DETERMINING THE TRUE CAUSE BEHIND SUPERCONDUCTIVITY, DEVELOPMENT OF A NEW THEORY TO EXPLAIN IT

KUNWAR JAGDISH NARAIN[a)]

Department of Physics, Govt. Bilasa Girls P.G. (Autonomous) College,

Bilaspur (C.G.) 495001, INDIA

In order to explain why (i.e. cause) and how (i.e. way) superconductivity is generated and related properties and its effects take place, presently a new theory has been propounded determining such a cause over which unfortunately, despite having its knowledge, nobody ever tried to think, while it acts as the true cause. Consequently, the present theory gives a very clear and complete explanation (picture) why and how superconductivity is generated and related properties and its effects take place. So far unexplained some properties have also been explained, e.g.: 1. Why and how transition temperature (T_c) varies from substance to substance; 2. Why and how very good conductors of current, e.g. gold, silver, copper do not superconduct even down to very low temperatures; 3. Why and how ferromagnetic substances do not superconduct; etc. Most important- it has also been tried to explain how currently known some non-superconducting (e.g. ferromagnetic) substances can be made superconducting. In order to verify/justify the truth of the determined cause, plausible arguments and evidences have been given from the well-established knowledge. The existing theories fail to give a clear and complete explanation as to how superconductivity is generated and related properties and effects take place, which is their great drawback. Because, whenever any phenomenon takes place, there occurs always a way (procedure), how that phenomenon and related properties take place, and hence if any theory is developed in order to explain that phenomenon, the theory must give a clear and complete explanation how that phenomenon and related properties take place. The existing theories, in addition, give rise to several such questions of which no any explanation can be given. The BCS theory for which it is claimed that it provides better explanation and accounts very well for all the properties exhibited by the superconductor. But if we examine this theory closely, we find that it is based on such concepts which: 1. Are practically not possible; 2. Contradict two well-observed facts; 3. Give rise to numerous such questions of which no explanation can be given. These drawbacks raise serious question mark over the truth of the BCS theory. Finally, some possible new effects have been predicted and it has been tried to explain why and how they shall take place.

Key Words: Resistanceless state, superconducting state, persistent current, transition temperature, diamagnetism.

a) kjnarain@yahoo.co.in

1. INTRODUCTION

As per existing concept of resistance, due to collisions of the charge carriers i.e. free electrons, with the atoms (or lattices) of the substance, the substance offers resistance to the current while that flows through the substance, because these collisions produce obstructions in the ways of flow of free electrons. When the temperature of the substance decreases, due to decrease in thermal vibrations of the atoms (or lattices) of the substance, the probability of their collisions with the flowing free electrons decreases, which consequently decreases the resistance of that substance. At transition temperature T_c of the substance, when the substance becomes superconductor and there starts flowing the persistent current (which flows for indefinitely long time without any external aid, e.g. voltage applied), it is assumed that the resistance of the substance is reduced to zero. But how can the resistance of any substance become zero as long as the atoms (or lattices) of that substance, the collisions of which with the free electrons of the substance give rise to resistance, exist over there into the substance? If we assume that, at temperature T_c, the vibrations of atoms (or lattices) of the substance is reduced so much that their collisions with the electrons stop taking place consequently the resistance of the substance is reduced to zero and current starts flowing persistently. Practically it is not possible.

2. THEORY

The collisions of electrons with the atoms (or lattices) of the substance and also among themselves can stop and persistent current can flow through the substance only if

i. All the free electrons of the substance possess direction of their linear motion, and at temperature T_c, the directions of their linear motion are oriented and aligned by some means (in practice, it is done by the applied external magnetic field, keeping in which the substance is cooled down to its T_c, for detail see onwards) in the direction of motion of the persistent current such that there do not lie atoms (or lattices) of the substance in their paths.

ii. Since the persistent current flows due to the persistent flow of free electrons, the free electrons (and the Cooper pairs of BCS theory, see section-5) have some initial linear velocity with which they start flowing and is maintained during their persistent flow. At T_c, there occurs no external source to provide initial linear velocity to them.

iii. There exists some source (or cause), which provides direction to the linear motion (velocity) of free electrons and maintains their motion in that direction for indefinitely long time (because the persistent current flows for indefinitely long time) against the gravitational force. Otherwise the gravitational force cannot let them to flow constantly for indefinitely long time and in a fixed direction, because the electron has mass and hence the effect of gravitational force on them cannot be ignored or ruled out, and that too when they flow for indefinitely long time.

At temperature T_c, since the persistent current flows in the substances, it implies, the above requirements are fulfilled. But how these requirements are fulfilled, let us find that out.

As the first step in the process of finding, let us examine the internal structure of different substances. When we examine, we find that the substances are mostly crystalline in which the atoms are found systematically and periodically arranged, and due to that, there are found huge number of inter-atomic passages (or can say, inter-lattice passages) through which the electrons can flow freely. If the directions of motion of electrons of the substance are somehow oriented and aligned by some means such that they may flow through these passages freely without having collisions with the atoms of the substance or among themselves, their flow can persist for indefinitely long time, provided there exists some source/cause with them to provide initial linear velocity to them and to keep their motion maintained against the gravitational force without any external aid. But the questions arise: 1- How the directions of motion of electrons are aligned, 2- What is that source or cause which provides initial linear velocity to them and keeps their motion maintained for indefinitely long time against the gravitational force without any external means. Let us try to find out that source/cause.

In order to find out that source/cause, let us examine the nature of electrons. The electron possesses spin motion, and by virtue of that, it possesses linear motion (velocity) in the direction of its spin angular momentum L_s (for detail, see reference-1). Therefore, the spin motion of electrons acts as the cause, and it provides initial linear velocity to them along the directions of their respective L_s and keeps their motion maintained for indefinitely long time without having any external aid. (How their velocities are oriented and aligned, see section-3.)

But the questions arise, if there exists such cause, which provides linear velocity to the free electrons and keeps their motion maintained for long-long time without having any external aid, why does only then the persistent current start flowing when the substance arrives at T_c? Why not earlier, i.e. at temperatures $>T_c$? Let us therefore think over it and try to find out the cause or reason lying behind it.

If we think deeply and thoroughly over it, the reason, which appears lying behind it, can be that, there exists some more obstacle(s) other than the atoms of the substance, which too lies in the way of flow of electrons and obstructs their flow. This obstacle persists there into the substance always as long as the temperature (T) of the substance remains $>T_c$, and as soon as T arrives at T_c, this obstacle disappears. Let us therefore try to find out, what is that obstacle(s).

We know that inside the substances, the emission of photons from the orbiting electrons of the substances goes on always. It can be verified too if we bring a substance from a hot place to some cooler place, the substance is cooled down to the temperature of that cooler place. This cooling occurs due to the emission of heat energy from the surface of the substance in the form of radiations, known as photons. The photons, which are emitted from the surface of the substance, do/can not start getting produced as soon as the substance is brought to cooler place. Their production goes on always in the substance at all its temperatures ($>T_c$). Then obviously, they exist always inside the substance and go on traveling here and there inside the substance. During their travel, the photons obviously collide with the free electrons of the substance found in their way of traveling and obstruct the flow of electrons.

Therefore, the obstacles, which persist there always into the substance at all its temperatures $>T_c$ and are disappeared at temperature $\leq T_c$, can be these photons. Let us now investigate whether these photons are disappeared at temperature $\leq T_c$ or not, and if these are disappeared, then how?

We know that the photons are emitted from the orbiting electrons when they are excited. But when the temperature of the substance decreases thermal energy of its atoms and hence of its orbiting electrons shall go on decreasing. In the process of decreasing of temperature of the substance, a temperature shall positively be obtained when the thermal energy of the orbiting electrons of the substance shall be reduced so much that some of the orbiting electrons shall become unable to excite to any allowed higher energy states. Consequently, these orbiting electrons shall stop exciting and hence emitting photons. Since the innermost orbiting electrons require maximum energy for their excitation because of having maximum binding energy, they shall stop exciting and emitting photons first. If the temperature of the substance is reduced further, the thermal energy of the comparatively outer orbiting electrons too shall be reduced so much that they shall be unable to excite and emit photons. If we go on reducing the temperature of the substance in this way, a temperature, say T', shall be obtained when the outermost orbiting electrons too shall be unable to excite and emit photons. Therefore, at temperature T' of the substance, all its orbiting electrons shall stop exciting and emitting photons.

At temperature T' of the specimen, when all its orbiting electrons stop exciting and emitting photons, the photons present inside the specimen start disappearing from the specimen. All the photons are not disappeared from the specimen immediately because practically it is not possible. They start disappearing continuously and quite fast and very shortly at T_c, their number is reduced so much that they become unable to disturb the flow of free electrons of the specimen. (Below T_c too the number of photons goes on decreasing but it becomes very gradual.) So, at T_c, the specimen can be said to be at resistanceless state, and the temperature T_c is the transition temperature of the specimen. (For confirmation that at T_c, due to disappearance of photons from the specimen, its resistance is reduced to zero, see section-2.1.) Now if by some means the motions of free electrons of the specimen are oriented and aligned in any direction, they can go on flowing persistently. (The means, by which the motions of the free electrons of the specimen are oriented and aligned and they start flowing persistently, i.e. superconducting state is obtained, see next section-3.).

Currently it is believed that at T_c of superconducting substance, its resistance suddenly reduces to zero, but it is not true. Before T_c of every superconducting substance, there occurs a temperature, say T'_c, from where the resistance of the substance starts decreasing suddenly very fast, and at T_c, that reduces to zero, as shown in Fig.1. The straight line joining points A (at T'_c) and B (at T_c), which shows the fall of resistivity of the substance during decrease in its temperature from T'_c to T_c, Fig. 1, is not found to be exactly vertical but a very little inclined. For example, in the case of mercury, Fig. 1(b) [2], where T'_c is nearly 4.25° K (Kelvin) and T_c is 4.2° K, and line AB is not vertical but very little inclined. The inclination of straight line AB varies from substance to substance. (Why and how the inclination of straight line AB varies from substance to substance has been explained onwards, see section-4.2.)

Resistance of the specimen does not reduce suddenly to zero at T_c but it starts decreasing suddenly very fast at $T'_c(>T_c)$ and at T_c reduces to zero, all these occur due to the reason that T'_c happens to be $=T'$. Due to start of very fast disappearance of photons from the specimen at $T'_c(=T')$ and then gradual decrease in their disappearance and very shortly at T_c, since their number is reduced so much that they become unable to disturb the flow of free electrons of the specimen, the resistance of the specimen starts decreasing suddenly very fast at $T'_c(>T_c)$ and at T_c it reduces to zero.

2.1 Evidence to confirm that at T_c, due to disappearance of photons from the specimen, its resistance is reduced to zero.

The photons are produced in the specimen as the consequence of application of an external magnetic field across it (section-7), and the superconducting state of the specimen is disappeared as the consequence of application of an external magnetic field H_c (section-4.7) mean (or infer) that, as the consequence of application of an external magnetic field H_c, the photons are produced in the specimen, and due to their presence, the supercnducting state of the specimen is disappeared. When the supercnducting state of the specimen is disappeared as the consequence of the presence of photons in the specimen, the supercnducting state of the specimen can be stored too as the consequence of disappearance of photons from the specimen, and it cannot be ruled out.

3. EXPLANATION OF WHY AND HOW SUPERCONDUCTIVITY IS GENERATED AT T_c

At T_c, when the number of photons inside the specimen is reduced very much (see section-II), the directions of L_s of the free electrons of the specimen are found to be randomly oriented in all the different directions in the same manner as they were oriented due to the frequent collisions of photons at temperature $> T_c$ when the photons were present inside the specimen. The external magnetic field, placing in which the specimen is cooled down to $\leq T_c$, orients and aligns the randomly oriented directions of motion (i.e. of L_s) of the free electrons along it's own direction, and as soon as the randomly oriented directions of motion of the free electrons are oriented and aligned, the electrons and hence the persistent (electronic) current starts flowing. How the external magnetic field orients and aligns the directions of motion of free electrons of the substance along its own direction, is as follows:

The electron possesses magnetic moment (μ_s) in the direction opposite to the direction of it's L_s, hence when the substance is brought down to T_c, the directions of μ_s of all the free the electrons of the substance too are oriented randomly in almost all the different directions. The external magnetic field, placing in which the specimen is cooled down to $\leq T_c$, orients and aligns the directions of μ_s of free electrons of the specimen in direction parallel but opposite to it's own direction (i.e. the directions of μ_s of electrons lie towards the north pole of the external magnetic field). Hence the directions of L_s (i.e. directions of linear motion) of electrons are also oriented and aligned parallel to the direction of external magnetic field. (For the confirmation of truth that the directions of μ_s and L_s of electrons are oriented and aligned, see section- 4.4.1) And as soon as the directions of linear motion of the free electrons are oriented and aligned, they start moving persistently in that direction. Once the directions of μ_s (and hence of L_s) of the electrons of the substance are oriented and aligned, the external magnetic field can be removed. The flow of electrons continues. This state of the substance is its superconducting state.

4. EXPLANATIONS OF RELATED PROPERTIES AND EFFECTS

4.1 Explanation of why and how the entropy at superconducting state of the substance decreases

The decrease in entropy at superconducting state of the specimen means, the system becomes more ordered, or in other words, the disturbance in the specimen is reduced. At T_c, since all the orbiting electrons of the specimen stop exciting and emitting photons, the disturbance due to their excitation is reduced to zero. And further, at T_c since the number of photons inside the specimen is reduced so much that they become unable to disturb the alignment of free electrons of the specimen due to their collisions with the electrons, then obviously the alignment of electrons persists, i.e. the system becomes ordered. Consequently the entropy of the substance is decreased.

4.2 Explanation of variation of T_c from substance to substance

The number of orbiting electrons per atom (i.e. atomic number Z) since varies from substance to substance, the magnitude of binding force (i.e. Ze^2/r^2, where r is the radial distance of the electron from the nucleus and e is its charge), by which the orbiting electrons are bound with their respective nuclei in atoms of different substances, varies from substance to substance. And the share of thermal energy, which every orbiting electron receives for its excitation and how much it is excited, also vary from substance to substance depending upon their Z and how their electronic orbits are configured. According to Avagadro's law, since equal volumes of different substances at the same temperature and pressure contain equal number of atoms, the substances, e.g. S_1, S_2, S_3, having atomic numbers Z_1, Z_2, Z_3 respectively (where $Z_1 < Z_2 < Z_3$), will have $A \times Z_1$, $A \times Z_2$, $A \times Z_3$ (where A is Avagadro's number) number of orbiting electrons per mole. If suppose the heat energy is supplied to each of these substances S_1, S_2, S_3 at the rate Q calories per mole, the average amount of heat energy, which each orbiting electron of these substances shall receive, will be as $Q/(A \times Z_1)$, $Q/(A \times Z_2)$, $Q/(A \times Z_3)$ respectively.

Therefore, due to these reasons and some more reasons [e.g. variation of mass number of nuclei of atoms from substance to substance, because nuclei of atoms of substances S_1, S_2, S_3 also share energy from Q accordingly as they possess mass number, and it affects $Q/(A \times Z)$ }], the orbiting electrons have different amount of energies and accordingly they are excited to different energy states in the atoms of substances S_1, S_2, S_3, kept at the same temperature. Suppose if we start reducing the temperature of substances S_1, S_2, S_3 by same amount, the orbiting electrons of the substance, having least amount of energy (i.e. S_3), shall stop exciting and emitting photons earlier (i.e. at higher temperature) in comparison to the orbiting electrons of substances S_2 and S_1. Consequently, substance S_3 shall acquire its T'_c (see section-II) at comparatively higher temperature than S_2 and S_1. And substance S_2 shall acquire it's T'_c a bit later (i.e. at comparatively lower temperature) and substance S_1 shall acquire it's T'_c in the last (i.e. at the lowest temperature). Therefore, this is the reason due to which the temperature T'_c varies from substance to substance.

Further, since the substances S_1, S_2, S_3 have different number of orbiting electrons and the orbiting electrons have different amount of energies and accordingly they are excited to different energy states, the substances S_1, S_2, S_3 possess different number of photons at their respective $T_c^{'}$, and the rate with which the photons are disappeared from them varies from substance to substance. The temperature T_c, at which the number of photons is reduced so much that they become unable to obstruct the flow of free electrons, also varies from substance to substance. Due to variation of the rate with which the photons are disappeared from the substances S_1, S_2, S_3 the inclination of the straight line AB varies from substance to substance.

4.3 Explanation of why and how the substances like Cu and Au etc. do not superconduct even down to very low temperatures

Some substances, e.g. *Cu* and *Au* etc., which are very good conductors of current, do not superconduct even at temperatures down to 0.05 K. If we investigate, we find that these substances are very good conductors of heat as well, which means, these are very susceptible to temperature and even a very little change in temperature is conducted to the whole system.

In conductors, the heat is mainly conducted by transportation, which is done by photons, because the photons are the radiation energy carriers [1] (like electrons which carry charge). In these substances, since even a very little change in temperature is conducted to the whole system, the excitation of orbiting electrons of these substances and hence emission of photons from them continues even down to very low temperatures. Therefore, these substances do not become able to get free from photons even at temperatures down to 0.05 K. Consequently they do not superconduct even down to so low temperatures.

4.4 Explanation of Meissner effect

The magnetic moment and magnetic field, which the electron possesses, do not occur as the consequence of spin motion of the charge of electron. But the electron possesses some magnetism by virtue of nature, similarly as it possesses charge e by virtue of nature (see reference-3). This magnetism occurs in the form of a circular ring, shown by a dark solid line circle, Fig. 2, around the charge of electron, where the charge has been shown by a spherical ball, Fig. 2(a), and by a thick dark circle, Fig. 2(b). As, for an example, there occur rings around the planet Saturn. The magnetism and charge of electron, both spin, but in directions opposite to each other, shown by arrows in opposite directions, Fig. 2(b). The magnetic moment (μ_s), which the electron possesses, arises due to the spin motion of this magnetism, and occurs in the direction of spin angular momentum of this magnetism. Around this magnetism of electron, there occurs magnetic field in the form of a band of sets of concentric magnetic lines of force all along its (magnetic ring) width, Fig. 2 [as, for example, there occurs magnetic field around a current carrying rod if we take it to be of very small length (like a thin slice), in the form of a band of sets of concentric magnetic lines of force all along its length], and this magnetic field spins along with the magnetic ring in the same direction. The magnetic field, which the electron possesses, happens to be actually this magnetic field. And the magnetic moment (μ_s), which the electron possesses, arises because of spin motion of this magnetism in the direction of its spin angular momentum. (For the confirmation of information mentioned above, see reference-3.)

At superconducting state, when the directions of μ_s of the electrons of the substance are oriented and aligned (see section-3), they (directions of μ_s of electrons) lie opposite to the direction of flow of electrons (because the directions of μ_s of electrons lie opposite to the directions of L_s of electrons, and the directions of L_s of electrons lie towards the directions of flow of electrons, i.e. opposite to the directions of flow of persistent current, because the electrons flow opposite to the direction of flow of current), i.e. in the direction of flow of current. When the directions of μ_s of electrons of the substance are oriented and aligned in the direction of flow of persistent current, obviously the planes of their magnetism and magnetic fields are also oriented and aligned in a plane perpendicular to the direction of flow of persistent current. When the planes of magnetic fields of electrons are oriented and aligned in a plane perpendicular to the direction of flow of persistent current, due to interaction between them, a magnetic field is generated around and along the length of the specimen rod in the form of co-axial hollow cylinders, Fig. 3 (a and b), similarly as a magnetic field is generated around and along the length of a current carrying specimen rod in the form of co-axial hollow cylinders (see reference- 3). This magnetic field (generated around and along the length of the rod) occurs obviously in a plane perpendicular to the direction of flow of persistent current. And the magnetism and fields of electrons since spin, the magnetic field generated around and along the length of the rod too spins along the directions of spin motions of the magnetism of electrons.

Therefore, when a long cylindrical specimen rod is cooled down to its T_c keeping it in an external longitudinal magnetic field, as Meissner did, due to the external magnetic field, the directions of μ_s of electrons of the specimen rod are oriented and aligned parallel to the direction of external magnetic field and the planes of magnetic fields of electrons are oriented and aligned in a plane perpendicular to the direction of external magnetic field. The aligned planes of magnetic fields of electrons block the passages of magnetic lines of force of external magnetic field through the rod, because to pass through the rod, the lines of force of external magnetic field need to intersect the lines of force of magnetic field of electrons, which they cannot do. Because, according to property of magnetic lines of force, the magnetic line of force neither intersects itself nor other magnetic lines of force. Consequently the lines of force of external magnetic field, which were earlier (when specimen rod was not cooled down to its T_c) passing through the rod, are expelled out from the rod (i.e. Meissner effect [4, 5]) and reach the other end of the rod (lying towards the south pole of the applied magnetic field) passing over the outer surface of the rod acquiring the form as shown in Fig. 4.

4.4.1 Confirmation of truth that, at superconducting state of the specimen rod, the directions of μ_s and L_s of electrons of the rod are oriented and aligned parallel to the direction of applied external magnetic field.

We take an iron bar and place it in the magnetic meridian of earth's magnetic field (or in an external magnetic field such that the length of the bar is parallel to the direction of external magnetic field). Now, if this iron bar is magnetized such that its north pole lies towards the geographical south pole of the earth (or towards the north pole of the external magnetic field) and south pole towards the geographical north pole of the earth (or towards the south pole of the external magnetic field), we find that all the magnetic lines of force of earth's magnetic field (or external magnetic field) are expelled out from the iron bar which were earlier passing through the bar when it was not magnetized. The expulsion of magnetic lines of force of earth's magnetic field (or external magnetic field) from the bar takes place because when the bar is magnetized, its lines of force start occurring, and according to property of magnetic lines of force, they neither intersect themselves nor other lines of force, the lines of force of earth's magnetic field (or external magnetic field) are expelled out from the bar.

Similarly, when the lines of force of external magnetic field are expelled out from the specimen rod at its superconducting state, it means, there starts occurring some magnetic lines of force in the rod, which are so oriented and aligned with respect to the direction of lines of force of external magnetic field such that they block the external magnetic lines of force to pass through the rod, consequently the external magnetic lines of force are expelled out from the rod. The lines of force, which block the external magnetic lines of force to pass through the rod, since do not come from outside but they are created in the rod when the persistent current starts flowing through that rod, it implies, the magnetic fields of electrons of the rod are oriented and aligned such that the external magnetic lines of force are blocked when the persistent current starts flowing through the rod. Other than electrons, there exists no any source, which possesses magnetic field and that's magnetic field can be assumed oriented and aligned.

It is therefore confirmed that the external magnetic field, applied across the specimen at it's resistanceless state to initiate the flow of persistent current, the directions of μ_s and hence of L_s and the planes of magnetic field of electrons of the specimen are oriented and aligned.

It is therefore confirmed that the external magnetic field, applied across the specimen at it's temperature $\leq T_c$ (section-4.4) or keeping in which the specimen is cooled down to it's temperature $\leq T_c$ (section-3), orients and aligns the directions of μ_s, L_s and of the planes of magnetic field of electrons of the specimen.

4.5 Explanation of why and how the diamagnetism developed in substances at their superconducting state persists while at normal state does not

In substances at their superconducting state, since the number of photons is reduced very much, the alignment of the directions of μ_s of the free electrons of the substance due to the external magnetic field applied to initiate the persistent current, persists, consequently diamagnetism developed in them persists even after the removal of the applied external magnetic field. While at their normal state (i.e. at temperatures $> T_c$), since the photons exist there in the substances, due to the frequent collisions of photons with the electrons of the substance, the alignment of directions of μ_s of electrons of the substance due to the external magnetic field applied to magnetize the substance (or due to the allowance of electric current to flow through the substance, because due to the allowance of electric current through the substance the magnetism, which is generated in the substance, happens to be diamagnetism, see reference-3) happens to be weak. And hence it (alignment) does not persist and very shortly it is being destroyed after the removal of the external magnetic field (or stopping the electric current to pass through the substance). Therefore, the diamagnetic property in substances at their normal state does not persist and very shortly it disappears.

4.6 Explanation of non occurrence of superconducting state in ferromagnetic substances.

We take a bar magnet and place it in an external magnetic field (or in magnetic meridian of earth's magnetic field) such that its poles S (south) and N (north) respectively lie towards the north and south poles of the external magnetic field (earth's magnetic field) and length is parallel to the direction of external magnetic field (earth's magnetic field). We find that the magnetic lines of force of the external magnetic field, coming out from its north pole, are deviated towards the pole S of the bar magnet and entering through it's (bar magnet) pole S, they come out from its pole N.

Now we take an iron (ferromagnetic substance) bar PQ and place it in an external magnetic field such that its ends P and Q respectively lie towards the north and south poles of the external magnetic field and length is parallel to the direction of external magnetic field. We find that the magnetic lines of force of the external magnetic field, coming out from its north pole, are deviated towards the end P of the iron bar and entering through its (iron bar) end P, they come out from its end Q.

The deviation of the magnetic lines of force towards pole S and end P of the bar magnet and iron bar respectively, their (lines of force) entrance through pole S and end P, their exit from pole N and end Q of the bar magnet and iron bar respectively infer (or mean) that the iron bar is magnetized (how it is magnetized, see section-4.6.1) and its ends P and Q acquire respectively south and north polarities. The iron bar possesses magnetic moment along the direction PQ, i.e. along the direction of the external magnetic field. The above inference cannot be ruled out, otherwise the question arises, why and how are the lines of force of external magnetic field deviated etc.? No explanation of this question can be given.

As the iron bar is magnetized, similarly when the specimen rod of ferromagnetic substance is cooled down to it's T_c keeping it in an external magnetic field, due to presence of external magnetic field the specimen rod is magnetized (obtains ferromagnetism) and it obtains magnetic moment in the direction of external magnetic field. The magnetic moment, say M, thus obtained happens to be quite strong (because ferromagnetism happens to be quite strong). Since M happens to be quite strong and it lies in the direction of external magnetic field, it opposes the orientation and alignment of μ_s of electrons (because μ_s is oriented and aligned in direction opposite to the direction of external magnetic field) of the specimen rod and does not let μ_s of electrons to get oriented and aligned. Obviously, then L_s of electrons too are not oriented and aligned and consequently electrons fail to flow persistently. Therefore, in ferromagnetic substances, superconducting state does not occur.

4.6.1 How the iron bar PQ is magnetized.

We observe that when a bar magnet or a current carrying closed loop of wire (or coil) is freely suspended between the north and south poles of an external magnetic, they are rotated such that their south and north poles lie towards the north and south poles respectively of the external magnetic field. If the bar magnet and current carrying closed loop of wire are not totally free to rotate, they are rotated depending upon how much they are free to rotate. The electronic orbits of substance behave like magnetic dipoles, therefore, if a specimen substance is placed in an external magnetic field, its orbits are rotated and their rotations depend upon how much they are free to rotate. In accordance as how much they are rotated, the specimen acquires magnetism. (For confirmation that the electronic orbits of the specimen are disturbed, e.g. rotated etc., as the consequence of application of an external magnetic field, see section-7.)

In ferromagnetic substance, the electronic orbits are probably so arranged in different planes and with different magnitudes of binding in their respective atoms such that when the substance is placed in an external magnetic field, the orbits are rotated significantly and such that the resultant magnetism generated in the substance due to their (orbits) rotations is obtained to be quite strong. (In non- ferromagnetic substances too, e.g. superconducting substances, the electronic orbits are rotated as the consequence of application of external magnetic fields across them, but due to rotations of electronic orbits, the resultant magnetisms produced in them are happened to be either insignificant in magnitude or insignificant in producing the effective obstruction in the orientation and alignment of μ_s and L_s etc. of their free electrons.)

4.6.2 Important conclusions

i. Currently known some non-superconducting substances, e.g. ferromagnetic substances, can be made superconducting.

In ferromagnetic substances, which are known some of non-superconducting substances, M does not let μ_s and hence L_s of electrons of the substance to get oriented and aligned at T_c and consequently electrons fail to flow persistently and superconducting state does not occur (see section-4.6). If by some means, other than the application of external magnetic field, it is tried to orient and align L_s of electrons, then M shall not be generated and L_s of electrons can be oriented and aligned. Then the ferromagnetic substances can be made superconducting. The means, other than the external magnetic field, which orients and aligns L_s of electrons, is the application of appropriate potential difference across the specimen rod, because the potential difference across the specimen rod orients and aligns L_s of electrons of the specimen rod (see reference-3).

In order to verify it, applying an appropriate potential difference across the specimen rod, the rod is cooled down. If it is true, at T_c, zero potential difference across the rod shall be obtained. And then if the potential difference across the specimen rod is removed, the current flowing through the rod shall persist.

Some other known non-superconducting substances, where though the number of photons is reduced very much such that they become unable to obstruct the flow of electrons, i.e. T_c is obtained, but due to some reasons (e.g., due to M in ferromagnetic substances) their free electrons do not become able to get oriented and aligned when they are cooled down to $\leq T_c$ keeping them in an external magnetic field, too can be tried to make superconducting cooling them down applying a potential difference across their ends. If in them superconducting state is obtained, a zero potential difference shall be obtained across their ends at some temperature during their cooling. That temperature shall be T_c of that substance.

ii. The strength of persistent current can be increased

At temperature T_c of the substance, i.e. when zero resistance is obtained across the ends of the substance, if, after increasing the strength of the applied external potential difference to such a value that the desired strength of the persistent current can be obtained, the applied external potential difference is removed, the persistent current of desired strength can be obtained. [It too is possible that the increased strength of current may not persist for long time. Because, when the strength of the current shall increase, i.e. when the velocity v of the free electrons shall increase, their frequency of spin motion ω shall also increase according to expression [1] $mv^2 = h\omega$ (where m is the mass of electron and h is Planck's constant). If their ϖ does not increase accordingly, or if ϖ increases but its increase does not persist for long time, the increased strength of current shall not persist for long time.]

4.7 Explanation of how normal state of the specimen is restored applying external magnetic field H_c across it at its superconducting state, why H_c increases as the temperature of the specimen decreases, and why H_c varies from substance to substance.

4.7.1 How normal state of the specimen is restored applying external magnetic field H_c across it at its superconducting state.

At superconducting state, when the planes of magnetic fields of the free electrons of the specimen are oriented and aligned in a plane perpendicular to the direction of external magnetic field applied to initiate the persistent current, due to interaction between magnetic fields of electrons, there are generated: 1. A magnetic field around and along the length of the specimen rod in co-axial hollow cylindrical form (see reference-3), and 2. A force of attraction among the electrons (see reference-3). So if the normal state of the specimen is to store, the alignment of the planes of magnetic fields of electrons will have to be broken down. It can be done either by generating ferromagnetism or by generating photons, sufficient in number, in the specimen. The former way is not possible because the ferromagnetism can be generated in ferromagnetic substances only, while the ferromagnetic substances do not superconduct. Therefore the later way only is possible.

In order to confirm that the photons are generated by applying external magnetic field, let us take the example of Zeeman effect [6].

In Zeeman effect, it is observed that when a strong magnetic field is applied across the system, the single spectral line is split into three lines (when seen in direction perpendicular to the magnetic field), which means, as the consequence of application of a strong magnetic field, there start emitting three photons of three different frequencies instead of emission of one photon of a single frequency. The emission of two additional photons as the consequence of application of a strong magnetic field across the system confirms that the orbiting electrons of the system (i.e. specimen) are excited and photons are emitted from them when some external magnetic field is applied across the system. (How photons are emitted as the consequence of application of an external magnetic field, see section- 7.)

The discontinuously increase in thermal conductivity of the specimen, when its superconducting state is destroyed by the application of external magnetic field H_c, also confirms the truth that the photons are generated by applying external magnetic field H_c (see section-4.8).

4.7.2 Why H_c increases as the temperature of the specimen decreases.

As the temperature of the specimen decreases, since the number of photons in the specimen goes on decreasing, and the binding force among the electrons generated due to the interaction between their magnetic fields (see reference-3) goes on increasing (because, as the temperature of the specimen decreases, thermal energy and hence thermal agitation of its free electrons goes on decreasing, and that causes the increase in binding force among the electrons), the need of number of photons to destroy the alignment of free electrons of the specimen, goes on increasing. To fulfill the increasing need of number of photons to destroy the alignment of free electrons of the specimen H_c is needed of increasing magnitude. Therefore, the magnitude of H_c goes on increasing as the temperature of the specimen decreases.

4.7.3 Why H_c varies from substance to substance.

The binding energy of orbiting electrons in the atoms of substances varies from substance to substance (for detail, see section-4.2), then naturally, to obtain the required number of photons to restore the normal state, the magnitude of H_c required to excite the orbiting electrons shall vary from substance to substance. Secondly, we know that at same temperature, the thermal conductivity varies from substance to substance. It happens so because at same temperature, the number of photons emitted from the orbiting electrons varies from substance to substance. Therefore, if at some temperature, say $T'(<T_c)$, H_c is applied to different substances to restore their normal states; the magnitude of H_c shall vary from substance to substance.

4.8 Explanation of why and how thermal conductivity of the specimen changes continuously between its two phases, and why and how it is discontinuously increased when superconducting state of the specimen is destroyed by the application of an external magnetic field H_c.

4.8.1 Why and how thermal conductivity of the specimen is discontinuously increased when superconducting state of the specimen is destroyed by the application of an external magnetic field H_c

Thermal conductivity of superconductors undergoes a continuous change between their two phases and is usually lower in the superconducting phase. For example, at 2 K, thermal conductivity of Tin (for which $T_c = 3.73\,K$) has value $34\,W\,cm^{-1}\,K^{-1}$ for the normal phase and $16\,W\,cm^{-1}\,K^{-1}$ for the superconducting phase (see reference-7). But it changes discontinuously when superconducting state of the specimen is destroyed by the application of external magnetic field H_c.

In order to destroy the superconducting state of the specimen, when critical value of external magnetic field H_c is applied across the specimen, huge number (depending on the magnitude of H_c) of orbiting electrons of the specimen are excited resulting into sudden emission of huge number of photons. The sudden production of huge number of photons in the specimen causes discontinuous increase in the thermal conductivity of the specimen (because the photons are the radiation energy carrier [1] and the heat energy is conducted through transportation by the photons). When the number of photons in the specimen is increased suddenly, the conduction of thermal energy by transportation is increased suddenly. Consequently the thermal conductivity of the specimen under goes a discontinuous change between its two phases.

4.8.2 Why and how thermal conductivity of the specimen changes continuously between its two phases

When the superconducting state of the specimen is stored by bringing down the temperature of the specimen to its T_c, since the photons are not disappeared from the specimen suddenly in a bulk but they go on disappearing continuously and quite fast, and very shortly their number is reduced very much (for detail, see section-2), thermal conductivity of the specimen does not undergo a discontinuous change but undergoes a continuous change between its (specimen) two phases.

4.9 Explanation of energy gap between the electrons at normal state and the electrons at superconducting state and why the energy of electrons at superconducting state goes on decreasing as the temperature of the specimen decreases.

4.9.1 Energy gap between the electrons at normal state and the electrons at superconducting state.

At superconducting state of the specimen, the planes of magnetic fields of its free electrons are oriented and aligned in a plane perpendicular to the direction of external magnetic field applied to initiate the persistent current, and due to interaction between magnetic fields of electrons, there is created a force of attraction among them (see reference-3). That force of attraction keeps them bound together, and due to that binding force, the energy of free electrons of the specimen at its superconducting state is being reduced, which causes an energy gap between the electrons of the specimen at its superconducting state and the electrons at its normal state.

4.9.2 Why the energy of electrons at superconducting state goes on decreasing as the temperature of the specimen decreases.

As the temperature of the specimen decreases (below its T_c), 1- due to decrease in thermal energy of its free electrons, their (free electrons) thermal agitation against the binding force, which is generated among them due to the interaction between their magnetic fields, goes on decreasing, and 2- the number of photons, left in the specimen, too goes on decreasing. Therefore, the binding force among the electrons goes on increasing continuously as the temperature of the specimen decreases. Consequently the energy of electrons at superconducting state goes on decreasing as the temperature of the specimen decreases (below its T_c).

4.10 Explanation of Josephson's Tunneling

The Josephson's effect is the phenomenon of supercurrent across two superconductors coupled by a weak link. The weak link can consist of a thin insulating barrier known as a S-I-S (superconductor-insulator-superconductor), or S-N-S (a short section of no-superconducting metal), or S-s-S (a physical construction that weakens the superconductivity at the point of contact).

Why and how the phenomenon of supercurrent across the weak link is obtained, is as follows:

Electron possesses motional energy [1] (kinetic energy + spin energy [1]) and motional momentum [1] (linear momentum + spin momentum [1]). The motional momentum of the electron lies along its linear velocity, and since its linear velocity lies along it's L_s , the motional momentum of the electron lies along its L_s . Therefore, when a voltage is applied across the weak link, L_s and hence the motional momenta of the free electrons are oriented and aligned parallel and opposite to the direction of electric field generated due to the applied voltage. (For confirmation that L_s of the electrons are oriented and aligned, see reference-3.) Now, if the applied voltage is removed, the motional momenta of the free electrons remain oriented and aligned as such because at T_c , the number of photons is reduced very much (see section-2) and hence they become unable to disturb the orientation and alignment of electrons..

Since the electrons possess spin momentum too, they possess more penetrating power in comparison to the particles having only the linear momentum (for its confirmation, see reference-1), and secondly, when they are oriented and aligned, they incident almost normally at the surface of the weak link, their power of penetration through the weak link is increased more. Therefore, when the applied voltage is removed, the flow of electrons and hence of the supercurrent remains continued. Consequently, the phenomenon of supercurrent across the weak link is obtained.

4.10.1 A short discussion

In quantum mechanical treatment of the phenomenon, transmittance T = finite for the particle having energy $E < V_0$ (where V_0 is the potential energy of the barrier), E contains only the kinetic energy and no account of the spin energy of the particle is being taken.

Consequently E happens to be $< V_0$ and to explain the phenomenon, wave nature of the particle is assumed to be responsible (while the wave nature of the particle is not true, see reference-1). Since the particles have spin motion (for electrons, experimentally it has been proved too), they have spin energy (which cannot be ruled out) and consequently spin momentum (see reference-1). Consequently, the resultant energy (kinetic energy + spin energy) of the particle happens to be $> V_0$ and T = finite is obtained (for detail, see reference-1).

Since the prediction of a mathematical relationship for the current and voltage across the weak link by Josephson [8] is based on quantum mechanical treatment and no account of spin energy of the electrons has been taken, it too should not be true.

4.11 Explanation of latent heat of transition

When the superconductivity of a specimen is destroyed isothermally (i.e. at constant temperature) by a magnetic field, the specimen absorbs heat and that happens to be the latent heat. For the adiabatic case (constant heat), the specimen's temperature becomes lower. In the isothermal case, when the field is reduced, the superconductor gives up that latent heat of transition.

Why and how the specimen absorbs heat when the superconductivity of the specimen is destroyed isothermally by a magnetic field (at constant temperature), is as follows: When the magnetic field is applied, the orbiting electrons of the specimen are excited and photons are emitted from them (see section-4.7). When the orbiting electrons are excited, they expand [1], and for their expansion, they need some energy which is naturally drawn from the heat energy of the specimen (see reference-9). Consequently the heat energy of the specimen is being reduced. And if the temperature of the substance is maintained constant, the heat energy is drawn by the orbiting electros in the form of latent heat. In the isothermal case, when the field is reduced, the superconductor gives up that latent heat of transition.

4.12 Explanation of why and how the specific heat of a specimen is discontinuously increased when the temperature of the specimen is brought down to its T_c.

The orbiting electrons of the specimen derive some part of heat energy for their excitation [9] from the heat subjected to increase the internal thermal energy of the specimen. Therefore, the heat energy left in order to increase the internal thermal energy of the specimen, say dE_{int}, is being reduced. Consequently the specific heat $C_v = dE_{\text{int}} / dT$ of the substance is also being reduced (for detail, see reference-9).

When the temperature of the specimen decreases, the heat energy, which the orbiting electrons find available for their excitation goes on decreasing. Consequently a temperature T_c is obtained when the orbiting electrons of the specimen become unable to excite (see section-2). Then the part of heat energy, which was earlier utilized by the orbiting electrons of the specimen for their excitation [9], is now left free and that is being used in increasing the internal thermal energy of the specimen. Consequently the internal thermal energy of the specimen is being increased, say by dE_{int}, which increases the specific heat $C_v = dE_{\text{int}} / dT$ of the specimen. Eventually at T_c of the specimen, since its all orbiting electrons stop exciting, the heat energy is left in a bulk and that obviously increases the internal thermal energy of the specimen in a bulk. Consequently C_v of the specimen is being increased discontinuously.

4.13 Explanation of gyromagnetic (or Einstein de Hass) effect

Since the magnetic field around the electron spins, the resultant magnetic field generated around and along the length of the specimen rod as the consequence of interaction between the magnetic fields of electrons, Fig. 2, also spins (see section-4.4). When the resultant magnetic field generated around and along the length of the specimen rod spins, it tries to make the specimen rod also to spin by dragging the rod along the direction of its spin motion. The rod since happens to be very much heavy in comparison to the electrons, very slow spin motion is imparted to the rod, consequently a very small angular momentum is observed with the rod.

It is possible that some people may argue, if the above explanation is true, some angular momentum should be observed with the electric current carrying rod too, where the magnetic field is generated around and along the length of the rod due to the interaction between the magnetic fields of electric current giving electrons (reference-3). This argument is absolutely true. But probably since no one ever tried to think over this matter in such a way, no effort was made to observe whether the current carrying rod possesses angular momentum or not. It too is possible that in electric current carrying rod, due to lot of disturbances inside the rod (e.g. due to the excitation of orbiting electrons and emission of photons from them, motion of photons in different directions of the rod and their collisions with the electrons), the rod does not become able to spin and hence does not possess any angular momentum.

5. DISCUSSION

It is very unfortunate that in order to explain superconductivity and related properties and effects, in existing theories, there is found no account of the role of photons existing inside the specimen. The production of photons as the consequence of application of an external magnetic field (see section-7), and the disappearance of supercnducting state as the consequence of application of an external magnetic field H_c (see section-4.7) confirm the role of photons in superconductivity. Further, as the temperature of the specimen decreases, thermal energy of its orbiting electrons shall definitely go on decreasing and ultimately a temperature T_c shall positively be obtained when all the orbiting electrons of the specimen shall stop exciting and emitting photons. Then the specimen shall become free from the photons, and the free electrons of the specimen shall become free from the frequent collisions of the photons (for detail, see section-2). But its account too is not found in any of the existing theories.

Unfortunately, instead of taking into account the above cause, in existing theories there have been taken such causes, which are practically impossible and unbelievable. Consequently the existing theories fail to give clear and complete knowledge (picture) why and how (i.e. way) the superconductivity is actually generated and related properties and effects take place. The BCS (Bardeen–Cooper–Schrieffer) theory [10, 11], for which it is claimed that it provides better quantum explanation of superconductivity and accounts very well for all the properties exhibited by the superconductors. But if we examine this theory closely, we find that it is based on such concepts which: i- are practically not possible; ii- contradict two well-observed facts; iii- give rise to numerous such questions of which no explanation can be given.

i. The concepts are practically not possible:

In BCS theory it is assumed that, at T_c of the specimen, when an electron approaches a positive ion core, the core suffers attractive Coulomb interaction and that sets the core in motion and consequently the lattice is distorted. Can it ever be possible that the ion core, which is approximately $1.84A\times10^3$ (where A is mass number, $1.84\times10^3 = m_n / m_e$, m_n and m_e respectively are mass of nucleon and mass of electron) times heavier than the electron and bound in the substance by inter-atomic force, is attracted by the electron, and that attraction sets the ion core in motion and the motion of core consequently distorts the lattice, which is a regular periodic array of number of atoms? No, practically it is impossible. The most surprising things are:

- The electron, which was earlier a part of that ion core before its (electron) ejection from that ion core because of thermal agitation at $T >> T_c$ (because, according to existing concept, the ion cores and free electrons are generated due to the ejection of orbiting electrons from their orbits due to their thermal agitation), exerts such a strong force on that ion core instead of being absorbed back into that ion core! Can it be believed or possible?

● The electron, when approaches a positive ion core, attracts the ion core so strongly that the ion core is set in motion and that distorts the lattice, while on the other hand, the same electron, when forms a Cooper pair with another electron as the consequence of electron-lattice-electron interaction, the Coulomb repulsive force between the electrons becomes so weak or negligible that the pair persists as long as the persistent current flows. Can it practically ever be possible? Probably, in order to avoid such questions, in BCS theory a postulate is taken that the Cooper pairs start forming and the superconductivity occurs when the attractive interaction between the two electrons by means of a phonon exchange dominates the usual repulsive interaction between them. But this postulate does not convince. Secondly, it gives rise to several questions (see below) of which no any answer can be given.

ii. The concepts contradict two well-observed facts:

● If due to Coulomb attractive interaction between the electrons and the ion cores of the specimen, its ion cores are set in motion and consequently the lattices are distorted, then the energy and disorderness in the specimen should be increased and consequently the entropy of the specimen should be increased, while on the contrary the entropy of the specimen is decreased. Further, if the ion cores are set in motion and consequently the lattices are distorted, then the resistance of the specimen should also be increased, while on the contrary it is reduced to zero.

iii. The concepts give rise to numerous such questions of which no explanation can be given:

● At T_c of the specimen, why, how and what situation is suddenly being created in it that its electron when approaches a positive ion core, the core starts suffering attractive Coulomb interaction? Why and how is that situation not being created at $T > T_c$? The postulate, mentioned above, has been taken in order to avoid such questions too. But such questions cannot be avoided because the situation of applicability of above postulate shall arise when the core is set in motion and that distorts the lattice. Why and how only at $\leq T_c$ when an electron approaches the core, is the core attracted by the electron and set in motion? Why and how at $T > T_c$, when an electron approaches the core, is the core not being attracted by the electron and not being set in motion. The above postulate too gives rise to several questions, e.g., why, how and what situation is suddenly being created at T_c that the attractive interaction between two electrons by means of a phonon exchange starts dominating the usual repulsive interaction between them? Why and how is that situation not being created at $T > T_c$.

- Why and how only in few substances (because superconductivity takes place only in few substances, not in all), when their electrons approach their ion cores, do the ion cores start suffering attractive Coulomb force and are set in motion and consequently the lattices are distorted? Why and how do all these not take place in all the substances?

The above all the drawbacks with the concepts of BCS theory infer that these concepts are not true. And hence the BCS theory too should not be true.

Further, since the concepts that, when an electron approaches a positive ion core, the ion core is set in motion and the motion of core distorts the lattice etc. are not true, there does not arise any question of emission of virtual phonons from the lattice. And hence the occurrence of electron-lattice-electron interaction cannot be possible. Consequently, Cooper pairs cannot be formed and the concept of Cooper pairs in the BCS theory is not true. Furthermore, the concept of Cooper pairs gives rise to number of such questions of which no answer or explanation can be given. For example:

1. According to existing concept of Cooper pairing, the Cooper pairing starts at T_c and their number goes on increasing till T = 0 K. Therefore, if the persistent current flows due to flow of Cooper pairs, the magnitude of persistent current must go on increasing as the temperature of the substance decreases. Does the magnitude of persistent current increase?

2. Applying H_c when the normal state of the specimen is restored (i.e. when the persistent current stops flowing), are the Cooper pairs broken and the electrons separated from their respective pairs? If the Cooper pairs are broken and the electrons are separated from their respective pairs, how does it happen? And if the Cooper pairs are not broken, the question arises, then how does the persistent current stop flowing?

3. In the specimen at its normal state, when a current flows through it, diamagnetism is generated in it due to orientation and alignment of μ_s , L_s etc. of its free electrons and interaction between their (free electrons) magnetic fields (see reference-3). In the specimen at its superconducting state, if the persistent current flows as the consequence of flow of Cooper pairs, then how is the diamagnetism is generated in it?

4. At temperatures $\leq T_c$ of the specimen, if the persistent current is obtained due to the flow of Cooper pairs, then how and from where they obtain their initial linear velocity with which they start flowing and how that is maintained against the gravitational force during their persistent flow which continues for indefinitely long time.

5. At temperatures $\leq T_c$ of the specimen, if the persistent current is obtained due to the flow of Cooper pairs, the directions of motion of the Cooper pairs must be oriented and aligned in one direction (unidirectional), i.e. along the direction of flow of the persistent current (otherwise the persistent flow of Cooper pairs for indefinite long time cannot be obtained). How are the directions of motion of the Cooper pairs oriented and aligned in one direction?

The energy gap between the electrons at normal state and the electrons at superconducting state does not occur because of formation of Cooper pairs (as assumed in BCS theory). That occurs because, due to interaction between the magnetic fields of electrons, when they start moving through the different inter-lattice passages of the specimen at its superconducting state, they are bound together (see section-4.9), consequently their energy is reduced in comparison to the electrons at their normal state.

In order to explain why (i.e. cause) and how (i.e. way) the lines of force of external magnetic field are expelled out from the substance at its superconducting state (i.e. Meissner effect), in existence there is found almost nothing. Whatever is found on the name of explanation (if we say it to be so) is that, at superconducting state since the substance becomes diamagnetic, i.e. it acquires magnetism in the direction opposite to the direction of external magnetic field; the lines of force of external magnetic field are expelled out from the substance. But this is not the explanation. Explanation means, there should be given a clear and complete explanation, how the substance is diamagnetized, and why, how and what situation is created when the substance is diamagnetized such that the lines of force of external magnetic field are expelled out (as has been explained presently in section-4.4).

6. POSSIBLE NEW EFFECTS

6.1 Effect-I: If the specimen substance is taken in the form of a rod and at its superconducting state it is placed in an external magnetic field with its length perpendicular to the direction of external magnetic field, the rod shall be deflected according to Fleming's left hand rule.

If the specimen substance is taken in the form of a rod and at its superconducting state it is placed in an external magnetic field with its length perpendicular to the direction of external magnetic field, as shown in Fig. 5(a), the external magnetic field and the magnetic field generated around the rod (see section-4.4) interact. Due to interaction between them, some lines of force of external magnetic field (e.g.. 5 and 6) shall be pushed aside while some of them (e.g. 1, 2, 3 and 4) shall be dragged along with the lines of force (c_3, c_4, c_5) of magnetic field generated around the specimen rod, as shown in Fig. 5(a) [because, according to property of magnetic lines of force, the magnetic line of force neither intersects itself nor other magnetic lines of force], similarly as some lines of force of earth's magnetic field (1, 2 above and 9, 10 below the magnetic axis of the bar magnet, Fig. 6) are pushed aside while some (3, 4, 5 above and 6, 7, 8 below the magnetic axis of the bar magnet, Fig. 6) are dragged along with the lines of force (m_3, m_4, m_5) of the bar magnet, which go into it through its south pole along with its lines of force, when it is placed in magnetic meridian of earth's magnetic field with its south pole towards the geographical south pole of earth and vice versa, Fig. 6.

Near point P, Fig. 5(a), the pushed aside lines of force (5 and 6) of external magnetic field shall be repelled by the lines of force c_2 and c_1 respectively of magnetic field around the specimen rod, because, near point P, they are in directions just opposite to each other. Consequently there shall be created a neutral space (i.e. space free from the magnetic effects of magnetic field around the rod and external magnetic field) around point P, similarly as a neutral space around P is created above the magnetic axis of the bar magnet due to repulsion between the magnetic lines of force 1, 2 of earth's magnetic field and m_1, m_2 of the bar magnet because near point P they are in directions opposite to each other, Fig. 6, and a neutral space around P' is created below the magnetic axis of the bar magnet due to repulsion between the magnetic lines of force 10, 9 of earth's magnetic field and m_1, m_2 of the bar magnet because near point P' they are in directions opposite to each other, Fig. 6.

The lines of force 1, 2, 3 and 4 of external magnetic field, dragged along with the lines of force c_3, c_4, c_5 of magnetic field around the specimen rod, shall be pushed behind the specimen rod, as shown in Fig 5(a). But in the process of pushing behind, the lines of force 1, 2, 3 and 4 of external magnetic field shall be expanded, hence they shall try to acquire their original form because, according to properties of magnetic lines of force, they are just like flexible strings and experience the longitudinal tension in its length. And secondly, as shown in Fig. 6, the lines of force 3,4,5 and 6,7,8 of earth's magnetic field acquire their original form after coming out from north pole of the bar magnet. These imply the magnetic lines of force possess tendency to acquire their original form. Therefore, in order to acquire their original forms, the lines of force 1, 2, 3 and 4 of the external magnetic field shall apply some pushing force on magnetic lines of force c_3, c_4, c_5 of the specimen rod, which in turn shall apply pushing force on the moving electrons (flowing through the specimen rod and gives rise to persistent current i) of the specimen rod (because the lines of force c_1, c_2, c_3, c_4, c_5 around the rod are generated due to interaction between the magnetic fields around the electrons, and hence the lines of force c_1, c_2, c_3, c_4, c_5 occur actually around the electrons), and electrons in turn apply pushing force on the lower surface, i.e. surface near the point P, of the specimen rod. Consequently there shall be observed force acting on specimen rod downwards, i.e. towards Y direction, Fig. 5(b). If we examine the direction of this force with respect to the direction of external magnetic field and direction of motion of electron, we find it to be in accordance with the Fleming's left hand rule.

The above whole phenomenon shall take place similarly as deflection in a current carrying rod (at normal state) takes place when it is placed in an external magnetic field with its length perpendicular to the direction of external magnetic field (see reference-3).

6.2 Effect-II: If the specimen is taken in the form of an anchor ring, and at supercondicting state it is placed in a plane perpendicular to the direction of an external magnetic field, the lines of force of the external magnetic field and of the magnetic field generated around the ring shall interact and consequently shall be deformed near the ring and contraction/ expansion in the length of the ring shall take place.

6.2.1 Why, how and when contraction in the length of the anchor ring shall take place.

If the specimen is taken in the form of an anchor ring of radius say R, Fig. 7(a), and is brought down at its superconducting state, a magnetic field shall be generated around it, Fig. 7(b), and it shall behave like a magnetic dipole similarly as, if, instead of bringing down the ring at its superconducting state, an electric current is allowed to flow through the ring at its normal state, a magnetic field is generated around the ring and it starts behaving like a magnetic dipole (see reference- 3). Let the direction of persistent current i in the ring is anticlockwise, shown by long arrows inside the ring in Fig. 7(b), and the ring is placed in an external magnetic field in a plane perpendicular to that's (external magnetic field) direction, Fig 7(c).

Let us assume the whole length of the ring is made up of large number (N) of very small pieces of rods (every piece is just like a thin slice) 1, 2, 3, ……, N. On every slice like piece, the Lorentz force shall come into play, which shall act radially (i.e. along the radius) towards the center of the ring. Therefore, every slice shall experience a force, acting radially towards the center of the ring, and consequently the ring shall get contracted, i.e., the length of the ring (= $2\pi R$) shall be reduced. The contraction in the length of the ring shall depend upon the strength of the current i and the strength of the external magnetic field.

When the length of the ring $(= 2\pi R)$ shall be reduced, obviously its area A $(= \pi R^2)$ shall also be reduced. Due to decrease in the length of the ring, the strength of current i shall be increased, which shall increase the magnetic dipole moment ($\mu = i\ A$) of the ring, but due to reduction in A, the increase in μ shall be balanced and finally μ shall remain unchanged.

6.2.2 How the lines of force of the interacting external magnetic field and the magnetic field generated around the anchor ring shall be deformed when contraction in the length of the ring shall take place.

When a persistent current i carrying rod is placed with its length perpendicular to the direction of an external magnetic field, Fig. 5(a), due to interaction between their magnetic fields (i.e. between external magnetic field and the magnetic field generated around the persistent current i carrying rod), the lines of force of interacting magnetic fields are deformed and a neutral space is created, towards which the Lorentz force comes into play on the persistent current i carrying rod (see the section-6.1), Fig. 5, similarly, due to interaction between the external magnetic field and the magnetic field generated around each slice (1, 2, 3, …., N), the lines of force of the external magnetic field and the magnetic field around each slice shall be deformed, as shown in Fig.7(c). Beneath every slice [i.e. the place, lying near the inner circular edge and radially towards the center of the ring in Fig. 7(c)], a neutral space shall be created, lines of force shall be deformed and the Lorentz force shall come into play similarly as has been shown in Fig. 5(a). But, in order to avoid complications in diagram, neutral spaces, deformation in lines of force around the neutral spaces etc. have not been shown in Fig. 7(c). The direction of Lorentz force, on every slice (acting towards the neutral space created beneath that slice), shall be radially towards the center of the ring. Consequently, the ring shall be contracted.

6.2.3 Why, how and when the expansion in the length of the anchor ring shall take place.

If the direction of persistent current i in the ring is clockwise, shown by long arrows inside the ring in Fig. 7(d), on every slice, the Lorentz force shall act in direction radially away from the center of the ring. Therefore, every slice shall experience a force, acting radially away from the center of the ring, and consequently the ring shall get expanded, i.e., the length of the ring ($= 2\pi R$) shall be increased. The expansion in the length of the ring shall depend upon the strength of the current i and the strength of the external magnetic field.

When the length of the ring ($= 2\pi R$) shall be increased, obviously its area A ($= \pi R^2$) shall also be increased. Due to increase in the length of the ring, the strength of current i shall be reduced, which shall decrease the magnetic dipole moment ($\mu = i\ A$) of the ring, but due increase in A, the decrease in μ shall be balanced and finally μ shall remain unchanged.

6.2.4 How the lines of force of the interacting external magnetic field and the magnetic field generated around the anchor ring shall be deformed when the expansion in the length of the ring shall take place.

Due to interaction between the external magnetic field and the magnetic field generated around each slice, their lines of force shall be deformed, and finally the deformation around the ring shall be obtained as shown in Fig. 7(d). Above the every slice [i.e. the place, lying near the outer circular edge and radially away from the center of the ring in Fig. 7(d)], a neutral space shall be created, lines of force shall be deformed and the Lorentz force shall come into play similarly as has been shown in Fig. 5(a). But, in order to avoid complications in diagram, neutral spaces, deformation in lines of force around the neutral spaces etc. have not been shown in Fig. 7(d). Since the direction of Lorentz force on every slice (acting towards the neutral space created above that slice) shall be radially away from the center of the ring, the ring shall be expanded

7. EXPLANATION OF WHY AND HOW IN AN EXTERNAL MAGNETIC FIELD, THE ORBITING ELECTRONS OF THE SPECIMEN ARE EXCITED AND THE PHOTONS ARE EMITTED FROM THEM

7.1 When the orbit of electron is in a plane perpendicular to the direction of external magnetic field and the direction of orbital velocity of the electron is clockwise

Let an electronic orbit of radius R of the specimen is in a plane perpendicular to the direction of an external magnetic field applied across the specimen, and the direction of motion of electron in its orbit is clockwise (when the direction of external magnetic field is towards the face of the clock). Then obviously the direction of flow of current i (created due to flow of electron) shall be anticlockwise, and the situation shall be exactly similar as has been shown in Fig. 7(c). Let us assume very large numbers of points from 1 to N are located consecutively on the orbit of electron all along its full length. During the orbital motion, at every point 1, 2, 3, ……, N, the electron shall experience a Lorentz in the direction towards the center of the orbit. Consequently, the electron shall transit to some lower energy state (i.e. to some inner orbit) emitting a photon having energy equal to the difference of energy between the two energy states of the electron. The energy of the lower energy state, to which the electron shall transit, shall depend upon the strength of the external magnetic field.

7.2 When the orbit of electron is in a plane perpendicular to the direction of external magnetic field but the direction of orbital velocity of the electron is anticlockwise

If the direction of motion of the electron in its orbit is anticlockwise, the direction of flow of current i (created due to flow of electron) shall be clockwise, and the situation shall be exactly similar as has been shown in Fig. 7(d). Let us assume further, a very large number of points from 1 to N are located consecutively on the orbit of electron all along its full length. In the present situation, during the orbital motion of electron, at every point 1, 2, 3, ……, N the electron shall experience a Lorentz in the direction away from the center of the orbit. Consequently, the electron shall be excited and shall transit to some higher energy state (i.e. to some outer orbit), and after emitting a photon having energy equal to the difference of energy between the two energy states of the electron, the electron shall transit back to its lower energy state. The energy of the higher energy state, to which the electron shall transit, shall depend upon the strength of the external magnetic field.

7.3 When the orbit of electron is not in a plane perpendicular to the direction of external magnetic field.

When the orbit of electron is not in a plane perpendicular to the direction of external magnetic field, the plane of the orbit shall be rotated, and the angle of rotation shall depend upon: i-the strength of the external magnetic field, ii-the orbiting velocity of the electron (because the orbiting velocity of the electron determines the strength of the current i flowing through the orbit), and iii-how much free is the orbit to rotate. It shall occur similarly as when an electric current carrying coil is suspended in an external magnetic field, the coil is rotated, and the angle of rotation depends upon, i- the strength of the external magnetic field, ii-the strength of the current i flowing through the coil, and iii-how much free is the coil to rotate (i.e. how much flexible is the suspension of the coil) During rotation, and also after rotation of the orbit, at instant(s) when the direction of orbital velocity of the electron and the direction of external magnetic field happen to be such that the condition of Lorentz force to come into play is satisfied, the electron is excited.

ACKNOWLEDGEMENT

The author is grateful to his respected teacher, Prof. Ashok Kumar Gupta, Professor of Physics (Retd.), Allahabad University, Allahabad (U.P.), INDIA, for his continuous encouragement, time to time discussion, sincere advice and help.

REFERENCES

[1] Kunwar Jagdish Narain, A new interpretation to quantum theory, Phys. Essays **22** (2009) p. 47.

[2] http://hyperphysics.phy-astr.gsu.edu/hbase/solids/scond.html

[3] Kunwar Jagdish Narain, Theory which explains several greatly important mysterious phenomena and it determines a new force having characteristics of nuclear force, vixXra: 1111.0072.

[4] W. Meissner, and R. Ochsenfeld, Ein neuer Effekt bei Eintritt der Supraleitfahigkeit, Naturwissenschaften **21** (1933) p. 787.

[5] http://en.wikipedia.org/wiki/Meissner_effect

[6] P, Zeeman, Doubles and triplets in the spectrum produced by external magnetic forces, Phil. Mag. 44 (1897) p. 55.

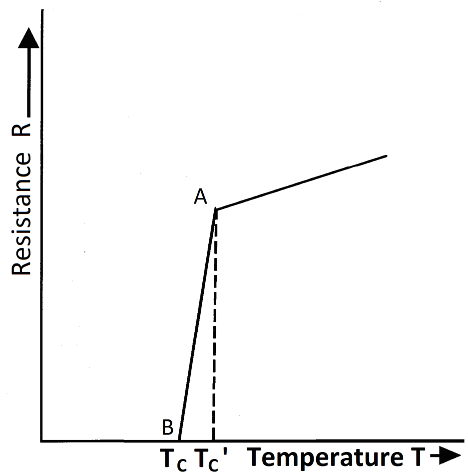
[7] S. O. Pillai, Solid State Physics, Revised Sixth Edition [New Age International (P) Ltd. (formerly Wiley Eastern Ltd.), New Delhi, India], p. 369-70, Section: Thermal Conductivity.

[8] B.D. Josephson, Possible new effects in superconductive tunneling, Phys. Lett. **1 (7)** (1962) p. 251.

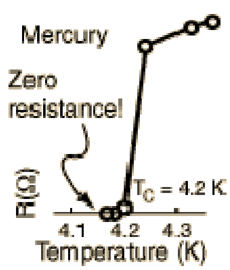
[9] Kunwar Jagdish Narain, A new theory to explain the variation of specific of solid elements at lower temperatures and behaviour of real gases, Phys. Essays **23** (2010) p. 320.

[10] J. Bardeen, L.N. Cooper, J.R. Schriefer, Theory of superconductivity, Phys. Rev. **108 (5)** (1957) p. 1175.

[11] S. O. Pillai: Solid State Physics, Revised Sixth Edition [New Age International (P) Ltd. (formerly Wiley Eastern Ltd.), New Delhi, India], p. 387-89, Section: BCS Theory.

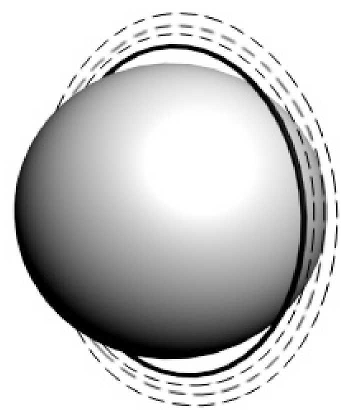


(a)

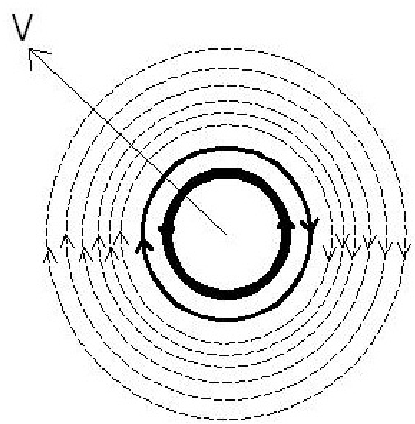


(b)

Fig. 1: Variation of resistance with temperature near the transition temperature

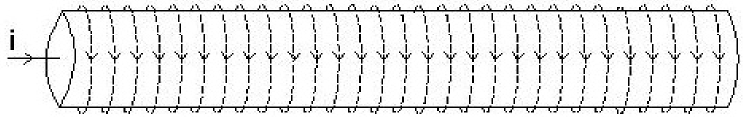


(a)

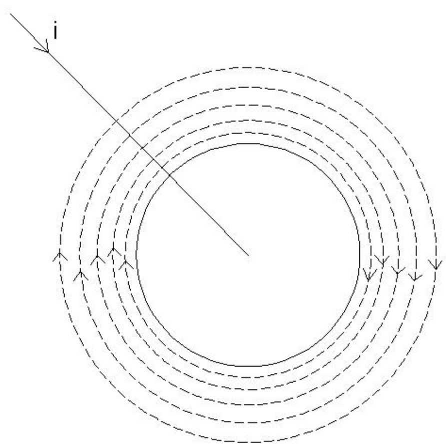


(b)

Fig. 2: (a) Spherical ball, dark solid line circle and concentric broken line circles respectively represent the charge, magnetism and magnetic field of electron. (b) Cross sectional view of electron where, in order to introduce arrow marks with the ball of charge to show the direction of its spin motion, the ball of charge has been shown by a dark thick solid line circle



(a)



(b)

Fig. 3: (a) Longitudinal view of magnetic field generated around the persistent current carrying specimen rod. (b) Transverse cross sectional views of magnetic field generated around the persistent current carrying rod

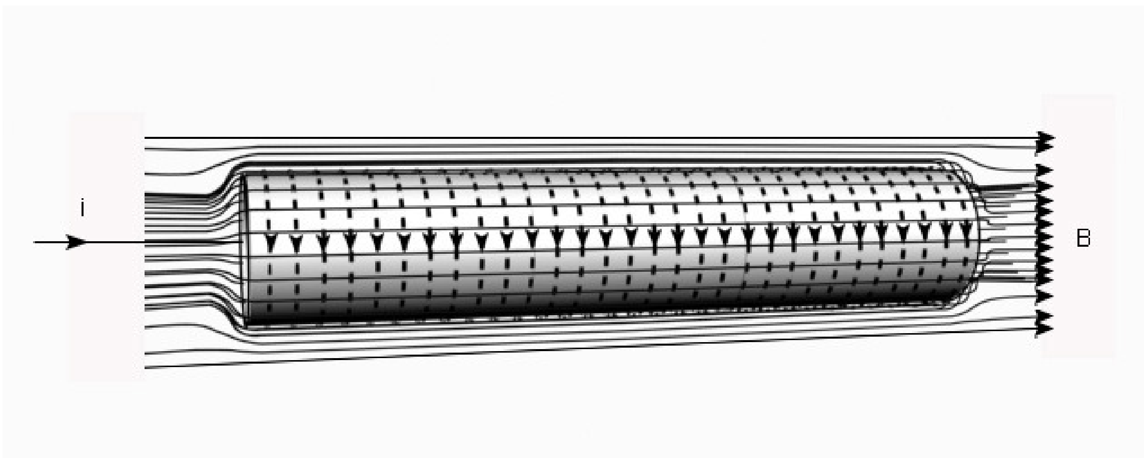
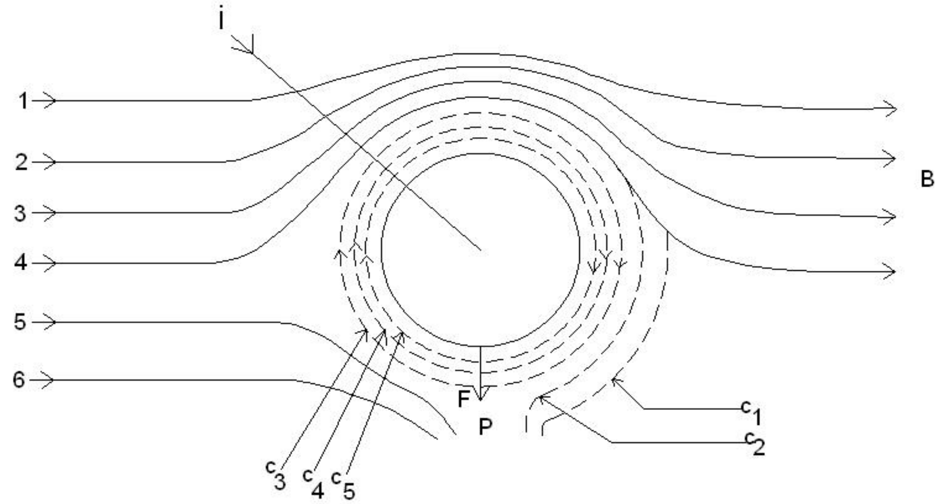
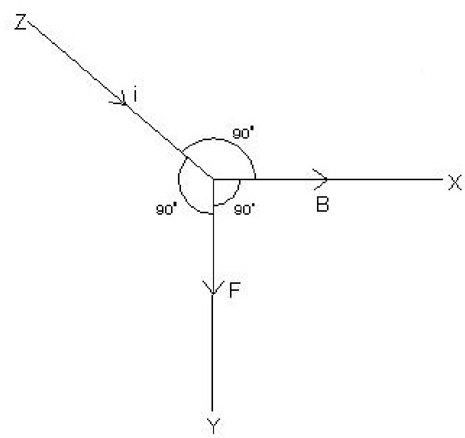


Fig. 4: Longitudinal view of ejection of magnetic lines of force of external magnetic field B from the rod when the persistent current i starts flowing through the rod



(a)



(b)

Fig. 5: (a) Transverse cross sectional view of interaction between the magnetic field generated around persistent current carrying specimen rod and the external magnetic field B. (b): X and Y are in the plane of the page and Z is perpendicularly upward to the plane of the page

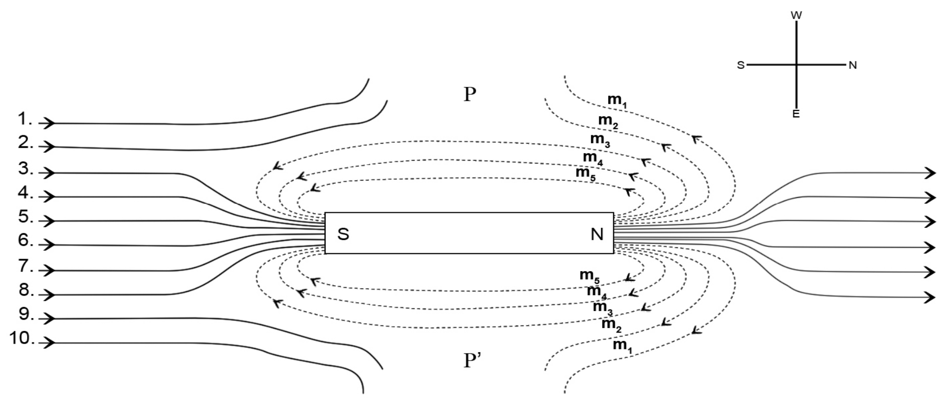
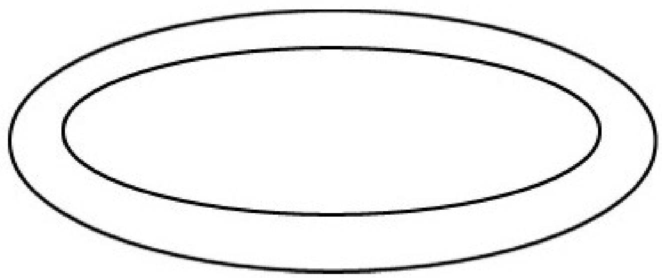
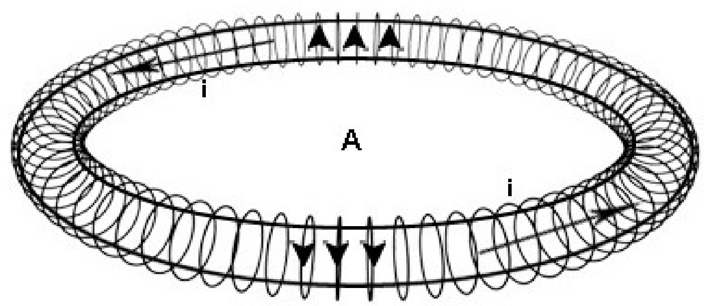


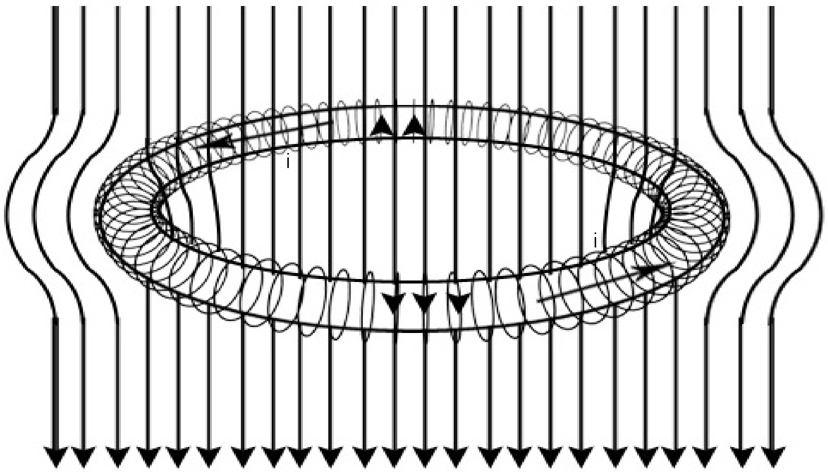
Fig. 6: Longitudinal cross sectional view of interaction between the earth's magnetic field and the magnetic field around a bar magnet placed in magnetic meridian



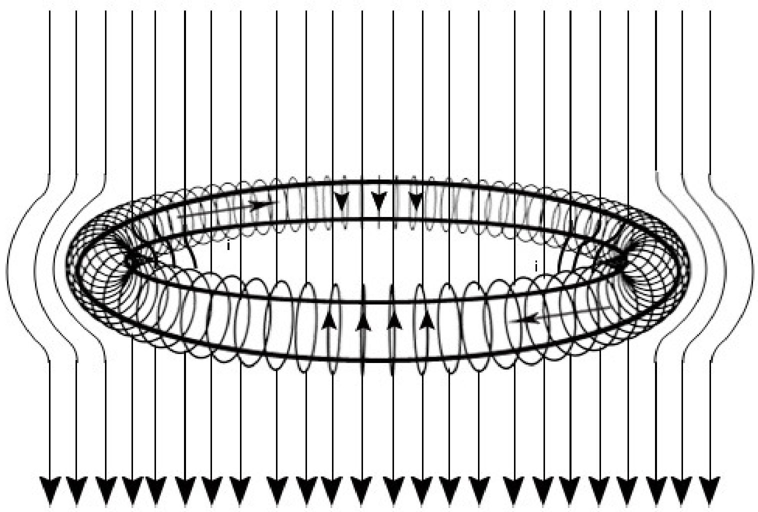
(a)



(b)



(c)



(d)

Fig. 7: (a) Specimen taken in the form of an anchor ring. (b) Circular rings with arrows round the thickness of the anchor ring show the magnetic field generated round the anchor ring due to flow of persistent current i through the ring, shown by long arrows inside the ring. (c) Deformations in the magnetic lines of force of interacting external magnetic field and the field generated around the anchor ring when the ring at its superconducting state, having persistent current i flowing through it in a anticlockwise direction shown by long arrows inside the ring, is placed in a plane perpendicular to the direction of that external magnetic field. (d) When the persistent current i flows in a clockwise direction shown by long arrows inside the ring