inherent that thermosetting materials be heated to an elevated temperature during application. Thus the specific limitation of an application temperature of 200°F ~ 700°F, or 550°F ~ 650°F does not carry any patentable weight. Further, the applicant has provided no explanation of why these specific temperature ranges are beneficial or significant.

Regarding claims 33-35, Huang discloses the stator segements are in contact with each other (Figure 4a).

Claims 3 & 30, are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang/Trago as modified above, and further in view of Hirano et al (US Patent No 5729072).

Huang/Trago discloses the instant invention except for a packing density of the wire around the stator poles is between 60% ~ 80%.

Hirano discloses a packing density of 70% (abstract line 11). A high packing density is advantageous in that it allows for an increase in magnetic flux while saving space as well. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify a stator core as disclosed by Huang/Trago with the packing density taught by Hirano in order to achieve a more efficient stator core.

Conclusion

The prior art made of record on the attached PTO-892, and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen J Kenny whose telephone number is 571-272-4531. The examiner can normally be reached on mon - fri 9am - 5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Peter Vo can be reached on 571-272-4690. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

sk S. Kenny

DAVID P. BRYANT
PRIMARY EXAMINER

Notice of References Cited	Application/Control No. 09/798,511	Applicant(s)/Patent Under Reexamination NEAL, GRIFFITH D.	
	Examiner Stephen J Kenny	Art Unit 3726	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-5,592,731	01-1997	Huang et al.	29/596
	B	US-4,015,154	03-1977	Tanaka et al.	310/42
	C	US-5,806,169	09-1998	Trago et al.	29/596
	D	US-4,365,180	12-1982	Licata et al.	310/216
	E	US-3,908,138	09-1975	Shieh, Ming K.	310/29
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application No. 09/798,511	Applicant(s) NEAL, GRIFFITH D.
	Examiner Stephen J Kenny	Art Unit 3726

√	Rejected		–	(Through numeral) Cancelled		N	Non-Elected		A	Appeal
=	Allowed		÷	Restricted		I	Interference		O	Objected

Final	Original	4/14/05
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Search Notes

Application No.	Applicant(s)
09/798,511	NEAL, GRIFFITH D.
Examiner	**Art Unit**
Stephen J Kenny	3726

SEARCHED			
Class	Subclass	Date	Examiner
29	596 598 606 732	4/14/2005	SK
310	216 45	4/14/2005	SK
310	154 156	4/14/2005	SK

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)	DATE	EXMR

ZNW
RCE#

OIPE JC112
FEB 0 7 2005

CERTIFICATE MAILING UNDER 37 C.F.R. §1.8

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to: Mail Stop RCE, P. O. Box 1450, Alexandria, VA 22313-1450 on the below date:

Date: February 3, 2005 Name: Steven P. Shurtz Signature: /Steven P. Shurtz/

BRINKS HOFER GILSON &LIONE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Appln. of: Griffith D. Neal

Appln. No.: 09/798,511

Filed: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Attorney Docket No: 8864/20

Examiner: Stephen J. Kenny

Art Unit: 3726

Mail Stop RCE
Commissioner for Patents
U.S. Patent and Trademark Office
P. O. Box 1450
Alexandria, VA 22313-1450

REQUEST FOR CONTINUED EXAMINATION (37 C.F.R. § 1.114)

Sir:

Applicant requests continued examination of the above-identified application under 37 C.F.R. §1.114.

☒ Submission under 37 CFR 1.114 (*check at least one of the following*):

- ☒ Previously submitted:
  - ☐ Applicant(s) requests nonentry of any previously-filed unentered amendments.
  - ☒ Please enter and consider the Amendment After Final Under 37 C.F.R. §1.116 previously filed on January 3, 2005
  - ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on ______
  - ☐ Other: _____
- ☐ Attached is/are:
  - ☐ An Information Disclosure Statement
  - ☐ An Amendment to the written description, claims, or drawings
  - ☐ New Arguments and/or New Evidence in support of Patentability
  - ☐ Other: _____

02/09/2005 MAHMED1 00000073 09798511

01 FC:2801 395.00 OP

☐ Request for suspension of action:

Applicant(s) hereby request suspension of action on the above-identified application under 37 C.F.R. §1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; requires Processing Fee under 37 C.F.R. §1.17(i)).

☒ Small Entity Status:

- ☒ Applicant hereby asserts entitlement to claim small entity status under 37 CFR §§ 1.9 and 1.27.
- ☐ A small entity statement or assertion of entitlement to claim small entity status was filed in prior application no.______/______ and such status is still proper and desired.
- ☐ Is no longer desired.

☒ Applicant(s) calculate the following fees to be due in connection with this Request:

- ☒ A Request fee of $395 under 37 C.F.R. §1.17(e).
- ☐ A suspension processing fee of $_____ under 37 C.F.R. §1.17(i).
- ☐ An additional filing fee of $_____ under 37 C.F.R. §1.16 (_____ additional independent claims and/or _____ additional total claims).
- ☒ An extension fee of $165.00 under 37 C.F.R. §1.17(a) for a second one-month extension of time.

☒ Fee payment to cover the above-enumerated fee(s):

- ☐ A check in the amount of $_____ is enclosed.
- ☐ Please charge Deposit Account No. 23-1925 (BRINKS HOFER GILSON & LIONE) in the amount of $_____. A copy of this Request is enclosed for this purpose.
- ☒ A payment by credit card in the amount of $560.00 (Form PTO-2038 is attached).
- ☒ The Commissioner is hereby authorized to charge payment of any additional filing fees required under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17 associated with this paper (including any extension fee required to ensure that this paper is timely filed), or to credit any overpayment, to Deposit Account No. 23-1925 (BRINKS HOFER GILSON & LIONE). A copy of this Request is enclosed for this purpose.

Respectfully submitted,

February 3, 2005
Date

/Steven P. Shurtz/
Steven P. Shurtz (Reg. No. 31,424)

CERTIFICATE MAILING UNDER 37 C.F.R. §1.8

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to: Mail Stop RCE, P. O. Box 1450, Alexandria, VA 22313-1450 on the below date:

Date: February 3, 2005 Name: Steven P. Shurtz Signature: /Steven P. Shurtz/

Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Griffith D. Neal

Serial No: 09/798,511 — Examiner: Stephen J. Kenny

Filed: March 2, 2001 — Group Art Unit: 3726

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

PETITION AND FEE FOR A ONE MONTH EXTENSION OF TIME (37 CFR § 1.136(a))

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is a petition for an extension of the time to respond to an Office Action dated September 3, 2004 for a period of a second month (a previous petition for a first month extension was previously filed and granted).

☒ Applicant:

- ☒ claims small entity status. See 37 C.F.R. §1.27.
- ☐ is other than small entity

	Extension Months	Other Than Small Entity	Small Entity
☐	One Month	$120.00	$60.00
☒	Two Months	$450.00	$225.00
☐	Three Months	$1,020.00	$510.00
☐	Four Months	$1,590.00	$795.00
☐	Five Months	$2,160.00	$1,080.00

Fee Payment

☐ Attached is a check for $_____ for the Petition fee.

☒ Attached is a credit card authorization form for $165.00 ($225-60) for the Petition fee.

☐ Charge Petition fee to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

☒ Charge any additional fee required or credit for any excess fee paid to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

Respectfully submitted,

Dated: February 3, 2005

/Steven P. Shurtz/
Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610
(312)321-4200

OIPE
FEB 0 7 2005

CERTIFICATE OF MAILING UNDER 37 C.F.R. §1.8

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to: Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450, on the below date:
Date: February 3, 2005 Name: Steven P. Shurtz Signature: /Steven P. Shurtz/

BRINKS
HOFER
GILSON
&LIONE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Appln. of: Griffith D. Neal

Appln. No.: 09/798,511

Filed: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Attorney Docket No: 8864/20

Examiner: Stephen J. Kenny

Art Unit: 3726

Mail Stop RCE
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL

Sir:

Attached is/are:

☒ Request For Continued Examination (37 C.F.R. §1.114)

☒ Return Receipt Postcard

Fee calculation:

☐ No additional fee is required.

☐ Small Entity.

☒ An extension fee in an amount of $165.00 for a second-month extension of time under 37 C.F.R. § 1.136(a).

☒ A petition or processing fee in an amount of $_____ under 37 C.F.R. § 1.17(_____).

☐ An additional filing fee has been calculated as shown below:

						Small Entity			Not a Small Entity	
	Claims Remaining After Amendment		Highest No. Previously Paid For	Present Extra		Rate	Add'l Fee	or	Rate	Add'l Fee
Total		Minus				x $25=			x $50=	
Indep.		Minus				x 100=			x $200=	
First Presentation of Multiple Dep. Claim						+$180=			+ $360=	
						Total	$		Total	$

Fee payment:

☐ A check in the amount of $_____ is enclosed.

☐ Please charge Deposit Account No. 23-1925 in the amount of $. A copy of this Transmittal is enclosed for this purpose.

☒ Payment by credit card in the amount of $560.00 (Form PTO-2038 is attached).

☒ The Director is hereby authorized to charge payment of any additional filing fees required under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17 associated with this paper (including any extension fee required to ensure that this paper is timely filed), or to credit any overpayment, to Deposit Account No. 23-1925.

Respectfully submitted,

February 3, 2005
Date

/Steven P. Shurtz/
Steven P. Shurtz (Reg. No. 31,424)

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

757 7590 01/13/2005

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610

EXAMINER	
KENNY, STEPHEN	

ART UNIT	PAPER NUMBER
3726	

DATE MAILED: 01/13/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Advisory Action	**Application No.** 09/798,511	**Applicant(s)** NEAL, GRIFFITH D.
	Examiner Stephen J Kenny	**Art Unit** 3726

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 03 January 2005 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE. Therefore, further action by the applicant is required to avoid abandonment of this application. A proper reply to a final rejection under 37 CFR 1.113 may only be either: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114.

PERIOD FOR REPLY [check either a) or b)]

a) ☒ The period for reply expires 3 months from the mailing date of the final rejection.

b) ☐ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
ONLY CHECK THIS BOX WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

1.☐ A Notice of Appeal was filed on _____. Appellant's Brief must be filed within the period set forth in 37 CFR 1.192(a), or any extension thereof (37 CFR 1.191(d)), to avoid dismissal of the appeal.

2.☒ The proposed amendment(s) will not be entered because:

(a) ☒ they raise new issues that would require further consideration and/or search (see NOTE below);

(b) ☐ they raise the issue of new matter (see Note below);

(c) ☐ they are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or

(d) ☐ they present additional claims without canceling a corresponding number of finally rejected claims.

NOTE: *See Continuation Sheet*.

3.☐ Applicant's reply has overcome the following rejection(s): _____.

4.☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).

5.☐ The a)☐ affidavit, b)☐ exhibit, or c)☐ request for reconsideration has been considered but does NOT place the application in condition for allowance because: _____.

6.☐ The affidavit or exhibit will NOT be considered because it is not directed SOLELY to issues which were newly raised by the Examiner in the final rejection.

7.☒ For purposes of Appeal, the proposed amendment(s) a)☒ will not be entered or b)☐ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.

The status of the claim(s) is (or will be) as follows:

Claim(s) allowed: _____.

Claim(s) objected to: _____.

Claim(s) rejected: *1-26 and 30-32*.

Claim(s) withdrawn from consideration: *27 and 28*.

8.☐ The drawing correction filed on _____ is a)☐ approved or b)☐ disapproved by the Examiner.

9.☐ Note the attached Information Disclosure Statement(s)(PTO-1449) Paper No(s). _____

10.☐ Other: _____

David P. Bryant

DAVID P. BRYANT
PRIMARY EXAMINER

Continuation of 2. NOTE: The newly added limitation that a plurality of individual stator arc segments, each having a pluralityof poles with wire wound around said poles, is a new issue that has not previously been considered .

S. Kenny
1/10/05

1/10/05 Do NOT Enter S. Kenny

Amendments to the Claims

Please cancel claims 2, 18 and 27-28, amend claims 1, 3, 9, 10, 15, and 19-21, and add new claims 33-35. A complete listing of the claims with proper claim identifiers follows.

Listing of Claims

1. (Currently amended) A stator assembly, comprising:

a) a plurality of individual stator arc segments forming a toroidal core, wherein each said stator arc segment has two end surfaces and a plurality of poles with wire wound around said poles [[that are each in contact with an end surface of another stator arc segment to form]] forming the toroidal core; and

b) a monolithic body of injection molded phase change material substantially encapsulating the stator arc segments and the wire wound around the poles, wherein said phase change material bonds the arc segments together to hold the arc segments in a toroidal shape.

2. (Canceled)

3. (Currently amended) The stator assembly of claim [[2]] 3 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

4. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than 2×10^{-5} in/in/°F throughout the range of 0-250°F.

5. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than 1.5×10^{-5} in/in/°F throughout the range of 0-250°F.

6. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of between about 0.8×10^{-5} in/in/°F and about 1.2×10^{-5} in/in/°F throughout the range of 0-250°F.

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2000

Application or Docket Number: 09/798511

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)	SMALL ENTITY TYPE RATE	FEE	OR	OTHER THAN SMALL ENTITY RATE	FEE
TOTAL CLAIMS	29						
FOR	NUMBER FILED	NUMBER EXTRA	BASIC FEE	355.00	OR	BASIC FEE	710.00
TOTAL CHARGEABLE CLAIMS	29 minus 20=	* 9	X$ 9=	81.00	OR	X$18=	
INDEPENDENT CLAIMS	5 minus 3 =	* 2	X40=	80.00	OR	X80=	
MULTIPLE DEPENDENT CLAIM PRESENT ☐			+135=		OR	+270=	
			TOTAL	516.00	OR	TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
Total	* 32	Minus	** 29	= 3	X$ 9=	27.00	OR	X$18=	
Independent	* 5	Minus	*** 5	=	X40=		OR	X80=	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐					+135=		OR	+270=	
					TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
Total	* 31	Minus	** 32	=	X$ 9=		OR	X$18=	
Independent	* 4	Minus	*** 5	=	X40=		OR	X80=	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐					+135=		OR	+270=	
					TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
Total	* 30	Minus	** 32	=	X$ 9=		OR	X$18=	
Independent	* 3	Minus	*** 5	=	X40=		OR	X80=	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM ☐					+135=		OR	+270=	
					TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If th "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875 (Rev. 8/00)

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I hereby certify that this correspondence is being sent via facsimile to 1-703-872-9306 to Examiner Kenny at the United States Patent & Trademark Office,

on January 3, 2005
Date of Deposit

Steven P. Shurtz, Reg. No. 31,424
Name of applicant, assignee or Registered Representative

Steven P. Shurtz
Signature

Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Griffith D. Neal

Serial No.: 09/798,511

Filing Date: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: Stephen J. Kenny

Group Art Unit No.: 3726

PETITION AND FEE FOR EXTENSION OF TIME (37 CFR § 1.136(a))

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is a petition for an extension of the time to respond to Office Action dated September 3, 2004 for a period of 1 month(s).

☒ Applicant:

☒ claims small entity status. See 37 C.F.R. §1.27.

☐ is other than small entity

Case No. 8864-20

	Extension Months	Other Than Small Entity	Small Entity
☒	One Month	$120.00	$60.00
☐	Two Months	$450.00	$225.00
☐	Three Months	$1020.00	$510.00
☐	Four Months	$1,590.00	$795.00
☐	Five Months	$2,160.00	$1,080.00

Fee Payment

☐ Attached is a check for $_____ for the Petition fee.

☒ A credit card authorization form for $60 for the Petition fee was transmitted previously.

☐ Charge Petition fee to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

☒ Charge any additional fee required or credit for any excess fee paid to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

Respectfully submitted,

Dated: January 3, 2005

Steven P. Shurtz

Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, ILLINOIS 60610
(312) 321-4200
Direct: (801) 444-3933

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CERTIFICATE OF FACSIMILE TRANSMISSION UNDER 37 C.F.R. §1.8
I hereby certify that this correspondence is being sent via facsimile to 1-703-872-9306 to Examiner Kenny at the United States Patent & Trademark Office , on the below date:
Date: January 3, 2005 Name: Steven P. Shurtz Signature: Steven P. Shurtz

BRINKS
HOFER
GILSON
&LIONE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Appln. of: Griffith D. Neal

Appln. No.: 09/798,511

Filed: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Attorney Docket No: 8864/20

Examiner: S. J. Kenny

Art Unit: 3726

Mail Stop Amendment
Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL

Sir:

Attached is/are:

☒ Amendment;

☐ Return Receipt Postcard

Fee calculation:

☐ No additional fee is required.

☒ Small Entity.

☒ An extension fee in an amount of $60 for a 1-month extension of time under 37 C.F.R. § 1.136(a).

☐ A petition or processing fee in an amount of $_____ under 37 C.F.R. § 1.17(_____).

☐ An additional filing fee has been calculated as shown below:

	Claims Remaining After Amendment		Highest No. Previously Paid For	Present Extra	Small Entity Rate	Small Entity Add'l Fee	or	Not a Small Entity Rate	Not a Small Entity Add'l Fee
Total	30	Minus	32	0	x $25=			x $50=	
Indep.	3	Minus	5	0	X100=			x $200=	
First Presentation of Multiple Dep. Claim					+$180=			+ $360=	
					Total	$		Total	$

Fee payment:

☐ A check in the amount of $_____ to cover the above-identified fee(s) is enclosed.

☐ Please charge Deposit Account No. 23-1925 in the amount of $. A copy of this Transmittal is enclosed for this purpose.

☒ Payment by credit card in the amount of $60.00 (Form PTO-2038 is attached).

☒ The Director is hereby authorized to charge payment of any additional filing fees required under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17 associated with this paper (including any extension fee required to ensure that this paper is timely filed), or to credit any overpayment, to Deposit Account No. 23-1925.

Respectfully submitted,

Jan. 3, 2005
Date

Steven P. Shurtz
Steven P. Shurtz (Reg. No. 31,424)

I hereby certify that this correspondence is being sent via facsimile to 1-703-872-9306 to Examiner Kenny at the United States Patent & Trademark Office, on January 3, 2005

Date of Deposit

Steven P. Shurtz, Reg. No. 31,424

Name of applicant, assignee or Registered Representative

Steven P. Shurtz

Signature

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Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Griffith D. Neal

Serial No.: 09/798,511

Filing Date: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: Stephen J. Kenny

Group Art Unit No.: 3726

AMENDMENT

Mail Stop: Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office Action mailed September 3, 2004, please enter the following amendment and consider the following remarks.

Amendments to the specification begin on page 2 of this paper.

Amendments to the claims are reflected in the listing of claims which begins on page 3 of this paper.

Remarks begin on page 8 of the paper.

01/04/2005 BBONNER 00000002 09798511

01 FC:2251 60.00 OP

Amendments to the Specification

Please amend the paragraph on page 8, lines 16-30, as follows:

As shown in FIG. 4, the individual stator arc segments 20 are then removed from the carrier and aligned to form a magnetically inducible toroidal core 17 having a plurality of poles 21 thereon, and wire windings 15 which serve as conductors. To form the toroidal core 17, an end surface 16 of each stator arc segment 20 is aligned and brought into contact with a corresponding end surface 19 of another stator arc segment 20. The wire 15 between the poles 21 of different stator arc segments 20 is also aligned in the toroidal core 17, following the arc of the stator arc segments 20. As a result, the wire in the toroidal core 17 is taught. After the wire is wound so that one set of three leads is terminated together to create the common ground 46, and the other ends of the wire, are for each of the three phases form the leads 47a, 47b and 47c by which current is supplied to the windings. The conductors induce or otherwise create a plurality of magnetic fields in the core when electrical current is conducted through the conductors. In this embodiment, a magnetic field is induced in each of the poles 21.

Amendments to the Claims

Please cancel claims 2, 18 and 27-28, amend claims 1, 3, 9, 10, 15, and 19-21, and add new claims 33-35. A complete listing of the claims with proper claim identifiers follows.

Listing of Claims

1. (Currently amended) A stator assembly, comprising:

a) a plurality of individual stator arc segments forming a toroidal core, wherein each said stator arc segment has two end surfaces and a plurality of poles with wire wound around said poles [[that are each in contact with an end surface of another stator arc segment to form]] forming the toroidal core; and

b) a monolithic body of injection molded phase change material substantially encapsulating the stator arc segments and the wire wound around the poles, wherein said phase change material bonds the arc segments together to hold the arc segments in a toroidal shape.

2. (Canceled)

3. (Currently amended) The stator assembly of claim [[2]] 3 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

4. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than $2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

5. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than $1.5x10^{-5}$ in/in/°F throughout the range of 0-250°F.

6. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of between about $0.8x10^{-5}$ in/in/°F and about $1.2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

7. (Original) The stator assembly of claim 1 wherein the phase change material has a thermal conductivity of at least 0.7 watts/meter°K at 23°C.

8. (Original) The stator assembly of claim 1 wherein the phase change material comprises polyphenyl sulfide.

9. (Currently amended) A method of making a stator assembly for a motor comprising:

a) providing at least two individual stator arc segments each having a first end surface and a second end surface and a plurality of poles with wire wound around said poles;

b) aligning said stator arc segments to form a toroidal core[[, wherein each said end surface of one segment is in contact with an opposing end surface of another segment]]; and

c) substantially encapsulating said toroidal core, including said windings, with a monolithic body of injection molded phase change material to form said stator assembly, wherein said phase change material bonds the arc segments together to hold the arc segments in a toroidal shape.

10. (Currently amended) The method of claim 9[[,]] wherein [[each of said stator arc segments have a plurality of]] the poles [[extending]] extend inwardly from a base of each of said stator arc [[segment]] segments.

11. (Original) The method of claim 10 wherein prior to said step of aligning, the wire is wound around said poles of said stator arc segments.

12. (Original) The method of claim 11 wherein said stator arc segments are placed in a carrier that holds and supports said stator arc segments while the wire is wound around said poles.

13. (Original) The method of claim 12 wherein said carrier has a plurality of cavities to hold and support said stator arc segments.

14. (Original) The method of claim 13 wherein said cavities are spaced apart a distance X, wherein X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

15. (Currently amended) The method of claim 9 wherein said [[toroidal core has]] <u>windings provide</u> multiple conductors that create a plurality of magnetic fields when electrical current is conducted through the conductors.

16. (Original) The method of claim 9 wherein said phase change material is selected from the group consisting of thermoplastics and thermosetting materials.

17. (Original) The method of claim 9 wherein prior to said substantially encapsulating, said toroidal core is clamped in an injection mold cavity to maintain the toroidal shape.

18. (Canceled)

19. (Currently amended) The method of claim [[18]] <u>9</u> wherein said phase change material is injected into a mold at temperature of between about 200°F and about 700°F.

20. (Currently amended) The method of claim [[18,]] <u>9</u> wherein said phase change material is injected into a mold at a temperature of between about 550°F to about 650°F.

21. (Currently amended) A method of making a motor comprising:

a) providing four <u>individual</u> stator arc segments, wherein each stator arc segment has a first end surface and a second end surface <u>and a plurality of poles with wire wound around said poles</u>;

b) aligning said stator arc segments to form a toroidal core[[, wherein each said end surface of one segment is in contact with an opposing end surface of another segment]];

c) substantially encapsulating said toroidal core<u>, including said windings,</u> with a monolithic body of phase change material, wherein said substantially encapsulating is by injection molding said phase change material around said toroidal core to form a stator assembly, wherein said phase change material bonds the arc segments together to hold the arc segments in a toroidal shape; and

d) constructing the stator assembly into a motor.

22. (Original) The method of claim 21 wherein each of said stator arc segments comprise a plurality of steel laminations.

23. (Previously presented) A motor comprising the stator assembly of claim 1.

24. (Previously presented) The motor of claim 23 wherein said motor comprises said stator assembly, a shaft, a base, bearings, a rotor, at least one permanent magnet and a hub.

25. (Previously presented) An electronic device including the motor of claim 23.

26. (Previously presented) A motor and disc assembly including the motor of claim 23.

27-29. (Canceled)

30. (Previously presented) The method of claim 11 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

31. (Previously presented) The method of claim 9 wherein the phase change material has a coefficient of linear thermal expansion of less than 2×10^{-5} in/in/°F throughout the range of 0-250°F.

32. (Previously presented) The method of claim 9 wherein the phase change material has a thermal conductivity of at least 0.7 watts/meter°K at 23°C.

33. (New) The stator assembly of claim 1 wherein said end surfaces of adjacent stator arc segments are in contact with one another.

34. (New) The method of claim 9 wherein said end surfaces of adjacent stator arc segments are in contact with one another.

35. (New) The method of claim 21 wherein said end surfaces of adjacent stator arc segments are in contact with one another.

REMARKS

The amendment does not involve new matter. The specification is amended in accordance with Fig. 4 to reflect that "individual" stator arc segments are assembled to make the stator assembly. The limitations added to claims 1, 9 and 21 are found in original claims 2, 10 and 18, and on page 8 as amended. New claims 33-35 are supported by original claims 1, 9 and 21 respectively.

In the outstanding Office Action, claims 1, 2, 9-10, 15-18 and 21-26 were rejected under 35 U.S.C. § 102(b) as anticipated by U.S. Patent No. 5,191,698 (Sumi), and alternatively under 35 U.S.C. § 103(a) as being unpatentable over Sumi in view of U.S. Patent No. 5,729,072 (Hirano). These rejections are respectfully traversed. Claim 1 is directed to a stator assembly, and requires a plurality of stator arc segments forming a toroidal core, with each arc segment having two end surfaces and a plurality of poles with wire wound around the poles. (This feature was originally found in claim 2, which has been cancelled.) Claim 1 also calls for a monolithic body of injection molded phase change material substantially encapsulating the stator arc segments, including the windings, wherein the phase change material bonds the arc segments together to hold the arc segments in a toroidal shape. The specification defines substantial encapsulation as meaning that the body either entirely surrounds the toroidal core, or surrounds almost all of it except for minor areas of the core that may be exposed. Substantial encapsulation also means that the body and toroidal core are rigidly fixed together and behave as a single component with respect to harmonic oscillation vibration. (Specification, page 9, lines 3-8.) The monolithic body is formed by an injection molding operation, preferably in which a plurality of stator arc segments are clamped in a mold, and thermoplastic material is injection molded around them to form the monolithic body.

Sumi discloses a method of making a resin molded motor. While Sumi discloses a plurality of assemblies of core sheets 8 with independent poles 4', these do not constitute a plurality of individual stator arc segments, each having a plurality of poles with windings thereon. Each assembly 8 only provides one pole. Units 7 of Sumi each constitute a plurality of poles 4, but these are all part of one solid piece forming a circle, they are not individual arc segments. The poles 4 of units 7 and poles 4' of assemblies

8 are joined together using fitting grooves 10 to make a magnetic pole member 3 (col. 2, lines 44-46). This entire pole member 3 then gets clad by molding an electrically insulating synthetic resin around it (col. 2, lines 53-58). In addition to the fact that the pieces 4, 4', 7 and 8 do not constitute a plurality of individual stator arc segments each with a plurality of poles, claim 1 (formerly claim 2) also requires that the poles have wire wound around them. The pole member 3 does not have any wire wound around the poles until later. The synthetic resin helps hold the pieces together and electrically insulates them. It does not encapsulate the windings 22a, 22b, 23a and 23b. These windings are provided later after the toroidal core section is all together and the insulating layer applied. (Col. 3, lines 10-12.) Thereafter the entire motor, including the shaft, is placed in a mold and a resin is poured into the mold to produce a casing and flange on the motor (col. 3, lines 39-44). This resin is not injection molded. Since there are no plurality of individual stator arc segments each with a plurality of poles with wire wound around them in Sumi, and there is no monolithic body of injection molded phase change material in Sumi substantially encapsulating the stator arc segments, including the windings, and bonding the arc segments together to hold the arc segments in a toroidal shape as required by claim 1, claim 1 is not anticipated by Sumi. Claims 23-26 are dependent on claim 1 are therefore likewise also not anticipated by Sumi. Furthermore, it would not have been obvious to use an injection molding process to produce the casing and flange in Sumi. First, injection molding was well known to Sumi, as the materials used to clad the pole members 3 as discussed in Col. 2, lines 55-59 are injection moldable thermoplastics. However, Sumi specifically teaches to use a poured resin material to make the casing. Second, once the wires are added to the poles, one of ordinary skill in the art would not want to subject that structure to the high pressures and temperatures typically found in an injection molding process. Thus, the invention of claim 1 and the claims dependant thereon would not have been obvious in view of Sumi.

The Office Action takes the position, in rejecting claim 2, that Figure 1 of Sumi shows each arc segment with a plurality of poles with wire 19 wound around them. As noted above, a careful reading of Sumi shows that by the time the windings are applied, there is just one pole member 3, not a plurality of stator arc segments each having a plurality of poles with wire around the poles. If the pieces are considered separately, none of the pieces constitutes a stator arc segment with a plurality of poles with wire would around the poles. If the whole pole member 3 is considered, it does not constitute a plurality of individual stator arc segments. Either way it is considered, the claim limitation is not met. Further, the last phrase of claim 1 is not met. Claim 1 requires that the monolithic body of phase change material substantially encapsulating the stator arc segments and the wire wound around the poles also bonds the arc segments together to hold the arc segments in a toroidal shape. By the time a resin material is poured into the mold in Sumi, the pole member 3 is already held in its toroidal shape by the fitting grooves 10 and the insulating layer of synthetic resin. The later added resin does not constitute a monolithic body of phase change material with this insulating layer. Thus there is no monolithic body of phase change material that both encapsulates the poles with windings on them and bonds the arc segments together to hold the arc segments in a toroidal shape.

Claims 9 and 21 also require individual stator arc segments each having a plurality of poles with wire wound around said poles, and also require substantially encapsulating the toroidal core formed of aligned stator arc segments with a monolithic body of phase change material, with the phase change material bonding the arc segments, and windings, together to hold the arc segments in a toroidal shape. As noted above, these features are not found in Sumi. Claims 9 and 21, and claims 10, 15-17 and 22 dependent thereon, are thus not anticipated by Sumi.

Hirano discloses a stator made of arc segments, but again the arc segments do not each include a plurality of poles, and there is no suggestion of substantially encapsulating the arc segments in the stator of Hirano with a monolithic body of phase change material. Rather, the segments are held together by "welding, bonding or applying an annular member." (Column 2, lines 47-48.) Thus even if Sumi and Hirano were somehow combined, and arc segments such as those disclosed in Hirano were used in the motor of Sumi, the stator segments would be bonded together by some other means before the wire was wound around the poles. Just as with Sumi, any resin material later poured into a mold to create the casing and flange for the motor would not constitute an injected molded monolithic body of phase change material which acts to hold the arc segments in a toroidal shape as required by claims 1, 9 and 21. Thus, even if the art were somehow combined, the resulting device would not have all of the elements called for by claims 1, 9 and 21. These claims, and the claims dependent thereon, are thus patentable over Sumi and Hirano.

Claims 3 and 30 were rejected in the outstanding Office Action under 35 U.S.C. § 103(a) as being unpatentable over Sumi in view of Hirano. This rejection is respectfully traversed. Claim 3 is ultimately dependent on claim 1, and claim 30 is ultimately dependent on claim 9. As discussed above, neither Sumi nor Hirano disclose a monolithic body of injection molded phase change material substantially encapsulating stator arc segments with wire windings on multiple poles on each segment, and bonding the arc segments together to hold the arc segments in a toroidal shape. Hence claims 3 and 30 are patentable over Sumi and Hirano.

In the outstanding Office Action claims 4-8, 11-14 and 31-32 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Sumi in view of U.S. Patent No. 5,592,731 (Huang). This rejection is also respectfully traversed. Claims 4-8 are ultimately dependent on claim 1, and claims 11-14 and 31-32 are ultimately dependent on claim 9. Huang discloses stator arc segments, but those arc segments are not substantially encapsulated by a monolithic body of phase change material as called for by claim 1. In Huang, individual particles of iron powder (each with an iron phosphate layer thereon) have a coating of thermoplastic material on them, and the thermoplastic material allows the particles to be compacted together. Thus in Huang, the iron particles are encapsulated in a thermoplastic, rather than the stator arc segments being encapsulated as called for by claim 1. These particles are then compacted in a die to form a stator arc segment, but these stator arc segments are not thereafter encapsulated. Rather, a metallic ring 62 is used to hold the arc segments together. See column 8, line 61 to column 9, line 10 of Huang.

Since Huang does not disclose the monolithic body of phase change material substantially encapsulating stator arc segments and bonding the arc segments together to hold the arc segments in a toroidal shape, nor would it have been obvious to modify Huang to include this element, claims 4-8, 11-14 and 31-32 are patentable over Sumi and Huang.

Claims 19-20 were rejected in the outstanding Office Action under 35 U.S.C. § 103(a) as being unpatentable over Sumi in view of U.S. Patent No. 4,015,154 (Tanaka). This rejection is respectfully traversed. Claims 19-20 are ultimately dependent on claim 9, and are patentable over Sumi for the reasons discussed above.

Tanaka discloses a motor made with a conventional laminated toroidal core, rather than a core made of stator arc segments. Such a laminated toroidal core is then placed in an injection molding machine and a specific combination of thermosetting and thermoplastic materials is used to form a casing around the core. Tanaka goes to great lengths in choosing the right combination of thermosetting and thermoplastic materials, and notes that significant problems surround molding cores for electric motors using these materials. Column 4, lines 29-51 describe these problems, which include contraction and shrinkage, cracks, cave-ins, lack of high fidelity reproduction, etc.

There is nothing in either Tanaka or Sumi that would suggest that stator pieces such as those in Sumi could or should be overmolded with the specific composition of Tanaka. The Tanaka injection molding is for laminated cores that form a complete annular ring, not a core made from pieces. Further, from the problems addressed in Tanaka with injection molding cores in general, it would go against Tanaka to try to mold stator core made of individual pieces, especially where the segments are then held together by the injection molded material. Hence claims 19-20 are patentable over Sumi and Tanaka.

Since each of the rejections has been overcome, an early notice of allowance is respectfully requested.

Respectfully submitted,

Steven P. Shurtz

Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant

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Application Number	09/798,511
Filing Date	3/2/01
First Named Inventor	Griffith Neal
Art Unit	3726
Examiner Name	Stephen Kenny
Attorney Docket Number	8864/20

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[X] Attorney or Agent of record. Registration Number 31,424

[ ] Registered practitioner named in the application transmittal letter in an application without an executed oath or declaration. See 37 CFR 1.33(a)(1). Registration Number ______

Typed or Printed Name	Steven P. Shurtz		
Signature	Steven P. Shurtz		
Date	10/20/04	Telephone	312 321-4230

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

[ ] *Total of ______ forms are submitted.

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Application Number	09/798,511
Filing Date	3/2/01
First Named Inventor	Griffith Neal
Art Unit	3726
Examiner Name	Stephen Kenny
Attorney Docket Number	8864/20

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[X] Attorney or Agent of record. Registration Number 31,424

[ ] Registered practitioner named in the application transmittal letter in an application without an executed oath or declaration. See 37 CFR 1.33(a)(1). Registration Number ______

Typed or Printed Name	Steven P. Shurtz		
Signature	Steven P. Shurtz		
Date	10/20/04	Telephone	312 321-4230

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Art Unit	3726
Examiner Name	Stephen Kenny
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☒ Attorney or Agent of record. Registration Number 31,914

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Date	10/20/04	Telephone	312 321-4234

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Application Number	09/798,511
Filing Date	3/2/01
First Named Inventor	Griffith Neal
Art Unit	3726
Examiner Name	Stephen Kenny
Attorney Docket Number	8864/20

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[ ] Registered practitioner named in the application transmittal letter in an application without an executed oath or declaration. See 37 CFR 1.33(a)(1). Registration Number________.

Typed or Printed Name	Steven P. Shurtz		
Signature	Steven P. Shurtz		
Date	10/20/04	Telephone	312 321-4230

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Application Number	09/798,511
Filing Date	March 2, 2001
First Named Inventor	Giffith D. Neal
Art Unit	3726
Examiner Name	Stephen Kenny
Attorney Docket Number	8864/20

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Typed or Printed Name	Steven P. Shurtz		
Signature	Steven P. Shurtz		
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

7590 09/03/2004

Sailesh K. Patel
Brinks Hofer Gilson & Lione
P.O. Box 10395
Chicago, IL 60610

EXAMINER	
KENNY, STEPHEN	
ART UNIT	PAPER NUMBER
3726	

DATE MAILED: 09/03/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)
	09/798,511	NEAL, GRIFFITH D.
	Examiner	Art Unit
	Stephen J Kenny	3726

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 May 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-28, 30-32* is/are pending in the application.

4a) Of the above claim(s) *27 and 28* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-26, 30-32* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-2, 9-10, 15-18, 21-26 are rejected under 35 U.S.C. 102(b) as being anticipated by Sumi et al. (US Patent No 5191698).

Regarding claims 1, 9, 16, 21, Sumi discloses forming a stator assembly comprising: a plurality of stator arc segments (7, 8) forming a toroidal core, having two ends in contact with each other (Figure 2), and a monolithic body of thermoplastic phase change material substantially encapsulating the stator arc segments via injection molding and holding said end surfaces with one another (column 1, lines 30-35, 46-50, 65-68 & column 2, lines 54-64).

Regarding claims 2, 10, & 15, Sumi discloses each arc segment has a plurality of poles with wire (19) wound around (Figure 1).

Regarding claims 17-18, Sumi discloses clamping the toroidal core in an injection mold cavity to maintain the shape (column 2, lines 54-56).

Regarding claims 22-26, Sumi discloses the stator arc segments are steel laminations (column 2, lines 41 & 54); a motor/electronic device having a shaft, base, bearings, rotor, & magnet hub (Figure 1).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

In the alternative to the U.S.C. 102 rejection above, claims 1-2, 9-10, 15-18, 21-26 are rejected under U.S.C. 103(a) as being unpatentable over Sumi in view of Hirano (US Patent No 5729072).

Sumi discloses the claimed invention as discussed above except for explicitly illustrating that the stator core segments are positioned such that the end surfaces of each segment are in contact with each other.

Hirano discloses a plurality of stator segments (11) positioned such that the end surfaces are in contact with each other. This configuration is widely known and practiced within the art, since it provides favorable magnetic flux characteristics, as well as facilitates the formation of a toroidal core. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to form a stator core as disclosed by Sumi wherein the segments are in contact with each other as taught by Hirano in order to realize the advantages discussed above.

Claims 3 & 30, are rejected under 35 U.S.C. 103(a) as being unpatentable over Sumi in view of Hirano et al (US Patent No 5729072).

Sumi discloses the instant invention except for a packing density of the wire around the stator poles is between 60% ~ 80%.

Hirano discloses a packing density of 70% (abstract line 11). A high packing density is advantageous in that it allows for an increase in magnetic flux while saving space as well. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify a stator core as disclosed by Sumi with the packing density taught by Hirano in order to achieve a more efficient stator core.

Claims 4-8, 11-14, & 31-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang (US Patent No 5592731).

Regarding claims 4, 5, & 31, Sumi discloses the claimed invention except for the bonding material having the claimed coefficient of linear thermal expansion (CLTE).

Regarding claims Huang discloses a phase change material for coating stator arc components having a coefficient of linear thermal expansion of less than $2*10^{-5}$in/in/°F & $1.5*10^{-5}$in/in/°F (column 9, lines 10-14). The use of a bonding agent having such a CLTE is advantageous in that it prevents geometric distortion of the stator segments, which in turn prevents performance degradation.

Regarding claims 6-8, & 32 Sumi/Huang disclose the claimed invention except for the specific values of Coefficient of Linear Thermal Expansion; thermal conductivity; and material composition. It would have been an obvious matter of design choice to use the specific values claimed, since applicant has disclosed that such values are merely the "preferred" values (applicant's page 10, lines 15+), thereby implying that the invention would perform equally well with alternative values as disclosed by Sumi/Huang.

Regarding claim 11, Huang discloses prior to the aligning step, the wire is wound around said poles of said stator arc segments (column 8, lines 34-35).

Regarding claims 12 & 13, Huang discloses stator segments placed in a carrier that holds said stator segments while wire is wound around said poles (column 8, lines 36-37) wherein said carrier has a plurality of cavities to hold and support said segments (Figure 5).

Regarding claim 14, Huang discloses spacing apart segments by a distance X, where X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core (Figure 6).

Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to form a stator core as disclosed by Sumi, with a bonding agent having the CLTE, winding method as taught by Huang in order to realize the improvements to performance afforded by these modifications as discussed above.

Claims 19-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sumi in view of Tanaka (US Patent No 4015154).

Sumi discloses the claimed invention except for the specific temperature at which the encapsulating material is heated to during the molding application.

Tanaka discloses that thermosetting materials be heated to an elevated temperature during application (column 5, line 36). Thus the specific limitation of an application temperature of 200°F ~ 700°F, or 550°F ~ 650°F is considered an obvious matter of design choice since applicant has provided no explanation of why these specific temperature ranges are beneficial or significant; and it appears as if the invention would perform equally well with the heating disclosed by Tanaka.

Response to Arguments

Applicant's arguments with respect to claims 1-32 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen J Kenny whose telephone number is 703-306-0359. The examiner can normally be reached on mon - fri 9am - 5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Peter Vo can be reached on 703-308-1789. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

sk S. Kenny
8/31/04

DAVID P. BRYANT
PRIMARY EXAMINER

Notice of References Cited	Application/Control No. 09/798,511	Applicant(s)/Patent Under Reexamination NEAL, GRIFFITH D.	
	Examiner Stephen J Kenny	Art Unit 3726	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-5,191,698	03-1993	Sumi et al.	29/596
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims

Application No.	Applicant(s)
09/798,511	NEAL, GRIFFITH D.
Examiner	**Art Unit**
Stephen J Kenny	3726

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

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Commissioner for Patents
P.O. Box 1450
Alexandra, VA 22313-1450
on May 17, 2004

Date of Deposit

Steven P. Shurtz, Reg. No. 31,424

Name of applicant, assignee or Registered Representative

Steven P. Shurtz

Signature

May 17, 2004

Date of Signature

Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Griffith D. Neal

Serial No.: 09/798,511

Filing Date: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: Stephen J. Kenny

Group Art Unit No.: 3726

AMENDMENT AND SUMMARY OF INTERVIEW

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office Action mailed November 18, 2003, please enter the following amendment and consider the following remarks.

Amendments to the specification are on page 3 of this paper.

Amendments to the drawings are on page 4 of this paper, and include both an attached replacement sheet and an annotated sheet showing changes.

Amendments to the claims are reflected in the listing of claims which begins on page 5 of this paper.

Remarks begin on page 9 of the paper.

Amendment to the Specification

Please replace the paragraph on page 6, lines 15-16, with the following amended paragraph:

FIG. 1 is an exploded, partial cross-sectional and perspective view of a conventional high speed motor of the [[present invention]] prior art.

Please replace the paragraph on page 11, lines 1-17, with the following amended paragraph:

One preferred thermoplastic material, Konduit OTF-212-11, was made into a thermoplastic body and tested for its coefficient of linear thermal expansion by a standard ASTM test method. It was found to have a CLTE in the range of –30 to 30°C of $1.09x10^{-5}$ in/in/°F in the X direction and $1.26x10^{-5}$ in/in/°F in both the Y and Z directions, and a CLTE in the range of 100 to 240°C of $1.28x10^{-5}$ in/in/°F in the X direction and $3.16x10^{-5}$ in/in/°F in both the Y and Z directions. (Hence, the relevant CLTEs for purposes of defining the invention are 1.09×10^{-5} in/in/°F and 1.28×10^{-5} in/in/°F.) Another similar material, Konduit PDX –0-988, was found to have a CLTE in the range of –30 to 30°C of $1.1x10^{-5}$ in/in/°F in the X direction and $1.46x10^{-5}$ in/in/°F in both the Y and Z directions, and a CLTE in the range of 100 to 240°C of $1.16x10^{-5}$ in/in/°F in the X direction and $3.4x10^{-5}$ in/in/°F in both the Y and Z directions. By contrast, a [[PBS]] PPS type polymer, (Fortron 4665) was likewise tested. While it had a low CLTE in the range of –30 to 30°C ($1.05x10^{-5}$ in/in/°F in the X direction and $1.33x10^{-5}$ in/in/°F in both the Y and Z directions), it had a much higher CLTE in the range of 100 to 240°C ($1.94x10^{-5}$ in/in/°F in the X direction and $4.17x10^{-5}$ in/in/°F in both the Y and Z directions).

Amendments to the Claims

Please amend claims 1, 9, 21 and 23-26. A complete listing of the claims with proper claim identifiers follows.

Listing of Claims

1. (Currently amended) A stator assembly, comprising:

a) a plurality of stator arc segments forming a toroidal core, wherein each said stator arc segment has two end surfaces that are each in contact with an end surface of another stator arc segment to form the toroidal core; and

b) a monolithic body of phase change material substantially encapsulating the stator arc segments [[and holding said end surfaces in contact with one another]] , wherein said phase change material bonds the arc segments together to hold the arc segments in a toroidal shape.

2. (Original) The stator assembly of claim 1 wherein each of the stator arc segments has a plurality of poles with wire wound around said poles.

3. (Original) The stator assembly of claim 2 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

4. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than $2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

5. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than $1.5x10^{-5}$ in/in/°F throughout the range of 0-250°F.

6. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of between about $0.8x10^{-5}$ in/in/°F and about $1.2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

7. (Original) The stator assembly of claim 1 wherein the phase change material has a thermal conductivity of at least 0.7 watts/meter°K at 23°C.

8. (Original) The stator assembly of claim 1 wherein the phase change material comprises polyphenyl sulfide.

9. (Currently amended) A method of making a stator assembly for a motor comprising:

a) providing at least two stator arc segments each having a first end surface and a second end surface;

b) aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment; and

c) substantially encapsulating said toroidal core with a monolithic body of phase change material to form said stator assembly<u>, wherein said phase change material bonds the arc segments together to hold the arc segments in a toroidal shape</u>.

10. (Original) The method of claim 9, wherein each of said stator arc segments have a plurality of poles extending inwardly from a base of said stator arc segment.

11. (Original) The method of claim 10 wherein prior to said step of aligning, the wire is wound around said poles of said stator arc segments.

12. (Original) The method of claim 11 wherein said stator arc segments are placed in a carrier that holds and supports said stator arc segments while the wire is wound around said poles.

13. (Original) The method of claim 12 wherein said carrier has a plurality of cavities to hold and support said stator arc segments.

14. (Original) The method of claim 13 wherein said cavities are spaced apart a distance X, wherein X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

15. (Original) The method of claim 9 wherein said toroidal core has multiple conductors that create a plurality of magnetic fields when electrical current is conducted through the conductors.

16. (Original) The method of claim 9 wherein said phase change material is selected from the group consisting of thermoplastics and thermosetting materials.

17. (Original) The method of claim 9 wherein prior to said substantially encapsulating, said toroidal core is clamped in an injection mold cavity to maintain the toroidal shape.

18. (Original) The method of claim 9 wherein said step of substantially encapsulating the core is performed by injection molding said phase change material around said toroidal core.

19. (Original) The method of claim 18 wherein said phase change material is injected into a mold at temperature of between about 200°F and about 700°F.

20. (Original) The method of claim 18, wherein said phase change material is injected into a mold at a temperature of between about 550°F to about 650°F.

21. (Currently amended) A method of making a motor comprising:

a) providing four stator arc segments, wherein each stator arc segment has a first end surface and a second end surface;

b) aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment;

c) substantially encapsulating said toroidal core with a monolithic body of phase change material, wherein said substantially encapsulating is by injection molding said phase change material around said toroidal core to form a stator assembly, wherein said phase change material bonds the arc segments together to hold the arc segments in a toroidal shape; and

d) constructing the stator assembly into a motor.

22. (Original) The method of claim 21 wherein each of said stator arc segments comprise a plurality of steel laminations.

23. (Currently Amended) A motor [[made from]] comprising the stator assembly of claim 1.

24. (Currently amended) The motor of claim [[21]] 23 wherein said motor comprises [[a]] said stator assembly, a shaft, a base, bearings, a rotor, at least one permanent magnet and a hub.

25. (Currently amended) An electronic device including the motor of claim [[21]] 23.

26. (Currently amended) A motor and disc assembly including the motor [[made by the method]] of claim [[21]] 23.

27. (Withdrawn) A combination of stator arc segments and a carrier used to support said stator arc segments during a winding operation comprising:

a) a plurality of stator arc segments; and

b) a plurality of cavities to hold and support said stator arc segments.

28. (Withdrawn) The combination of stator arc segments and carrier of claim 27 wherein said cavities are spaced apart a distance X, wherein the distance X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

29. (Canceled)

30. (Previously presented) The method of claim 11 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

31. (Previously presented) The method of claim 9 wherein the phase change material has a coefficient of linear thermal expansion of less than $2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

32. (Previously presented) The method of claim 9 wherein the phase change material has a thermal conductivity of at least 0.7 watts/meter°K at 23°C.

REMARKS

Examiner Kenny is thanked for the courtesy of a telephone interview with the below signed Attorney for Applicant on May 14, 2004. During that interview, claims 1, 9, 17, 21 and 23-26 were discussed. U.S. Patent No. 5,592,731 (Huang) and U.S. Patent No. 4,015,154 (Tanaka) were discussed. Arguments presented during the interview are included in the remarks below. The foregoing drawing amendments were also discussed. Agreement was reached that the forgoing amendments would overcome all outstanding rejections.

In the outstanding Office Action, claims 23, 25 and 26 were rejected under 35 U.S.C. § 112, second paragraph as indefinite. The forgoing amendments to these claims overcomes this rejection.

In the outstanding Office Action, claims 1, 2, 4, 5, 9-16, 23, 25-26 and 31 were rejected under 35 U.S.C. § 102(b) as anticipated by U.S. Patent No. 5,592,731 (Huang). Claim 1 is directed to a stator assembly, and requires a plurality of stator arc segments forming a toroidal core, with each arc segment having two end surfaces that contact an end surface of another stator arc segment. Claim 1 also calls for a monolithic body of phase change material substantially encapsulating the stator arc segments wherein said phase change material bonds the arc segments together to hold the arc segments in a toroidal shape. The specification defines substantial encapsulation as meaning that the body either entirely surrounds the toroidal core, or surrounds almost all of it except for minor areas of the core that may be exposed. Substantial encapsulation also means that the body and toroidal core are rigidly fixed together and behave as a single component with respect to harmonic oscillation vibration. (Specification, page 9, lines 3-8.) In the preferred embodiment, the monolithic body is formed by an injection molding operation, in which a plurality of stator arc segments are clamped in a mold, and thermoplastic material is injection molded around them to form the monolithic body.

Huang discloses stator arc segments, but those arc segments are not substantially encapsulated by a monolithic body of phase change material as called for by claim 1. The Office Action refers to column 5, lines 1-15 of Huang as teaching the monolithic body of phase change material substantially encapsulating the stator arc segments and holding the end surfaces together. However, lines 1-15 simply describe how individual particles of iron powder (each with an iron phosphate layer thereon) have a coating of thermoplastic material on them, and how the thermoplastic material behaves when the particles are compacted together. Thus in Huang, the iron particles are encapsulated in a thermoplastic, rather than the stator arc segments being encapsulated as called for by claim 1. These particles are then compacted in a die to form a stator arc segment, but these stator arc segments are not thereafter encapsulated. Rather, a metallic ring 62 is used to hold the arc segments together. See column 8, line 61 to column 9, line 10.

The Office Action refers to Figures 4a and 4c of Huang as disclosing stator arc segments with ends "fixed" together. While this characterization of Huang is traversed, it was agreed that the modification of claims 1 and 9, which make it explicit that the phase change material bonds the arc segments together to hold the arc segments in a toroidal shape, would distinguish over the reference.

Since there is no monolithic body of phase change material in Huang substantially encapsulating the stator arc segments and bonding the arc segments together to hold the arc segments in a toroidal shape as required by claim 1, claim 1 is not anticipated by Huang. Claims 2, 4, 5, 23 and 25-26 dependent on claim 1 are therefore likewise also not anticipated by Huang.

Claim 9 requires substantially encapsulating the toroidal core formed of aligned stator arc segments with a monolithic body of phase change material, with the phase change material bonding the arc segments together to hold the arc segments in a toroidal shape. As noted above, this feature is not found in Huang. Claim 9, and claims 10-16 and 31 dependent thereon are not anticipated by Huang.

Claims 3 and 30 were rejected in the outstanding Office Action under 35 U.S.C. § 103(a) as being unpatentable over Huang in view of U.S. Patent No. 5,729,072 (Hirano). This rejection is respectfully traversed. Claim 3 is ultimately dependent on claim 1, and claim 30 is ultimately dependent on claim 9. As discussed above, Huang does not disclose a monolithic body of phase change material substantially encapsulating stator arc segments and bonding the arc segments together to hold the arc segments in a toroidal shape. Hirano discloses a stator made of arc segments, but again there is no suggestion of substantially encapsulating the arc segments in the stator of Hirano with a monolithic body of phase change material. Rather, the segments are held together by "welding, bonding or applying an annular member." (Column 2, lines 47-48.) Thus even if Huang and Hirano were somehow combined the resulting device would not have all of the elements called for by claims 1 and 9. Hence claims 3 and 30 are patentable over Huang and Hirano.

In the outstanding Office Action claims 6-8 and 32 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Huang. This rejection is also respectfully traversed. Claims 6-8 are ultimately dependent on claim 1, and claim 32 is ultimately dependent on claim 9. Since Huange does not disclose the monolithic body of phase change material substantially encapsulating stator arc segments and bonding the arc segments together to hold the arc segments in a toroidal shape, nor would it have been obvious to modify Huang to include this element, claims 6-8 and 32 are patentable over Huange.

Claims 17-26 were rejected in the outstanding Office Action under 35 U.S.C. § 103(a) as being unpatentable over Huang in view of U.S. Patent No. 4,015,154 (Tanaka). This rejection is respectfully traversed. Claims 17-20 are ultimately dependent on claim 9. Claim 21, like claim 9, requires substantially encapsulating a toroidal core made of stator arc segments with a monolithic body of phase change material, with the phase change material bonding the arc segments together to hold the arc segments in a toroidal shape. Claim 21 goes on to require that the phase change material is injection molded around the toroidal core. Claim 22 is dependent on claim 21. Claims 23-26 are dependent on claim 1. Thus all of the rejected claims are patentable over Huange for the reasons discussed above.

Tanaka discloses a motor made with a conventional laminated toroidal core, rather than a core made of stator arc segments. Such a laminated toroidal core is then placed in an injection molding machine and a specific combination of thermosetting and thermoplastic materials is used to form a casing around the core. Tanaka goes to great lengths in choosing the right combination of thermosetting and thermoplastic materials, and notes that significant problems surround molding cores for electric motors using these materials. Column 4, lines 29-51 describe these problems, which include contraction and shrinkage, cracks, cave-ins, lack of high fidelity reproduction, etc.

There is nothing in either Tanaka or Huang that would suggest that stator arc segments such as those in Huang could or should be overmolded with the specific composition of Tanaka. The Tanaka injection molding is for laminated cores that form a complete annular ring, not core segments. Further, from the problems addressed in Tanaka with injection molding cores in general, it would go against Tanaka to try to mold stator core segments, especially where the ends of the segments are then held together by the injection molded material.

Huang does not suggest encapsulating stator arc segments. Hence it would not have been obvious to modify Huang and somehow come up with a process of injection molding stator arc segments to hold their ends together and form an encapsulated toroidal core. Hence claims 17-26 are patentable over Huang and Tanaka.

Since each of the rejections has been overcome, an early notice of allowance is respectfully requested.

Respectfully submitted,

Steven P. Shurtz

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Registration No. 31,424
Attorney for Applicant

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Amendment to the Drawings

Attached is an annotated sheet 1 of the drawings showing the change (in red) to reflect that FIG. 1 represents prior art and to show the electrical connector 9 discussed on page 1 of the specification but inadvertently left off of the original FIG. 1. A new formal drawing of sheet 1 incorporating those changes is also attached.

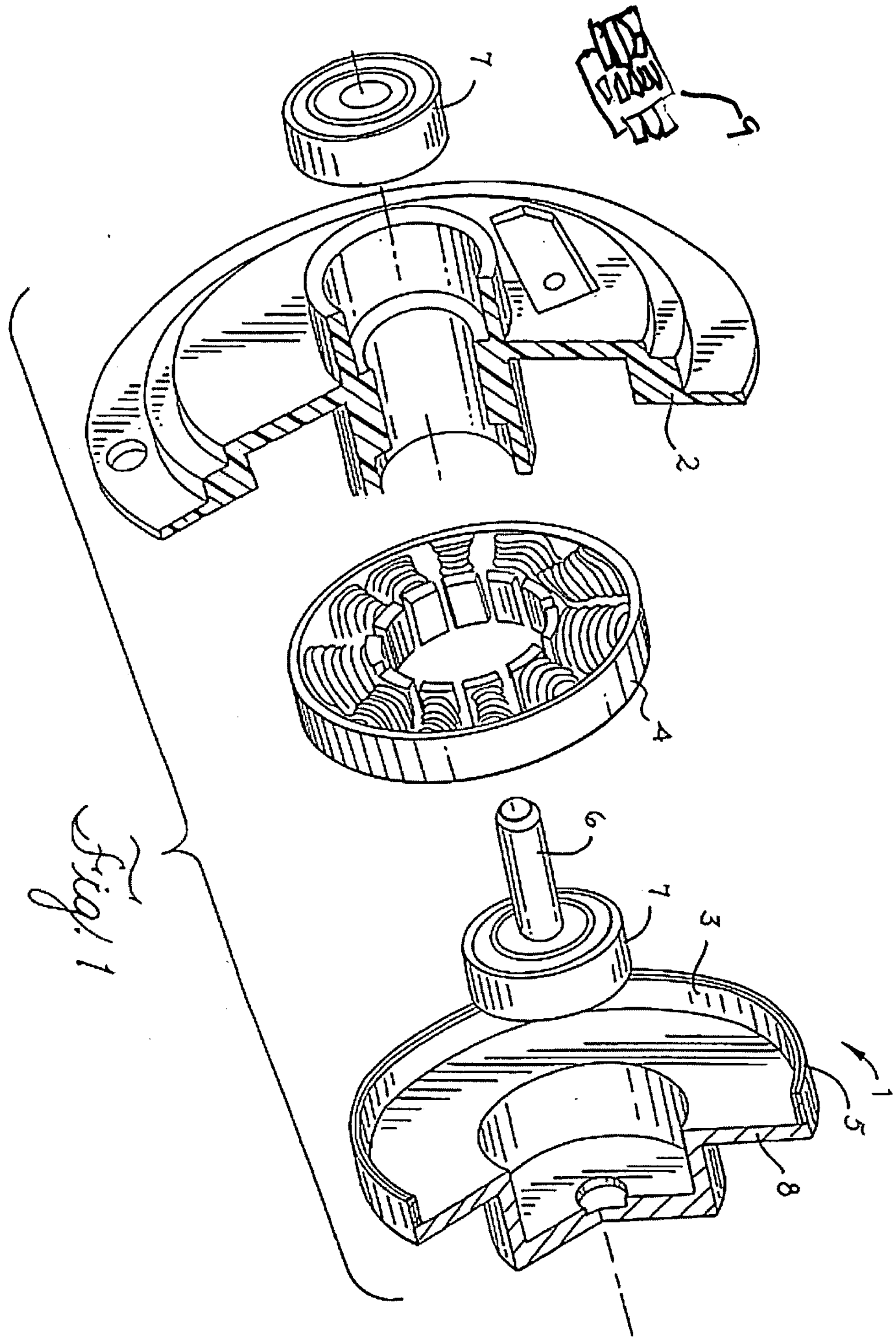

Fig. 1

PRIOR ART

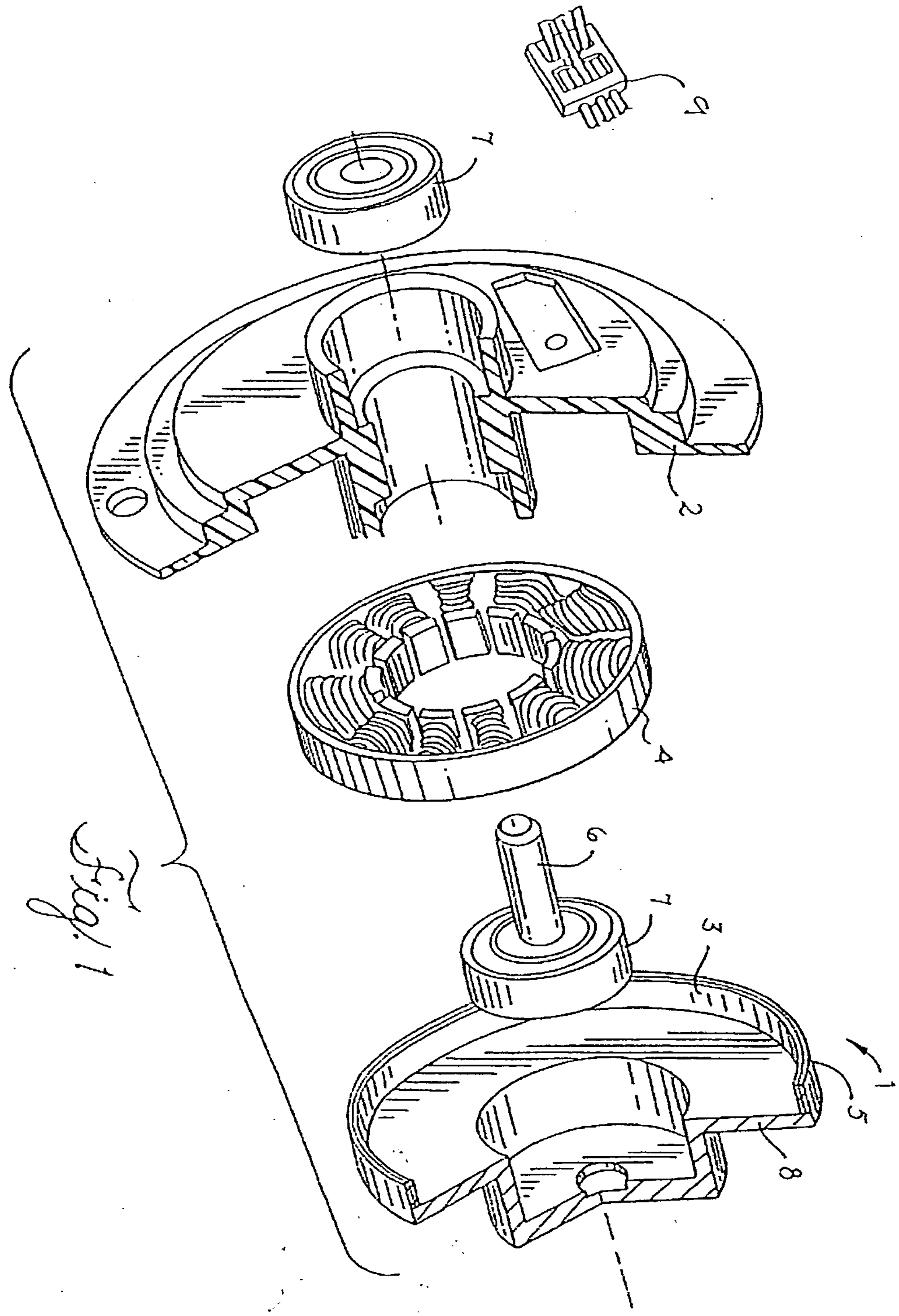

Fig. 1

Prior Art

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Date: May 17, 2004 Name: Steven P. Shurtz Signature: Steven P. Shurtz

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Appln. of:	Griffith D. Neal		
Appln. No.:	09/798,511	Examiner:	S. J. Kenny
Filed:	March 2, 2001	Art Unit:	3726
For:	STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME		
Attorney Docket No:	8864/20		

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TRANSMITTAL

Sir:

Attached is/are:

- ☒ Amendment and Summary of Interview; Annotated Sheet 1 of drawing; 1 sheet of new formal drawing;
- ☒ Return Receipt Postcard

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Fee calculation:

- ☐ No additional fee is required.
- ☒ Small Entity.
- ☒ An extension fee in an amount of $475 for a 3-month extension of time under 37 C.F.R. § 1.136(a).
- ☐ A petition or processing fee in an amount of $_____ under 37 C.F.R. § 1.17(_____).
- ☐ An additional filing fee has been calculated as shown below:

	Claims Remaining After Amendment		Highest No. Previously Paid For	Present Extra		Small Entity Rate	Small Entity Add'l Fee	or	Not a Small Entity Rate	Not a Small Entity Add'l Fee
Total		Minus				x $9=			x $18=	
Indep.		Minus				x 43=			x $86=	
First Presentation of Multiple Dep. Claim						+$145=			+ $290=	
						Total	$		Total	$

Fee payment:

- ☐ A check in the amount of $_____ to cover the above-identified fee(s) is enclosed.
- ☐ Please charge Deposit Account No. 23-1925 in the amount of $. A copy of this Transmittal is enclosed for this purpose.
- ☒ Payment by credit card in the amount of $475.00 (Form PTO-2038 is attached).
- ☒ The Director is hereby authorized to charge payment of any additional filing fees required under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17 associated with this paper (including any extension fee required to ensure that this paper is timely filed), or to credit any overpayment, to Deposit Account No. 23-1925.

Respectfully submitted,

5/17/04
Date

Steven P. Shurtz
Steven P. Shurtz (Reg. No. 31,424)

OIPE JC196
MAY 2 0 2004
PATENT & TRADEMARK OFFICE

I hereby certify that this correspondence is being deposited with the United States Postal Service, with sufficient postage, as first class mail in an envelope addressed to:

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313
on May 17, 2004

Date of Deposit

Steven P. Shurtz, Reg. No. 31,424

Name of applicant, assignee or Registered Representative

Steven P. Shurtz, Jr

Signature

5/17/04

Date of Signature

RECEIVED
MAY 2 6 2004
GROUP 3600

Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Griffith D. Neal

Serial No: 09/798,511

Filed: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: Stephen J. Kenny

Group Art Unit: 3726

PETITION AND FEE FOR EXTENSION OF TIME (37 CFR § 1.136(a))

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is a petition for an extension of the time to respond to Office Action dated November 18, 2003 for a period of 3 month(s).

☒ Applicant:

05/21/2004 LWONDIM1 00000036 09798511

01 FC:2253 475.00 OP

☒ claims small entity status. See 37 C.F.R. §1.27.

☐ is other than small entity

	Extension Months	Other Than Small Entity	Small Entity
☐	One Month	$110.00	$55.00
☐	Two Months	$420.00	$210.00
☒	Three Months	$950.00	$475.00
☐	Four Months	$1,480.00	$740.00
☐	Five Months	$2,010.00	$1,005.00

Fee Payment

☐ Attached is a check for $_____ for the Petition fee.

☒ Attached is a credit card authorization form for $475 for the Petition fee.

☐ Charge Petition fee to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

☒ Charge any additional fee required or credit for any excess fee paid to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

Respectfully submitted,

Dated: May 17, 2004

Steven P. Shurtz
Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610
(312)321-4200

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

7590 11/18/2003

Sailesh K. Patel
Brinks Hofer Gilson & Lione
P.O. Box 10395
Chicago, IL 60610

EXAMINER	
KENNY, STEPHEN	
ART UNIT	PAPER NUMBER
3726	12

DATE MAILED: 11/18/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

08

Office Action Summary	Application No.	Applicant(s)
	09/798,511	NEAL, GRIFFITH D.
	Examiner	**Art Unit**
	Stephen J Kenny	3726

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 18 August 2003.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-28 and 30-32 is/are pending in the application.

4a) Of the above claim(s) 27 and 28 is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-26, 30-32 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 23, 25, & 26 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding claim 23 is drawn to a motor made from the stator of claim 1, however the stator is only one component to a motor, therefore it is unclear as to how a motor can be produced by the method of claim 1.

Regarding claims 25 & 26, claim 25 is drawn to an "electronic device" whereas claim 26 is drawn to a "motor and disc assembly". It is unclear as to how the same method (claim 21) can be used to produce two different products (i.e. an electronic device vs. a motor & disc assembly).

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 2, 4, 5, 9-16, 23, 25-26, &31 are rejected under 35 U.S.C. 102(b) as being anticipated by Huang (US Patent No 5592731).

Regarding claims 1, 2, 9, & 10, Huang discloses a stator assembly comprising a plurality of stator arc segments (22) forming a toroidal core, having two ends in contact with each other (Figure 4a), and a monolithic body of phase change material substantially encapsulating the stator arc segments and holding said end surfaces with one another (column 5, lines 1-15).

Regarding claims 4, 5, & 31, Huang discloses the phase change material having a coefficient of linear thermal expansion of less than $2*10^{-5}$in/in/°F & $1.5*10^{-5}$in/in/°F (column 9, lines 10-14).

Regarding claim 11, Huang discloses prior to the aligning step, the wire is wound around said poles of said stator arc segments (column 8, lines 34-35).

Regarding claims 12 & 13, Huang discloses stator segments placed in a carrier that holds said stator segments while wire is wound around said poles (column 8, lines 36-37) wherein said carrier has a plurality of cavities to hold and support said segments (Figure 5).

Regarding claim 14, Huang discloses spacing apart segments by a distance X, where X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core (Figure 6).

Regarding claim 15, Huang discloses multiple conductors (37) that create a plurality of magnetic fields when electrical current is conducted through said conductors (Figure 6).

Regarding claim 16, Huang discloses said phase change material selected from the group of thermoplastics & thermosetting materials (column 5, lines 13-15).

Regarding claims 23, 25-26, Huang discloses a motor/electrical device made from a stator assembly (column 3, line 67). (See MPEP 2173.05(p)).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 3 & 30, are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang in view of Hirano et al (US Patent No 5729072).

Huang discloses the instant invention except for a packing density of the wire around the stator poles is between 60% ~ 80%.

Hirano discloses a packing density of 70% (abstract line 11). A high packing density is advantageous in that it allows for an increase in magnetic flux while saving space as well. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify a stator core as disclosed by Huang with the packing density taught by Hirano in order to achieve a more efficient stator core.

Claims 6-8, & 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang.

Huang discloses the claimed invention except for the specific values of Coefficient of Linear Thermal Expansion; thermal conductivity; and material composition. It would have been an obvious matter of design choice to use the specific values claimed, since applicant has disclosed that such values are merely the "preferred" values (applicant's page 10, lines 15+), thereby implying that the invention would perform equally well with alternative values as disclosed by Huang.

Claims 17-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang in view of Tanaka et al (US Patent No 4015154).

Regarding claims 17, 18, 21-23, & 26 Huang discloses the instant invention except for injection molding the substantially encapsulating material.

Tanaka discloses clamping (column 3, line 64) a stator core in an mold cavity and subsequently injection molding a thermosetting resin substantially encapsulating said core (column 5, lines 1-5). Injection molding is a technique old and well established for effectively encompassing components of dynamoelectric machines in order to provide improved vibration & noise characteristics as well as heat dissipation (column 1, lines 48-52). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the stator disclosed by Huang whereby the thermosetting material is injection molded as taught by Tanaka in order to realize the advantages discussed above.

Regarding claims 19 & 20, Tanaka discloses that thermosetting materials be heated to an elevated temperature during application (column 5, line 36). Thus the specific limitation of an application temperature of 200°F ~ 700°F, or 550°F ~ 650°F is considered an obvious matter of design choice since applicant has provided no explanation of why these specific temperature ranges are beneficial or significant; and it appears as if the invention would perform equally well with the heating disclosed by Tanaka.

Regarding claims 24& 25, it is inherent that a motor assembly include a shaft, base, bearings, rotor at least one permanent magnet, and a hub and an electronic device. These components (along with a winding assembly) are the defining features of a motor assembly.

Conclusion

The prior art made of record in the previous office action, and not relied upon is considered pertinent to applicant's disclosure.

Response to Arguments

Applicant's arguments filed 3/2/01 have been fully considered but they are not persuasive. The applicant has put forth the argument that the Huang reference does not disclose encapsulating the stator arc segments in a monolithic body of phase change material. The examiner points out that the stator arc segments of Huang are formed of iron powder (as described in column 4, lines 53-65), which is then encapsulated with a thermoplastic coating (i.e. a monolithic body of phase change material) (column 4, lines 66+) which serves as a binding means to hold the iron powder particles together (column 5, line 5), while the end surfaces of the stator arc segments are held together. Figures 4a, 4c disclose the stator arc segments (20) comprised of iron powder encapsulated and bonded by a thermoplastic coating having the end surfaces of the stator arc segments fixed together (without welding, or annular member 90).

In response to applicant's argument that the examiner's conclusion of obviousness for the Huang & Tanaka references is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made, and does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971). Furthermore, the fact that Tanaka is drawn to a stator core of a complete annular ring in no way limits the teachings therein from being applied to segmented cores as disclosed by Huang. It is widely known in the art that stator cores can be manufactured either as an annular ring, or a segmented core – and it is the desired application (i.e. number of poles & density of the windings) which determines which of these configurations is most advantageous. Tanaka discloses the advantage of injection molded cores (i.e. high accuracy – column 4, line 29) thus it would not go against Tanaka to try to mold stator core segments, where accuracy is of even greater concern given the more densely positioned poles & windings.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen J Kenny whose telephone number is 703-306-0359. The examiner can normally be reached on mon - fri 9am - 5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Peter Vo can be reached on 703-308-1789. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-1148.

sk

PETER VO
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 3700

L Number	Hits	Search Text	DB	Time stamp
4	412	29/596.ccls. and stator and (segment or divid$3)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/04 11:25
5	169	29/598.ccls. and stator and (segment or divid$3)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/04 11:25
6	28	29/597.ccls. and stator and (segment or divid$3)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/04 11:25
7	68	29/605.ccls. and stator and (segment or divid$3)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/04 11:25
8	63	29/606.ccls. and stator and (segment or divid$3)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/04 11:25
9	81	310/214.ccls. and stator and (segment or divid$3)	USPAT; US-PGPUB; EPO; JPO; DERWENT	2003/11/04 11:25

AUG 1 8 2003

TRANSMITTAL LETTER			Case No. 8864/20
Serial No. 09/798,511	Filing Date March 2, 2001	Examiner Pedro J. Cuevas	Group Art Unit 2834
Inventor(s) Griffith D. Neal			
Title of Invention STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME			

TO THE COMMISSIONER FOR PATENTS

Transmitted herewith is an Amendment and Credit Card Form in the amount of $465.00.

☐ Small entity status of this application under 37 CFR § 1.27 has been established by verified statement previously submitted.

☐ Applicant claims small entity status. See 37 CFR1.27.

☒ Petition for a three (3) month extension of time.

☐ No additional fee is required.

☐ The fee has been calculated as shown below:

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	Claims Remaining After Amendment		Highest No. Previously Paid For	Present Extra	Small Entity Rate	Small Entity Add'l Fee	or	Other Than Small Entity Rate	Other Than Small Entity Add'l Fee
Total		Minus			x $9 =			x $18 =	
Indep.		Minus			x 42 =			x $84 =	
First Presentation of Multiple Dep. Claim					+ $140 =			+ $280 =	
					Total add'l fee	$		Total add'l fee	$

☐ Please charge Deposit Account No. 23-1925 (BRINKS HOFER GILSON & LIONE) in the amount of $_____. A duplicate copy of this sheet is enclosed.

☐ A check in the amount of $_____ to cover the filing fee is enclosed.

☒ The Commissioner is hereby authorized to charge payment of any additional filing fees required under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17 associated with this communication or credit any overpayment to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.

☒ I hereby petition under 37 CFR § 1.136(a) for any extension of time required to ensure that this paper is timely filed. Please charge any associated fees which have not otherwise been paid to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

Steven P. Shurtz

Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant
Customer No. 00757 - Brinks Hofer Gilson Lione

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AUG 22 2003
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BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, ILLINOIS 60610
(312) 321-4200

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on August 13, 2003.

Date: 8/13/2003 Signature: Steven P. Shurtz

AUG 1 8 2003

#10/ Ext. of Time
Hawkins
9/14/03

I hereby certify that this correspondence is being deposited with the United States Postal Service, with sufficient postage, as first class mail in an envelope addressed to:

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313
on August 13, 2003

Date of Deposit

Steven P. Shurtz, Reg. No. 31,424

Name of applicant, assignee or Registered Representative

Steven P. Shurtz

Signature

8/13/2003

Date of Signature

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Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Griffith D. Neal

Serial No: 09/798,511

Filed: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: Stephen J. Kenny

Group Art Unit: 3726

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PETITION AND FEE FOR A THREE (3) MONTH EXTENSION OF TIME (37 CFR § 1.136(a))

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This is a petition for an extension of the time to respond to Office Action dated February 13, 2003 for a period of three (3) month(s).

☒ Applicant:

08/19/2003 DTESSEM1 00000086 09798511

01 FC:2253 465.00 OP

☒ claims small entity status. See 37 C.F.R. §1.27.

☐ is other than small entity

	Extension Months	Other Than Small Entity	Small Entity
☐	One Month	$110.00	$55.00
☐	Two Months	$410.00	$205.00
☒	Three Months	$930.00	$465.00
☐	Four Months	$1,450.00	$725.00
☐	Five Months	$1,970.00	$985.00

Fee Payment

☐ Attached is a check for $_____ for the Petition fee.

☒ Attached is a credit card authorization form for $465 for the Petition fee.

☐ Charge Petition fee to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

☒ Charge any additional fee required or credit for any excess fee paid to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

Respectfully submitted,

Dated: August 13, 2003

Steven P. Shurtz lei

Steven P. Shurtz
Registration No. 31,424
Attorney for Applicants

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610
(312)321-4200

Rev. Oct.-01
Y:\sps\8864 - Encap Motors\8864-20\8864-20 Petition for 3-Month Extension of Time.doc

AUG 1 8 2003

PATENT & TRADEMARK OFFICE

CL 2834
3726 $

TRANSMITTAL LETTER			Case No. 8864/20
Serial No. 09/798,511	Filing Date March 2, 2001	Examiner Pedro J. Cuevas	Group Art Unit 2834
Inventor(s) Griffith D. Neal			
Title of Invention STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME			

TO THE COMMISSIONER FOR PATENTS

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☐ No additional fee is required.

☐ The fee has been calculated as shown below:

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First Presentation of Multiple Dep. Claim					+$140=			+ $280=	
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☒ I hereby petition under 37 CFR § 1.136(a) for any extension of time required to ensure that this paper is timely filed. Please charge any associated fees which have not otherwise been paid to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

Steven P. Shurtz

Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant
Customer No. 00757 - Brinks Hofer Gilson Lione

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BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
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(312) 321-4200

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail, with sufficient postage, in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on August 13, 2003.

Date: 8/13/2003 Signature: Steven P. Shurtz

AUG 1 8 2003

#11/B
Hawkins
9/14/03

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Commissioner for Patents
P.O. Box 1450
Alexandra, VA 22313-1450
on August 13, 2003

Date of Deposit

Steven P. Shurtz, Reg. No. 31,424

Name of applicant, assignee or Registered Representative

Steven P. Shurtz /ei

Signature

8/13/2003

Date of Signature

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TC 3700 MAIL ROOM

Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	
Griffith D. Neal	
Serial No.: 09/798,511	Examiner: Stephen J. Kenny
Filing Date: March 2, 2001	Group Art Unit No.: 3726
For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME	

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AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office Action mailed February 13, 2003, please enter the following amendment and consider the following remarks. Amendments to the claims are reflected in the listing of claims which begins on page 2 of this paper. Remarks begin on page 6 of the paper.

Amendm nts to the Claims

Please cancel claim 29. No other amendments are being made to the claims. A complete listing of the claims with proper claims identifiers follows.

Listing of Claims

B' cont.

1. (Original) A stator assembly, comprising:

a) a plurality of stator arc segments forming a toroidal core, wherein each said stator arc segment has two end surfaces that are each in contact with an end surface of another stator arc segment to form the toroidal core; and

b) a monolithic body of phase change material substantially encapsulating the stator arc segments and holding said end surfaces in contact with one another.

2. (Original) The stator assembly of claim 1 wherein each of the stator arc segments has a plurality of poles with wire wound around said poles.

3. (Original) The stator assembly of claim 2 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

4. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than $2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

5. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than $1.5x10^{-5}$ in/in/°F throughout the range of 0-250°F.

6. (Original) The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of between about $0.8x10^{-5}$ in/in/°F and about $1.2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

7. (Original) The stator assembly of claim 1 wherein the phase change material has a thermal conductivity of at least 0.7 watts/meter°K at 23°C.

B' cont.

8. (Original) The stator assembly of claim 1 wherein the phase change material comprises polyphenyl sulfide.

9. (Original) A method of making a stator assembly for a motor comprising:

a) providing at least two stator arc segments each having a first end surface and a second end surface;

b) aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment; and

c) substantially encapsulating said toroidal core with a monolithic body of phase change material to form said stator assembly.

10. (Original) The method of claim 9, wherein each of said stator arc segments have a plurality of poles extending inwardly from a base of said stator arc segment.

11. (Original) The method of claim 10 wherein prior to said step of aligning, the wire is wound around said poles of said stator arc segments.

12. (Original) The method of claim 11 wherein said stator arc segments are placed in a carrier that holds and supports said stator arc segments while the wire is wound around said poles.

13. (Original) The method of claim 12 wherein said carrier has a plurality of cavities to hold and support said stator arc segments.

14. (Original) The method of claim 13 wherein said cavities are spaced apart a distance X, wherein X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

15. (Original) The method of claim 9 wherein said toroidal core has multiple conductors that create a plurality of magnetic fields when electrical current is conducted through the conductors.

B' cont.

16. (Original) The method of claim 9 wherein said phase change material is selected from the group consisting of thermoplastics and thermosetting materials.

17. (Original) The method of claim 9 wherein prior to said substantially encapsulating, said toroidal core is clamped in an injection mold cavity to maintain the toroidal shape.

18. (Original) The method of claim 9 wherein said step of substantially encapsulating the core is performed by injection molding said phase change material around said toroidal core.

19. (Original) The method of claim 18 wherein said phase change material is injected into a mold at temperature of between about 200°F and about 700°F.

20. (Original) The method of claim 18, wherein said phase change material is injected into a mold at a temperature of between about 550°F to about 650°F.

21. (Original) A method of making a motor comprising:

a) providing four stator arc segments, wherein each stator arc segment has a first end surface and a second end surface;

b) aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment;

c) substantially encapsulating said toroidal core with a monolithic body of phase change material, wherein said substantially encapsulating is by injection molding said phase change material around said toroidal core to form a stator assembly; and

d) constructing the stator assembly into a motor.

22. (Original) The method of claim 21 wherein each of said stator arc segments comprise a plurality of steel laminations.

23. (Original) A motor made from the stator assembly of claim 1.

B' cont'd.

24. (Original) The motor of claim 21 wherein said motor comprises a stator assembly, a shaft, a base, bearings, a rotor, at least one permanent magnet and a hub.

25. (Original) An electronic device including the motor of claim 21.

26. (Original) A motor and disc assembly including the motor made by the method of claim 21.

27. (Withdrawn) A combination of stator arc segments and a carrier used to support said stator arc segments during a winding operation comprising:

a) a plurality of stator arc segments; and

b) a plurality of cavities to hold and support said stator arc segments.

28. (Withdrawn) The combination of stator arc segments and carrier of claim 27 wherein said cavities are spaced apart a distance X, wherein the distance X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

29. (Canceled)

30. (Previously presented) The method of claim 11 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

31. (Previously presented) The method of claim 9 wherein the phase change material has a coefficient of linear thermal expansion of less than $2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

32. (Previously presented) The method of claim 9 wherein the phase change material has a thermal conductivity of at least 0.7 watts/meter°K at 23°C.

REMARKS

In the outstanding Office Action, claims 1, 2, 4, 5, 9-16, 29 and 31 were rejected under 35 U.S.C. § 102(b) as anticipated by U.S. Patent No. 5,592,731 (Huang). Claim 29 has been canceled. Otherwise, this rejection is respectfully traversed.

Claim 1 is directed to a stator assembly, and requires a plurality of stator arc segments forming a toroidal core, with each arc segment having two end surfaces that contact an end surface of another stator arc segment. Claim 1 also calls for a monolithic body of phase change material substantially encapsulating the stator arc segments and holding the end surfaces in contact with one another. The specification defines substantial encapsulation as meaning that the body either entirely surrounds the toroidal core, or surrounds almost all of it except for minor areas of the core that may be exposed. Substantial encapsulation also means that the body and toroidal core are rigidly fixed together and behave as a single component with respect to harmonic oscillation vibration. (Specification, page 9, lines 3-8.) In the preferred embodiment, the monolithic body is formed by an injection molding operation, in which a plurality of stator arc segments are clamped in a mold, and thermoplastic material is injection molded around them to form the monolithic body.

Huang discloses stator arc segments, but those arc segments are not substantially encapsulated by a monolithic body of phase change material as called for by claim 1. The Office Action refers to column 5, lines 1-15 of Huang as teaching the monolithic body of phase change material substantially encapsulating the stator arc segments and holding the end surfaces together. However, lines 1-15 simply describe how individual particles of iron powder (each with an iron phosphate layer thereon) have a coating of thermoplastic material on them, and how the thermoplastic material behaves when the particles are compacted together. Thus in Huang, the iron particles are encapsulated in a thermoplastic, rather than the stator arc segments as called for by claim 1. These particles are then compacted in a die to form a stator arc segment, but these stator arc segments are not thereafter encapsulated. Rather, a metallic ring 62 is used to hold the arc segments together. See column 8, line 61 to column 9, line 10.

but the iron particles make up the stator the segments are

Since there is no monolithic body of phase change material in Huang substantially encapsulating the stator arc segments and holding their end surfaces together as required by claim 1, claim 1 is not anticipated by Huang. Claims 2, 4 and 5 dependent on claim 1 are therefore likewise also not anticipated by Huang.

Claim 9 requires substantially encapsulating the toroidal core formed of aligned stator arc segments with a monolithic body of phase change material. As noted above, this feature is not found in Huang. Claim 9, and claims 10-16 and 31 dependent thereon are not anticipated by Huang.

Claims 3 and 30 were rejected in the outstanding Office Action under 35 U.S.C. § 103(a) as being unpatentable over Huang in view of U.S. Patent No. 5,729,072 (Hirano). This rejection is respectfully traversed. Claim 3 is ultimately dependent on claim 1, and claim 30 is ultimately dependent on claim 9. As discussed above, Huang does not disclose a monolithic body substantially encapsulating stator arc segments. Hirano discloses a stator made of arc segments, but again there is no suggestion of substantially encapsulating the arc segments in the stator of Hirano with a monolithic body of phase change material. Rather, the segments are held together by "welding, bonding or applying an annular member." (Column 2, lines 47-48.) Thus even if Huang and Hirano were somehow combined the resulting device would not have all of the elements called for by claims 1 and 9. Hence claims 3 and 30 are patentable over Huang and Hirano.

In the outstanding Office Action claims 6-8 and 32 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Huang. This rejection is also respectfully traversed. Claims 6-8 are ultimately dependent on claim 1, and claim 32 is ultimately dependent on claim 9. Since Huange does not disclose the monolithic body substantially encapsulating the stator arc segments, nor would it have been obvious to modify Huang to include this element, claims 6-8 and 32 are patentable over Huange.

Claims 17-26 were rejected in the outstanding Office Action under 35 U.S.C. § 103(a) as being unpatentable over Huang in view of U.S. Patent No. 4,015,154 (Tanaka). This rejection is respectfully traversed. Claims 17-20 are ultimately dependent on claim 9. Claim 21, like claim 9, requires substantially encapsulating a toroidal core made of stator arc segments with a monolithic body of phase change material. Claim 21 goes on to require that the phase change material is injection molded around the toroidal core. Claims 22 and 24-26 are dependent on claim 21. Claim 23 is dependent on claim 1. Thus all of the rejected claims are patentable over Huange for the reasons discussed above.

Tanaka discloses a motor made with a conventional laminated toroidal core, rather than a core made of stator arc segments. Such a laminated toroidal core is then placed in an injection molding machine and a specific combination of thermosetting and thermoplastic materials is used to form a casing around the core. Tanaka goes to great lengths in choosing the right combination of thermosetting and thermoplastic materials, and notes that significant problems surround molding cores for electric motors using these materials. Column 4, lines 29-51 describe these problems, which include contraction and shrinkage, cracks, cave-ins, lack of high fidelity reproduction, etc.

The rejection is based on an impermissible hindsight combination of the references, and should be withdrawn. First, there is nothing in either Tanaka or Huang that would suggest that stator arc segments such as those in Huang could or should be overmolded with the specific composition of Tanaka. The Tanaka injection molding is for laminated cores that form a complete annular ring, not core segments. Second, from the problems addressed in Tanaka with injection molding cores in general, it would go against Tanaka to try to mold stator core segments, especially where the ends of the segments are then held together by the injection molded material.

The Office Action states, "it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the stator disclosed by Huang whereby the thermosetting material is injection molded as taught by Tanaka in order to realize the advantages discussed above." This statement suggests that Huang teaches to use a thermosetting material to encapsulate the stator arc segments. This is simply not the case. Huang does not suggest encapsulating stator arc segments. Hence it would not have been obvious to modify Huang and somehow come up with a process of injection molding stator arc segments to hold their ends together and form an encapsulated toroidal core. Hence claims 17-26 are patentable over Huang and Tanaka.

Since each of the rejections has been overcome, an early notice of allowance is respectfully requested.

Respectfully submitted,

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

7590 02/13/2003

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EXAMINER	
KENNY, STEPHEN	
ART UNIT	PAPER NUMBER
3726	

DATE MAILED: 02/13/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

Office Action Summary	Application No.	Applicant(s)	
	09/798,511	NEAL, GRIFFITH D.	
	Examiner	Art Unit	
	Stephen J Kenny	3726	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *11/25/02* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-32* is/are pending in the application.

4a) Of the above claim(s) *27 and 28* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-26 and 29-32* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *4, 8* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Election/Restrictions

The applicant has elected with traverse the invention of Group II (claims 9-20, 30-32) and put forth the argument that the restriction was improper, the examiner agrees with the applicant and hereby declares claims 1-26, & 29-32 as Group I; however claims 27 & 28 stand restricted as Group II. The claims of Group II (27 & 28) are distinct from Group since Group II requires a plurality of cavities to support stator arc segments.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 2, 4, 5, 9-16, 29, 31 are rejected under 35 U.S.C. 102(b) as being anticipated by Huang (US Patent No 5592731).

Regarding claims 1, 2, 9, 10, & 29 Huang discloses a stator assembly comprising a plurality of stator arc segments (22) forming a toroidal core, having two ends in contact with each other (Figure 4a), and a monolithic body of phase change material substantially encapsulating the stator arc segments and holding said end surfaces with one another (column 5, lines 1-15).

Regarding claims 4, 5, & 31, Huang discloses the phase change material having a coefficient of linear thermal expansion of less than $2*10^{-5}$in/in/°F & $1.5*10^{-5}$in/in/°F (column 9, lines 10-14).

Regarding claim 11, Huang discloses prior to the aligning step, the wire is wound around said poles of said stator arc segments (column 8, lines 34-35).

Regarding claims 12 & 13, Huang discloses stator segments placed in a carrier that holds said stator segments while wire is wound around said poles (column 8, lines 36-37) wherein said carrier has a plurality of cavities to hold and support said segments (Figure 5).

Regarding claim 14, Huang discloses spacing apart segments by a distance X, where X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core (Figure 6).

Regarding claim 15, Huang discloses multiple conductors (37) that create a plurality of magnetic fields when electrical current is conducted through said conductors (Figure 6).

Regarding claim 16, Huang discloses said phase change material selected from the group of thermoplastics & thermosetting materials (column 5, lines 13-15).

Regarding claim 29, Huang discloses a stator arc segment comprising a plurality of steel laminations and at least one pole (column 1, lines 20-35).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 3 & 30, are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang in view of Hirano et al (US Patent No 5729072).

Huang discloses the instant invention except for a packing density of the wire around the stator poles is between 60% ~ 80%.

Hirano discloses a packing density of 70% (abstract line 11). A high packing density is advantageous in that it allows for an increase in magnetic flux while saving space as well. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify a stator core as disclosed by Huang with the packing density taught by Hirano in order to achieve a more efficient stator core.

Claims 6-8, & 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang.

Huang discloses the claimed invention except for the specific values of Coefficient of Linear Thermal Expansion; thermal conductivity; and material composition. It would have been an obvious matter of design choice to use the specific values claimed, since applicant has not disclosed that such values solves any stated problem or is for any particular purpose, and it appears that the invention would perform equally well with alternative values as disclosed by Huang. Therefore, these specific values do not carry any patentable weight.

Claims 17-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Huang in view of Tanaka et al (US Patent No 4015154).

Regarding claims 17, 18, 21-23, & 26 Huang discloses the instant invention except for injection molding the substantially encapsulating material.

Tanaka discloses clamping (column 3, line 64) a stator core in an mold cavity and subsequently injection molding a thermosetting resin substantially encapsulating said core (column 5, lines 1-5). Injection molding is a technique old and well established for effectively encompassing components of dynamoelectric machines in order to provide improved vibration & noise characteristics as well as heat dissipation. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the stator disclosed by Huang whereby the thermosetting material is injection molded as taught by Tanaka in order to realize the advantages discussed above.

Regarding claims 19 & 20, it is inherent that thermosetting materials be heated to an elevated temperature during application. Thus the specific limitation of an application temperature of 200°F ~ 700°F, or 550°F ~ 650°F does not carry any patentable weight. Further, the applicant has provided no explanation of why these specific temperature ranges are beneficial or significant.

Regarding claims 24& 25, it is inherent that a motor assembly include a shaft, base, bearings, rotor at least one permanent magnet, and a hub and an electronic device.

Conclusion

The prior art made of record on the attached PTO-892, and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephen J Kenny whose telephone number is 703-306-0359. The examiner can normally be reached on mon - fri 9am - 5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Greg Vidovich can be reached on 703-308-1513. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9302 for regular communications and 703-872-9303 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-1148.

sk SK
February 10, 2003

GREGORY VIDOVICH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 3700

Notice of References Cited	Application/Control No. 09/798,511	Applicant(s)/Patent Under Reexamination NEAL, GRIFFITH D.	
	Examiner Stephen J Kenny	Art Unit 3726	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-4,015,154	03-1977	Tanaka et al.	310/42
	B	US-5,592,731	01-1997	Huang et al.	29/596
	C	US-5,729,072	03-1998	Hirano et al.	310/258
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

OIPE JC17 JUL 1 1 2001 PATENT & TRADEMARK OFFICE

FORM PTO-1449	SERIAL NO. 09/798,511	CASE NO. 8864/20
LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	FILING DATE March 2, 2001	GROUP ART UNIT 2834
(use several sheets if necessary)	APPLICANT: Griffith D. Neal	

REFERENCE DESIGNATION U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS/ SUBCLASS	FILING DATE
SK	A1	3,590,328	06/29/1971	Bert L. Frescura		
SK	A2	3,638,055	01/25/1972	Zimmermann		
SK	A3	3,874,073	04/01/1975	Dochterman et al.		
SK	A4	3,942,054	03/02/1976	Kristen et al.		
SK	A5	3,979,530	09/07/1976	Schwider et al.		
SK	A6	4,128,527	12/05/1978	Kinjo et al.		
SK	A7	4,352,897	10/05/1982	Ogata et al.		
SK	A8	4,387,311	06/07/1983	Kobayashi et al.		
SK	A9	4,492,889	01/08/1985	Fukushi et al.		
SK	A10	4,572,979	02/25/1986	Haar et al.		
SK	A11	4,679,313	07/14/1987	Schultz et al.		
SK	A12	4,760,299	07/26/1988	Dickie et al.		
SK	A13	4,801,833	01/31/1989	Dye		
SK	A14	4,853,576	08/01/1989	Mayumi et al.		
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SK	A23	5,134,327	07/28/1992	Sumi et al.		
SK	A24	5,142,103	08/25/1992	Stine		
SK	A25	5,147,982	09/15/1992	Steffen		
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SK	A27	5,268,607	12/07/1993	McManus		
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SK	A31	5,396,210	03/07/1995	Purohit et al.		
SK	A32	5,400,218	03/21/1995	Val		
SK	A33	5,414,317	05/09/1995	Reid et al.		
SK	A34	5,461,772	10/31/1995	Puri		
SK	A35	5,500,780	03/19/1996	Boutaghou et al.		
SK	A36	5,506,458	04/09/1996	Pace et al.		
SK	A37	5,541,787	07/30/1996	Jabbari et al.		

EXAMINER Stephen Kenny	DATE CONSIDERED 2/4/03

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Rev. Dec.-99
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FORM PTO-1449

OIPE JUL 1 1 2001

LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	SERIAL NO. 09/798,511	CASE NO. 8864/20
	FILING DATE March 2, 2001	GROUP ART UNIT
(use several sheets if necessary)	APPLICANT(S): Griffith D. Neal	

REFERENCE DESIGNATION U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS/ SUBCLASS	FILING DATE
SK	A38	5,548,458	08/20/1996	Pelstring et al.		
SK	A39	5,558,445	09/24/1996	Chen et al.		
SK	A40	5,579,188	11/26/1996	Dunfield et al.		
SK	A41	5,587,617	12/24/1996	Dunfield et al.		
SK	A42	5,598,048	01/28/1997	Dunfield et al.		
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SK	A49	5,668,427	09/16/1997	Morita		
SK	A50	5,672,927	09/30/1997	Viskochil		
SK	A51	5,675,196	10/07/1997	Huang et al.		
SK	A52	5,694,268	12/02/1997	Dunfield et al.		
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SK	A54	5,728,600	03/17/1998	Saxelby, Jr. et al.		
SK	A55	5,729,404	03/17/1998	Dunfield et al.		
SK	A56	5,742,450	04/21/1998	Moser		
SK	A57	5,751,085	05/12/1998	Hayashi		
SK	A58	5,751,514	05/12/1998	Hyde et al.		
SK	A59	5,766,535	06/16/1998	Ong		
SK	A60	5,783,888	07/21/1998	Yamano		
SK	A61	5,806,169	09/15/1998	Trago et al.		
SK	A62	5,814,412	09/29/1998	Terada et al.		
SK	A63	5,850,318	12/15/1998	Dunfield		
SK	A64	5,880,179	03/09/1999	Ito et al.		
SK	A65	5,881,447	03/16/1999	Molnar		
SK	A66	5,942,824	08/24/1999	Shioya et al.		
SK	A67	5,958,466	09/28/1999	Ong		
SK	A68	5,973,424	10/26/1999	Engelberger et al.		
SK	A69	5,982,057	11/09/1999	Imada et al.		
SK	A70	5,986,365	11/16/1999	Kuwert et al.		
SK	A71	5,990,247	11/23/1999	Terada et al.		
SK	A72	6,002,185	12/14/1999	Nakao et al.		
SK	A73	6,019,516	02/01/2000	Leuthold et al.		
SK	A74	6,020,661	02/01/2000	Trago et al.		
SK	A75	6,034,841	03/07/2000	Albrecht et al.		
SK	A76	6,043,583	03/28/2000	Kurosawa et al.		

EXAMINER Stephen Kenny	DATE CONSIDERED 2/4/03

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Rev. Feb.-97
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JUL 1 1 2001

FORM PTO-1449	SERIAL NO. 09/798,511	CASE NO. 8864/20
LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	FILING DATE March 2, 2001	GROUP ART UNIT
(use several sheets if necessary)	APPLICANT(S): Griffith D. Neal	

REFERENCE DESIGNATION **U.S. PATENT DOCUMENTS**

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS/ SUBCLASS	FILING DATE
SK	A77	6,071,014	06/06/2000	Lee et al.		
SK	A78	6,075,304	06/13/2000	Nakatsuka		

FOREIGN PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER	DATE	COUNTRY	CLASS/ SUBCLASS	TRANSLATION YES	NO
SK	A79	DT 25 39 492 A1	03/10/77	Germany		Abstract	
SK	A80	870.878	01/15/79	Belgium		Abstract	
SK	A81	891.258	03/16/82	Belgium		Abstract	
SK	A82	SU 1334297	08/30/87	Soviet Union		Abstract	
SK	A83	SU 1494148	07/15/89	Soviet Union		Abstract	
SK	A84	2 647 958	12/07/90	France		Abstract	
SK	A85	WO 92/06532	04/16/92	PCT			
SK	A86	05336722	12/17/93	Japan		Abstract	
SK	A87	WO 96/20501	07/04/96	PCT			
SK	A88	WO 96/33533	10/24/96	PCT			
SK	A89	WO 97/39870	10/30/97	PCT			
SK	A90	EP 0 747 943 A2	12/11/96	EPO			
SK	A91	10070870	03/10/98	Japan		Abstract	
SK	A92	410271719	10/09/1998	Japan		Abstract	
SK	A93	EP 0 883 171 A1	12/09/98	EPO		Abstract	
SK	A94	11082508	03/26/99	Japan		Abstract	

EXAMINER INITIAL		OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)
SK	A95	LNP Engineering Plastics, Advertisement entitled "Konduit™ Thermally Conductive Composites," undated (2 pages)
	A96	~~Product Information from Dupont Engineering Polymers entitled "Electrical/Electronic~~ Thermoplastic Encapsulation," undated, Publ. Reorder No.: H-58633 (R, 96.7), 20 pages.
SK	A97	LNP Engineering Plastics, Press Release entitled "LNP Introduces First-Ever Line of Thermally Conductive Compounds," January 28, 1999 (2 pages)
	A98	~~Buchanan Motor Works, Inc., article from the Internet entitled~~ "Epoxy Seal - Prevents Down Time and Keeps Equipment Running Longer," 07/14/99, <http://www.bmwworks.com/VIP.htm>,1 page.
	A99	The Epoxylite Corporation, article from the Internet entitled "Vacuum Pressure Impregnation (VPI) Systems", 11/19/99, <http://www.epoxylite.com/EpoxyliteEquipment.htm>, 3 pages.
	A100	~~Neeltran Inc., article from the Internet entitled "Vacuum Pressure Impregnation (VPI)",~~ 11/19/99, <http://www.neeltran.thomasregister.com/olc/neeltran/neel9.htm> ~~2 pages.~~

EXAMINER Stephen Kenny	DATE CONSIDERED 2/4/03

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FORM PTO-1449 LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT (use several sheets if necessary)	SERIAL NO. 09/798,511	CASE NO. 8864/20
	FILING DATE March 2, 2001	GROUP ART UNIT
	APPLICANT(S): Griffith D. Neal	

EXAMINER INITIAL		OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)
	A101	Copy of Search Report for PCT Application No. US00/19870 filed on July 19, 2000 (19.07.00) which is for a corresponding PCT case filed by the assignee Encap Motors Corporation who is also the assignee of this US application

EXAMINER INITIAL		Filing Date	U.S. Patent Applications Serial No.	
	A102	Dec. 22, 1999	09/470,424	copy of claims as filed enclosed
	A103	Dec. 22, 1999	09/470,425	copy of claims as filed enclosed
	A104	Dec. 22, 1999	09/470,426	copy of claims as filed enclosed
	A105	Dec. 22, 1999	09/470,427	copy of claims as filed enclosed
	A106	Dec. 22, 1999	09/470,428	copy of claims as filed enclosed
	A107	Dec. 22, 1999	09/470,429	copy of claims as filed enclosed
	A108	Dec. 22, 1999	09/470,430	copy of claims as filed enclosed
	A109	Dec. 22, 1999	09/470,431	copy of claims as filed enclosed
	A110	Dec. 22, 1999	09/470,432	copy of claims as filed enclosed
	A111	Dec. 22, 1999	09/470,433	copy of claims as filed enclosed
	A112	Dec. 22, 1999	09/470,434	copy of claims as filed enclosed
	A113	Dec. 15, 2000	09/738,268	copy of claims as filed enclosed
	A114	Feb. 1, 2001	09/775,242	copy of claims as filed enclosed

EXAMINER Stephen Kenny	DATE CONSIDERED 2/4/03

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PTO-1449	SERIAL NO. 09/798,511	CASE NO. 8864/20
LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	FILING DATE March 2, 2001	GROUP ART UNIT 2834
(use several sheets if necessary)	APPLICANT(S): Griffith D. Neal	

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REFERENCE DESIGNATION

U.S. PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER Number-Kind Code (if known)	DATE	NAME	CLASS/ SUBCLASS	FILING DATE
SK	B1	3,802,066	4/09/1974	Barrett		
SK	B2	4,173,822	11/13/1979	Futterer et al.		
SK	B3	4,372,035	2/08/1983	McMillen		
SK	B4	4,643,346	2/17/1987	Gotoh		
SK	B5	4,712,035	12/08/1987	Forbes et al.		
SK	B6	4,990,809	2/05/1991	Artus et al.		
SK	B7	5,459,190	10/17/1995	Nakamura et al.		
SK	B8	5,592,731	1/14/1997	Huang et al.		
SK	B9	5,729,072	3/17/1998	Hirano et al.		
SK	B10	5,859,486	1/12/1999	Nakahara et al.		
SK	B11	5,875,540	3/02/1999	Sargent et al.		
SK	B12	5,898,252	3/27/1999	Tanaka et al.		
SK	B13	5,918,360	7/06/1999	Fornes et al.		
SK	B14	5,949,172	9/07/1999	Katagiri		
SK	B15	5,986,377	11/16/1999	Yamada et al.		
SK	B16	6,049,153	4/11/2000	Nishiyama et al.		
SK	B17	6,153,959	11/28/2000	Lorenzo		
SK	B18	6,163,952	12/26/2000	Takehara		
SK	B19	US 6,167,610 B1	1/02/2001	Nakahara et al.		
SK	B20	US 6,201,334 B1	3/13/2001	Sargeant et al.		
SK	B21	US 6,265,800 B1	7/24/2001	Kimura et al.		
SK	B22	US 6.265,804 B1	7/24/2001	Nitta et al.		

FOREIGN PATENT DOCUMENTS

EXAMINER INITIAL		DOCUMENT NUMBER Number-Kind Code (if known)	DATE	COUNTRY	CLASS/ SUBCLASS	TRANSLATION YES OR NO
	B					
	B					

EXAMINER INITIAL		OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)
SK	B23	Search Report for Patent Cooperation Treaty application No. PCT/US02/06508, Date of Mailing 07/12/2002, 3 pages.
	B	
	B	

EXAMINER Stephen Kenny	DATE CONSIDERED 2/4/03

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#6/Ext. (5)
Hawkins
11/14/02

I hereby certify that this correspondence is being deposited with the United States Postal Service, with sufficient postage, as first class mail in an envelope addressed to:

Commissioner for Patents
Washington, D.C. 20231
on November 7, 2002

Date of Deposit

Steven P. Shurtz, Reg. No. 31,424

Name of applicant, assignee or Registered Representative

Steven P. Shurtz

Signature

November 7, 2002

Date of Signature

Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Griffith D. Neal

Serial No: 09/798,511

Filed: March 2, 2001

For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: Pedro J. Cuevas

Group Art Unit: 2834

PETITION AND FEE FOR FIVE (5) MONTHS EXTENSION OF TIME
(37 CFR § 1.136(a))

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

This is a petition for an extension of the time to respond to Office Action dated May 7, 2002 for a period of five (5) month(s).

☒ Applicant is:
- ☒ a small entity:
  - ☐ verified statement is attached
  - ☒ already established

1/13/2002 NMOHAMM1 00000164 09798511
FC:2255 980.00 OP

☐ other than small entity

	Ext nsion Months	Other Than Small Entity	Small Entity
☐	One Month	$110.00	$55.00
☐	Two Months	$400.00	$200.00
☐	Three Months	$920.00	$460.00
☐	Four Months	$1,440.00	$720.00
☒	Five Months	$1,960.00	$980.00

Fee Payment

☒ Attached is a USPTO Credit Card Payment Form for $980.00 for the Petition fee.

☐ Charge Petition fee to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

☒ Charge any additional fee required or credit for any excess fee paid to Deposit Account No. 23-1925. A duplicate copy of this Petition is attached.

Respectfully submitted,

Dated: November 7, 2002

Steven P. Shurtz

Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, IL 60610
(312)321-4200

Rev. Oct.-01

#7/Election/a Hawkins 11/14/02

OIPE NOV 12 2002 PATENT & TRADEMARK OFFICE

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Washington, D.C. 20231
on November 7, 2002

Date of Deposit

Steven P. Shurtz, Reg. No. 31,424

Name of applicant, assignee or Registered Representative

Steven P. Shurtz

Signature

November 7, 2002

Date of Signature

Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	
Griffith D. Neal	
Serial No.: 09/798,511	
Filing Date: March 2, 2001	Examiner: Pedro J. Cuevas
For: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME	Group Art Unit No.: 2834

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AMENDMENT AND RESPONSE TO RESTRICTION REQUIREMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

In response to the Office Action mailed May 7, 2002, please enter the following amendment and consider the following remarks.

11/13/2002 NMOHAMM1 00000164 09798511

01 FC:2202 27.00 OP

In The Claims

Please add new claims 30-32 as follows:

a'
sub
B1
cncl'd

30. (New) The method of claim 11 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

31. (New) The method of claim 9 wherein the phase change material has a coefficient of linear thermal expansion of less than $2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

32. (New) The method of claim 9 wherein the phase change material has a thermal conductivity of at least 0.7 watts/meter°K at 23°C.

REMARKS

The amendment does not involve new matter. New claims 30-32 are patterned after original claims 3, 4 and 7.

Applicant hereby elects to prosecute the claims of Group II, claims 9-20. Claims 30-32 are dependent on method claims in Group II. It is believed that these claims should thus be examined and acted upon in the present application.

The election is made with traverse. First with respect to the Group I and Group II claims, the Office Action takes the position that the claimed process can be used to make other and material different products, namely, a stator assembly having a wide range of stator arc segments. This argument is flawed. The product claims, 1-8, are not limited to any particular stator arc segments or number of stator arc segments. The given "example" of a material different product is, in fact, covered by the product claims. That is, the claimed method can also be used to make a stator assembly having a wide range of stator arc segments. Since the rational for making the restriction is flawed, the claims of Group I should be examined with the claims of Group II.

As to the restriction between the Group II claims and each of the Group III, Group IV and Group V claims, the Office Action is silent. No rational is even given for why restriction between these groups of claims is proper, other than to say that the claims would be classified in separate classes. This is not a sufficient basis for making a restriction. It must also be shown that the inventions are distinct. MPEP §806.05. No such showing has been made in the Office Action. For example, it has not been shown how the method of claim 9 is distinct from the method of claim 21. Until such a showing is made, Applicant traverses these various restriction requirements.

Respectfully submitted,

Steven P. Shurtz

Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant

November 7, 2002
BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, ILLINOIS 60610
(312) 321-4200

TRANSMITTAL LETTER			Case No. 8864/20
Serial No. 09/798,511	Filing Date March 2, 2001	Examiner Pedro J. Cuevas	Group Art Unit 2834
Inventor(s) Griffith D. Neal			
Title of Invention STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME			

2834

OIPE JC102 NOV 12 2002 PATENT & TRADEMARK OFFICE

TO THE COMMISSIONER FOR PATENTS

Transmitted herewith is USPTO Credit Card Payment Forms for Added Claims (3) ($27) and Extension Fee ($980); Transmittal Letter (in Duplicate); Amendment and Response to Restriction Requirement (OA 5/7/02); Petition for Extension (5 Months) (in Duplicate); Return Postcard Evidencing Receipt.

☒ Small entity status of this application under 37 CFR § 1.27 has been established by verified statement previously submitted.

☐ A verified statement to establish small entity status under 37 CFR §§ 1.9 and 1.27 is enclosed.

☒ Petition for a five (5) month extension of time.

☐ No additional fee is required.

☐ The fee has been calculated as shown below:

OIPE JC102 NOV 12 2002 PATENT & TRADEMARK OFFICE

	Claims Remaining After Amendment		Highest No. Previously Paid For	Present Extra	Small Entity Rate	Small Entity Add'l Fee	or	Other Than Small Entity Rate	Other Than Small Entity Add'l Fee
Total	32	Minus	29	3	x $9 =	27		x $18 =	
Indep.	5	Minus	5	0	x 42 =			x $84 =	
First Presentation of Multiple Dep. Claim					+ $140 =			+ $280 =	
					Total add'l fee	$27		Total add'l fee	$

☐ Please charge Deposit Account No. 23-1925 (BRINKS HOFER GILSON & LIONE) in the amount of $______. A duplicate copy of this sheet is enclosed.

☒ Attached are USPTO Credit Card Payment Forms in the total amount of $1,007 to cover the filing fees (Added Claims and Petition for Five Months Extension of Time).

☒ The Commissioner is hereby authorized to charge payment of any additional filing fees required under 37 CFR § 1.16 and any patent application processing fees under 37 CFR § 1.17 associated with this communication or credit any overpayment to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.

☒ I hereby petition under 37 CFR § 1.136(a) for any extension of time required to ensure that this paper is timely filed. Please charge any associated fees which have not otherwise been paid to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.

RECEIVED NOV 14 2002 TECHNOLOGY CENTER 2800

Respectfully submitted,

Steven P. Shurtz

Steven P. Shurtz
Registration No. 31,424
Attorney for Applicant

BRINKS HOFER GILSON & LIONE
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CHICAGO, ILLINOIS 60610
(312) 321-4200

00757 PATENT TRADEMARK OFFICE

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Date: Nov. 7, 2002 Signature: Steven P. Shurtz

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Document3

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11

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/798,511	03/02/2001	Griffith D. Neal	8864/20	9388

7590 05/07/2002

Sailesh K. Patel
Brinks Hofer Gilson & Lione
P.O. Box 10395
Chicago, IL 60610

EXAMINER	
CUEVAS, PEDRO J	
ART UNIT	**PAPER NUMBER**
2834	

DATE MAILED: 05/07/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 07-01)

Office Action Summary	**Application N .** 09/798,511	**Applicant(s)** NEAL, GRIFFITH D.	
	Examiner Pedro J. Cuevas	**Art Unit** 2834	

-- The MAILING DATE of this communication appears on the cover sheet with the c rrespondence address --

P riod for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _1_ MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _1-29_ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☒ Claim(s) _1-29_ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .

4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: .

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

   I. Claims 1-8 and 23, drawn to a stator assembly, classified in class 310, subclass 164.

   II. Claims 9-20, drawn to a method of making a stator assembly for a motor, classified in class 29, subclass 596.

   III. Claims 21-26, drawn to a method of making a motor, classified in class 29, subclass 592.1.

   IV. Claims 27 and 28, drawn to a combination of stator arc segments and a carrier, classified in class 310, subclass 259.

   V. Claim 29, drawn to a stator arc segment, classified in class 310, subclass 254.

The inventions are distinct, each from the other because of the following reasons:

2. Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case invention II can be used to make a stator assembly having a wide range of stator arc segments.

3. Inventions I and III are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be

made by another and materially different process (MPEP § 806.05(f)). In the instant case invention III has to be used to construct a four stator arc segment motor.

4. Inventions I and IV are related as combination and subcombination. Inventions in this relationship are distinct if it can be shown that (1) the combination as claimed does not require the particulars of the subcombination as claimed for patentability, and (2) that the subcombination has utility by itself or in other combinations (MPEP § 806.05(c)). In the instant case, the combination as claimed does not require the particulars of the subcombination as claimed because invention I can be constructed with a plurality of similar and patentably distinct stator arc segments. The subcombination has separate utility such as forming a toroidal core.

5. Inventions V and IV are related as combination and subcombination. Inventions in this relationship are distinct if it can be shown that (1) the combination as claimed does not require the particulars of the subcombination as claimed for patentability, and (2) that the subcombination has utility by itself or in other combinations (MPEP § 806.05(c)). In the instant case, the combination as claimed does not require the particulars of the subcombination as claimed because invention V is a patentable element used in the construction of invention IV. The subcombination has separate utility such as forming a toroidal core.

6. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

7. Because these inventions are distinct for the reasons given above and the search required for Groups I or IV or V is not required for Groups II or III, restriction for examination purposes as indicated is proper.

8. Because these inventions are distinct for the reasons given above and the search required for Group I is not required for Group IV, restriction for examination purposes as indicated is proper.

9. Because these inventions are distinct for the reasons given above and the search required for Group I is not required for Group V, restriction for examination purposes as indicated is proper.

10. Because these inventions are distinct for the reasons given above and the search required for Group II is not required for Group III, restriction for examination purposes as indicated is proper.

11. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art because of their recognized divergent subject matter, restriction for examination purposes as indicated is proper.

12. Applicant is advised that the reply to this requirement to be complete must include an election of the invention to be examined even though the requirement be traversed (37 CFR 1.143).

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Pedro J. Cuevas whose telephone number is (703) 308-4904. The examiner can normally be reached on M-F from 8:30 - 6:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nestor R. Ramírez can be reached on (703) 308-1371. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 305-1341 for regular communications and (703) 305-3432 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Pedro J. Cuevas
May 4, 2002

NESTOR RAMIREZ
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

0300

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OIPE JC174
JUL 19 2001
PATENT & TRADEMARK OFFICE

July 16, 2001
Date of Deposit

Sailesh K. Patel, Reg. No. 46,982
Name of Applicant, assignee or Registered Representative

Signature

Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

GRIFFITH D. NEAL

Serial No. 09/798,511

Filing Date: March 2, 2001

For STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: To Be Assigned

Group Art Unit No. 2834

10591856 .071501

SUBMISSION OF FORMAL DRAWINGS

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

In response to the Notice to File Corrected Application Papers mailed May 16, 2001, Applicant submits herewith six (6) sheets of corrected formal drawings (Figures 1-9) for the above-referenced application.

Respectfully submitted,

Sailesh K. Patel
Registration No. 46,982
Attorney for Applicant

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, ILLINOIS 60610
(312) 321-4200

UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
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WASHINGTON, D.C. 20231
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APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/798,511	03/02/2001	Griffith D. Neal	8864/20

CONFIRMATION NO. 9388

FORMALITIES LETTER

OC000000006080658

Sailesh K. Patel
Brinks Hofer Gilson & Lione
P.O. Box 10395
Chicago, IL 60610

Date Mailed: 05/16/2001

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

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Patent Application for: Stator Assembly Made From A Plurality Of Toroidal Core Arc Segments And Motor Using Same
Inventor(s): Griffith D. Neal
Attorney Docket No. and Serial No. 8864/20 - 09/798,511 (Page 1 of 6)

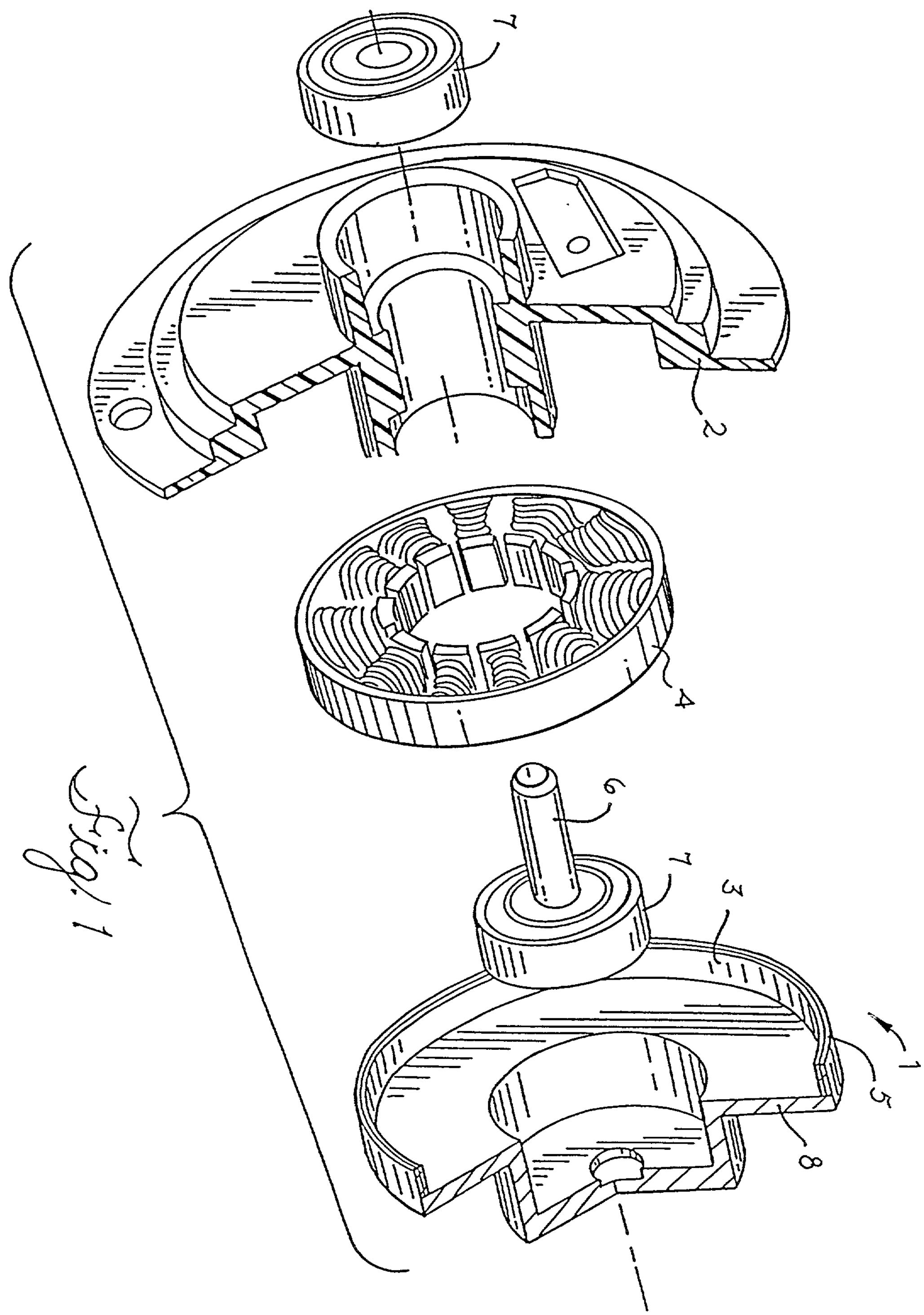

Fig. 1

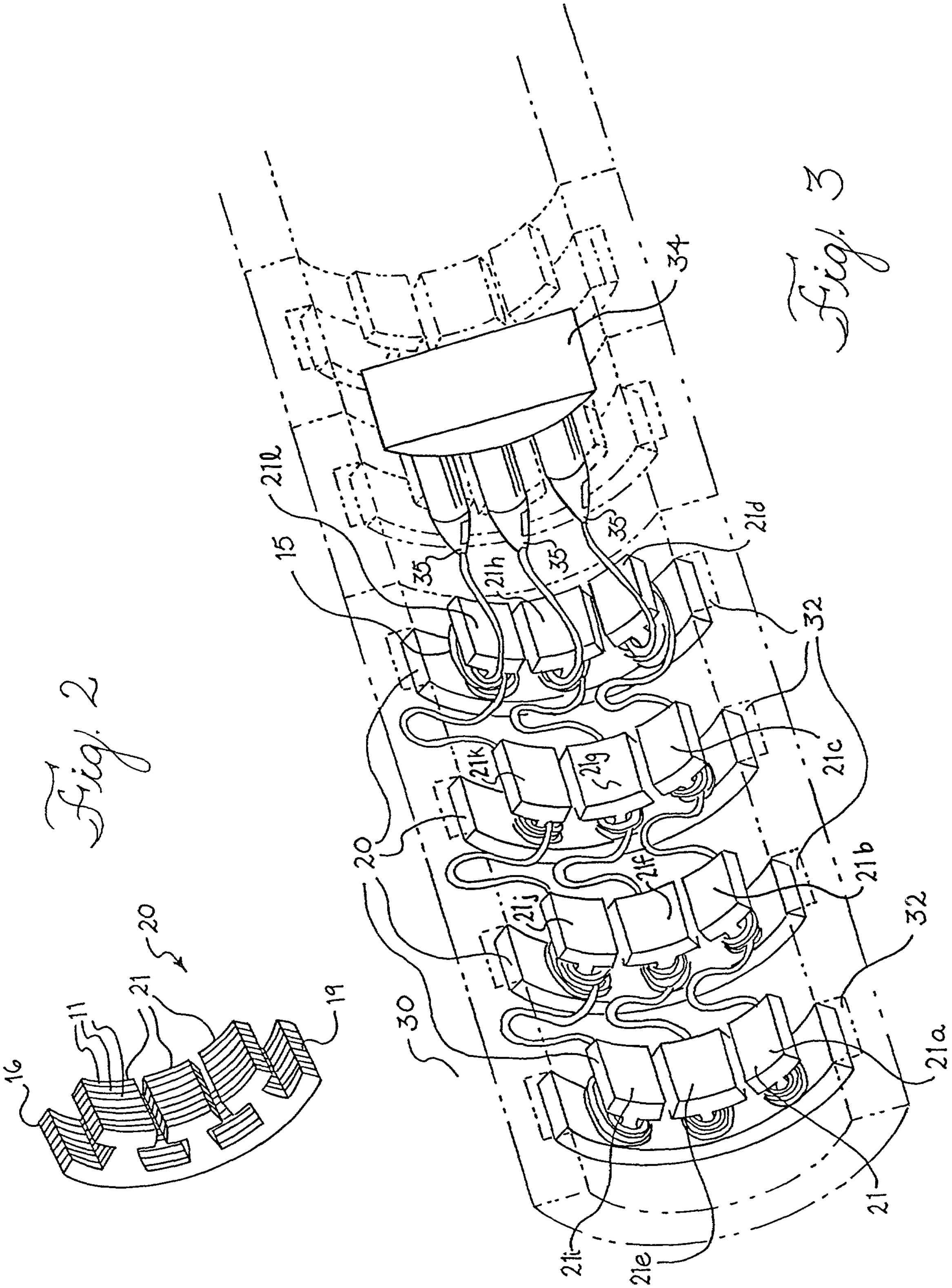
Fig. 2
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Fig. 3
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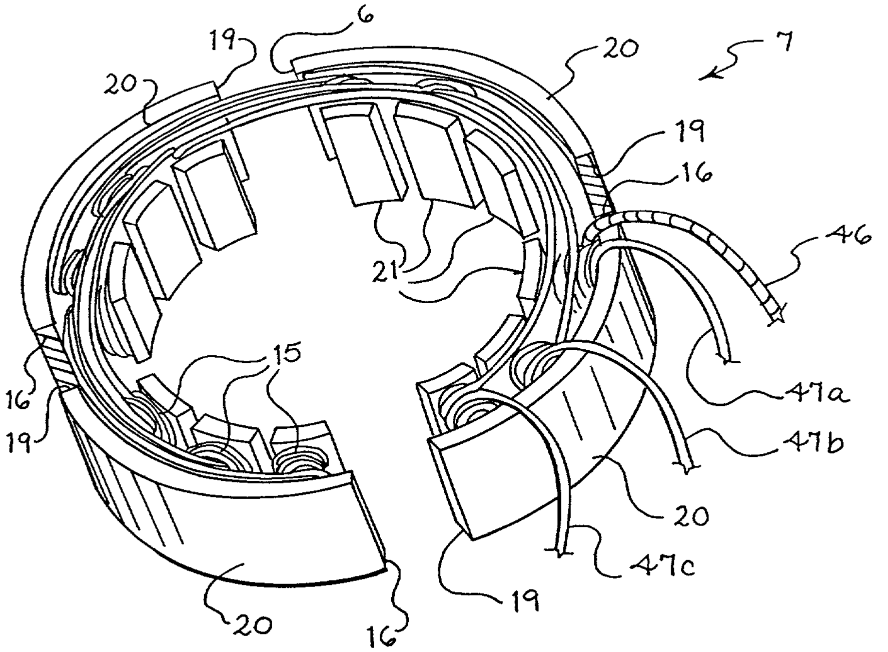
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Fig. 4

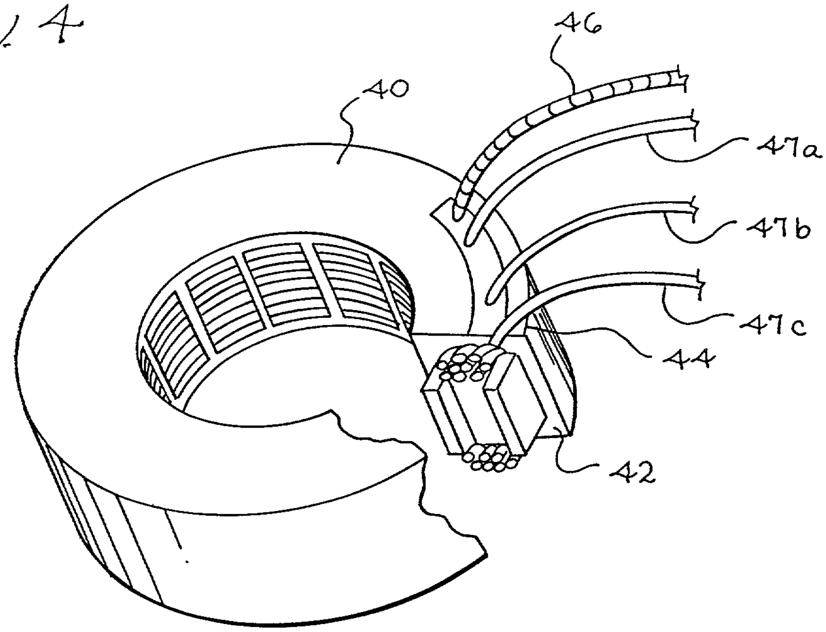
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Fig. 5

Fig. 6a

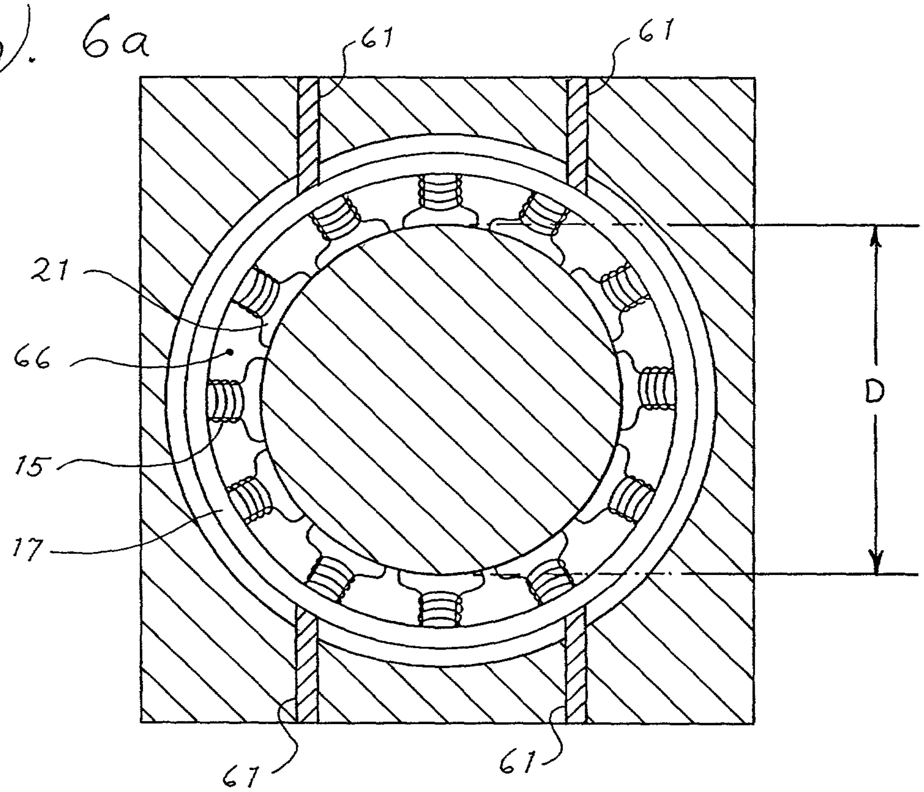
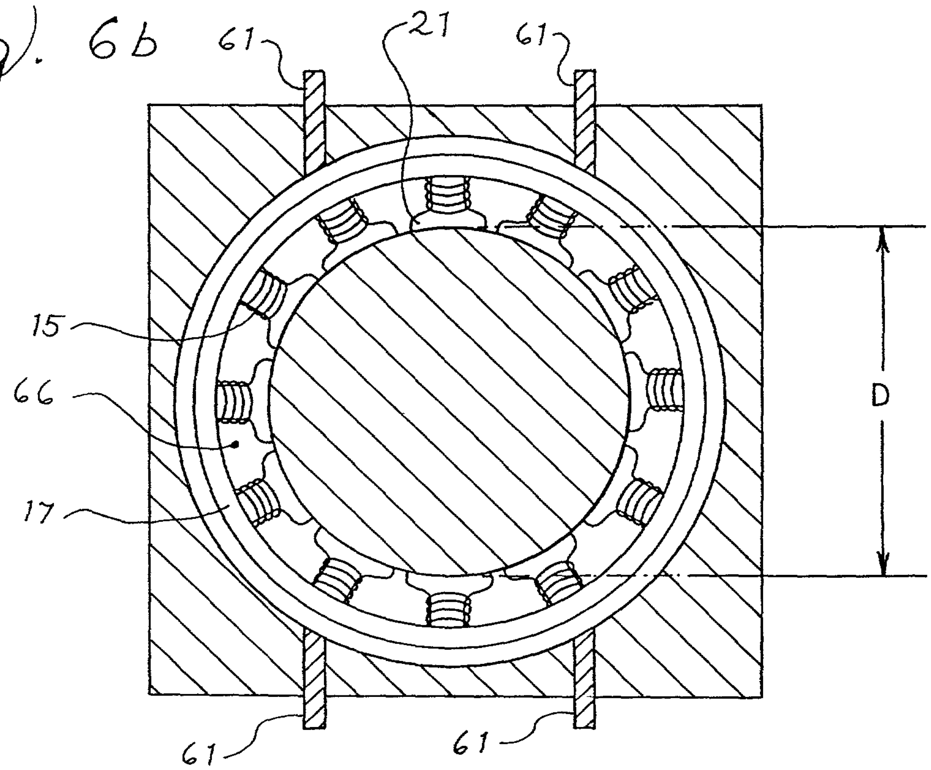


Fig. 6b



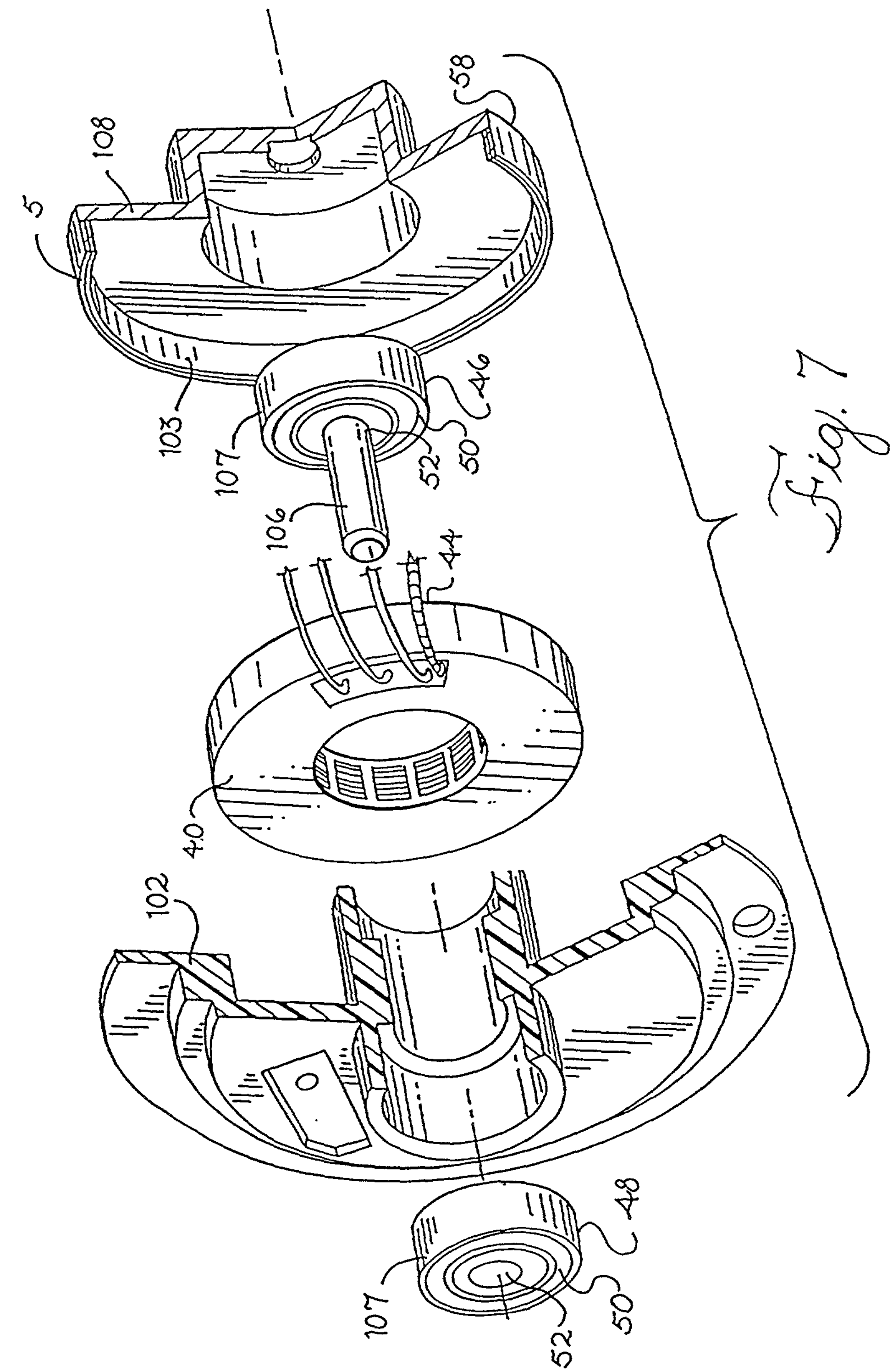


Fig. 7

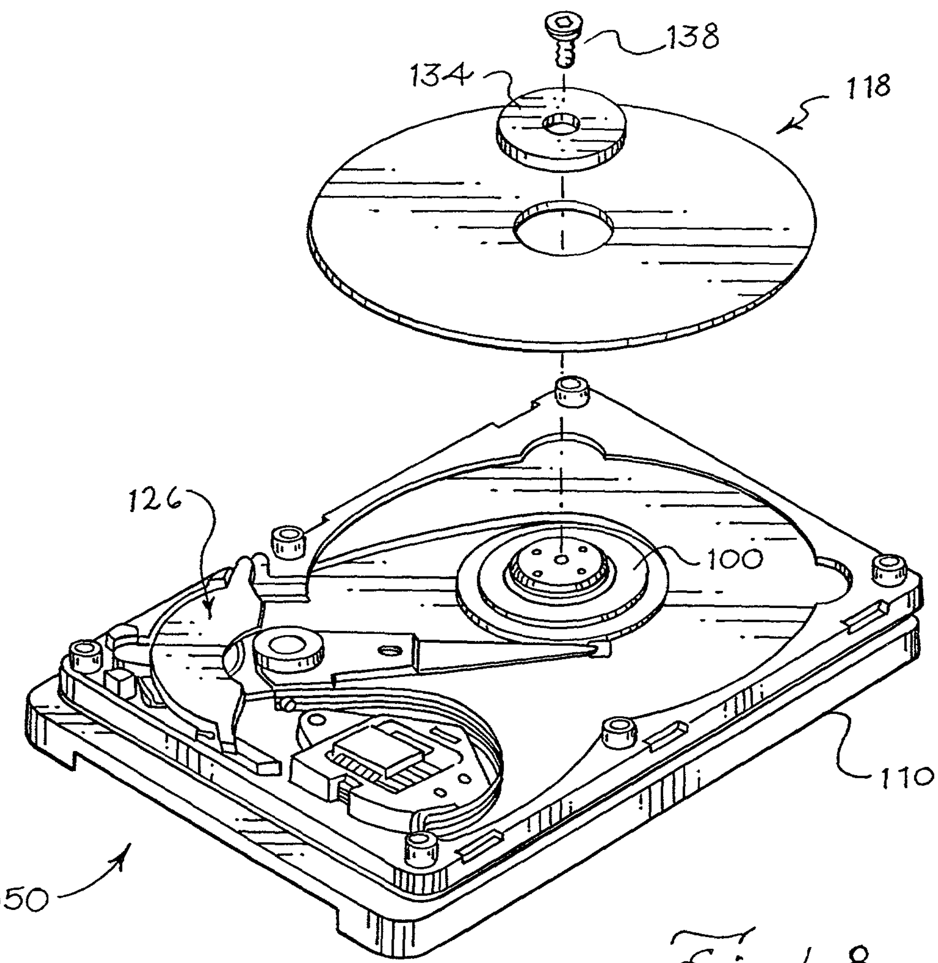

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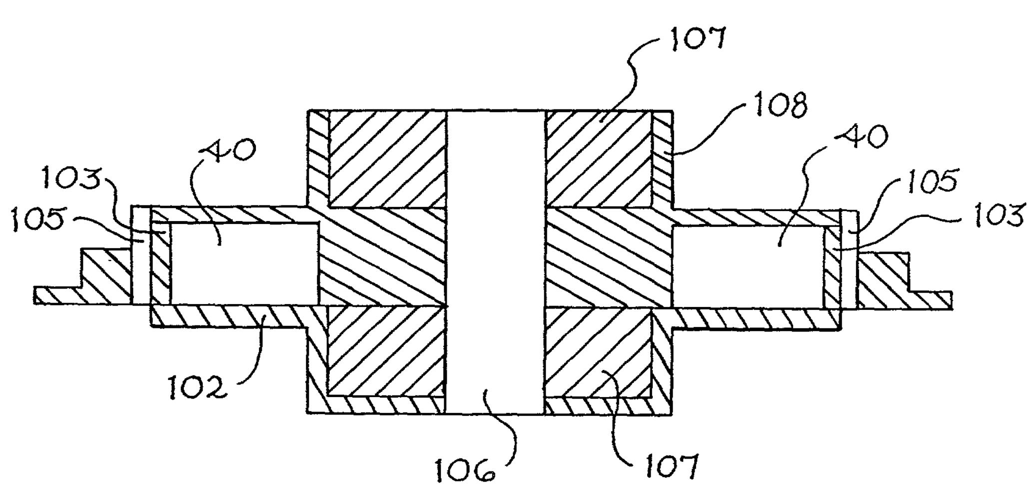
Fig. 8

Fig. 9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July 16, 2001
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Sailesh K. Patel, Reg. No. 46,982
Name of Applicant, assignee or Registered Representative

[signature]
Signature

Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

09798511 .071901

In re Application of:

GRIFFITH D. NEAL

Serial No. 09/798,511

Filing Date: March 2, 2001

For STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

Examiner: To Be Assigned

Group Art Unit No. 2834

SUBMISSION OF FORMAL DRAWINGS

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

In response to the Notice to File Corrected Application Papers mailed May 16, 2001, Applicant submits herewith six (6) sheets of corrected formal drawings (Figures 1-9) for the above-referenced application.

Respectfully submitted,

[signature]

Sailesh K. Patel
Registration No. 46,982
Attorney for Applicant

BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, ILLINOIS 60610
(312) 321-4200

09798511.071901

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APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/798,511	03/02/2001	Griffith D. Neal	8864/20

Sailesh K. Patel
Brinks Hofer Gilson & Lione
P.O. Box 10395
Chicago, IL 60610

CONFIRMATION NO. 9388
FORMALITIES LETTER

OC000000006080658

Date Mailed: 05/16/2001

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

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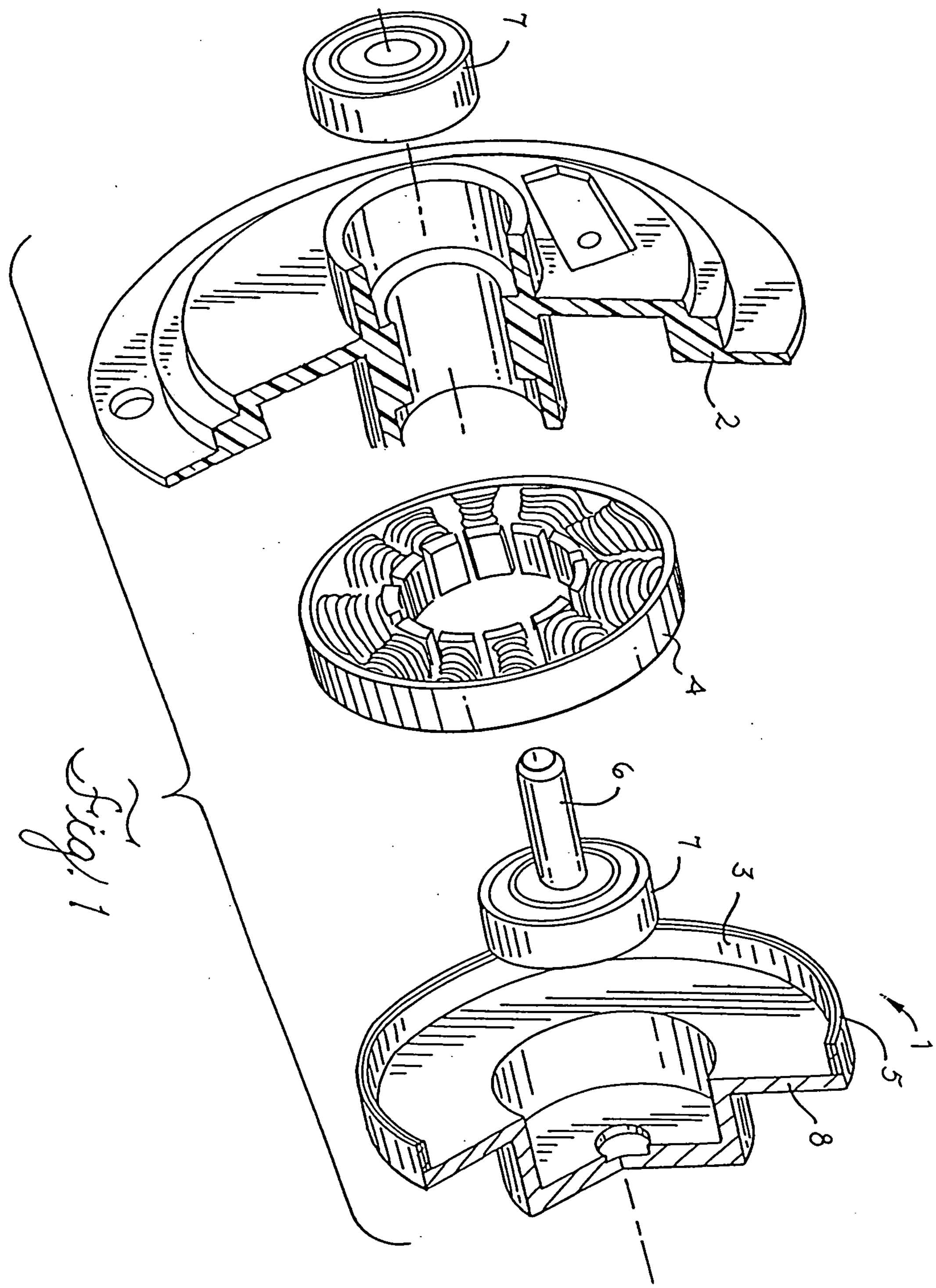

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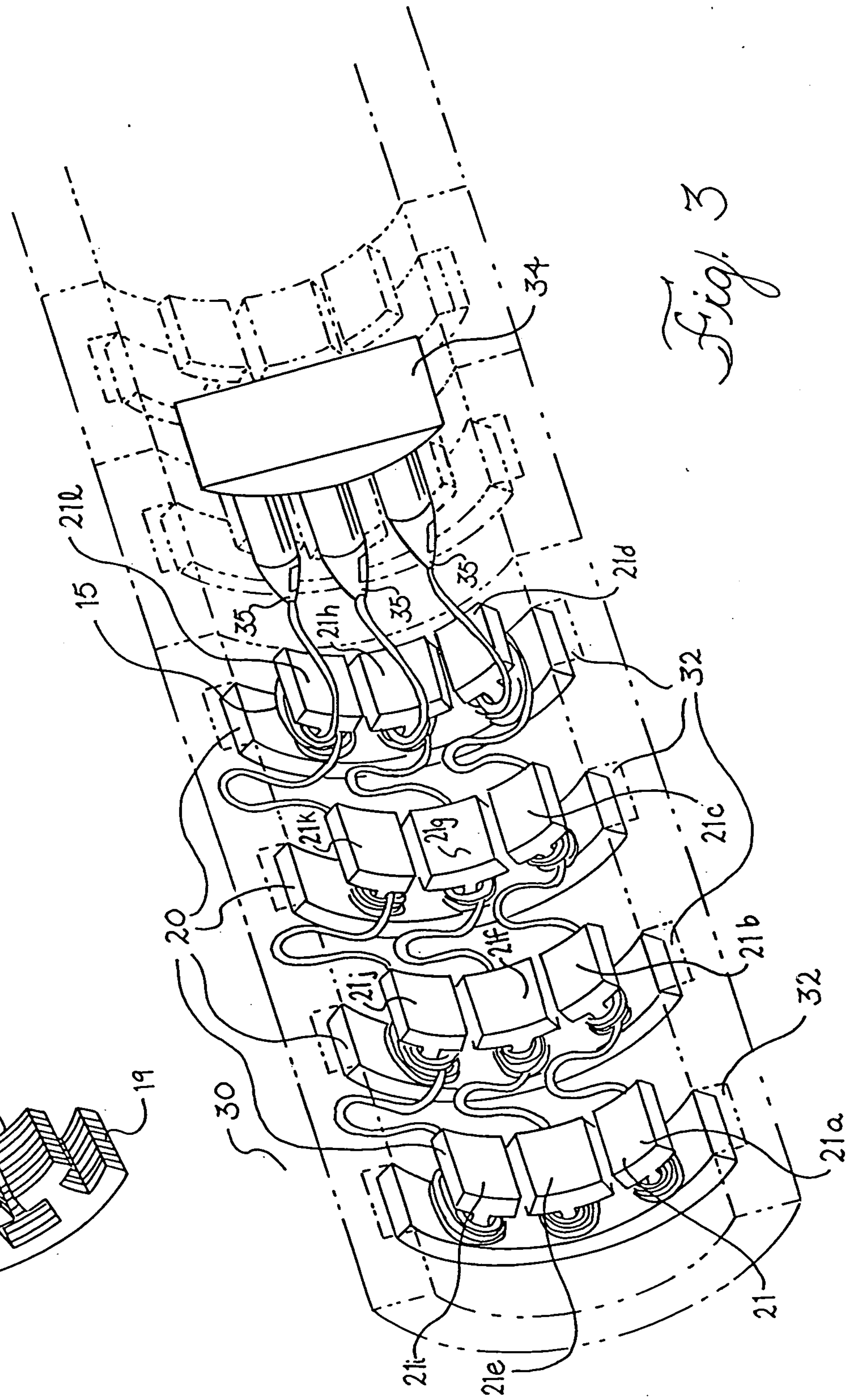
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Fig. 3

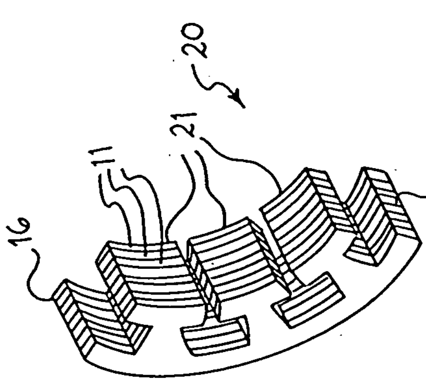
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Fig. 2

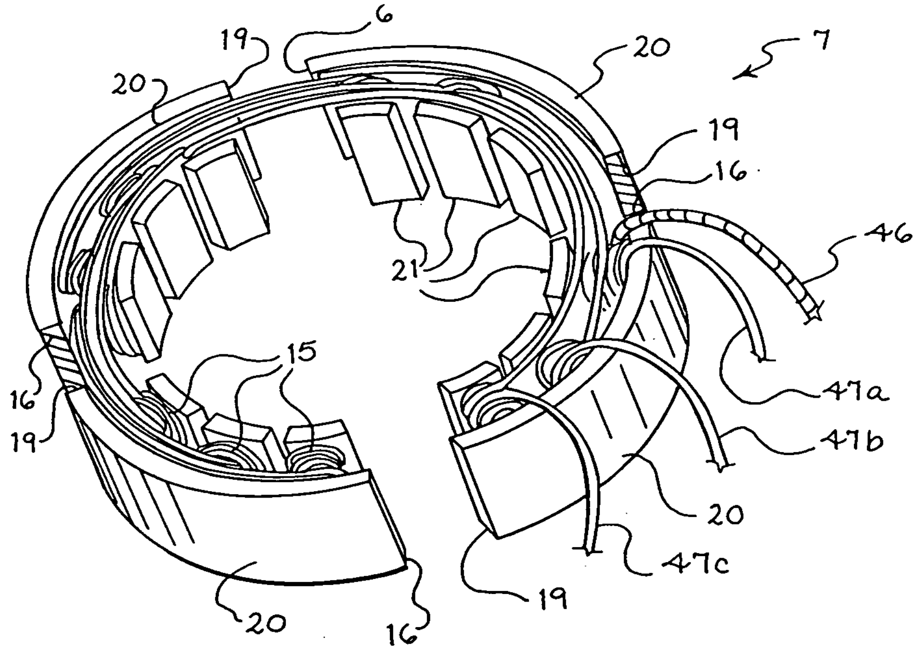
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Fig. 4

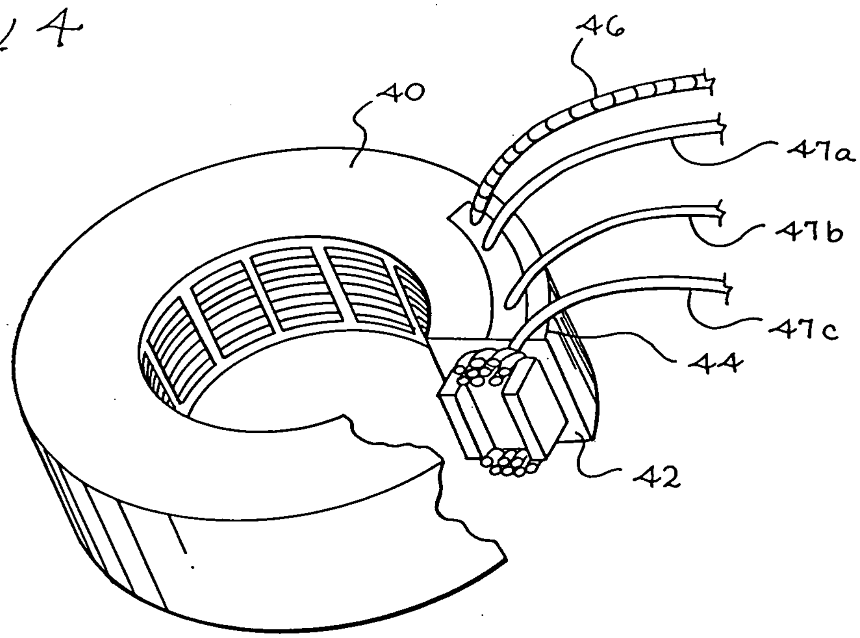
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Fig. 5

Fig. 6a

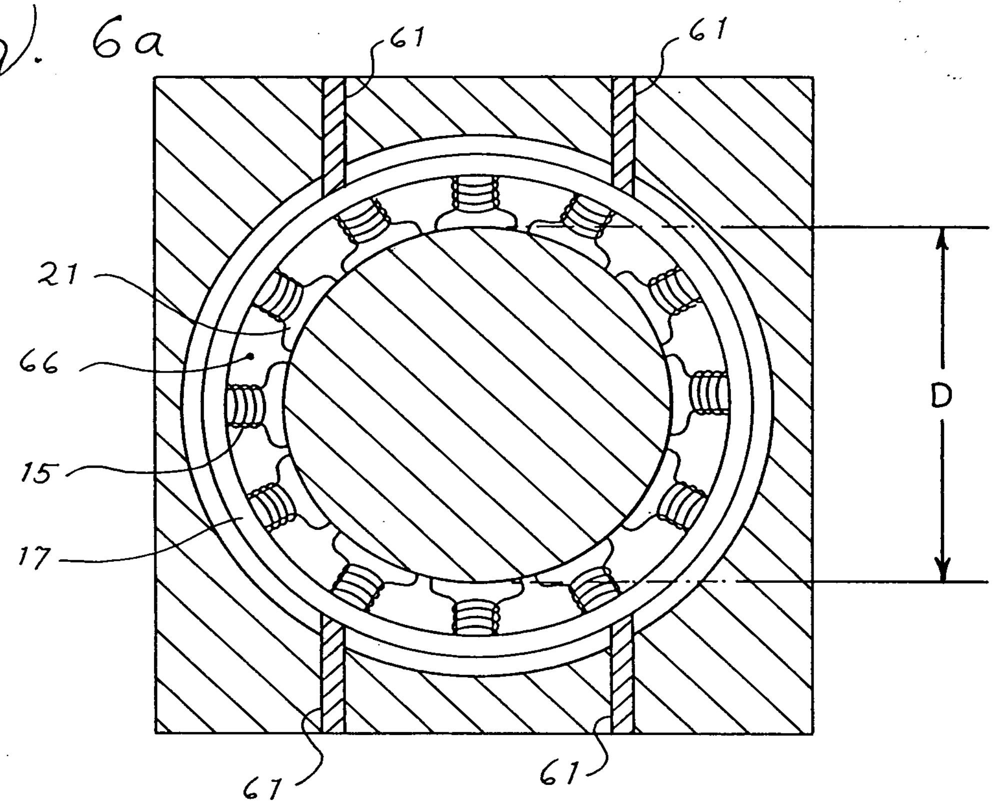
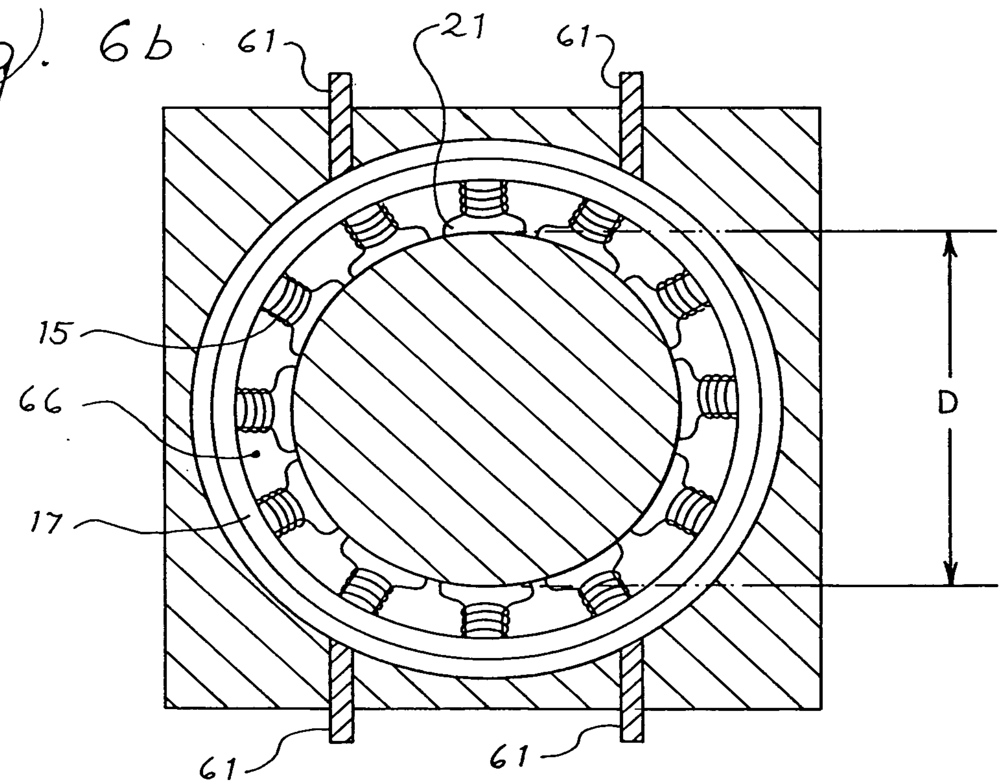


Fig. 6b



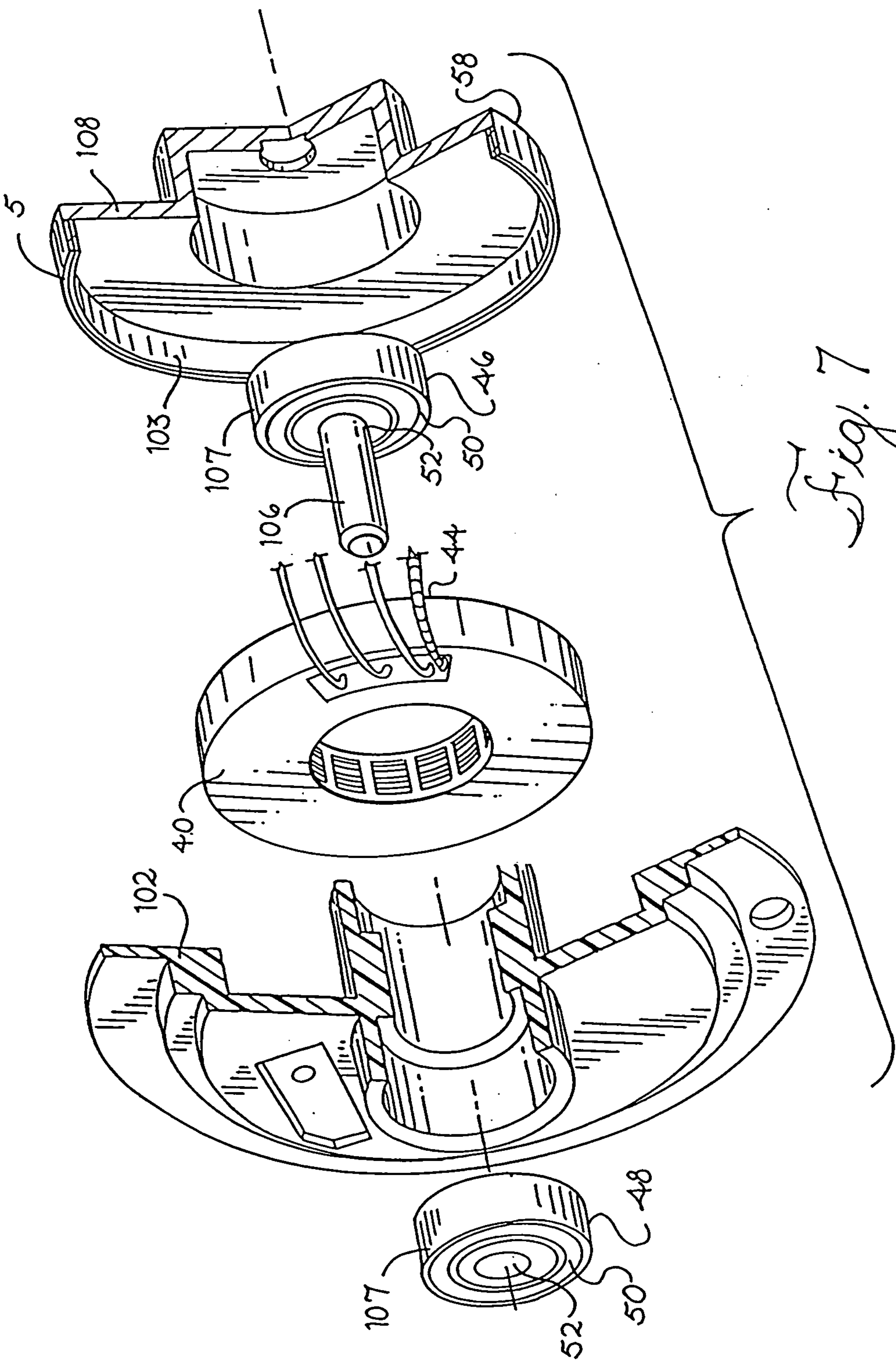


Fig. 7

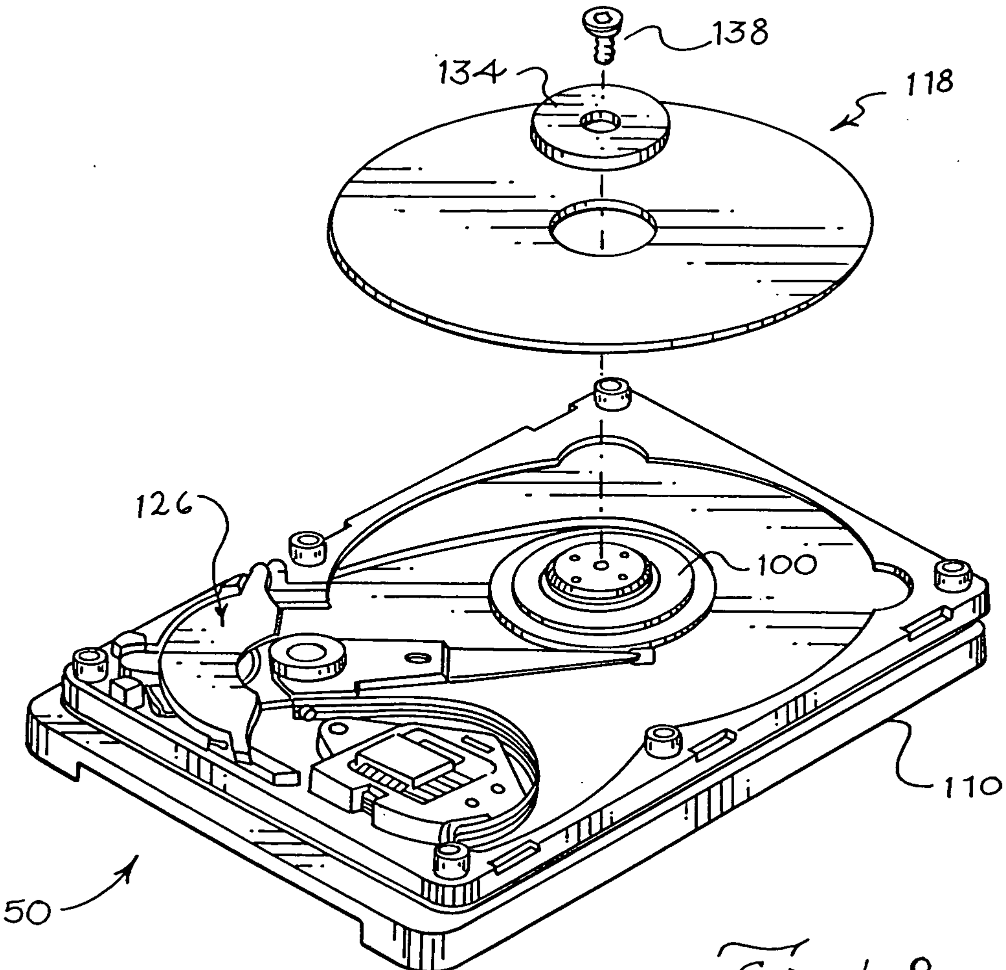

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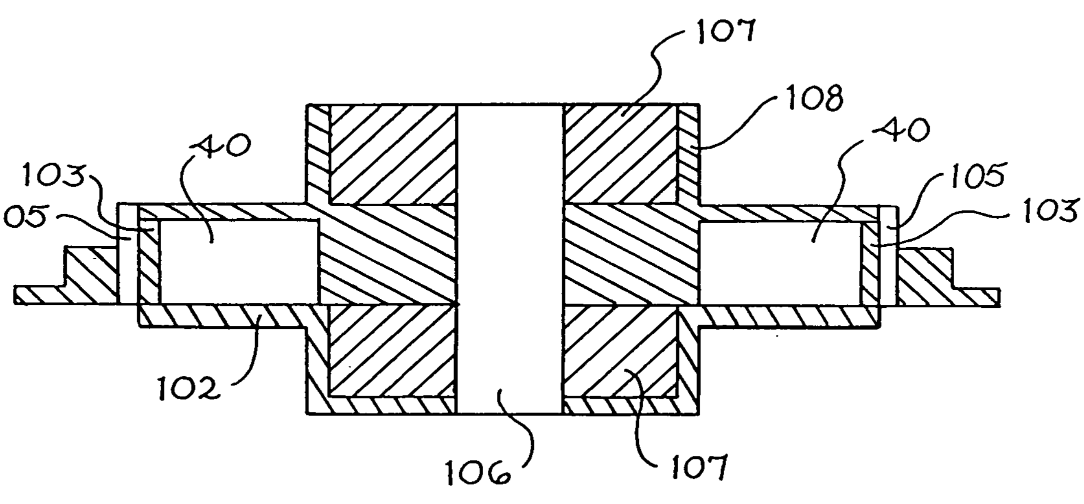
Fig. 8

Fig. 9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APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/798,511	03/02/2001	Griffith D. Neal	8864/20

CONFIRMATION NO: 9388

FORMALITIES LETTER

OC000000006080658

Sailesh K. Patel
Brinks Hofer Gilson & Lione
P.O. Box 10395
Chicago, IL 60610

Date Mailed: 05/16/2001

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PART 3 - OFFICE COPY

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Date of Deposit March 2, 2001

Case No. 8864/20

PATENT APPLICATION TRANSMITTAL LETTER

To the Commissioner for Patents:

Transmitted herewith for filing is the patent application of: Griffith D. Neal for : STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS ANDMOTOR USING SAME. Enclosed are:

- ☒ Six (6) sheet(s) of drawings, twenty-four (24) pages of application (including title page), and the following Appendices : _____.
- ☒ Declaration.
- ☒ Power of Attorney.
- ☐ Verified statement to establish small entity status under 37 CFR §§ 1.9 and 1.27.
- ☒ Assignment transmittal letter and Assignment of the invention to : Encap Motor Corporation.
- ☐ _____.

JC996 U.S. PTO 09/798511 03/02/01

Claims as Filed	Col. 1	Col. 2		Small Entity			Other Than Small Entity	
For	No. Filed	No. Extra		Rate	Fee	or	Rate	Fee
Basic Fee					$ 355	or		$ 710
Total Claims	29-20	9		x$9=	$81	or	x$18=	$
Indep. Claims	5-3	2		x$40=	$40	or	x$80=	$
Multiple Dependent Claims Present				+$135=	$	or	+$270=	$
				Total	$516	or	Total	$

*If the difference in col. 1 is less than zero, enter "0" in col. 2.

- ☐ Please charge my Deposit Account No. 23-1925 in the amount of $: _____. A duplicate copy of this sheet is enclosed.
- ☒ A check in the amount of $: 516 to cover the filing fee is enclosed.
- ☒ The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.
  - ☒ Any additional filing fees required under 37 CFR § 1.16.
  - ☒ Any patent application processing fees under 37 CFR §1.17.
- ☐ The Commissioner is hereby authorized to charge payment of the following fees during the pendency of this application or credit any overpayment to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.
  - ☐ Any filing fees under 37 CFR § 1.16 for presentation of extra claims.
  - ☐ Any patent application processing fees under 37 CFR § 1.17.
  - ☐ The issue fee set in 37 CFR § 1.18 at or before mailing of the Notice of Allowance, pursuant to 37 CFR § 1.311(b).

3/2/01
Date

Sailesh Patel
Sailesh K. Patel
BRINKS HOFER GILSON & LIONE
Registration No. 46,982

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Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
APPLICATION FOR UNITED STATES LETTERS PATENT

INVENTOR: GRIFFITH D. NEAL

TITLE: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

ATTORNEYS: STEVEN P. SHURTZ
REG. NO. 31,424
SAILESH K. PATEL
REG. NO. 46,982
BRINKS HOFER GILSON & LIONE
P.O. BOX 10395
CHICAGO, ILLINOIS 60610
(312) 321-4200

STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME

FIELD OF THE INVENTION

The present invention relates generally to a stator assembly used in a motor. It relates particularly to a spindle motor such as used in a hard disc drive, and to the construction and arrangement of a stator assembly made from a plurality of arc segments.

BACKGROUND OF THE INVENTION

Computers commonly use disc drives for memory storage purposes. Disc drives include a stack of one or more magnetic discs that rotate and are accessed using a head or read-write transducer. Typically, a high speed motor such as a spindle motor is used to rotate the discs.

In conventional spindle motors, stators have been made by laminating together stamped pieces of steel. These stamped pieces of steel are generally circular in nature, but also have "poles" extending either inwardly or outwardly, depending on whether the rotor is on the inside or surrounds the stator. The stamped pieces are laminated together and then coated with insulation. Wire is then wound around the poles to form stator windings.

An example of a conventional spindle motor 1 is shown in FIG. 1. The motor 1 includes a base 2 which is usually made from die cast aluminum, a stator 4, a shaft 6, bearings 7 and a disc support member 8, also referred to as a hub. A magnet 3 and flux return ring 5 are attached to the disc support member 8. The stator 4 is separated from the base 2 using an insulator (not shown) and attached to the base 2 using a glue. Distinct structures are formed in the base 2 and the disc support member 8 to accommodate the bearings 7. One end of the shaft 6 is inserted into the bearing 7 positioned in the base 2 and the other end of the shaft 6 is placed in the bearing 7 located in the hub 8. A separate electrical connector 9 may also be inserted into the base 2.

Each of these parts must be fixed at predefined tolerances with respect to one another. Accuracy in these tolerances can significantly enhance motor performance.

In operation, the disc stack is placed upon the hub. The stator windings are selectively energized and interact with the permanent magnet to cause a defined rotation of the hub. As hub 8 rotates, the head engages in reading or writing activities based upon instructions from the CPU in the computer.

Manufacturers of disc drives are constantly seeking to improve the speed with which data can be accessed. To an extent, this speed depends upon the efficiency of the spindle motor, as existing magneto-resistive head technology is capable of accessing data at a rate greater than the speed offered by the highest speed spindle motor currently in production. The efficiency of the spindle motor is dependent upon the dimensional consistency or tolerances between the various components of the motor. Greater dimensional consistency between components leads to a smaller gap between the stator 4 and the magnet 3, producing more force, which provides more torque and enables faster acceleration and higher rotational speeds.

The conventional method of forming stators has a number of drawbacks. First, most steel is manufactured in rolled sheets and thus has a grain orientation. The grain orientation has an effect on the magnetic flux properties of the steel. In circular stamped pieces of steel, the grain orientation at different points around the circle differs. Compared from the radius line of the circle, the grain orientation is sometimes aligned along the radius, sometimes transverse to it, and mostly at a varying angle to the radius. The un-aligned grain structure of conventional stators causes the magnetic flux values to differ in parts of the stator and thus the motor does not have consistent and uniform torque properties as it rotates.

Another drawback with using circular steel pieces is that, especially for inward facing poles, it has been difficult to wind the wire windings tightly because of the cramped space to work inside of the laminated stator core. The cramped working space creates a lower limit on the size of the stator and thus the motor. The limited working space also results in a low packing density of wire. The packing density of wire coiled around the poles affects the amount of power generated by the motor. Increasing packing density increases the power and thus the efficiency of the spindle motor.

An important factor in motor design is to reduce stack up tolerances in the motor. Stack up tolerances reduce the overall dimensional consistency between the components. Stack up tolerances refer to the sum of the variation of all the tolerances of all the parts, as well as the overall tolerance that relates to the alignment of the parts relative to one another. One source of stack up tolerances is from the circular stator body. Generally, the thickness of rolled steel is not uniform across the width of the roll. Sometimes the edges are thicker or thinner than the center. In a stator made from circular stamped pieces, the thickness of individual laminations are thus different from one side to the other. When stacked together, this creates a stack up tolerance problem. Furthermore, the circular stampings leave a lot of wasted steel that is removed and must be recycled or discarded.

Another important factor in motor design is the lowering of the operating temperature of the motor. Increased motor temperature affects the electrical efficiency of the motor and bearing life. As temperature increases, resistive loses in wire increase, thereby reducing total motor power. Furthermore, the Arhennius equation predicts that the failure rate of an electrical device is exponentially related to its operating temperature. The frictional heat generated by bearings increases with speed. Also, as bearings get hot they expand, and the bearing cages get stressed and may deflect, causing non-uniform rotation reducing bearing life. This non-uniform rotation causes a further problem of limiting the ability of the servo system controlling the read/write heads to follow data tracks on the magnetic media. One drawback with existing motor designs is their limited effective dissipation of the heat, and difficulty in incorporating heat sinks to aid in heat dissipation. In addition, in current motors the operating temperatures generally increase as the size of the motor is decreased.

Manufacturers have established strict requirements on the outgassing of materials that are used inside a hard disc drive. These requirements are intended to reduce the emission of materials onto the magnetic media or heads during the operation of the drive. Of primary concern are glues used to attach components together, varnish used to insulate wire, and epoxy used to protect steel laminations from oxidation.

In addition to such outgassed materials, airborne particulate in a drive may lead to head damage. Also, airborne particulates in the disc drive could interfere with signal transfer between the read/write head and the media. To reduce the effects of potential airborne particulate, hard drives are manufactured to exacting clean room standards and air filters are installed inside of the drive to reduce the contamination levels during operation.

An example of a spindle motor is shown in U.S. Patent No. 5,694,268 (Dunfield *et al.*) (incorporated herein by reference). Referring to FIG. 5 of this patent, a stator of the spindle motor is encapsulated with an overmold 42. The overmolded stator 40 contains openings through which mounting pins 44 may be inserted for attaching the stator 200 to a base. U.S. Patent No. 5,672,972 (Viskochil) (incorporated herein by reference) also discloses a spindle motor having an overmolded stator. One drawback with the overmold used in these patents is that it has a different coefficient of linear thermal expansion ("CLTE") than the corresponding metal parts to which it is attached. Another drawback with the overmold is that it is not very effective at dissipating heat. Further, the overmolds shown in these patents are not effective in dampening some vibrations generated by energizing the stator windings.

U.S. Patent No. 5,806,169 (Trago) (incorporated herein by reference) discloses a method of fabricating an injection molded motor assembly. However, the motor disclosed in Trago is a step motor, not a high speed spindle motor, and would not be used in applications such as hard disc drives. Further, none of these three prior art designs address the problem of variation in the thickness of steel used to make the stator cores and the non-uniform grain structure in the steel compared to the magnetic flux in the stator during operation of the motor. Thus, a need exists for an improved high speed spindle motor, having properties that will be especially useful in a hard disc drive, overcoming the aforementioned problems.

BRIEF SUMMARY OF THE INVENTION

A high speed motor has been invented which overcomes many of the foregoing problems. In addition, unique stator assemblies and other components of a high speed motor have been invented, as well as methods of manufacturing motors and hard disc drives. In one aspect, the invention is a motor comprising: a plurality of stator arc segments forming a toroidal core, wherein each said stator arc segment has two end surfaces that are each in contact with an end surface of another stator arc segment to form a toroidal core; and a monolithic body of phase change material substantially encapsulating the stator arc segments and holding said toroidal core in place.

In another aspect the invention is a method of making a motor comprising: providing at least two stator arc segments each having a first end surface and a second end surface; aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment; and substantially encapsulating said toroidal core with a monolithic body of phase change material and solidifying the phase change material to hold the stator arc segments together.

In another aspect the invention is a method of making a motor comprising: providing four stator arc segments, wherein each stator arc segment has a first end surface and a second end surface; aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment; and substantially encapsulating said toroidal core with a monolithic body of phase change material, wherein said substantially encapsulating is by injection molding said phase change material around said toroidal core.

In yet another aspect, the invention is a combination of stator arc segments and a carrier used to support said stator arc segments during a winding operation comprising a plurality of stator arc segments, and: a plurality of cavities to hold and support said stator arc segments, wherein said cavities are spaced apart a distance X, wherein the distance X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

The invention provides the foregoing and other features, and the advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention and do not limit the scope of the invention, which is defined by the appended claims and equivalents thereof.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is an exploded, partial cross-sectional and perspective view of a conventional high speed motor of the present invention.

FIG. 2 is a perspective view of a stator arc segment.

FIG. 3 is a perspective view of a combined carrier assembly and stator arc segments of FIG. 2.

FIG. 4 is a perspective view of stator arc segments of FIG. 2 with windings thereon ready to be formed into a toroidal core.

FIG. 5 is a perspective view of an injection molded stator assembly using the stator arc segments of FIG. 4.

FIG. 6a is a cross-sectional view of the toroidal core of FIG. 4 in an injection mold assembly, prior to injecting a phase change material.

FIG. 6b is a cross-sectional view of the toroidal core of FIG. 4 in an injection mold assembly, after injecting a phase change material.

FIG. 7 is an exploded, partial cross-sectional and perspective view of a high speed motor using the encapsulated stator of FIG. 5.

FIG. 8 is an exploded, partial cross-sectional and perspective view of a high speed motor and disc assembly made with the motor of FIG. 7.

FIG. 9 is a cross-sectional view of the motor of FIG. 8.

DETAILED DESCRIPTION OF THE DRAWINGS AND PREFERRED EMBODIMENTS OF THE INVENTION

A preferred embodiment of a high speed motor of the present invention and portions of the motor at different stages of manufacture are shown in FIGS. 2-7 and 9. By "high speed" it is meant that the motor can operate at over 5,000 rpm. The spindle motor 100 is designed for rotating a disc or stack of discs in a computer hard drive. Motor 100 is formed by using an injection molded stator assembly 40, that is formed by injection molding a plurality of stator arc segments 20 aligned to form a toroidal core 17. Although the embodiment described here uses four arc segments, one of ordinary skill in the art will understand that two, three or any greater number of arc segments may be used. The preferred motor of the present invention is smaller, has a grain structure that is more uniformly aligned, allows for greater packing density of wire and reduces waste of steel in the manufacturing process as compared with conventional motors used for disc drives, thereby increasing power and reducing stack up tolerances and manufacturing costs and producing other advantages discussed below.

Referring to FIG. 2, a stator arc segment 20 is first constructed, using steel laminations 11. The stator arc segment 20 is made of steel pieces that are stamped out of rolled steel. The stamped steel pieces are arc segments, but also have poles 21 extending inwardly or outwardly depending on whether the rotor is inside or surrounds the stator. In the embodiment shown in FIG. 2, the poles 21 are shown extending inwardly. The stamped pieces are then coated with epoxy which provides insulation and laminates the pieces together to form a stator arc segment 20.

As shown in FIG. 3, the stator arc segments 20 are then preferably placed in a carrier 30. The carrier 30 has a plurality of cavities 32 that hold the stator arc segments 20 in place. In a preferred embodiment, the space between the cavities is equivalent to the length of wire needed to travel from a point on one pole 21a to the next pole 21b in the same phase of windings following the arc of the stator arc segments 20. The carrier 30 shown in FIG. 3 shows an alternative embodiment where the space between the cavities is not necessarily equivalent to the length of wire needed to travel from a point on one pole 21a to the next pole 21b. By precisely aligning the stator arc segments 20, the carrier 30 greatly enhances the efficiency for winding wire 15 around the poles 21 and manufacturing stators.

Wire 15 is then wound around the poles 21 of the stator arc segments 20 using a spool winder 34 that has a set of needles 35 that wind wire around the poles 21. The wire 15 is wound around one pole 21 and is then wound around another pole 21 in its phase until all poles 21 in the same phase are wound with the same wire 15. Poles 21 in other phases are also similarly wound. Having only arc segments, rather than a full toroidal core, and placing the arc segments 20 in the carrier 30 makes it much easier for needle 35 to wind wire 15 around poles 21. Using this method, a wire packing density of about 60 percent to about 80 percent can be achieved.

As shown in FIG. 4, the stator arc segments 20 are then removed from the carrier and aligned to form a magnetically inducible toroidal core 17 having a plurality of poles 21 thereon, and wire windings 15 which serve as conductors. To form the toroidal core 17, an end surface 16 of each stator arc segment 20 is aligned and brought into contact with a corresponding end surface 19 of another stator arc segment 20. The wire 15 between the poles 21 of different stator arc segments 20 is also aligned in the toroidal core 17, following the arc of the stator arc segments 20. As a result, the wire in the toroidal core 17 is taught. After the wire is wound so that one set of three leads is terminated together to create the common ground 46, and the other ends of the wire, are for each of the three phases form the leads 47a, 47b and 47c by which current is supplied to the windings. The conductors induce or otherwise create a plurality of magnetic fields in the core when electrical current is conducted through the conductors. In this embodiment, a magnetic field is induced in each of the poles 21.

As shown in FIG. 5, the toroidal core 17 is then encapsulated in a body 42. Together the toroidal core 17 and the body 42 make up an injection molded stator assembly 40. The body 42 is preferably a monolithic body. Monolithic is defined as being formed as a single piece. The body 42 substantially encapsulates the toroidal core 17. Substantial encapsulation means that the body 42 either entirely surrounds the toroidal core 17, or surrounds almost all of it except for minor areas of the toroidal core 17 that may be exposed. However, substantial encapsulation means that the body 42 and toroidal core 17 are rigidly fixed together, and behave as a single component with respect to harmonic oscillation vibration.

The body 42 is preferably formed of a phase change material, meaning a material that can be used in a liquid phase to envelope the stator, but which later changes to a solid phase. There are two types of phase change materials that will be most useful in practicing the invention: temperature activated and chemically activated. A temperature activated phase change material will become molten at a higher temperature, and then solidify at a lower temperature. However, in order to be practical, the phase change material must be molten at a temperature that is low enough that it can be used to encapsulate a toroidal core. Preferred phase change materials will be changed from a liquid to a solid in the range of about 200 °F to about 700 °F, more preferably in the range of about 550 °F to about 650 °F. The most preferred temperature activated phase change materials are thermoplastics. The preferred thermoplastic will become molten at a temperature at which it is injection-moldable, and then will be solid at normal operating temperatures for the motor. An example of a phase change material that changes phases due to a chemical reaction, and which could be used to form the body, is an epoxy. Other suitable phase change materials may be classified as thermosetting materials.

The preferred method of developing the monolithic body 42 comprises designing a phase change material to have a coefficient of linear thermal expansion such that the phase change material contracts and expands at approximately the same rate as the metal laminations of the toroidal core 17. For example, the preferred phase change material should have a CLTE of between 70% and 130% of the CLTE of the core of the stator. The phase change material should have a CLTE that is intermediate the maximum and minimum CLTE of the toroidal core and other motor components where the body is in contact with those other components and they are made of a different material than the core. Also, the CLTE's of the body and toroidal core should match throughout the temperature range of the motor during its operation. An advantage of this method is that a more accurate tolerance may be achieved between the body and the components of the toroidal core because the CLTE of the body matches the CLTE of the toroidal core components more closely. Most often the toroidal core components will be metal, and most frequently steel and copper. Other motor parts are often made of aluminum and steel.

Most thermoplastic materials have a relatively high CLTE. Some thermoplastic materials may have a CLTE at low temperatures that is similar to the CLTE of metal. However, at higher temperatures the CLTE does not match that of the metal. A preferred thermoplastic material will have a CLTE of less than 2×10^{-5} in/in/°F, more preferably less than 1.5×10^{-5} in/in/°F, throughout the expected operating temperature of the motor, and preferably throughout the range of 0-250°F. Most preferably, the CLTE will be between about 0.8×10^{-5} in/in/°F and about 1.2×10^{-5} in/in/°F throughout the range of 0-250°F. (When the measured CLTE of a material depends on the direction of measurement, the relevant CLTE for purposes of defining the present invention is the CLTE in the direction in which the CLTE is lowest.)

The CLTE of common solid parts used in a motor are as follows:

	23°C	250°F	
Steel	0.5	0.8	($\times 10^{-5}$ in/in/°F)
Aluminum	0.8	1.4	
Ceramic	0.3	0.4	

Of course, if the motor is designed with two or more different solids, such as steel and aluminum components, the CLTE of the phase change material would preferably be one that was intermediate, the maximum CLTE and the minimum CLTE of the different solids, such as 0.65 in/in/°F at room temperature and 1.1×10^{-5} in/in/°F at 250°F.

One preferred thermoplastic material, Konduit OTF-212-11, was made into a thermoplastic body and tested for its coefficient of linear thermal expansion by a standard ASTM test method. It was found to have a CLTE in the range of –30 to 30°C of 1.09×10^{-5} in/in/°F in the X direction and 1.26×10^{-5} in/in/°F in both the Y and Z directions, and a CLTE in the range of 100 to 240°C of 1.28×10^{-5} in/in/°F in the X direction and 3.16×10^{-5} in/in/°F in both the Y and Z directions. (Hence, the relevant CLTEs for purposes of defining the invention are 1.09×10^{-5} in/in/°F and 1.28×10^{-5} in/in/°F.) Another similar material, Konduit PDX –0-988, was found to have a CLTE in the range of –30 to 30°C of 1.1×10^{-5} in/in/°F in the X direction and 1.46×10^{-5} in/in/°F in both the Y and Z directions, and a CLTE in the range of 100 to 240°C of 1.16×10^{-5} in/in/°F in the X direction and 3.4×10^{-5} in/in/°F in both the Y and Z directions. By contrast, a PBS type polymer, (Fortron 4665) was likewise tested. While it had a low CLTE in the range of –30 to 30°C (1.05×10^{-5} in/in/°F in the X direction and 1.33×10^{-5} in/in/°F in both the Y and Z directions), it had a much higher CLTE in the range of 100 to 240°C (1.94×10^{-5} in/in/°F in the X direction and 4.17×10^{-5} in/in/°F in both the Y and Z directions).

In addition to having a desirable CLTE, the preferred phase change material will also have a high thermal conductivity. A preferred thermoplastic material will have a thermal conductivity of at least 0.7 watts/meter°K using ASTM test procedure 0149 and tested at room temperature (23°C).

Stator assemblies made from arc segments held together by a body of phase change material partially encapsulating the stator are themselves novel and define another aspect of the present invention.

In the present embodiment, the phase change material used to make the body 42 is preferably a thermally conductive but non-electrically conductive plastic. In addition, the plastic preferably includes ceramic filler particles that enhance the thermal conductivity, while reducing the coefficient of linear thermal expansion of the plastic. A preferred form of plastic is polyphenyl sulfide (PPS) sold under the tradename "Konduit" by LNP. Grade OTF-212 PPS is particularly preferred. Examples of other suitable thermoplastic resins include, but are not limited to, thermoplastic resins such as 6,6-polyamide, 6-polyamide, 4,6-polyamide, 12,12-polyamide, 6,12-polyamide, and polyamides containing aromatic monomers, polybutylene terephthalate, polyethylene terephthalate, polyethylene napththalate, polybutylene napththalate, aromatic polyesters, liquid crystal polymers, polycyclohexane dimethylol terephthalate, copolyetheresters, polyphenylene sulfide, polyacylics, polypropylene, polyethylene, polyacetals, polymethylpentene, polyetherimides, polycarbonate, polysulfone, polyethersulfone, polyphenylene oxide, polystyrene, styrene copolymer, mixtures and graft copolymers of styrene and rubber, and glass reinforced or impact modified versions of such resins. Blends of these resins such as polyphenylene oxide and polyamide blends, and polycarbonate and polybutylene terephthalate, may also be used in this invention.

As shown in FIG. 6a, to encapsulate the toroidal core 17 and form body 42, the toroidal core 17 is first clamped and held in place by pins 61 in an injection mold cavity 66. The injection mold cavity 66 is very effective and maintains the toroidal shape of the toroidal core 17. Molten phase-change material is then injected into the molding cavity 66 with an extrusion screw (not shown) until the pressure inside the cavity reaches a predetermined molding pressure. After injecting the molten phase change material, the pins 61 retract as shown in FIG. 6b. The phase change material is then allowed to cool and solidify into a monolithic body 42 that substantially encapsulates the toroidal core 17. The preferred thickness of the body 42 depends on the aspect ratio of the toroidal core 17.

The injection molded stator assembly 40 is then used to construct the rest of the spindle motor 100 (FIG. 7). The spindle motor 100 includes a hub 108, which serves as a disc support member, the stator assembly 40, a base 102, a shaft 106 and bearings 107.

As shown in FIG. 7, a shaft 106 is connected to the hub or disc support member 108 and is surrounded by bearings 107, which are adjacent against the base 102 of the motor. A rotor or magnet 103 is fixed to the inside of the hub 108 on a flange so as to be in operable proximity to the stator assembly. The magnet 103 is preferably a permanent magnet, as described below.

Referring to FIG. 7, the bearings 107 include an upper bearing 46 and a lower bearing 48. Also, each bearing 107 has an outer surface 50 and an inner surface 52. The outer surface 50 of the upper bearing contacts the hub 108 and the outer surface 50 of the lower bearing 48 contacts the lower support base 102. The inner surfaces 52 of the bearings 107 contact the shaft 116. The bearings are preferably annular shaped. The inner surfaces 52 of the bearings 107 may be press fit onto the shaft 16. A glue may also be used. The outer surface 50 of the bearings 107 may be press fit into the interior portion of the base 102. A glue may also be used. The bearings in the embodiment shown in FIG. 7 are ball bearings. Alternatively other types of bearings, such as hydrodynamic or combinations of hydrodynamic and magnetic bearings, may be used. The bearings are typically made of stainless steel.

The shaft 106 is concentrically disposed within the interior portion of the stator assembly 40 and the base 102. The bearings 107 surround portions of the shaft 106. As described above, the inner surfaces 52 of the bearings are in contact with the shaft 106. The shaft 106 includes a top portion 54 and a bottom portion 56. The top portion 54 of the shaft 106 is fixed to the hub 108. The bottom portion 54 of the shaft 106 is free to rotate inside the lower bearing. Thus, in this embodiment, the shaft 106 is freely rotatable relative to the base 102. The shaft 106 is preferably cylindrical shaped. The shaft 106 may be made of stainless steel.

Referring to FIGS. 7 and 9, the hub 108 is concentrically disposed around the stator assembly 40 and the base 102. The hub 108 is fixed to the shaft 106 and is spaced apart from the stator assembly 40 and the base 102. The hub 108 includes a flux return ring 58 and the magnet 103. The flux return ring 58 is glued to the disc support member. The magnet 103 is glued to the hub 108. As shown in FIG. 7, the magnet 103 concentrically surrounds the stator assembly 40. In this embodiment the magnet 103 and stator assembly 40 are generally coplanar when the motor 100 is assembled.

The magnet 103 is preferably a sintered part and is one solid piece. The magnet 103 is placed in a magnetizer which puts a plurality of discrete

North and South poles onto the magnet 103, dependant on the number of poles 21 on the toroidal core 17. The flux return ring 58 is preferably made of a magnetic steel. The hub is preferably made of aluminum. Also, the hub may be made of a magnetic material to replace the flux return ring. Other motor designs using an encapsulated stator that can be made by the present invention are disclosed in provisional U.S. Patent Application Serial No. 60/171,817, filed December 21, 1999, incorporated herein by reference.

The spindle motor described above can be part of a motor and disc assembly 150 as shown in FIG. 8. The disc assembly 150 has a disc stack assembly 118, spindle motor 100, an actuator assembly 126, and a base 110. These subassemblies of the disc assembly are maintained in a precise relationship by precisely machined mounting positions on base 110.

The spindle motor 100 is mounted securely to the base 110, for example through mounting holes and matching bolts (not shown) located on the hub 108 of spindle motor 100. Alternatively, spindle motor 100 may be adhesively mounted to base 110. The disc stack assembly is then mounted to spindle motor 100 through a disc clamp 134 through a mounting screw 138. The spindle motor 100, as shown in FIG.8, has a hub 108, stator assembly 40 and base 102 that are mounted together using bearings 107 and axle 106.

Advantages of the Present invention

An advantageous feature of the preferred embodiment is provided by the fact that the stator assembly 40 is formed from stator arc segments 20 that are aligned to form a toroidal core 17 and substantially encapsulated with a monolithic body 42 to form a stator assembly 40. Using stator arc segments 20 provides a more uniform grain structure to the toroidal core 17. The grain orientation of prior art circular stampings varies a great deal at different points around the circle. By using arc segments, a more uniform grain structure may be obtained. The grain orientation has an effect on the magnetic flux properties of the steel. By making all the arc segments have the same orientation compared to the grain structure of the steel from which they are stamped, the grain structure in the core is more uniform and the magnetic flux is more uniform and the motor 100 of the present invention has more consistent and uniform torque properties as it rotates. This also leads to greater motor efficiency and performance.

The preferred spindle motor also has greater packing density of wire 15. In the disclosed embodiment of the invention, the toroidal core 17 is made of sections, preferably four stator arc segments 20. It should be understood that the disclosed method can use any number of stator arc segments 20 greater than at least two. With circular stamped stators, there is a limitation of the spacing between each pole 21 to allow the needle 35 feeding the winding wire 15 to enter and exit the gap. Additionally in small motors (less than 1.5 inches outer diameter), it is difficult to wind three phases of wire concurrently. Furthermore, this geometry makes the process of applying uniform, evenly spaced turns difficult to achieve. In this case, since only quarter circles are stamped, there is more room to work, and a needle 35 feeding the winding wire 15 can thus pack the windings more tightly. The carrier 30 also allows for this winding to be done more efficiently. Increasing the packing density of wire 15 increases the magnetic field thereby providing more electromotive force and increased power to the motor 100.

The limited working space for winding wire 15 around the poles 21 in circular stamped stators limits the size of spindle motors as well. Since the disclosed method allows for increased working room, smaller motors may be made with the present method compared to prior art methods.

The disclosed spindle motor 100 minimizes stack up tolerances. Since in the present embodiment only quarter circles are being used, the stamped quarter circles can be stamped from portions of the steel roll that is of consistent thickness. Thus, the resulting stacked stator arc segment 20 will have reduced stack up tolerances. Reducing the stack up tolerances optimizes dimensional consistency and thereby enables higher rotational speeds with lower vibration induced runout. Furthermore, since arc segments are used instead of circular stampings, they can be more closely laid out when being stamped, reducing the amount of resulting scrap.

Further, in the prior art, to prevent a motor from seizing when it gets hot, larger than desired gaps between the magnet 3 and the stator assembly 4 were used so that when pieces expanded from being heated, the magnet would not contact the stator. If the magnet contacted the stator, the contact would generate magnetic particulate which can damage the heads and interfere with their ability to read or record data on the discs. Also, if the body has a CLTE greater than that of the steel laminations in the stator, the gap has to be large enough so that the expansion of the body as the motor heats up does not cause the body to contact the rotating magnet (even though the steel laminations are not close to contacting the magnet). With the preferred embodiment of the present invention, with the CLTE of the body matching that of the steel laminations, much smaller gaps, as low as 0.005 inches and more preferably as low as 0.003 inches, can be utilized. As the body 42 expands, it only expands at the same rate as the laminations, and does not grow to the point that the body 42 diminishes the gap size to zero. Thus, the only gap that is needed is one sufficient for expansion of the steel laminations. These smaller gaps make the motor 100 more efficient, as the electrical efficiency of the motor decreases with larger distances between the stator and the rotating magnet.

Through the use of the present embodiment, a particular plastic may be chosen for the body 42 that has properties of rockwell hardness, flex modulus, and elongation that are specifically designed to counteract the vibratory frequencies generated by the motor 100. Thus, the disclosed spindle motor 100 substantially reduces motor vibration. This reduced vibration allows information on a disc to be stored closer together, thereby enabling higher data density.

The disclosed spindle motor 100 also reduces the emission of materials from the motor components onto the magnetic media or heads of the disc drive. This is achieved because components such as the stator, which potentially emit such materials, are substantially encapsulated in plastic.

In addition, the disclosed spindle motor 100 obviates the necessity of a separate plastic or rubber ring sometimes used to isolate the spindle motor from the hard drive in order to prevent shorts from being transferred to the magnetic media and ultimately the read-write heads. Because the disclosed spindle motor body 42 is preferably made of a non-electrically conductive (having a dielectric strength of at least 250 volts/mil) and injectable thermoplastic material, such a separate rubber isolating ring is unnecessary. Once again this reduces manufacturing costs and the stack up tolerances associated with using an additional part.

It is contemplated that numerous modifications may be made to the spindle motor and method for making the spindle motor of the present invention without departing from the spirit and scope of the invention as defined in the claims. For example, while the exemplary embodiment shown in the drawings has four stator arc segments 20, those skilled in the art will appreciate that the same method can be used to make stator assemblies with two stator arc segments or any number greater than two. Furthermore, the body 42 can encapsulate more than just the toroidal core. The body 42 can also encapsulate or form the base 102 of the motor without departing from the scope of the invention. Accordingly, while the present invention has been described herein in relation to several embodiments, the foregoing disclosure is not intended or to be construed to limit the present invention or otherwise to exclude any such other embodiments, arrangements, variations, or modifications and equivalent arrangements. Rather, the present invention is limited only by the claims appended hereto and the equivalents thereof.

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CLAIMS

1. A stator assembly, comprising:

a) a plurality of stator arc segments forming a toroidal core, wherein each said stator arc segment has two end surfaces that are each in contact with an end surface of another stator arc segment to form the toroidal core; and

b) a monolithic body of phase change material substantially encapsulating the stator arc segments and holding said end surfaces in contact with one another.

2. The stator assembly of claim 1 wherein each of the stator arc segments has a plurality of poles with wire wound around said poles.

3. The stator assembly of claim 2 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

4. The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than $2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

5. The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than $1.5x10^{-5}$ in/in/°F throughout the range of 0-250°F.

6. The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of between about $0.8x10^{-5}$ in/in/°F and about $1.2x10^{-5}$ in/in/°F throughout the range of 0-250°F.

7. The stator assembly of claim 1 wherein the phase change material has a thermal conductivity of at least 0.7 watts/meter°K at 23°C.

8. The stator assembly of claim 1 wherein the phase change material comprises polyphenyl sulfide.

9. A method of making a stator assembly for a motor comprising:

a) providing at least two stator arc segments each having a first end surface and a second end surface;

b) aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment; and

c) substantially encapsulating said toroidal core with a monolithic body of phase change material to form said stator assembly.

10. The method of claim 9, wherein each of said stator arc segments have a plurality of poles extending inwardly from a base of said stator arc segment.

11. The method of claim 10 wherein prior to said step of aligning, the wire is wound around said poles of said stator arc segments.

12. The method of claim 11 wherein said stator arc segments are placed in a carrier that holds and supports said stator arc segments while the wire is wound around said poles.

13. The method of claim 12 wherein said carrier has a plurality of cavities to hold and support said stator arc segments.

14. The method of claim 13 wherein said cavities are spaced apart a distance X, wherein X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

15. The method of claim 9 wherein said toroidal core has multiple conductors that create a plurality of magnetic fields when electrical current is conducted through the conductors.

16. The method of claim 9 wherein said phase change material is selected from the group consisting of thermoplastics and thermosetting materials.

17. The method of claim 9 wherein prior to said substantially encapsulating, said toroidal core is clamped in an injection mold cavity to maintain the toroidal shape.

18. The method of claim 9 wherein said step of substantially encapsulating the core is performed by injection molding said phase change material around said toroidal core.

19. The method of claim 18 wherein said phase change material is injected into a mold at temperature of between about 200°F and about 700°F.

20. The method of claim 18, wherein said phase change material is injected into a mold at a temperature of between about 550°F to about 650°F.

21. A method of making a motor comprising:

a) providing four stator arc segments, wherein each stator arc segment has a first end surface and a second end surface;

b) aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment;

c) substantially encapsulating said toroidal core with a monolithic body of phase change material, wherein said substantially encapsulating is by injection molding said phase change material around said toroidal core to form a stator assembly; and

d) constructing the stator assembly into a motor.

22. The method of claim 21 wherein each of said stator arc segments comprise a plurality of steel laminations.

23. A motor made from the stator assembly of claim 1.

24. The motor of claim 21 wherein said motor comprises a stator assembly, a shaft, a base, bearings, a rotor, at least one permanent magnet and a hub.

25. An electronic device including the motor of claim 21.

26. A motor and disc assembly including the motor made by the method of claim 21.

27. A combination of stator arc segments and a carrier used to support said stator arc segments during a winding operation comprising:

a) a plurality of stator arc segments; and

b) a plurality of cavities to hold and support said stator arc segments.

28. The combination of stator arc segments and carrier of claim 27 wherein said cavities are spaced apart a distance X, wherein the distance X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

29. A stator arc segment comprising a plurality of steel laminations and at least one pole.

ABSTRACT OF THE DISCLOSURE

A plurality of stator arc segments form a toroidal core for a stator assembly used to make a motor. In a preferred embodiment, a plurality of magnetic fields is created when electrical current is conducted through wire wound around poles on the toroidal core. A monolithic body of phase change material substantially encapsulates the conductors and holds the stator arc segments in contact with each other in the toroidal core. Hard disc drives using the motor, and methods of constructing the motor and hard disc drives are also disclosed.

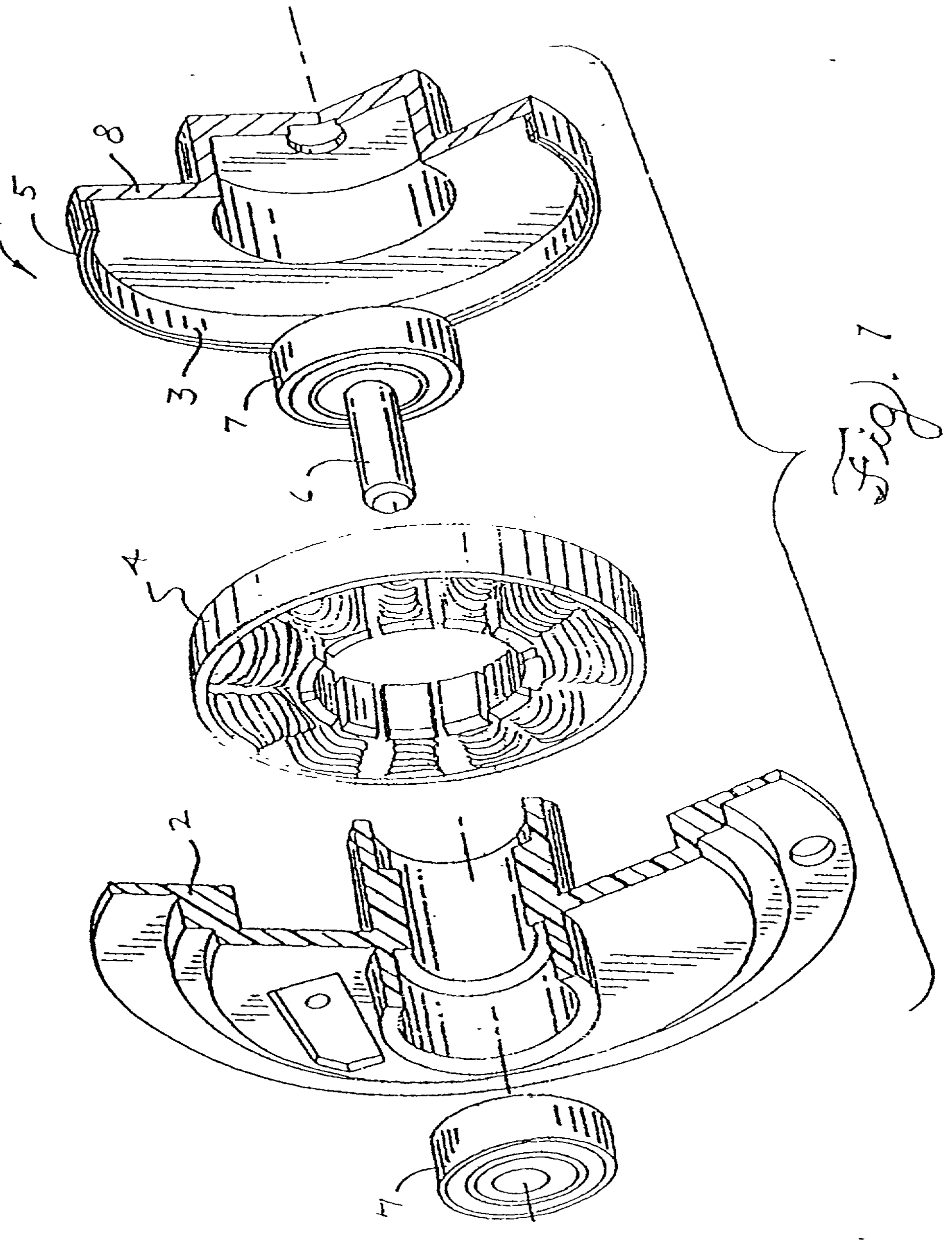


Fig. 7

2/3

8864/30 (2)

SCANNED, # 20

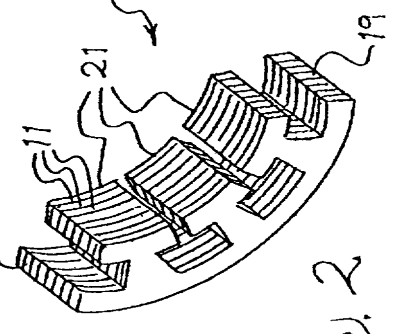


Fig. 2

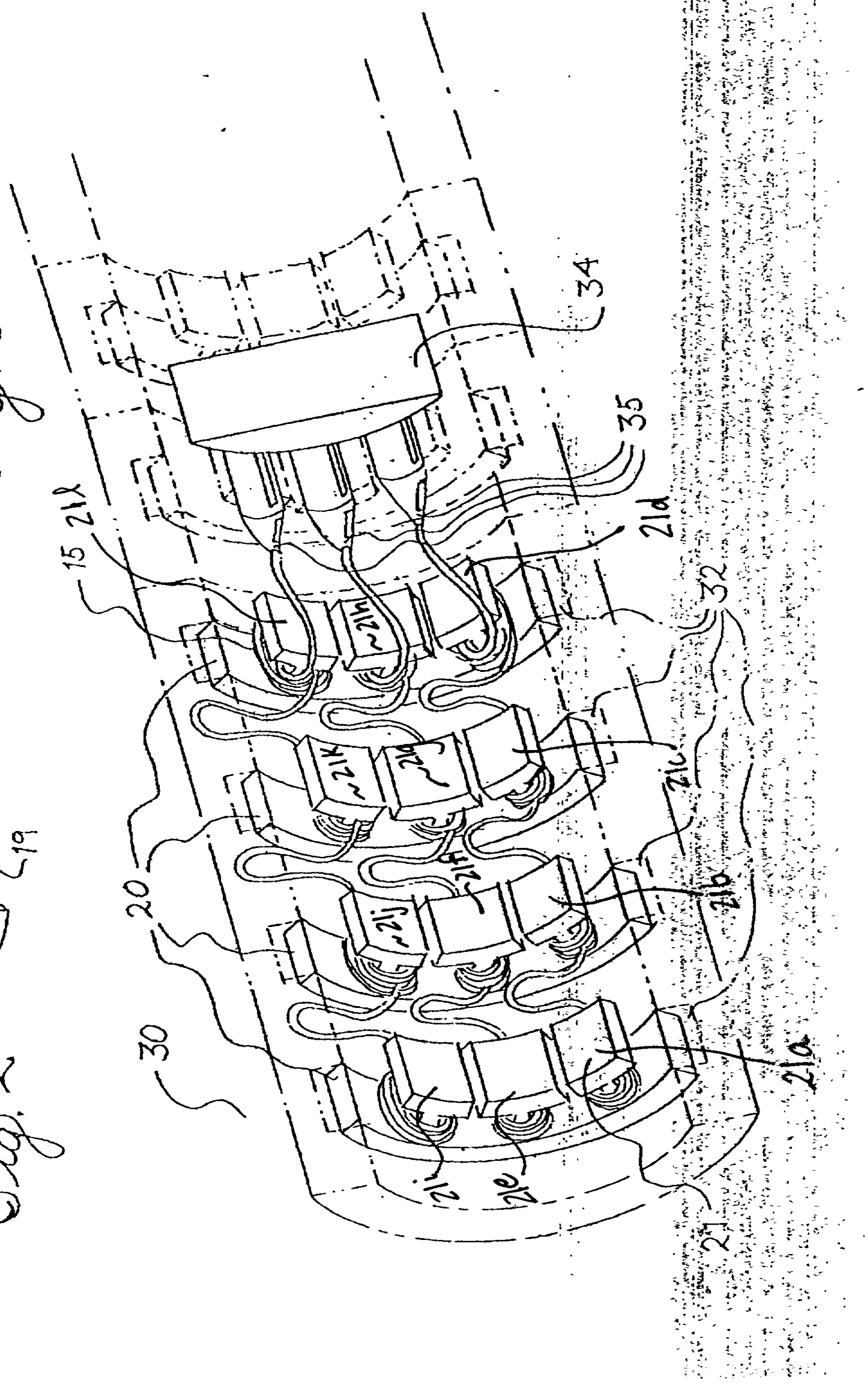


Fig. 3

98 64/20 (3)

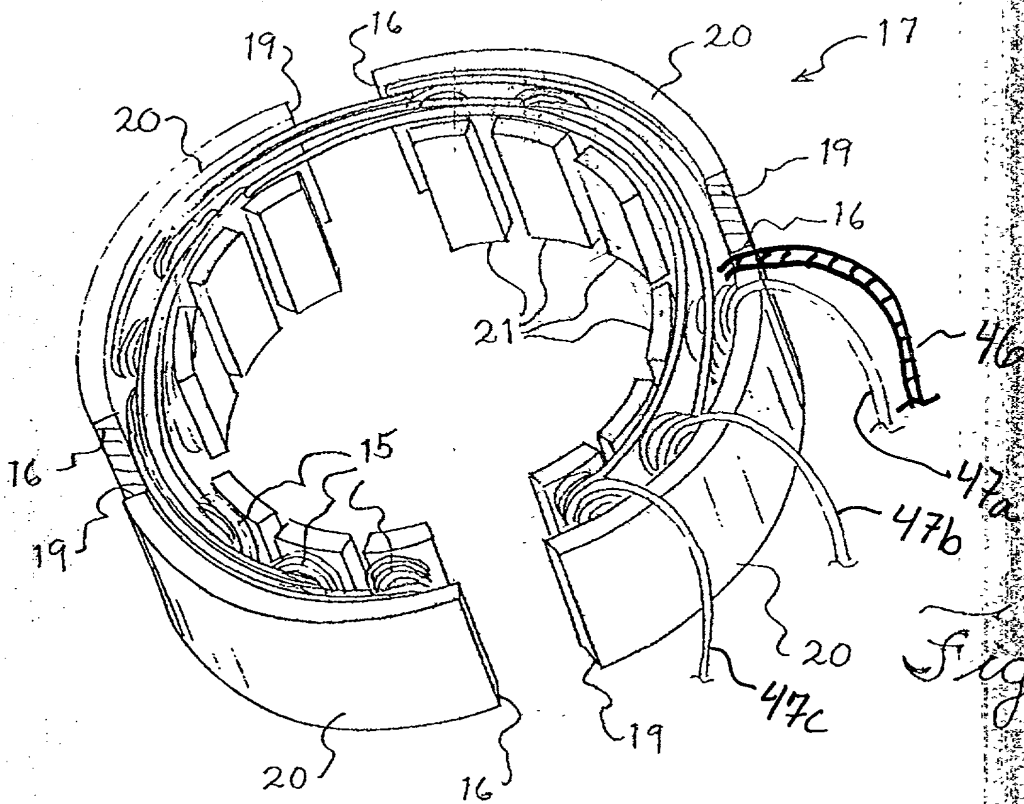


Fig. 4

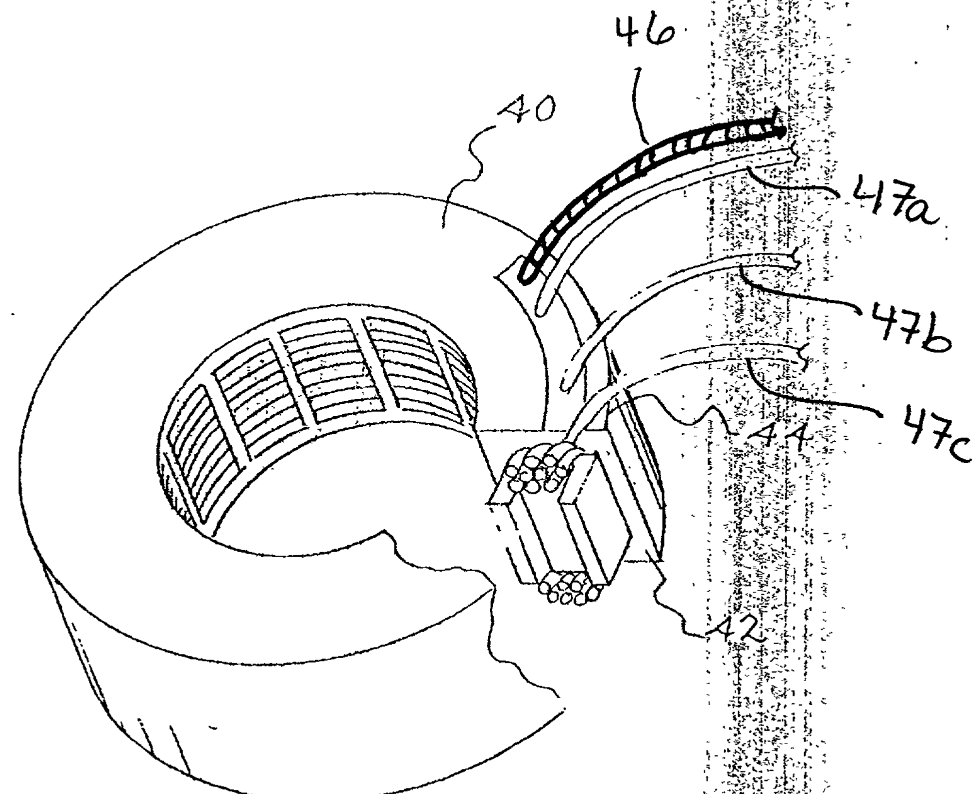


Fig. 5

Fig. 6a

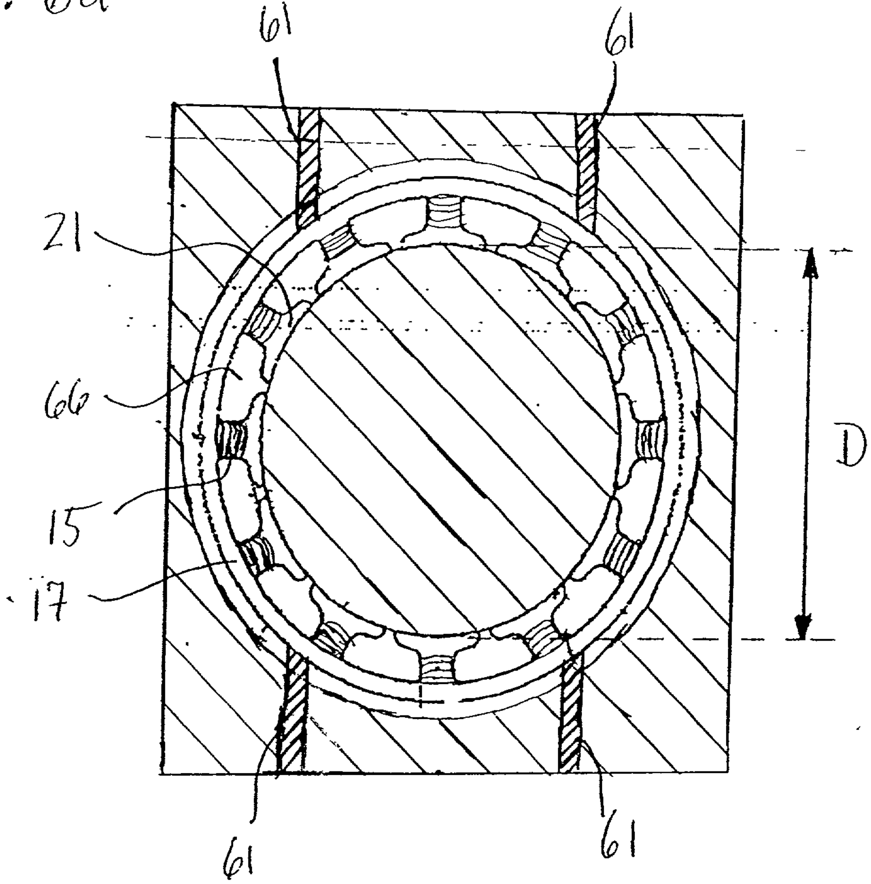
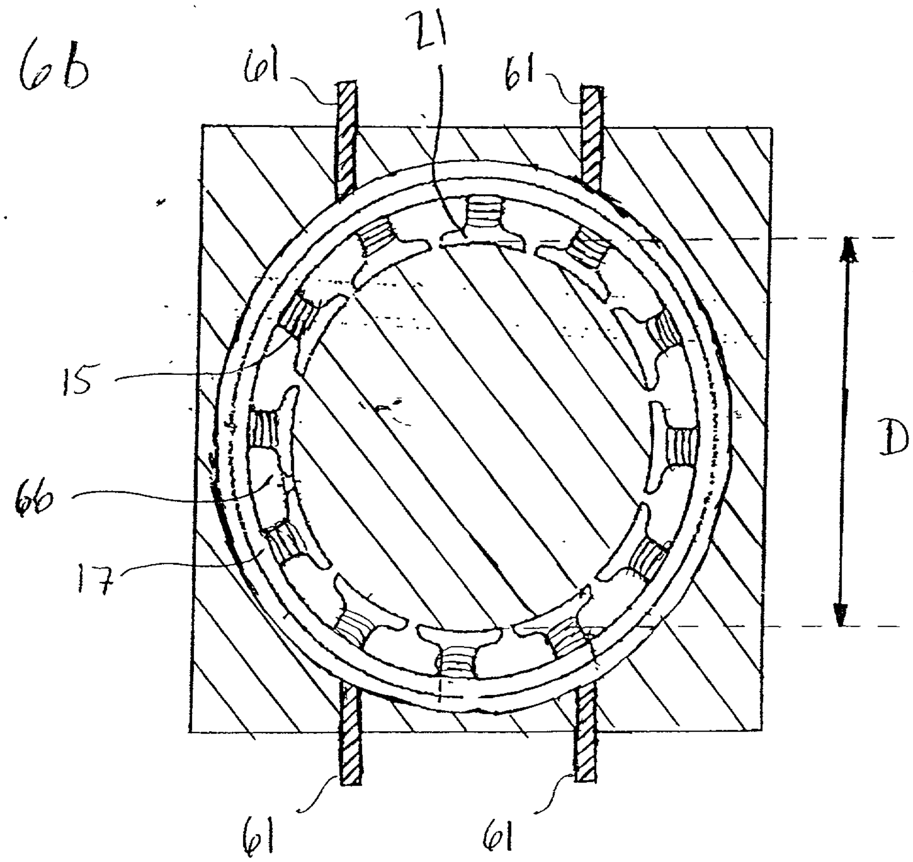


Fig. 6b



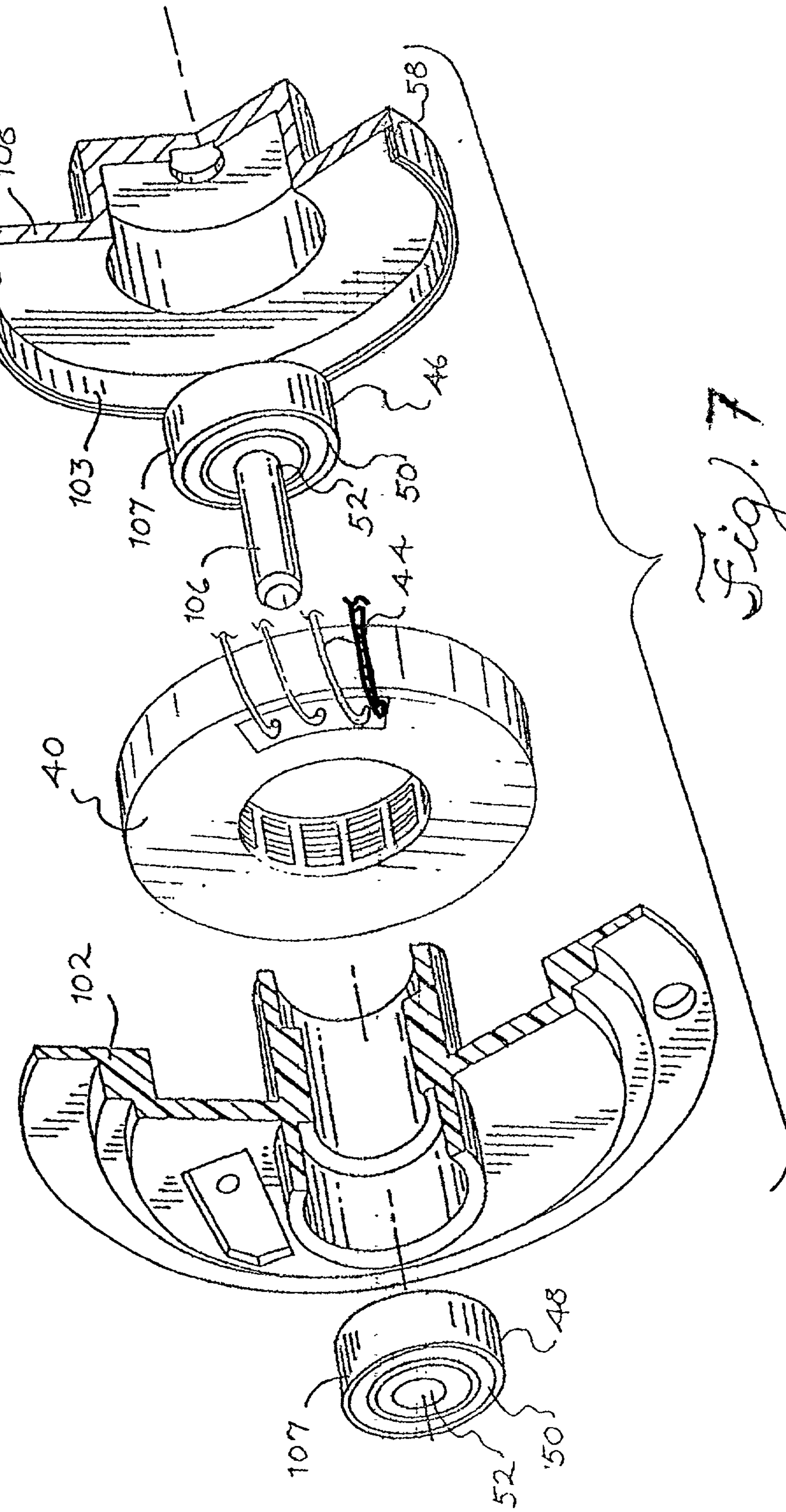


Fig. 7

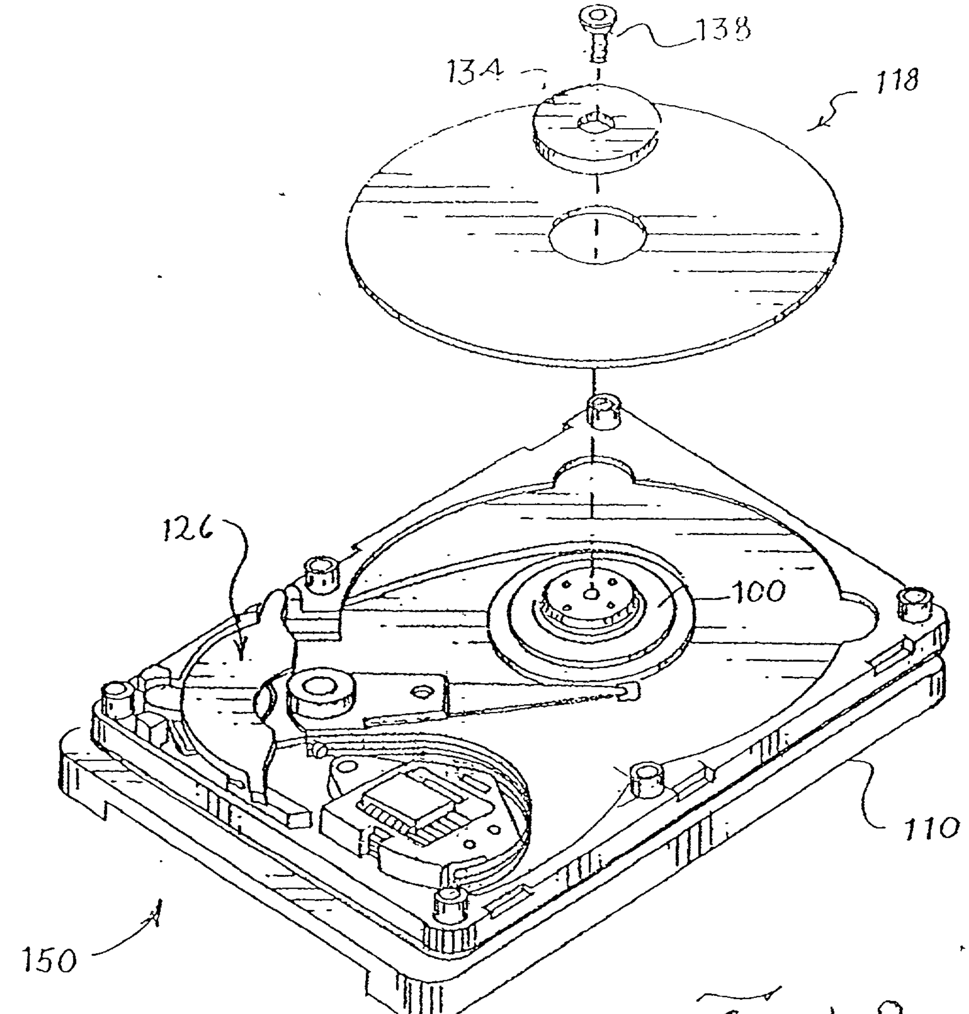

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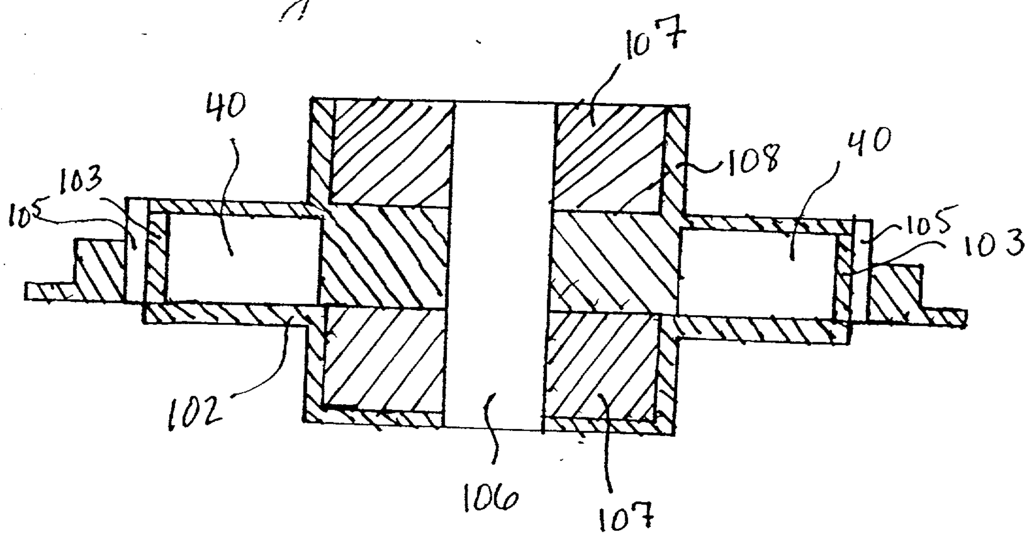
Fig. 8

Fig. 9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Case No. 8864/20

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled Stator Assembly Made From a Plurality of Torodal Core Arc Segements and Motor Using Same, the specification of which:

☒ is attached hereto.

☐ was filed on _____ as Application Serial No. _____.

☐ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability as defined in Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed Yes	Priority Claimed No
None			☐	☐

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

(Application Serial No.)	(Filing Date)
None	

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)	(Filing Date)	(Status-patented, pending, abandoned)
		none

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Inventor's Signature	Griffith D. Neal Date: 3/1/01
Full name of sole or first inventor	Griffith D. Neal
Residence	Alameda, California
Citizenship	United States of America
Post Office Address	1334 Bay Street, Alameda,California 94501

BRINKS HOFER GILSON & LIONE
P.O. Box 10395
Chicago, IL 60610
(312) 321-4200

rev. Dec.-99
F:\HOME\SPATEL\My Documents\Encap\8864-20 Declaration.doc

Case No. 8864/20

Inventor(s): GRIFFITH D. NEAL

Title: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

POWER OF ATTORNEY

The specification of the above-identified patent application:

☒ is attached hereto
☐ was filed on _____ as application Serial No. _____

I hereby revoke all previously granted powers of attorney in the above-identified patent application and appoint the following attorneys to prosecute said patent application and to transact all business in the Patent and Trademark Office connected therewith:

Steven P. Shurtz - 31,424
Jeffery M. Duncan - 31,609
Sailesh K. Patel - 46,982

Please address all correspondence and telephone calls to Sailesh K. Patel in care of:

Brinks Hofer Gilson & Lione
P.O. Box 10395
Chicago, IL 60610
(312)321-4200

The undersigned hereby authorizes the U.S. attorneys named herein to accept and follow instructions from GRIFFITH D. NEAL as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

ENCAP MOTOR CORPORATION, a CORPORATION, certifies that it is the assignee of the entire right, title and interest in the patent application identified above by virtue of either:

☒ An assignment from the inventor(s) of the patent application identified above, a copy of which is attached hereto.
OR

☐ An assignment from the inventor(s) of the patent application identified above. The assignment was recorded in the Patent and Trademark Office at Reel _____, frame _____.
OR

☐ A chain of title from the inventor(s), of the patent application identified above, to the current assignee as shown below:

1. From _____ To: _____
The document was recorded in the Patent and Trademark Office at
Reel _____, frame _____, or a copy thereof is attached.

2. From _____ To: _____
The document was recorded in the Patent and Trademark Office at
Reel _____, frame _____, or a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

The undersigned has reviewed the assignment or all the documents in the chain of title of the patent application identified above and, to the best of undersigned's knowledge and belief, title is in the assignee identified above.

The undersigned (whose title is supplied below) is empowered to act on behalf of the assignee.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signature Griffith D. Neal Date: 3/1/01
Name: Griffith D. Neal
Title: CEO

Rev. Nov. 98

Case No. 8864/20

ASSIGNMENT

WHEREAS, Griffith D. Neal, hereinafter called the "Assignor", has made the invention described in the United States patent application entitled Stator Assembly Made From a Plurality Of Toroidal Core Arc Segments and Motor Using Same, executed by Assignor on the same date of this Assignment;

WHEREAS, Encap Motor Corporation, a corporation organized and existing under the laws of the State of California, having a place of business at 540 Delancey Street, Suite 301, San Francisco, California 94107, hereinafter called the "Assignee", desires to acquire the entire right, title and interest in and to the invention and the patent application identified above, and all patents which may be obtained for said invention, as set forth below;

NOW, THEREFORE, in consideration of the sum of One Dollar ($1.00), and other valuable and legally sufficient consideration, the receipt of which by the Assignor from the Assignee is hereby acknowledged, the Assignor has sold, assigned and transferred, and by these presents does sell, assign and transfer to the Assignee, the entire right, title and interest for the United States in and to the invention and the patent application identified above, and any patents that may issue for said invention in the United States; together with the entire right, title and interest in and to said invention and all patent applications and patents therefor in all countries foreign to the United States, including the full right to claim for any such application all benefits and priority rights under any applicable convention; together with the entire right, title and interest in and to all continuations, divisions, renewals and extensions of any of the patent applications and patents defined above; to have and to hold for the sole and exclusive use and benefit of the Assignee, its successors and assigns, to the full end of the term or terms for all such patents.

The Assignor hereby covenants and agrees, for both the Assignor and the Assignor's legal representatives, that the Assignor will assist the Assignee in the prosecution of the patent application identified above; in the making and prosecution of any other patent applications that the Assignee may elect to make covering the invention identified above; in vesting in the Assignee like exclusive title in and to all such other patent applications and patents; and in the prosecution of any interference which may arise involving said invention, or any such patent application or patent; and that the Assignor will execute and deliver to the Assignee any and all additional papers which may be requested by the Assignee to carry out the terms of this Assignment.

The Commissioner of Patents and Trademarks is hereby authorized and requested to issue patents to the Assignee in accordance with the terms of this Assignment.

IN TESTIMONY WHEREOF, the Assignor has executed this agreement.

DATED: 3/1/01 Griffith D. Neal

Griffith D. Neal

STATE OF Illinois)
) ss.
COUNTY OF Cook)

I, MARIA DAVIDSON-PERRY, a Notary Public in and for the County and State aforesaid, do hereby certify that Griffith D. Neal, personally known to me to be the same person whose name is subscribed to the foregoing instrument, appeared before me this day in person and acknowledged that (s)he signed, sealed and delivered the said instrument as his/her free and voluntary act for the uses and purposes therein set forth.

IN WITNESS WHEREOF, I have hereunto set my hand and Notarial Seal, this 1st day of Feb., 20 01 .

Maria Davidson-Perry

Notary Public

OFFICIAL SEAL
MARIA DAVIDSON-PERRY
NOTARY PUBLIC, STATE OF ILLINOIS
MY COMMISSION EXPIRES:07/14/02

(SEAL)

My Commission Expires: July 14, 2002

Rev. Dec -99
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JC996 U.S. PTO
09/798511
03/02/01

JC41920

ISSUE CLASSIFICATION	
Class	Subclass

PATENT NUMBER

U.S. UTILITY Patent Application

O.I.P.E.

SCANNED RW Q.A.

PATENT DATE

APPLICATION NO.	CONT/PRIOR	CLASS	SUBCLASS	ART UNIT	EXAMINER
09/798511		310	164	~~2834~~ 3926	Stephen, K.

APPLICANTS Griffith Neal

TITLE Stator assembly made from a plurality of toroidal core segments and motor using same

PTO-2040 12/99

ISSUING CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)					
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
INTERNATIONAL CLASSIFICATION							

☐ Continued on Issue Slip Inside File Jacket

☐ TERMINAL DISCLAIMER	DRAWINGS			CLAIMS ALLOWED	
	Sheets Drwg.	Figs. Drwg.	Print Fig.	Total Claims	Print Claim for O.G.
☐ The term of this patent subsequent to ____________ (date) has been disclaimed.	(Assistant Examiner) (Date)			NOTICE OF ALLOWANCE MAILED	
☐ The term of this patent shall not extend beyond the expiration date of U.S Patent. No. ____________	(Primary Examiner) (Date)			ISSUE FEE: Amount Due	Date Paid
☐ The terminal ____ months of this patent have been disclaimed.	(Legal Instruments Examiner) (Date)			ISSUE BATCH NUMBER	

WARNING:
The information disclosed herein may be restricted. Unauthorized disclosure may be prohibited by the United States Code Title 35, Sections 122, 181 and 368. Possession outside the U.S. Patent & Trademark Office is restricted to authorized employees and contractors only.

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SEARCHED

Class	Sub.	Date	Exmr.
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310	214		

INTERFERENCE SEARCHED

Class	Sub.	Date	Exmr.

SEARCH NOTES
(INCLUDING SEARCH STRATEGY)

	Date	Exmr.

(RIGHT OUTSIDE)

ISSUE SLIP STAPLE AREA (for additional cross references)

POSITION	INITIALS	ID NO.	DATE
FEE DETERMINATION	[illegible]		03-08-0[illegible]
O.I.P.E. CLASSIFIER		10	3-28-01
FORMALITY REVIEW	MH	920	05-11-01
RESPONSE FORMALITY REVIEW	[illegible]	1110	9-5-01

INDEX OF CLAIMS

✓ .... Rejected		N .... Non-elected	
= .... Allowed		I .... Interference	
— (Through numeral)... Canceled		A .... Appeal	
÷ .... Restricted		O .... Objected	

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03/02/01

"Express Mail" mailing label number EL669269646US.
Date of Deposit March 2, 2001

Case No. 8864/20

PATENT APPLICATION TRANSMITTAL LETTER

To the Commissioner for Patents:

Transmitted herewith for filing is the patent application of: Griffith D. Neal for : STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS ANDMOTOR USING SAME. Enclosed are:

- ☒ Six (6) sheet(s) of drawings, twenty-four (24) pages of application (including title page), and the following Appendices : _____.
- ☒ Declaration.
- ☒ Power of Attorney.
- ☐ Verified statement to establish small entity status under 37 CFR §§ 1.9 and 1.27.
- ☒ Assignment transmittal letter and Assignment of the invention to : Encap Motor Corporation.
- ☐ _____.

JC996 U.S. PTO
09/798511
03/02/01

Claims as Filed	Col. 1	Col. 2	Small Entity		or	Other Than Small Entity	
For	No. Filed	No. Extra	Rate	Fee	or	Rate	Fee
Basic Fee				$ 355	or		$ 710
Total Claims	29-20	9	x$9=	$81	or	x$18=	$
Indep. Claims	5-3	2	x$40=	$40	or	x$80=	$
Multiple Dependent Claims Present			+$135=	$	or	+$270=	$
			Total	$516	or	Total	$

*If the difference in col. 1 is less than zero, enter "0" in col. 2.

- ☐ Please charge my Deposit Account No. 23-1925 in the amount of $: _____. A duplicate copy of this sheet is enclosed.
- ☒ A check in the amount of $: 516 to cover the filing fee is enclosed.
- ☒ The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.
  - ☒ Any additional filing fees required under 37 CFR § 1.16.
  - ☒ Any patent application processing fees under 37 CFR §1.17.
- ☐ The Commissioner is hereby authorized to charge payment of the following fees during the pendency of this application or credit any overpayment to Deposit Account No. 23-1925. A duplicate copy of this sheet is enclosed.
  - ☐ Any filing fees under 37 CFR § 1.16 for presentation of extra claims.
  - ☐ Any patent application processing fees under 37 CFR § 1.17.
  - ☐ The issue fee set in 37 CFR § 1.18 at or before mailing of the Notice of Allowance, pursuant to 37 CFR § 1.311(b).

3/2/01
Date

Sailesh Patel
Sailesh K. Patel
BRINKS HOFER GILSON & LIONE
Registration No. 46,982

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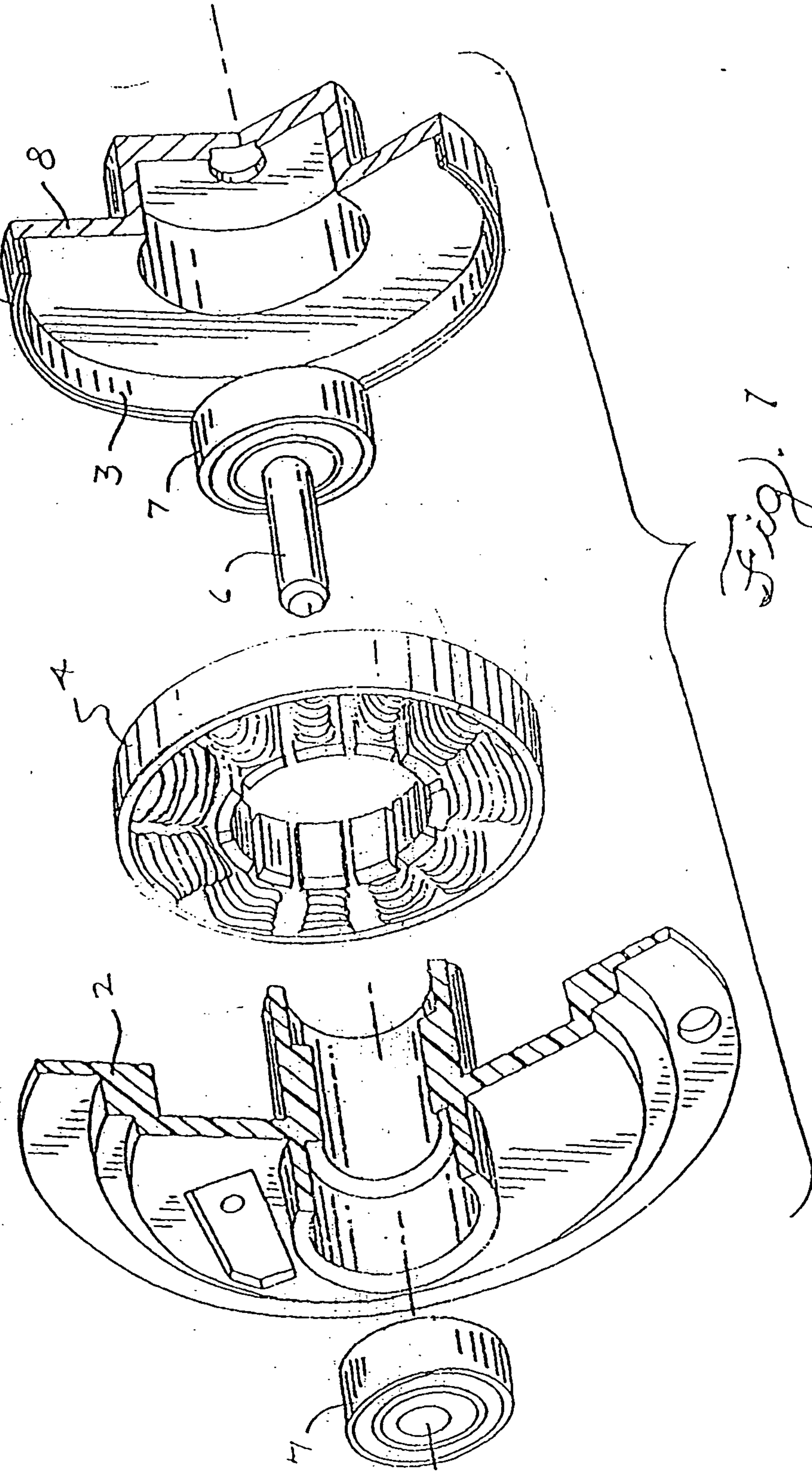

Fig. 1

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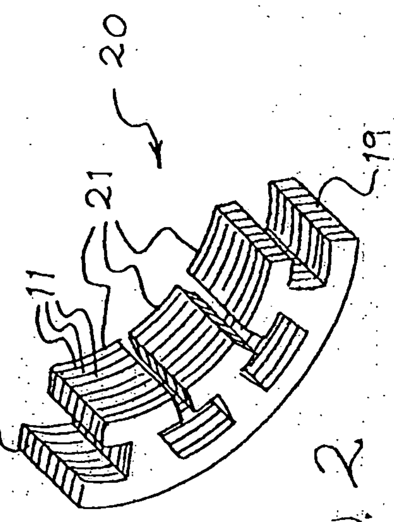

Fig. 2

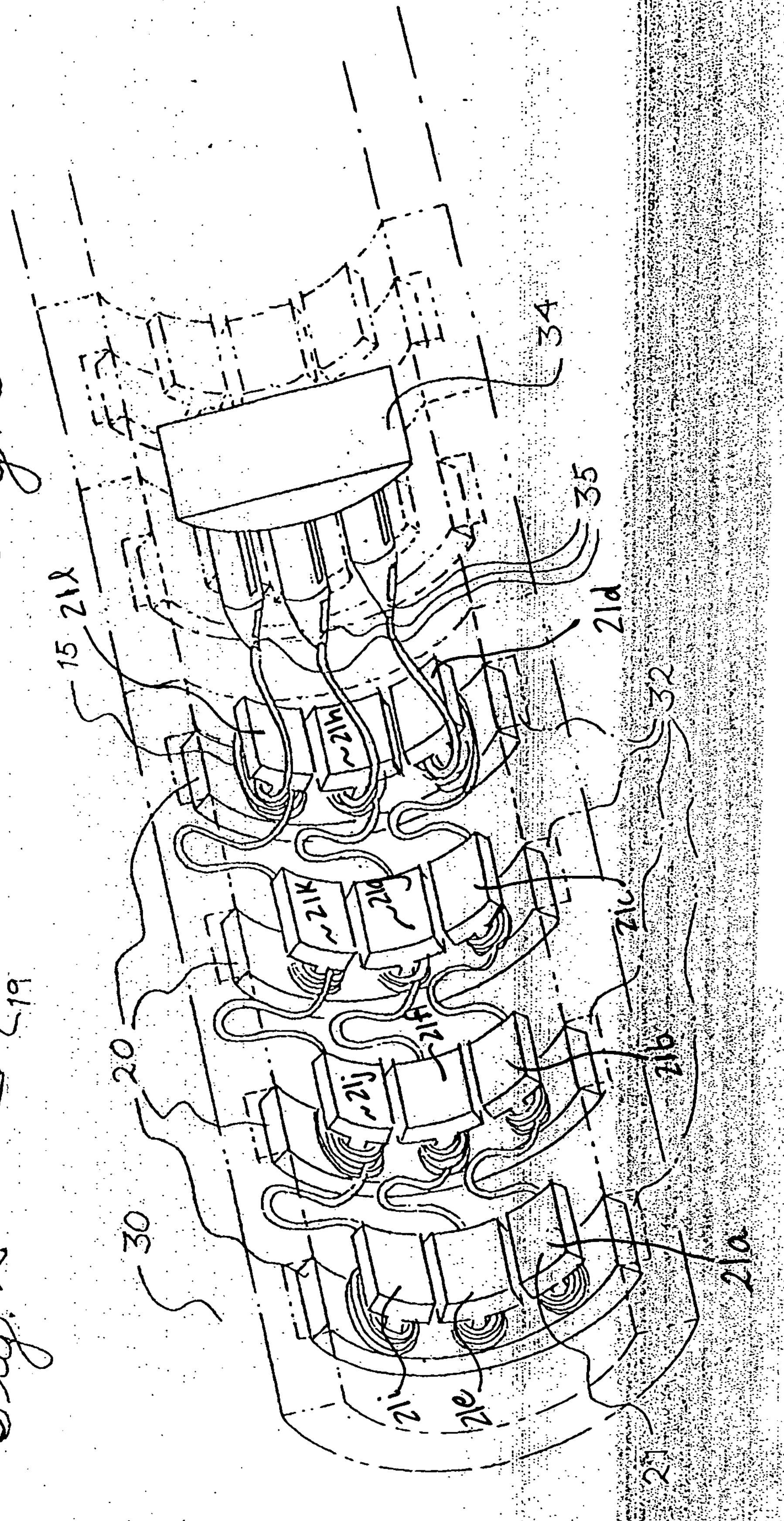

Fig. 3

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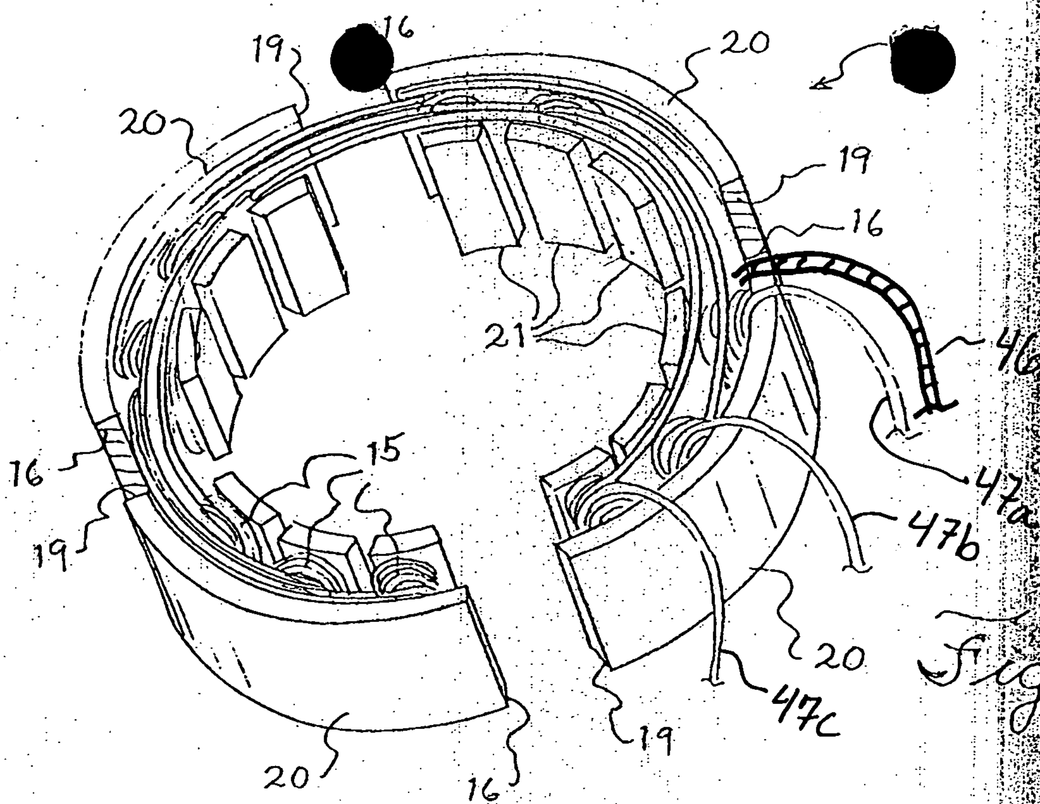


Fig. 4

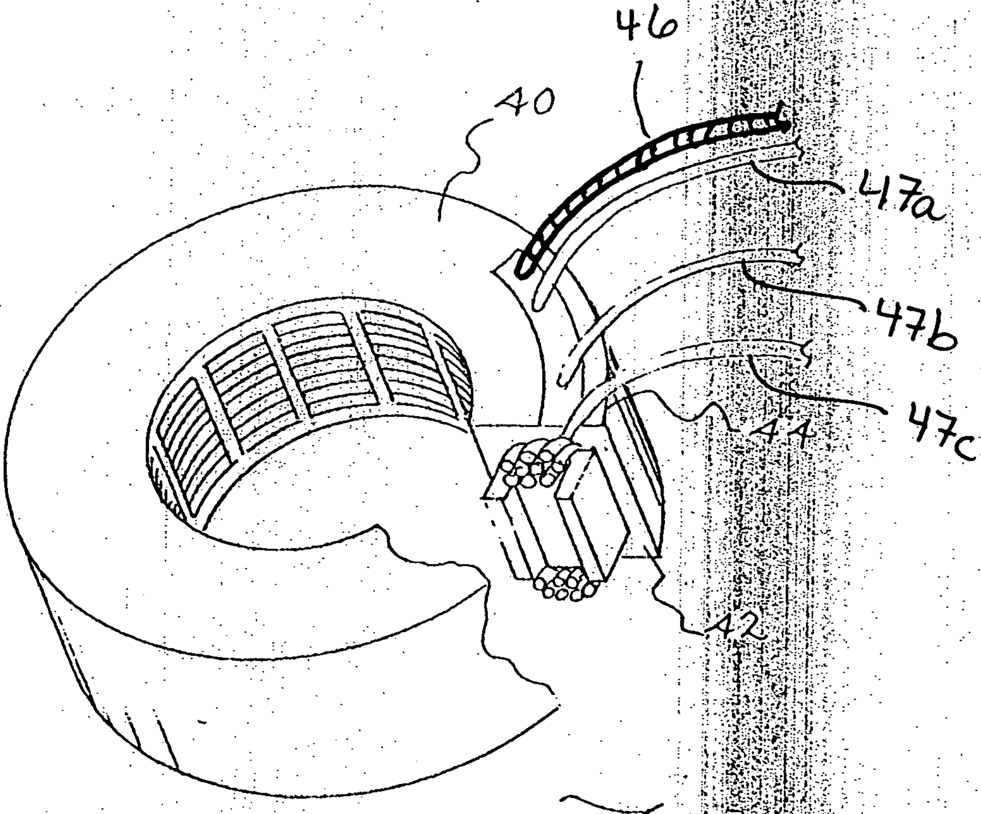


Fig. 5

Fig. 6a

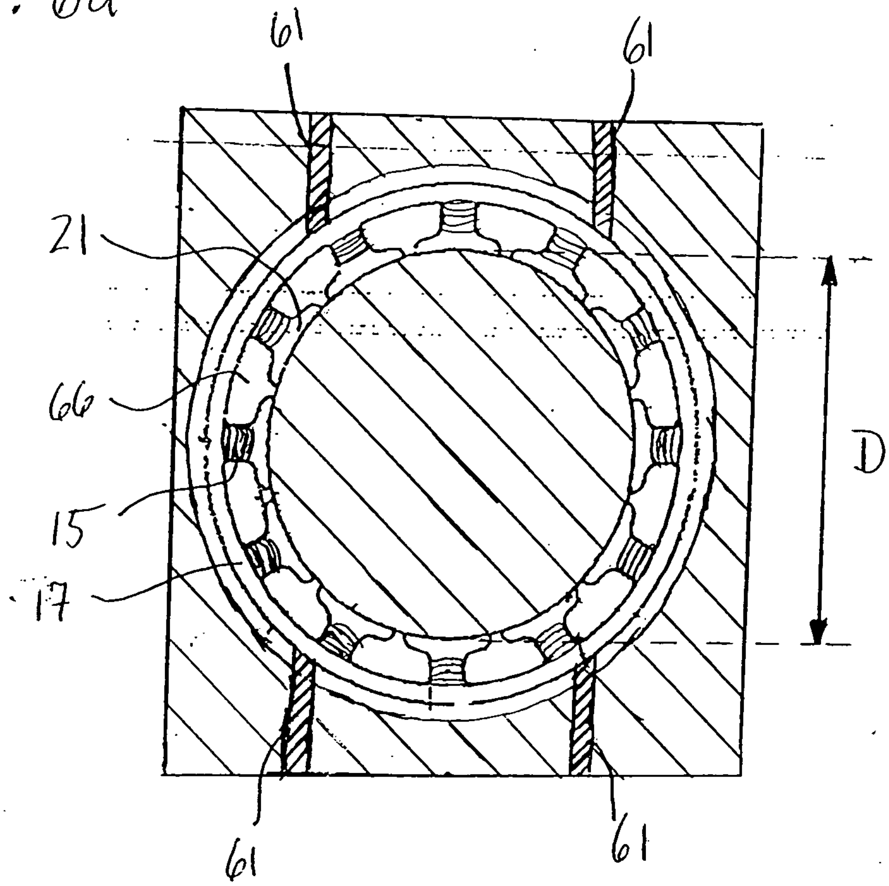
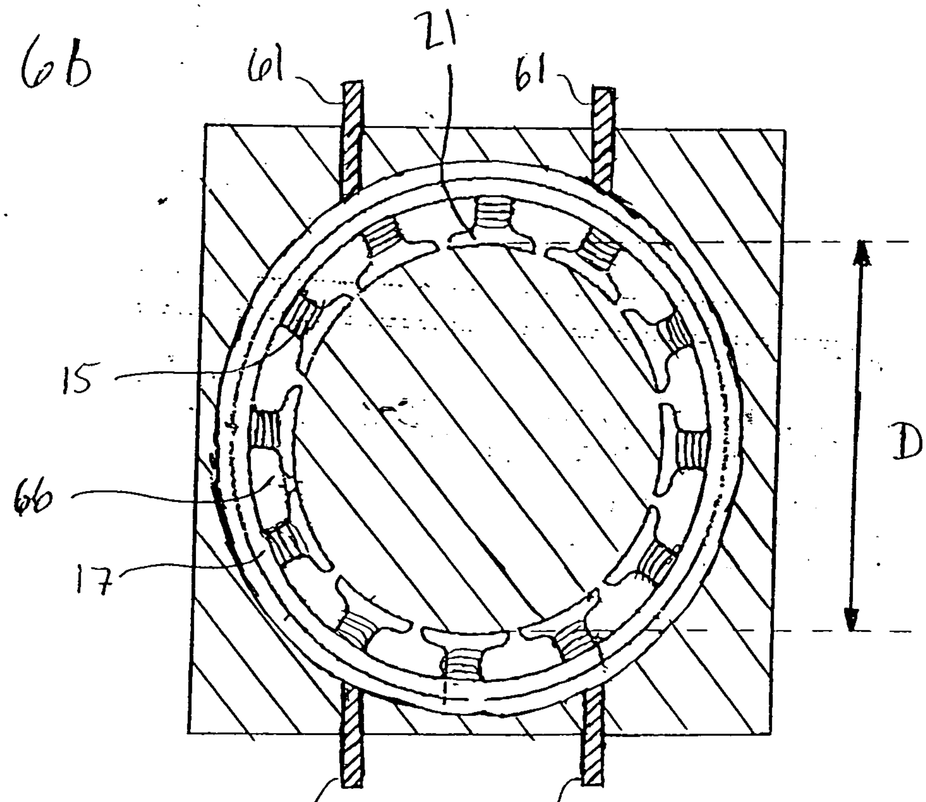


Fig. 6b



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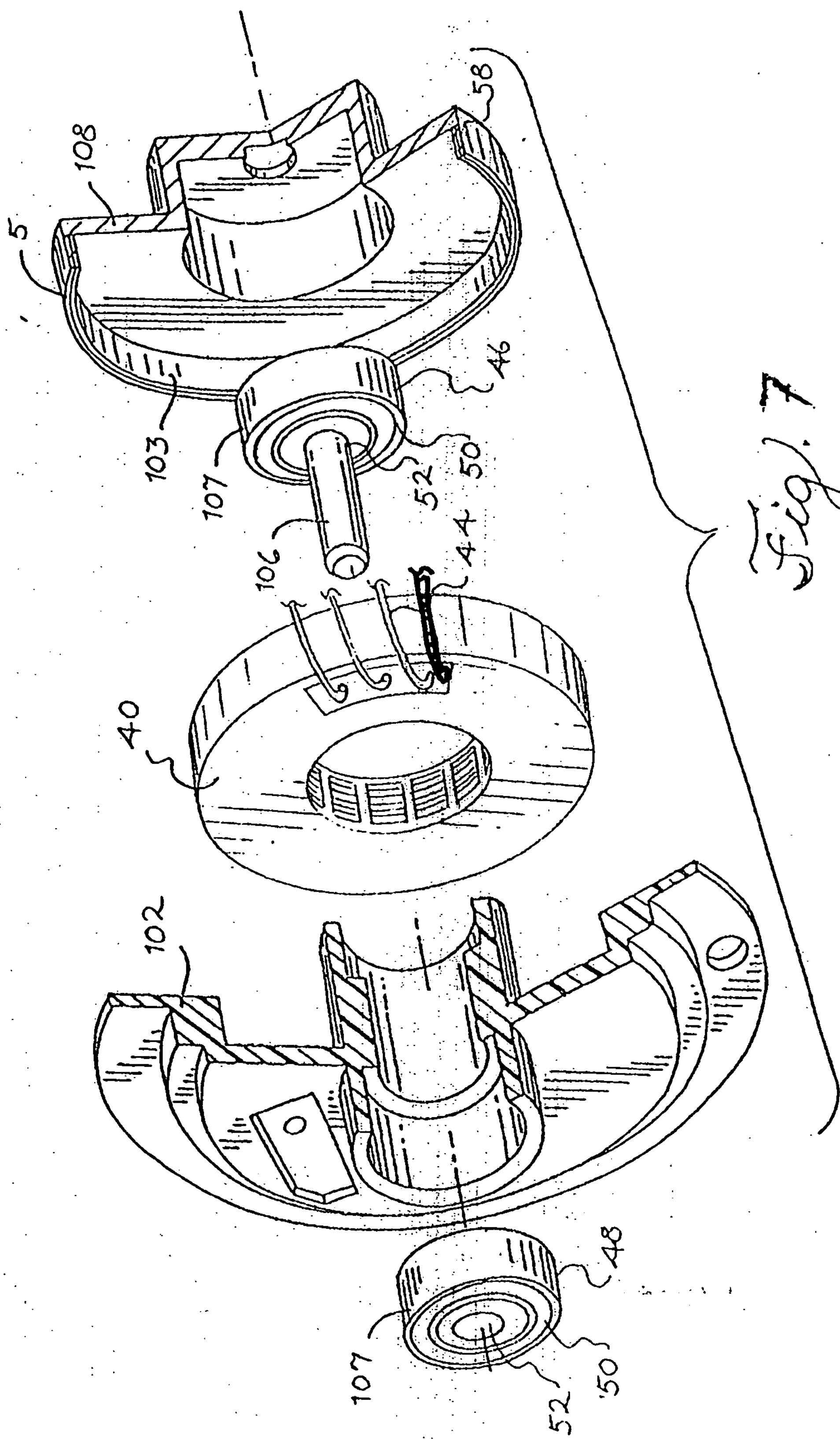

Fig. 7

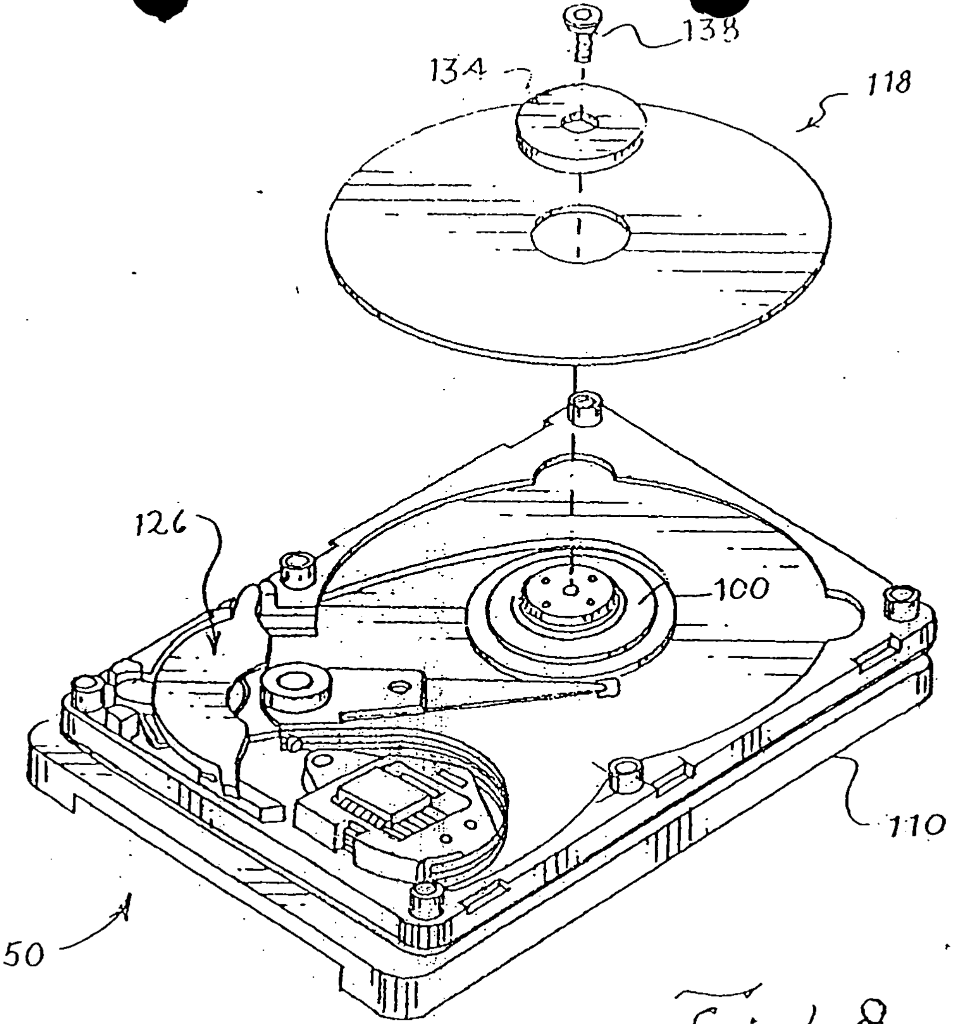
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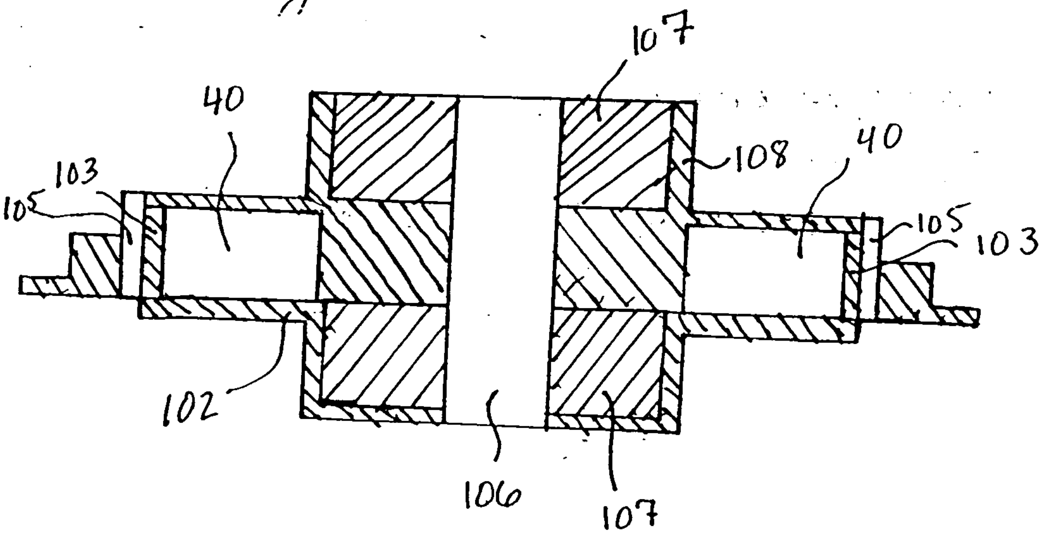
Fig. 8

Fig. 9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Our Case No. 8864/20

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
APPLICATION FOR UNITED STATES LETTERS PATENT

INVENTOR: GRIFFITH D. NEAL

TITLE: STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE ARC SEGMENTS AND MOTOR USING SAME

ATTORNEYS:

STEVEN P. SHURTZ
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SAILESH K. PATEL
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CHICAGO, ILLINOIS 60610
(312) 321-4200

STATOR ASSEMBLY MADE FROM A PLURALITY OF TOROIDAL CORE SEGMENTS AND MOTOR USING SAME

FIELD OF THE INVENTION

The present invention relates generally to a stator assembly used in a motor. It relates particularly to a spindle motor such as used in a hard disc drive, and to the construction and arrangement of a stator assembly made from a plurality of arc segments.

BACKGROUND OF THE INVENTION

Computers commonly use disc drives for memory storage purposes. Disc drives include a stack of one or more magnetic discs that rotate and are accessed using a head or read-write transducer. Typically, a high speed motor such as a spindle motor is used to rotate the discs.

In conventional spindle motors, stators have been made by laminating together stamped pieces of steel. These stamped pieces of steel are generally circular in nature, but also have "poles" extending either inwardly or outwardly, depending on whether the rotor is on the inside or surrounds the stator. The stamped pieces are laminated together and then coated with insulation. Wire is then wound around the poles to form stator windings.

An example of a conventional spindle motor 1 is shown in FIG. 1. The motor 1 includes a base 2 which is usually made from die cast aluminum, a stator 4, a shaft 6, bearings 7 and a disc support member 8, also referred to as a hub. A magnet 3 and flux return ring 5 are attached to the disc support member 8. The stator 4 is separated from the base 2 using an insulator (not shown) and attached to the base 2 using a glue. Distinct structures are formed in the base 2 and the disc support member 8 to accommodate the bearings 7. One end of the shaft 6 is inserted into the bearing 7 positioned in the base 2 and the other end of the shaft 6 is placed in the bearing 7 located in the hub 8. A separate electrical connector 9 may also be inserted into the base 2.

Each of these parts must be fixed at predefined tolerances with respect to one another. Accuracy in these tolerances can significantly enhance motor performance.

In operation, the disc stack is placed upon the hub. The stator windings are selectively energized and interact with the permanent magnet to cause a defined rotation of the hub. As hub 8 rotates, the head engages in reading or writing activities based upon instructions from the CPU in the computer.

Manufacturers of disc drives are constantly seeking to improve the speed with which data can be accessed. To an extent, this speed depends upon the efficiency of the spindle motor, as existing magneto-resistive head technology is capable of accessing data at a rate greater than the speed offered by the highest speed spindle motor currently in production. The efficiency of the spindle motor is dependent upon the dimensional consistency or tolerances between the various components of the motor. Greater dimensional consistency between components leads to a smaller gap between the stator 4 and the magnet 3, producing more force, which provides more torque and enables faster acceleration and higher rotational speeds.

The conventional method of forming stators has a number of drawbacks. First, most steel is manufactured in rolled sheets and thus has a grain orientation. The grain orientation has an effect on the magnetic flux properties of the steel. In circular stamped pieces of steel, the grain orientation at different points around the circle differs. Compared from the radius line of the circle, the grain orientation is sometimes aligned along the radius, sometimes transverse to it, and mostly at a varying angle to the radius. The un-aligned grain structure of conventional stators causes the magnetic flux values to differ in parts of the stator and thus the motor does not have consistent and uniform torque properties as it rotates.

Another drawback with using circular steel pieces is that, especially for inward facing poles, it has been difficult to wind the wire windings tightly because of the cramped space to work inside of the laminated stator core. The cramped working space creates a lower limit on the size of the stator and thus the motor. The limited working space also results in a low packing density of wire. The packing density of wire coiled around the poles affects the amount of power generated by the motor. Increasing packing density increases the power and thus the efficiency of the spindle motor.

An important factor in motor design is to reduce stack up tolerances in the motor. Stack up tolerances reduce the overall dimensional consistency between the components. Stack up tolerances refer to the sum of the variation of all the tolerances of all the parts, as well as the overall tolerance that relates to the alignment of the parts relative to one another. One source of stack up tolerances is from the circular stator body. Generally, the thickness of rolled steel is not uniform across the width of the roll. Sometimes the edges are thicker or thinner than the center. In a stator made from circular stamped pieces, the thickness of individual laminations are thus different from one side to the other. When stacked together, this creates a stack up tolerance problem. Furthermore, the circular stampings leave a lot of wasted steel that is removed and must be recycled or discarded.

Another important factor in motor design is the lowering of the operating temperature of the motor. Increased motor temperature affects the electrical efficiency of the motor and bearing life. As temperature increases, resistive loses in wire increase, thereby reducing total motor power. Furthermore, the Arhennius equation predicts that the failure rate of an electrical device is exponentially related to its operating temperature. The frictional heat generated by bearings increases with speed. Also, as bearings get hot they expand, and the bearing cages get stressed and may deflect, causing non-uniform rotation reducing bearing life. This non-uniform rotation causes a further problem of limiting the ability of the servo system controlling the read/write heads to follow data tracks on the magnetic media. One drawback with existing motor designs is their limited effective dissipation of the heat, and difficulty in incorporating heat sinks to aid in heat dissipation. In addition, in current motors the operating temperatures generally increase as the size of the motor is decreased.

Manufacturers have established strict requirements on the outgassing of materials that are used inside a hard disc drive. These requirements are intended to reduce the emission of materials onto the magnetic media or heads during the operation of the drive. Of primary concern are glues used to attach components together, varnish used to insulate wire, and epoxy used to protect steel laminations from oxidation.

In addition to such outgassed materials, airborne particulate in a drive may lead to head damage. Also, airborne particulates in the disc drive could interfere with signal transfer between the read/write head and the media. To reduce the effects of potential airborne particulate, hard drives are manufactured to exacting clean room standards and air filters are installed inside of the drive to reduce the contamination levels during operation.

An example of a spindle motor is shown in U.S. Patent No. 5,694,268 (Dunfield *et al.*) (incorporated herein by reference). Referring to FIG. 5 of this patent, a stator of the spindle motor is encapsulated with an overmold 42. The overmolded stator 40 contains openings through which mounting pins 44 may be inserted for attaching the stator 200 to a base. U.S. Patent No. 5,672,972 (Viskochil) (incorporated herein by reference) also discloses a spindle motor having an overmolded stator. One drawback with the overmold used in these patents is that it has a different coefficient of linear thermal expansion ("CLTE") than the corresponding metal parts to which it is attached. Another drawback with the overmold is that it is not very effective at dissipating heat. Further, the overmolds shown in these patents are not effective in dampening some vibrations generated by energizing the stator windings.

U.S. Patent No. 5,806,169 (Trago) (incorporated herein by reference) discloses a method of fabricating an injection molded motor assembly. However, the motor disclosed in Trago is a step motor, not a high speed spindle motor, and would not be used in applications such as hard disc drives. Further, none of these three prior art designs address the problem of variation in the thickness of steel used to make the stator cores and the non-uniform grain structure in the steel compared to the magnetic flux in the stator during operation of the motor. Thus, a need exists for an improved high speed spindle motor, having properties that will be especially useful in a hard disc drive, overcoming the aforementioned problems.

BRIEF SUMMARY OF THE INVENTION

A high speed motor has been invented which overcomes many of the foregoing problems. In addition, unique stator assemblies and other components of a high speed motor have been invented, as well as methods of manufacturing motors and hard disc drives. In one aspect, the invention is a motor comprising: a plurality of stator arc segments forming a toroidal core, wherein each said stator arc segment has two end surfaces that are each in contact with an end surface of another stator arc segment to form a toroidal core; and a monolithic body of phase change material substantially encapsulating the stator arc segments and holding said toroidal core in place.

In another aspect the invention is a method of making a motor comprising: providing at least two stator arc segments each having a first end surface and a second end surface; aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment; and substantially encapsulating said toroidal core with a monolithic body of phase change material and solidifying the phase change material to hold the stator arc segments together.

In another aspect the invention is a method of making a motor comprising: providing four stator arc segments, wherein each stator arc segment has a first end surface and a second end surface; aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment; and substantially encapsulating said toroidal core with a monolithic body of phase change material, wherein said substantially encapsulating is by injection molding said phase change material around said toroidal core.

In yet another aspect, the invention is a combination of stator arc segments and a carrier used to support said stator arc segments during a winding operation comprising a plurality of stator arc segments, and: a plurality of cavities to hold and support said stator arc segments, wherein said cavities are spaced apart a distance X, wherein the distance X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

The invention provides the foregoing and other features, and the advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention and do not limit the scope of the invention, which is defined by the appended claims and equivalents thereof.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is an exploded, partial cross-sectional and perspective view of a conventional high speed motor of the present invention.

FIG. 2 is a perspective view of a stator arc segment.

FIG. 3 is a perspective view of a combined carrier assembly and stator arc segments of FIG. 2.

FIG. 4 is a perspective view of stator arc segments of FIG. 2 with windings thereon ready to be formed into a toroidal core.

FIG. 5 is a perspective view of an injection molded stator assembly using the stator arc segments of FIG. 4.

FIG. 6a is a cross-sectional view of the toroidal core of FIG. 4 in an injection mold assembly, prior to injecting a phase change material.

FIG. 6b is a cross-sectional view of the toroidal core of FIG. 4 in an injection mold assembly, after injecting a phase change material.

FIG. 7 is an exploded, partial cross-sectional and perspective view of a high speed motor using the encapsulated stator of FIG. 5.

FIG. 8 is an exploded, partial cross-sectional and perspective view of a high speed motor and disc assembly made with the motor of FIG. 7.

FIG. 9 is a cross-sectional view of the motor of FIG. 8.

DETAILED DESCRIPTION OF THE DRAWINGS AND PREFERRED EMBODIMENTS OF THE INVENTION

A preferred embodiment of a high speed motor of the present invention and portions of the motor at different stages of manufacture are shown in FIGS. 2-7 and 9. By "high speed" it is meant that the motor can operate at over 5,000 rpm. The spindle motor 100 is designed for rotating a disc or stack of discs in a computer hard drive. Motor 100 is formed by using an injection molded stator assembly 40, that is formed by injection molding a plurality of stator arc segments 20 aligned to form a toroidal core 17. Although the embodiment described here uses four arc segments, one of ordinary skill in the art will understand that two, three or any greater number of arc segments may be used. The preferred motor of the present invention is smaller, has a grain structure that is more uniformly aligned, allows for greater packing density of wire and reduces waste of steel in the manufacturing process as compared with conventional motors used for disc drives, thereby increasing power and reducing stack up tolerances and manufacturing costs and producing other advantages discussed below.

Referring to FIG. 2, a stator arc segment 20 is first constructed, using steel laminations 11. The stator arc segment 20 is made of steel pieces that are stamped out of rolled steel. The stamped steel pieces are arc segments, but also have poles 21 extending inwardly or outwardly depending on whether the rotor is inside or surrounds the stator. In the embodiment shown in FIG. 2, the poles 21 are shown extending inwardly. The stamped pieces are then coated with epoxy which provides insulation and laminates the pieces together to form a stator arc segment 20.

As shown in FIG. 3, the stator arc segments 20 are then preferably placed in a carrier 30. The carrier 30 has a plurality of cavities 32 that hold the stator arc segments 20 in place. In a preferred embodiment, the space between the cavities is equivalent to the length of wire needed to travel from a point on one pole 21a to the next pole 21b in the same phase of windings following the arc of the stator arc segments 20. The carrier 30 shown in FIG. 3 shows an alternative embodiment where the space between the cavities is not necessarily equivalent to the length of wire needed to travel from a point on one pole 21a to the next pole 21b. By precisely aligning the stator arc segments 20, the carrier 30 greatly enhances the efficiency for winding wire 15 around the poles 21 and manufacturing stators.

Wire 15 is then wound around the poles 21 of the stator arc segments 20 using a spool winder 34 that has a set of needles 35 that wind wire around the poles 21. The wire 15 is wound around one pole 21 and is then wound around another pole 21 in its phase until all poles 21 in the same phase are wound with the same wire 15. Poles 21 in other phases are also similarly wound. Having only arc segments, rather than a full toroidal core, and placing the arc segments 20 in the carrier 30 makes it much easier for needle 35 to wind wire 15 around poles 21. Using this method, a wire packing density of about 60 percent to about 80 percent can be achieved.

As shown in FIG. 4, the stator arc segments 20 are then removed from the carrier and aligned to form a magnetically inducible toroidal core 17 having a plurality of poles 21 thereon, and wire windings 15 which serve as conductors. To form the toroidal core 17, an end surface 16 of each stator arc segment 20 is aligned and brought into contact with a corresponding end surface 19 of another stator arc segment 20. The wire 15 between the poles 21 of different stator arc segments 20 is also aligned in the toroidal core 17, following the arc of the stator arc segments 20. As a result, the wire in the toroidal core 17 is taught. After the wire is wound so that one set of three leads is terminated together to create the common ground 46, and the other ends of the wire, are for each of the three phases form the leads 47a, 47b and 47c by which current is supplied to the windings. The conductors induce or otherwise create a plurality of magnetic fields in the core when electrical current is conducted through the conductors. In this embodiment, a magnetic field is induced in each of the poles 21.

As shown in FIG. 5, the toroidal core 17 is then encapsulated in a body 42. Together the toroidal core 17 and the body 42 make up an injection molded stator assembly 40. The body 42 is preferably a monolithic body. Monolithic is defined as being formed as a single piece. The body 42 substantially encapsulates the toroidal core 17. Substantial encapsulation means that the body 42 either entirely surrounds the toroidal core 17, or surrounds almost all of it except for minor areas of the toroidal core 17 that may be exposed. However, substantial encapsulation means that the body 42 and toroidal core 17 are rigidly fixed together, and behave as a single component with respect to harmonic oscillation vibration.

The body 42 is preferably formed of a phase change material, meaning a material that can be used in a liquid phase to envelope the stator, but which later changes to a solid phase. There are two types of phase change materials that will be most useful in practicing the invention: temperature activated and chemically activated. A temperature activated phase change material will become molten at a higher temperature, and then solidify at a lower temperature. However, in order to be practical, the phase change material must be molten at a temperature that is low enough that it can be used to encapsulate a toroidal core. Preferred phase change materials will be changed from a liquid to a solid in the range of about 200 °F to about 700 °F, more preferably in the range of about 550 °F to about 650 °F. The most preferred temperature activated phase change materials are thermoplastics. The preferred thermoplastic will become molten at a temperature at which it is injection-moldable, and then will be solid at normal operating temperatures for the motor. An example of a phase change material that changes phases due to a chemical reaction, and which could be used to form the body, is an epoxy. Other suitable phase change materials may be classified as thermosetting materials.

The preferred method of developing the monolithic body 42 comprises designing a phase change material to have a coefficient of linear thermal expansion such that the phase change material contracts and expands at approximately the same rate as the metal laminations of the toroidal core 17. For example, the preferred phase change material should have a CLTE of between 70% and 130% of the CLTE of the core of the stator. The phase change material should have a CLTE that is intermediate the maximum and minimum CLTE of the toroidal core and other motor components where the body is in contact with those other components and they are made of a different material than the core. Also, the CLTE's of the body and toroidal core should match throughout the temperature range of the motor during its operation. An advantage of this method is that a more accurate tolerance may be achieved between the body and the components of the toroidal core because the CLTE of the body matches the CLTE of the toroidal core components more closely. Most often the toroidal core components will be metal, and most frequently steel and copper. Other motor parts are often made of aluminum and steel.

Most thermoplastic materials have a relatively high CLTE. Some thermoplastic materials may have a CLTE at low temperatures that is similar to the CLTE of metal. However, at higher temperatures the CLTE does not match that of the metal. A preferred thermoplastic material will have a CLTE of less than 2 x 10^{-5} in/in/°F, more preferably less than 1.5 x 10^{-5} in/in/°F, throughout the expected operating temperature of the motor, and preferably throughout the range of 0-250°F. Most preferably, the CLTE will be between about 0.8 x 10^{-5} in/in/°F and about 1.2 x 10^{-5} in/in/°F throughout the range of 0-250°F. (When the measured CLTE of a material depends on the direction of measurement, the relevant CLTE for purposes of defining the present invention is the CLTE in the direction in which the CLTE is lowest.)

The CLTE of common solid parts used in a motor are as follows:

	23°C	250°F	
Steel	0.5	0.8	(x10^{-5} in/in/°F)
Aluminum	0.8	1.4	
Ceramic	0.3	0.4	

Of course, if the motor is designed with two or more different solids, such as steel and aluminum components, the CLTE of the phase change material would preferably be one that was intermediate, the maximum CLTE and the minimum CLTE of the different solids, such as 0.65 in/in/°F at room temperature and 1.1 x10^{-5} in/in/°F at 250°F.

One preferred thermoplastic material, Konduit OTF-212-11, was made into a thermoplastic body and tested for its coefficient of linear thermal expansion by a standard ASTM test method. It was found to have a CLTE in the range of –30 to 30°C of 1.09×10^{-5} in/in/°F in the X direction and 1.26×10^{-5} in/in/°F in both the Y and Z directions, and a CLTE in the range of 100 to 240°C of 1.28×10^{-5} in/in/°F in the X direction and 3.16×10^{-5} in/in/°F in both the Y and Z directions. (Hence, the relevant CLTEs for purposes of defining the invention are 1.09×10^{-5} in/in/°F and 1.28×10^{-5} in/in/°F.) Another similar material, Konduit PDX –0-988, was found to have a CLTE in the range of –30 to 30°C of 1.1×10^{-5} in/in/°F in the X direction and 1.46×10^{-5} in/in/°F in both the Y and Z directions, and a CLTE in the range of 100 to 240°C of 1.16×10^{-5} in/in/°F in the X direction and 3.4×10^{-5} in/in/°F in both the Y and Z directions. By contrast, a PBS type polymer, (Fortron 4665) was likewise tested. While it had a low CLTE in the range of –30 to 30°C (1.05×10^{-5} in/in/°F in the X direction and 1.33×10^{-5} in/in/°F in both the Y and Z directions), it had a much higher CLTE in the range of 100 to 240°C (1.94×10^{-5} in/in/°F in the X direction and 4.17×10^{-5} in/in/°F in both the Y and Z directions).

In addition to having a desirable CLTE, the preferred phase change material will also have a high thermal conductivity. A preferred thermoplastic material will have a thermal conductivity of at least 0.7 watts/meter°K using ASTM test procedure 0149 and tested at room temperature (23°C).

Stator assemblies made from arc segments held together by a body of phase change material partially encapsulating the stator are themselves novel and define another aspect of the present invention.

In the present embodiment, the phase change material used to make the body 42 is preferably a thermally conductive but non-electrically conductive plastic. In addition, the plastic preferably includes ceramic filler particles that enhance the thermal conductivity, while reducing the coefficient of linear thermal expansion of the plastic. A preferred form of plastic is polyphenyl sulfide (PPS) sold under the tradename "Konduit" by LNP. Grade OTF-212 PPS is particularly preferred. Examples of other suitable thermoplastic resins include, but are not limited to, thermoplastic resins such as 6,6-polyamide, 6-polyamide, 4,6-polyamide, 12,12-polyamide, 6,12-polyamide, and polyamides containing aromatic monomers, polybutylene terephthalate, polyethylene terephthalate, polyethylene napththalate, polybutylene napththalate, aromatic polyesters, liquid crystal polymers, polycyclohexane dimethylol terephthalate, copolyetheresters, polyphenylene sulfide, polyacylics, polypropylene, polyethylene, polyacetals, polymethylpentene, polyetherimides, polycarbonate, polysulfone, polyethersulfone, polyphenylene oxide, polystyrene, styrene copolymer, mixtures and graft copolymers of styrene and rubber, and glass reinforced or impact modified versions of such resins. Blends of these resins such as polyphenylene oxide and polyamide blends, and polycarbonate and polybutylene terephthalate, may also be used in this invention.

As shown in FIG. 6a, to encapsulate the toroidal core 17 and form body 42, the toroidal core 17 is first clamped and held in place by pins 61 in an injection mold cavity 66. The injection mold cavity 66 is very effective and maintains the toroidal shape of the toroidal core 17. Molten phase-change material is then injected into the molding cavity 66 with an extrusion screw (not shown) until the pressure inside the cavity reaches a predetermined molding pressure. After injecting the molten phase change material, the pins 61 retract as shown in FIG. 6b. The phase change material is then allowed to cool and solidify into a monolithic body 42 that substantially encapsulates the toroidal core 17. The preferred thickness of the body 42 depends on the aspect ratio of the toroidal core 17.

The injection molded stator assembly 40 is then used to construct the rest of the spindle motor 100 (FIG. 7). The spindle motor 100 includes a hub 108, which serves as a disc support member, the stator assembly 40, a base 102, a shaft 106 and bearings 107.

As shown in FIG. 7, a shaft 106 is connected to the hub or disc support member 108 and is surrounded by bearings 107, which are adjacent against the base 102 of the motor. A rotor or magnet 103 is fixed to the inside of the hub 108 on a flange so as to be in operable proximity to the stator assembly. The magnet 103 is preferably a permanent magnet, as described below.

Referring to FIG. 7, the bearings 107 include an upper bearing 46 and a lower bearing 48. Also, each bearing 107 has an outer surface 50 and an inner surface 52. The outer surface 50 of the upper bearing contacts the hub 108 and the outer surface 50 of the lower bearing 48 contacts the lower support base 102. The inner surfaces 52 of the bearings 107 contact the shaft 116. The bearings are preferably annular shaped. The inner surfaces 52 of the bearings 107 may be press fit onto the shaft 16. A glue may also be used. The outer surface 50 of the bearings 107 may be press fit into the interior portion of the base 102. A glue may also be used. The bearings in the embodiment shown in FIG. 7 are ball bearings. Alternatively other types of bearings, such as hydrodynamic or combinations of hydrodynamic and magnetic bearings, may be used. The bearings are typically made of stainless steel.

The shaft 106 is concentrically disposed within the interior portion of the stator assembly 40 and the base 102. The bearings 107 surround portions of the shaft 106. As described above, the inner surfaces 52 of the bearings are in contact with the shaft 106. The shaft 106 includes a top portion 54 and a bottom portion 56. The top portion 54 of the shaft 106 is fixed to the hub 108. The bottom portion 54 of the shaft 106 is free to rotate inside the lower bearing. Thus, in this embodiment, the shaft 106 is freely rotatable relative to the base 102. The shaft 106 is preferably cylindrical shaped. The shaft 106 may be made of stainless steel.

Referring to FIGS. 7 and 9, the hub 108 is concentrically disposed around the stator assembly 40 and the base 102. The hub 108 is fixed to the shaft 106 and is spaced apart from the stator assembly 40 and the base 102. The hub 108 includes a flux return ring 58 and the magnet 103. The flux return ring 58 is glued to the disc support member. The magnet 103 is glued to the hub 108. As shown in FIG. 7, the magnet 103 concentrically surrounds the stator assembly 40. In this embodiment the magnet 103 and stator assembly 40 are generally coplanar when the motor 100 is assembled.

The magnet 103 is preferably a sintered part and is one solid piece. The magnet 103 is placed in a magnetizer which puts a plurality of discrete

North and South poles onto the magnet 103, dependant on the number of poles 21 on the toroidal core 17. The flux return ring 58 is preferably made of a magnetic steel. The hub is preferably made of aluminum. Also, the hub may be made of a magnetic material to replace the flux return ring. Other motor designs using an encapsulated stator that can be made by the present invention are disclosed in provisional U.S. Patent Application Serial No. 60/171,817, filed December 21, 1999, incorporated herein by reference.

The spindle motor described above can be part of a motor and disc assembly 150 as shown in FIG. 8. The disc assembly 150 has a disc stack assembly 118, spindle motor 100, an actuator assembly 126, and a base 110. These subassemblies of the disc assembly are maintained in a precise relationship by precisely machined mounting positions on base 110.

The spindle motor 100 is mounted securely to the base 110, for example through mounting holes and matching bolts (not shown) located on the hub 108 of spindle motor 100. Alternatively, spindle motor 100 may be adhesively mounted to base 110. The disc stack assembly is then mounted to spindle motor 100 through a disc clamp 134 through a mounting screw 138. The spindle motor 100, as shown in FIG.8, has a hub 108, stator assembly 40 and base 102 that are mounted together using bearings 107 and axle 106.

Advantages of the Present invention

An advantageous feature of the preferred embodiment is provided by the fact that the stator assembly 40 is formed from stator arc segments 20 that are aligned to form a toroidal core 17 and substantially encapsulated with a monolithic body 42 to form a stator assembly 40. Using stator arc segments 20 provides a more uniform grain structure to the toroidal core 17. The grain orientation of prior art circular stampings varies a great deal at different points around the circle. By using arc segments, a more uniform grain structure may be obtained. The grain orientation has an effect on the magnetic flux properties of the steel. By making all the arc segments have the same orientation compared to the grain structure of the steel from which they are stamped, the grain structure in the core is more uniform and the magnetic flux is more uniform and the motor 100 of the present invention has more consistent and uniform torque properties as it rotates. This also leads to greater motor efficiency and performance.

The preferred spindle motor also has greater packing density of wire 15. In the disclosed embodiment of the invention, the toroidal core 17 is made of sections, preferably four stator arc segments 20. It should be understood that the disclosed method can use any number of stator arc segments 20 greater than at least two. With circular stamped stators, there is a limitation of the spacing between each pole 21 to allow the needle 35 feeding the winding wire 15 to enter and exit the gap. Additionally in small motors (less than 1.5 inches outer diameter), it is difficult to wind three phases of wire concurrently. Furthermore, this geometry makes the process of applying uniform, evenly spaced turns difficult to achieve. In this case, since only quarter circles are stamped, there is more room to work, and a needle 35 feeding the winding wire 15 can thus pack the windings more tightly. The carrier 30 also allows for this winding to be done more efficiently. Increasing the packing density of wire 15 increases the magnetic field thereby providing more electromotive force and increased power to the motor 100.

The limited working space for winding wire 15 around the poles 21 in circular stamped stators limits the size of spindle motors as well. Since the disclosed method allows for increased working room, smaller motors may be made with the present method compared to prior art methods.

The disclosed spindle motor 100 minimizes stack up tolerances. Since in the present embodiment only quarter circles are being used, the stamped quarter circles can be stamped from portions of the steel roll that is of consistent thickness. Thus, the resulting stacked stator arc segment 20 will have reduced stack up tolerances. Reducing the stack up tolerances optimizes dimensional consistency and thereby enables higher rotational speeds with lower vibration induced runout. Furthermore, since arc segments are used instead of circular stampings, they can be more closely laid out when being stamped, reducing the amount of resulting scrap.

Further, in the prior art, to prevent a motor from seizing when it gets hot, larger than desired gaps between the magnet 3 and the stator assembly 4 were used so that when pieces expanded from being heated, the magnet would not contact the stator. If the magnet contacted the stator, the contact would generate magnetic particulate which can damage the heads and interfere with their ability to read or record data on the discs. Also, if the body has a CLTE greater than that of the steel laminations in the stator, the gap has to be large enough so that the expansion of the body as the motor heats up does not cause the body to contact the rotating magnet (even though the steel laminations are not close to contacting the magnet). With the preferred embodiment of the present invention, with the CLTE of the body matching that of the steel laminations, much smaller gaps, as low as 0.005 inches and more preferably as low as 0.003 inches, can be utilized. As the body 42 expands, it only expands at the same rate as the laminations, and does not grow to the point that the body 42 diminishes the gap size to zero. Thus, the only gap that is needed is one sufficient for expansion of the steel laminations. These smaller gaps make the motor 100 more efficient, as the electrical efficiency of the motor decreases with larger distances between the stator and the rotating magnet.

Through the use of the present embodiment, a particular plastic may be chosen for the body 42 that has properties of rockwell hardness, flex modulus, and elongation that are specifically designed to counteract the vibratory frequencies generated by the motor 100. Thus, the disclosed spindle motor 100 substantially reduces motor vibration. This reduced vibration allows information on a disc to be stored closer together, thereby enabling higher data density.

The disclosed spindle motor 100 also reduces the emission of materials from the motor components onto the magnetic media or heads of the disc drive. This is achieved because components such as the stator, which potentially emit such materials, are substantially encapsulated in plastic.

In addition, the disclosed spindle motor 100 obviates the necessity of a separate plastic or rubber ring sometimes used to isolate the spindle motor from the hard drive in order to prevent shorts from being transferred to the magnetic media and ultimately the read-write heads. Because the disclosed spindle motor body 42 is preferably made of a non-electrically conductive (having a dielectric strength of at least 250 volts/mil) and injectable thermoplastic material, such a separate rubber isolating ring is unnecessary. Once again this reduces manufacturing costs and the stack up tolerances associated with using an additional part.

It is contemplated that numerous modifications may be made to the spindle motor and method for making the spindle motor of the present invention without departing from the spirit and scope of the invention as defined in the claims. For example, while the exemplary embodiment shown in the drawings has four stator arc segments 20, those skilled in the art will appreciate that the same method can be used to make stator assemblies with two stator arc segments or any number greater than two. Furthermore, the body 42 can encapsulate more than just the toroidal core. The body 42 can also encapsulate or form the base 102 of the motor without departing from the scope of the invention. Accordingly, while the present invention has been described herein in relation to several embodiments, the foregoing disclosure is not intended or to be construed to limit the present invention or otherwise to exclude any such other embodiments, arrangements, variations, or modifications and equivalent arrangements. Rather, the present invention is limited only by the claims appended hereto and the equivalents thereof.

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CLAIMS

SUB B' cont.

1. A stator assembly, comprising:

a) a plurality of stator arc segments forming a toroidal core, wherein each said stator arc segment has two end surfaces that are each in contact with an end surface of another stator arc segment to form the toroidal core; and

b) a monolithic body of phase change material substantially encapsulating the stator arc segments and holding said end surfaces in contact with one another.

2. The stator assembly of claim 1 wherein each of the stator arc segments has a plurality of poles with wire wound around said poles.

3. The stator assembly of claim 2 wherein the packing density of the wire around the poles is between about 60 percent and about 80 percent.

4. The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than 2×10^{-5} in/in/°F throughout the range of 0-250°F.

5. The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of less than 1.5×10^{-5} in/in/°F throughout the range of 0-250°F.

6. The stator assembly of claim 1 wherein the phase change material has a coefficient of linear thermal expansion of between about 0.8×10^{-5} in/in/°F and about 1.2×10^{-5} in/in/°F throughout the range of 0-250°F.

7. The stator assembly of claim 1 wherein the phase change material has a thermal conductivity of at least 0.7 watts/meter°K at 23°C.

8. The stator assembly of claim 1 wherein the phase change material comprises polyphenyl sulfide.

SUB B1 cont.

9. A method of making a stator assembly for a motor comprising:

a) providing at least two stator arc segments each having a first end surface and a second end surface;

b) aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment; and

c) substantially encapsulating said toroidal core with a monolithic body of phase change material to form said stator assembly.

10. The method of claim 9 wherein each of said stator arc segments have a plurality of poles extending inwardly from a base of said stator arc segment.

11. The method of claim 10 wherein prior to said step of aligning, the wire is wound around said poles of said stator arc segments.

12. The method of claim 11 wherein said stator arc segments are placed in a carrier that holds and supports said stator arc segments while the wire is wound around said poles.

13. The method of claim 12 wherein said carrier has a plurality of cavities to hold and support said stator arc segments.

14. The method of claim 13 wherein said cavities are spaced apart a distance X, wherein X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

15. The method of claim 9 wherein said toroidal core has multiple conductors that create a plurality of magnetic fields when electrical current is conducted through the conductors.

SUB B' cont.

16. The method of claim 9 wherein said phase change material is selected from the group consisting of thermoplastics and thermosetting materials.

17. The method of claim 9 wherein prior to said substantially encapsulating, said toroidal core is clamped in an injection mold cavity to maintain the toroidal shape.

18. The method of claim 9 wherein said step of substantially encapsulating the core is performed by injection molding said phase change material around said toroidal core.

19. The method of claim 18 wherein said phase change material is injected into a mold at temperature of between about 200°F and about 700°F.

20. The method of claim 18, wherein said phase change material is injected into a mold at a temperature of between about 550°F to about 650°F.

21. A method of making a motor comprising:

a) providing four stator arc segments, wherein each stator arc segment has a first end surface and a second end surface;

b) aligning said stator arc segments to form a toroidal core, wherein each said end surface of one segment is in contact with an opposing end surface of another segment;

c) substantially encapsulating said toroidal core with a monolithic body of phase change material, wherein said substantially encapsulating is by injection molding said phase change material around said toroidal core to form a stator assembly; and

d) constructing the stator assembly into a motor.

22. The method of claim 21 wherein each of said stator arc segments comprise a plurality of steel laminations.

23. A motor made from the stator assembly of claim 1.

Sub B' cont.

24. The motor of claim 21 wherein said motor comprises a stator assembly, a shaft, a base, bearings, a rotor, at least one permanent magnet and a hub.

25. An electronic device including the motor of claim 21.

26. A motor and disc assembly including the motor made by the method of claim 21.

27. A combination of stator arc segments and a carrier used to support said stator arc segments during a winding operation comprising:

a) a plurality of stator arc segments; and

b) a plurality of cavities to hold and support said stator arc segments.

28. The combination of stator arc segments and carrier of claim 27 wherein said cavities are spaced apart a distance X, wherein the distance X is the length of uncoiled wire necessary to align said stator arc segments to form a toroidal core.

29. A stator arc segment comprising a plurality of steel laminations and at least one pole.

add a'

ABSTRACT OF THE DISCLOSURE

A plurality of stator arc segments form a toroidal core for a stator assembly used to make a motor. In a preferred embodiment, a plurality of magnetic fields is created when electrical current is conducted through wire wound around poles on the toroidal core. A monolithic body of phase change material substantially encapsulates the conductors and holds the stator arc segments in contact with each other in the toroidal core. Hard disc drives using the motor, and methods of constructing the motor and hard disc drives are also disclosed.

Case No. 8864/20

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled Stator Assembly Made From a Plurality of Torodal Core Arc Segements and Motor Using Same, the specification of which:

☒ is attached hereto.

☐ was filed on _____ as Application Serial No. _____.

☐ and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability as defined in Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s) — Priority Claimed

(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
None			☐	☐

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

(Application Serial No.)	(Filing Date)
None	

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)	(Filing Date)	(Status-patented, pending, abandoned)
		none

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Inventor's Signature: Griffith D. Neal Date: 3/1/01

Full name of sole or first inventor: Griffith D. Neal

Residence: Alameda, California

Citizenship: United States of America

Post Office Address: 1334 Bay Street, Alameda,California 94501

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P.O. Box 10395
Chicago, IL 60610
(312) 321-4200

rev. Dec.-99
F:\HOME\SPATEL\My Documents\Encap\8864-20 Declaration.doc

Inventor(s): GRIFFITH [redacted] EAL

Title: STATOR ASSEMBLY MADE FROM A PLURALITY OF TO[redacted]IDAL CORE ARC SEGMENTS AND MOTOR USING SAME

POWER OF ATTORNEY

The specification of the above-identified patent application:

☒ is attached hereto
☐ was filed on _____ as application Serial No. _____

I hereby revoke all previously granted powers of attorney in the above-identified patent application and appoint the following attorneys to prosecute said patent application and to transact all business in the Patent and Trademark Office connected therewith:

Steven P. Shurtz - 31,424
Jeffery M. Duncan - 31,609
Sailesh K. Patel - 46,982

Please address all correspondence and telephone calls to Sailesh K. Patel in care of:

Brinks Hofer Gilson & Lione
P.O. Box 10395
Chicago, IL 60610
(312)321-4200

The undersigned hereby authorizes the U.S. attorneys named herein to accept and follow instructions from GRIFFITH D. NEAL as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorneys named herein will be so notified by the undersigned.

ENCAP MOTOR CORPORATION, a CORPORATION, certifies that it is the assignee of the entire right, title and interest in the patent application identified above by virtue of either:

☒ An assignment from the inventor(s) of the patent application identified above, a copy of which is attached hereto.
OR

☐ An assignment from the inventor(s) of the patent application identified above. The assignment was recorded in the Patent and Trademark Office at Reel _____, frame _____.
OR

☐ A chain of title from the inventor(s), of the patent application identified above, to the current assignee as shown below:

1. From _____ To: _____
   The document was recorded in the Patent and Trademark Office at
   Reel _____, frame _____, or a copy thereof is attached.

2. From _____ To: _____
   The document was recorded in the Patent and Trademark Office at
   Reel _____, frame _____, or a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

The undersigned has reviewed the assignment or all the documents in the chain of title of the patent application identified above and, to the best of undersigned's knowledge and belief, title is in the assignee identified above.

The undersigned (whose title is supplied below) is empowered to act on behalf of the assignee.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Signature Griffith D Neal Date: 3/1/01
Name: Griffith D. Neal
Title: CEO

Rev. Nov. 98

PATENT APPLICATION SERIAL NO. ______________________

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

03/12/2001 EHAILU 00000028 09798511

01 FC:201	355.00 OP
02 FC:202	80.00 OP
03 FC:203	81.00 OP

PTO-1556
(5/87)

*U.S. GPO: 2000-468-987/39595

PATENT APPLICATION FEE DETERMINATION RECORD Effective October 1, 2000	Application or Docket Number

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	29	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	29 minus 20=	* 9
INDEPENDENT CLAIMS	5 minus 3 =	* 2
MULTIPLE DEPENDENT CLAIM PRESENT		☐

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	355.00	OR	BASIC FEE	710.00
X$ 9=	81.00	OR	X$18=	
X40=	80.00	OR	X80=	
+135=		OR	+270=	
TOTAL	516.00	OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 32	Minus	** 29	= 3
Independent	* 5	Minus	*** 5	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDI-TIONAL FEE		RATE	ADDI-TIONAL FEE
X$ 9=	27.00	OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 31	Minus	** 32	=
Independent	* 4	Minus	*** 5	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDI-TIONAL FEE		RATE	ADDI-TIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDI-TIONAL FEE		RATE	ADDI-TIONAL FEE
X$ 9=		OR	X$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."
***If th "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875
(Rev. 8/00)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET *(FOR USE WITH FORM PTO-875)*	SERIAL NO. 09798511	FILING DATE 03-02-01
	APPLICANT(S)	

CLAIMS

	AS FILED		AFTER 1st AMENDMENT		AFTER 2nd AMENDMENT	
	IND.	DEP.	IND.	DEP.	IND.	DEP.
1	/					
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TOTAL IND.	5					
TOTAL DEP.	24					
TOTAL CLAIMS	29					

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TOTAL DEP.						
TOTAL CLAIMS						

*MAY BE USED FOR ADDITIONAL CLAIMS OR ADMENDMENTS

FORM PTO-1360 (REV. 3-78)

U.S.DEPARTMENT OF COMMERCE
Patent and Trademark Office