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BICYCLE LIGHTING SYSTEM AND GENERATOR

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(57) Claim

1. A bicycle lighting system comprising a dynamo system drivable by a ridden bicycle and mounted thereon, at least one front light and at least one rear light, both of which are supplied with electric power from the dynamo system, and an electronic circuitry which converts the electric power output of the dynamo system into a regulated direct-current voltage for producing light and for charging a rechargeable accumulator battery,

characterized in that

the dynamo system is provided with a dynamo generator (1) comprising an inner circuit (21) and an outer circuit (22), both of which are mounted for synchronous rotation in a same direction about a stationary air-core coil (23) consisting of coil sections (23.1 to 23.6), whereby said inner and outer circuits (21, 22) each comprise n pole shoes (a-f and g-m, respectively) in identical pole pitch, and between said n pole shoes (a-f) of the inner circuit (21) there are disposed

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n permanent magnets (24-29) in such a manner that in each case said permanent magnets (24-29) rest homopolar against both sides of each of the n pole shoes (a-f) of the inner circuit (21), so that from a minimum traveling speed of approximately 5 to 7 kmph said electric power output of the dynamo system is adequate to charge the rechargeable accumulator battery (4) and simultaneously energize the lights (2, 3), and in that the electronic circuitry (5) comprises a converter (10) having a voltage set-up and set-down mode of operation such that, for a determinate stabilized output voltage, a fed input voltage can be lower than, equal to, or higher than said determinate stabilized output voltage, whereby said converter (10) is additionally supplied by the accumulator battery (4) as long as said minimum traveling speed of approximately 5 to 7 kmph is not reached.

23. A generator comprising an inner circuit and an outer circuit, both of which are mounted for synchronous rotation in a same direction about a stationary air-core coil, these inner and outer circuits having n inner pole shoes and n outer pole shoes, respectively, in identical pole pitch, characterized in that between the n inner pole shoes (a-f) there are disposed n permanent magnets (24-29) in such a manner that in each case respective magnetic poles (M_1-M_{12}) of said permanent magnets (24-29) rest in homopolar configuration against both sides of each of the n inner pole shoes (a-f), and in that said n outer pole shoes (g-m) facing said n inner pole shoes (a-f) are structured to nose-shapedly project toward the latter.

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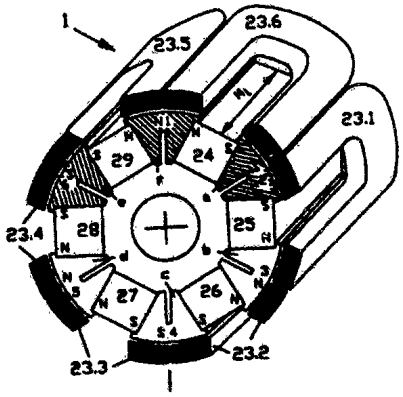
(54) Title: BICYCLE LIGHTING SYSTEM AND GENERATOR

(54) Bezeichnung: FAHRRADBELEUCHTUNGSSYSTEM UND GENERATOR

(57) Abstract

A new type of bicycle lighting system has a high-capacity dynamo system (1, 5), including a dynamo generator (1), and a converter (5) connected thereto and to the lighting bodies to convert the electric power generated by the dynamo generator (1) into light and at the same time into a regulated direct voltage for loading a battery. The dynamo generator (1) consists of an inner and an outer circle (21, 22) that rotate both around a fixed, air-core coil (23). The pole pieces form together with the fixed air-core coil a high-capacity generator that reaches at least 90 % efficiency. This capacity ensures that the dynamo system (1, 5) generates enough electric energy to load the battery and at the same time to feed front and rear lights (2, 3) from a minimum driving speed of about 5 km/h. As long as the minimum driving speed is not exceeded, the converter (5) and the front and rear lights (2, 3) are additionally fed by the battery (parking light). Electronic components, such as a threshold value device (12-16) and a delay circuit (17) ensure that the disclosed bicycle lighting system generates a constant lighting voltage of about 6 V and that the ratio of distribution between the energy required for generating light and the energy required for loading the accumulator battery (4) lies between 1 and 2:1, regardless of the speed from about 5 km/h. When the battery (4) fails, the dynamo generator (1) feeds the light sources directly through the dynamo system.



(57) Zusammenfassung

Ein neuartiges Fahrradbeleuchtungssystem weist ein Hochleistungsdynamosystem (1, 5) einschließlich eines Dynamogenerators (1) und einer damit und mit den Beleuchtungskörpern verbundene Wandleranordnung (5) auf, die die vom Dynamogenerator (1) erzeugte elektrische Leistung zur Lichterzeugung und gleichzeitig zum Laden einer Batterie in eine geregelte Gleichspannung umsetzt. Der Dynamogenerator (1) besteht aus einem Innen- und einem Außenkreis (21, 22), die beide um eine feststehende, eisenlose Spule (23) rotieren, und die Polschuhe bilden in Verbindung mit der stehenden eisenlosen Spule eine hochleistungsfähige Generatoranordnung, mit der ein Wirkungsgrad von mindestens 90 % erreichbar ist. Mit dieser Leistung ist sichergestellt, daß das Dynamosystem (1, 5) ab einer Mindestfahrgeschwindigkeit von etwa 5 km/h eine zum Laden der Batterie und gleichzeitig zur Speisung eines Vorder- und Rücklichts (2, 3) ausreichende elektrische Energie erzeugt. Solange die Mindestfahrgeschwindigkeit nicht überschritten wird, wird die Wandleranordnung (5) sowie das Vorder- und Rücklicht (2, 3) zusätzlich von der Batterie gespeist (Standlicht). Elektronische Komponenten, wie eine Schwellwertvorrichtung (12-16) und ein Verzögerungskreis (17) stellen sicher, daß das vorgeschlagene Fahrradbeleuchtungssystem eine konstante Beleuchtungsspannung von etwa 6 V erzeugt und eine Aufteilung der zum Lichterzeugen benötigten Energie und zum Laden der Akkumulatorbatterie (4) benötigten Energie im Verhältnis von 1-2:1 im wesentlichen unabhängig von der Geschwindigkeit ab etwa 5 km/h möglich ist. Bei Ausfall der Batterie (4) versorgt der Dynamogenerator (1) die Lichtquellen durch das Dynamosystem direkt.

LEDIGLICH ZUR INFORMATION

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BACKGROUND OF THE INVENTION

The present invention relates to a bicycle lighting system comprising a dynamo system drivable by a ridden bicycle and mounted thereupon, at least one front light or headlamp and at least one rear light or tail lamp, both of which are supplied with electric power from the dynamo system, and an electronic circuitry which converts the electric power produced by the dynamo system into a regulated direct-current voltage for the purpose of generating light and charging an accumulator or storage battery. The invention also relates to a new and improved generator for general applications, particularly however for use as a bicycle dynamo generator.

Conventional and marketable bicycle lighting systems have to comply, with respect to the electric power and voltage, with the Standards determined by law. At a traveling speed of 15 kilometers per hour and beyond that, these Standards specify a maximum voltage of 7 V for the dynamo output voltage applied to the lamps. In accordance with legal regulations, the minimum value of the output voltage of the dynamo lies between 3 V at 5 kmph and 5.8 V at 15 kmph and - as indicated in Figure 5a of the annexed drawings - must not fall short of 5.8 V at a speed beyond or better than 15 kmph. On the basis of the aforementioned regulations, present-day or state-of-the-art dynamos allow producing merely 1.4 W power at a bicycle traveling speed of 5 to 6 kmph. If such power or output of present-day conventional dynamos is increased, it would be physically impossible to meet or observe the legally specified maximum voltage of 7 V at 15 kmph or beyond such speed. Only by taking respective load measures would it be possible to prevent exceeding the legally

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specified maximum value. As a result, the power dissipation or loss would greatly increase and the efficiency would then considerably decrease.

Therefore, conventional bicycle lighting systems cannot be additionally loaded in the lower speed range for the purpose of charging a rechargeable accumulator battery. Only from a traveling speed of approximately 15 kmph, conventional dynamos will generate sufficient power that could be used for charging the rechargeable accumulator battery, the efficiency of these known systems being extremely low when the traveling speed is below the aforementioned speed of 15 kmph. Laterally mounted dynamos have an efficiency of approximately 17% to 24%, roller dynamos can achieve an efficiency of 30% to 35% at the most, and the efficiency of hub dynamos is approximately 40%. When the traveling speed of the bicycle exceeds 15 kmph, the efficiency additionally decreases because of the power draw or consumption while charging the accumulator battery. Under such circumstances, the bicycle rider is obliged to expend additional physical energy for actuating the dynamo.

Those skilled in the art have criticized the aforementioned limitations and drawbacks of prior-art constructions and have realized that conventional dynamos and bicycle lighting systems do not correspond at all with the state of present-day engineering knowledge.

SUMMARY OF THE INVENTION

Therefore, with the foregoing in mind, it is a primary object of the present invention to provide a new and improved construction of a bicycle lighting system in combination

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with a generator, which system is adapted to the latest state of advanced engineering and technology and accommodated to present-day requirements.

Another significant object of the present invention is directed to the provision of a new and improved bicycle lighting system which is relatively simple in construction and design and, particularly, economical to manufacture.

Yet a further significant object of the present invention is concerned with a new and improved dynamo system, which - with regard to construction, power efficiency and production cost thereof - meets all requirements of the bicycle lighting system of the present invention.

The implementation of these and further objects of the present invention is based on the finding and conclusion that a satisfactory bicycle lighting system can only be realized by means of a dynamo generator having an efficiency considerably higher than that of conventional dynamos.

The bicycle lighting system of the present development is characterized in that the dynamo system is provided with a dynamo generator comprising an inner circuit and an outer circuit, both of which are mounted for synchronous rotation in a same direction about a stationary air-core coil consisting of coil sections, whereby the inner circuit and the outer circuit each comprise n pole shoes in identical pole pitch, and between the n pole shoes of said inner circuit there are disposed n permanent magnets, whereby at each of said n pole shoes of said inner circuit there are laterally positioned two magnetic poles in homopolar configuration, so that from a minimum traveling speed of approximately 5 to 7 kmph the power output of the dynamo

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system is adequate to charge the rechargeable accumulator battery and simultaneously energize the bicycle lamps; and in that the electronic circuitry comprises a converter having a voltage set-up and set-down mode of operation such that - for a determinate stabilized output voltage - a fed input voltage can be lower than, equal to or higher than said determinate stabilized output voltage, whereby the converter is additionally supplied from the rechargeable accumulator battery as long as the traveling speed falls short of said minimum traveling speed of approximately 5 to 7 kmph.

In order to ensure the required characteristic features and properties of the dynamo system, the generator has high efficiency and very low coil internal resistance, so that at said minimum traveling speed the output is at least 4.5 W at a relatively low output voltage. The generator output is thereby converted into an output voltage of 6.2 to 7 V.

As aforementioned, two magnetic poles in homopolar configuration are laterally positioned at each inner pole shoe of the inner circuit. In this manner, two magnetic surfaces project themselves upon a respective pole-shoe surface. Since said two magnetic surfaces are structured to be substantially larger than said respective pole-shoe surface, the density of a magnetic flux correspondingly increases toward the respective pole-shoe surface. This arrangement is advantageous in that these inner pole shoes each possess a relatively small mass and thereby render possible a substantial weight reduction.

The n pole shoes (preferably six by way of example) of the outer circuit facing the n pole shoes of the inner circuit are structured to nose-shapedly project toward the latter, these n pole shoes of the outer circuit being thereby formed such that

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an air gap defined between the inner pole shoes and the respective outer pole shoes assigned to the latter is a shortest possible path for a magnetic flux. In this manner, magnetic leakage flux is advantageously reduced.

In order to reduce the mutual interference of the two homopolar magnetic poles lying laterally against the respestive inner pole shoe thereof, each inner pole shoe of the inner circuit is divided in a mid-portion thereof into two identical parts by a slot providing an air gap extending in the radial direction. This arrangement results in an additional advantage of a smaller pole-shoe volume as well as larger magnet heights or, in other words, two half magnet-lengths per pole together with a smallest magnet-volume and double magnet-surface are possible.

The air gap in each inner pole shoe reduces the mutual interference of the two homopolar magnet faces because the magnetic flux glides in each case with respective halves over the pole shoe to the outer circuit. The two magnetic fluxes in each inner pole shoe possess an optimally short magnetic-circuit path, so that there results an optimal magnetic flux. A further advantage is seen in the fact that an extremely small generator with very high flux densities can be produced, such generator having at the same time a light-weight, small magnet-volume and high-efficiency structure. The efficiency achievable by means of the new and improved generator provided for the bicycle lighting system constructed according to the present invention is at least approximately 90%.

In a preferred embodiment of the dynamo system according to the present invention, the converter of the

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electronic circuitry comprises a voltage-converting and energy--limiting device for converting the input voltage into a determinate stabilized output voltage and for limiting the converted energy to a determinate maximum power output. The electronic circuitry further comprises a threshold-value device which detects a rectified dynamo output voltage, whereby in case the threshold-value device detects that a determinate minimum voltage of the dynamo generator is exceeded, the voltage supplied from the accumulator battery is fed by means of an electronic switchgear - in addition to the rectified dynamo output voltage - to the voltage-converting and energy-limiting device. During battery operation, the output voltage of the voltage-converting and energy-limiting device lies within a first constant output voltage range. During dynamo operation, the output voltage of the voltage-converting and energy-limiting device lies within a second constant output voltage range, the latter lying above the first constant output voltage range. The electronic circuitry further comprises a battery charging device which is activated above an output charging voltage that lies between the first constant output voltage range and the second constant output voltage range.

The first constant output voltage range of the electronic circuitry preferably lies within a fixedly set range from 4.5 V to 6 V. During this mode of operation, the input voltage range of the converter lies between 0.8 V minimum threshold-value voltage and 4.8 V maximum switch-over voltage.

The second constant output voltage range of the electronic circuitry preferably lies within a range from 6.2 V to 7 V, but advantageously above 6.4 V. During this mode of operation, the input voltage range of the converter lies in

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an initial speed range between approximately 5 V and a voltage level rising to a maximum of 80 V at a speed of about 80 kmph. By virtue of this setting of the electronic circuitry in accordance with the teachings of the present invention, the legal requirements and Standards are ideally met at each and every bicycle traveling speed. The combination of a powerful high-efficiency dynamo generator with the electronic circuitry and the rechargeable accumulator battery renders possible a combined battery-charging, standstill-light and travel-light system. The electronic circuitry is operated by the accumulator battery as well as directly by the dynamo generator.

The voltage-converting and energy-limiting device preferably limits the output power of the electronic circuitry invariably between 4 W and 6 W, advantageously between 4.5 W and 5 W. In this manner, the short-circuit safety of the accumulator battery and of the dynamo generator as well as of the entire dynamo system is ensured.

According to a particularly preferred embodiment of the present invention, the electronic circuitry further comprises (a) a rectifier circuit for the purpose of producing the aforementioned rectified and smoothed dynamo output voltage which is supplied to the voltage-converting and energy-limiting device, (b) a first voltage divider network for the purpose of converting a first rectified and speed-proportional output voltage of the dynamo generator into a first component voltage and applying such first component voltage to a first threshold-value switch, (c) a second voltage divider network for the purpose of converting the rectified and speed-proportional output voltage of the dynamo generator into a second component voltage and applying such second component voltage to a second threshold-value switch, whereby the first threshold-value switch

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applies the battery voltage to the voltage-converting and energy-limiting device by means of the electronic switchgear when the rectified output voltage supplied from the dynamo generator exceeds a first threshold voltage detected by the first threshold-value switch, and whereby the second threshold-value switch transmits to the voltage-converting and energy-limiting device a signal for switching over the output voltage of the latter from the first determinate or constant output voltage to the second determinate or constant output voltage, and vice versa, whenever the second threshold-value switch detects that a second threshold voltage is not reached or is exceeded, (d) a delay circuit connected to the output of the first threshold-value switch as well as to the electronic switchgear and which - in case the rectified output voltage of the dynamo generator falls short of the first threshold voltage - opens the electronic switchgear at the end of a predetermined period of time, e.g. four minutes, for the purpose of switching off the voltage of the accumulator battery from the input of the voltage-converting and energy-limiting device, and (e) the aforementioned battery charging device which is coupled at the output side thereof to the voltage-converting and energy-limiting device and which - also in the case of battery operation - remains activated for charging the battery.

The first threshold-value switch switches on, by means of the electronic switchgear, the battery voltage at a threshold voltage of approximately 0.8 V.

The battery charging device operates at an output voltage of 6.1 V up to maximum 7 V, such output voltage proportionally increasing with higher power conversion depending on the charging condition of the battery.

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By way of example, the thereby resulting effective or actual efficiency of the entire bicycle lighting system constructed according to the invention for 3 W luminous power and 1 W battery charging energy is - with reference to 3 W - approximately 60% in the case of a discharged accumulator battery and approximately 80% in the case of a charged accumulator battery.

As alluded to above, the invention is not only concerned with the bicycle lighting system, but also relates to a new and improved construction of the generator. Those skilled in the art will readily understand that the underlying principles and concepts of the dynamo generator can be also employed for other generator applications.

The inventive generator comprising an inner circuit and an outer circuit, both of which are mounted for synchronous rotation in a same direction about a stationary air-core coil consisting of coil sections, the inner circuit and the outer circuit comprising n inner pole shoes and n outer pole shoes, respectively, in identical pole pitch, is characterized in that between said n inner pole shoes there are disposed n permanent magnets, whereby at each inner pole shoe there are laterally positioned two magnetic poles in homopolar configuration, and in that said n outer pole shoes facing said n inner pole shoes are structured to nose-shapedly project toward the latter.

The nose-shapedly protruding n outer pole shoes of the outer circuit and the n inner pole shoes of the inner circuit directly facing the latter form in each case an air gap which defines a shortest flux path for a magnetic flux.

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Preferably, each inner pole shoe of the inner circuit comprises in a mid-portion thereof a slot extending in radial direction, thereby forming in each case an air gap for the purpose of reducing mutual interference of respective two permanent magnets laterally lying against a respective inner pole shoe. Furthermore, the sum of the surfaces of said two permanent magnets adjacent to the respective inner pole shoe is larger than a peripheral surface of such inner pole shoe.

The air-core coil is divided per pole field into two identical coil sections which are pole-correctly connected in series.

Those skilled in the art will readily understand that the characteristics of the magnet arrangement and of the magnetic circuit structure can be advantageously applied to and used for electric motors, for instance, servomotors.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein throughout the various figures of these drawings, there have been generally used the same reference characters to denote the same or analogous components and wherein:

Figure 1a is an enlarged detail showing of a part of a cross-sectional view of a dynamo generator illustrated in Figure 1b;

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Figure 1b shows a cross-sectional view of a preferred exemplary embodiment of the dynamo generator constructed in accordance with the present invention;

Figure 2a shows the inner magnetic circuit arrangement in a perspective cross-sectional illustration;

Figure 2b shows the arrangement of the stationary coil in a stretched illustration of the coil arrangement;

Figure 3 schematically shows a block diagram of a preferred exemplary embodiment of the bicycle lighting system constructed according to the present invention whereby, in particular, the role of the proposed electronic circuitry becomes apparent;

Figure 4a shows a voltage + speed/variation-in-time diagram and Figures 4b, 4c, 4d and 4e depict voltage/time diagrams for the purpose of explaining the function of the bicycle lighting system according to the present invention;

Figures 5a, 5b and 5c show voltage/speed diagrams to further explain the function of the inventive dynamo system, whereby Figure 5a depicts operation with a discharged or defective accumulator battery and Figure 5c refers to operation with a normal functioning accumulator battery;

Figure 6 shows an exemplary accomplished embodiment of the electronic circuitry of the bicycle lighting system constructed according to the present invention and realized by means of a customized solid-state integrated switching circuit (ASIC);

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Figure 7 shows a longitudinal sectional view of a first exemplary embodiment of the dynamo system constructed according to the present invention and structured as a laterally mounted bicycle dynamo; and

Figure 8 shows a longitudinal sectional view of a second exemplary embodiment of the dynamo system constructed according to the present invention and structured as a roller bicycle dynamo.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Describing now the drawings, it is to be understood that to simplify the showing thereof, only enough of the construction of the exemplary embodiment of the bicycle lighting system and generator has been illustrated therein as is needed to enable one skilled in the art to readily understand the underlying principles and concepts of this invention.

Turning attention now specifically to Figures 1a and 1b of the drawings, a dynamo generator 1 illustrated therein by way of example and not limitation will be seen to comprise in concentric arrangement from the center to the circumference a rotating inner circuit 21, a stationary air-core coil 23 and an outer circuit 22 synchronously rotating with the inner circuit 21. In the exemplary embodiment depicted in Figures 1a and 1b, the inner circuit 21 and the outer circuit 22 each comprise six poles in identical pole pitch, the poles of the inner circuit 21 thereby facing the respective poles of the outer circuit 22, so that the resulting pole-pitch angle is 60°. The six poles of the inner circuit 21 are structured in the form of six pole shoes a, b, c, d, e, and f, while the

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poles of the outer circuit 22 are structured in the form of likewise six pole shoes g, h, i, k, l and m which are situated opposite to the pole shoes a-f and which nose-shapedly project toward the latter, so that a smallest possible air gap 30 is formed. The pole shoes a-f of the inner circuit 21 are made of soft iron, while a carrier or support 41 of the inner magnetic circuit is itself non-ferrous. The outer circuit 22 consists entirely of soft iron. The number of poles, namely six, is specified only by way of a preferred example.

Between the six pole shoes a-f of the inner circuit 21 there are arranged six permanent magnets 24-29 in such a manner that in each case they rest homopolar against both sides of each pole shoe. The result is that the two magnet surfaces, which in Figure 1a are designated by reference characters a_1 and a_2' (magnet width) at the respective magnets 24 and 29, project themselves upon a pole-shoe surface b_1 of the respective pole shoe f. The magnet lengths M_1 (refer to Figure 2a) of the permanent magnets 24-29 extending perpendicularly with respect to the illustration in Figures 1a and 1b and the entire arrangement are determined such, that in each case the sum of the respective magnet surfaces a_1 and a_2 is far larger than the respective pole-shoe surface b_1. In this manner, the magnetic flux density correspondingly increases toward the pole-shoe surface b_1. This arrangement is furthermore advantageous in that the six pole shoes a-f of the inner circuit 21 possess a relatively small mass, so that a substantial weight reduction is rendered possible.

However, the entire rotating part of the dynamo generator 1 possesses, mainly because of the rotating outer circuit 22, a relatively high moment of inertia, so that the wheel slippage behavior is substantially improved.

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The magnetic flux from the pole shoes a-f of the inner circuit 21 is divided across the respective nose-shapedly projecting pole shoes g-m of the outer circuit 22 into two parts or portions as illustrated in Figure 1b and designated by the reference characters MK1 and MK2. By virtue of the nose-shaped form of the pole shoes g-m of the outer circuit 22, such form being also adapted to the periphery of the coil, there results the air gap 30 - indicated between a pole-shoe pair, namely the pole shoes f and m in Figure 1a - as the shortest path for the magnetic flux. The magnetic leakage flux is thus reduced.

In order to reduce interaction of the homopolar magnets 24-29 resting against both sides of the respective pole shoes a-f of the inner circuit 21, these pole shoes a-f are provided each with a slot in the mid-portion thereof, such slots forming radial air gaps 31-36. The advantage of this arrangement is seen in a small pole-shoe volume in view of coincident large magnet heights. i.e. two magnet widths per pole with coincidentally the smallest magnet volume and the double magnet-surface.

The radial gaps 31-36 provided in the pole shoes a-f prevent interaction of the two homopolar magnet-face surfaces, since the magnetic flux flows in halves through the respective pole shoe of the inner circuit 21 to the respective pole shoe of the outer circuit 22. The two magnetic-flux halves in each of the pole shoes a-f have an optimally short magnetic circuit path MK1 and MK2 depicted in Figure 1b. The result is an optimal magnetic flux. A further advantage is that, in this manner, a relatively small dynamo generator 1 with extremely high flux density, low weight, small magnet volume, homogeneous magnetic loading and a very high efficiency can be realized.

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Figure 2a illustrates the inner magnetic circuit as well as the coil arrangement of the preferred embodiment of the dynamo generator 1 in a perspective cross-sectional view. In Figure 2b there is shown in a stretched or unfolded arrangement a segment of the wire-wound coil in the sequence 23.2, 23.1, 23.6 and 23.5, which together with the pole shoes b, a, f and e form pole fields N3, S2 and N1. The coil connections and two winding directions I and II of the coil sections 23.2, 23.1, 23.6 and 23.5 are schematically indicated in Figure 2b.

Since normally one coil is guided over two heteropolar poles, three coils are required for a six-polar arrangement not particularly illustrated in the drawings. In this manner, the stationary air-core coil arrangement 23, generally represented by reference chararter 23(1...6) in Figure 1a, is divided per pole field into two identical coil sections, so that there are six coil sections 23.1-23.6 pole-correctly connected in series. There is thus achieved a substantially smaller overall height. As depicted in Figures 1a and 1b, there are provided six coil sections 23.1-23.6 mutually arranged at an angular pitch of 60°.

In order to fabricate the firm stationary air-core coil or coil arrangement 23, the windings consisting of backlack copper wire are wound in self-contained manner and bent onto the reference circle of the air-core coil arrangement. The coils are inserted in a suitable plastic injection molding die. The mutual coil connections are already connected and mounted at a connection pin plug shown, for instance, in Figure 7 and designated by reference character 39. The plastic injection molding die includes at the same time a housing base or bottom shown, for instance, in Figure 7 and designated by reference

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character 37. Subsequently, the whole unit is injection molded with plastic material to form a leadless plug-in component. This type of construction renders possible that the electronic part can be plugged in directly at the housing bottom of the dynamo system. A further wiring is thus unnecessary. The wires of the stationary air-core coil have been previously processed and require no subsequent treatment or refinishing.

The process described hereinbefore renders possible a stationary air-core coil 23 comprising a very low inductance, i.e. preferably lower than 150 uH. In this manner, there is produced a negligible counter inductance by which the pole sensitivity is hardly or not at all noticeable. The coil resistance is preferably smaller than 1.6 ohms whereby - in the case of an actually accomplished construction of the dynamo generator 1 - a resulting magnetic loading was larger than 0.6 T. In this realized construction the average coil diameter was 31 mm, the magnet length 30 mm and the outer diameter approximately 44 mm. The present invention aims at providing a shorter coil length of approximately 20 mm. Such coil length has been designated by reference character 40 in Figure 2b as well as in Figure 7. By virtue of this shorter coil length it is possible to also improve the essential inventive energy and power characteristics of the dynamo generator 1 constructed in accordance with the invention.

Having now had the benefit of the foregoing description of the dynamo generator 1 as considered with respect to Figures 1a, 1b, 2a and 2b, the construction and the mode of operation of the entire bicycle lighting system and particularly of a preferred embodiment of an electronic circuitry 5 will be now explained by referring to Figures 3, 4 and 5.

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Figure 3 illustrates a block diagram of the electronic circuitry 5 of a preferred exemplary embodiment of the bicycle lighting system constructed in accordance with the invention. The electric alternating voltage produced by the dynamo generator 1 constructed in the foregoing described manner is rectified by a rectifier 11 and smoothed by a capacitor C_1. At a circuit node 18 there is formed the sum of a rectified dynamo voltage U_{eDYN} and a battery voltage U_{BATT} as will be hereinafter described. The combined voltage U_{eDYN} and U_{BATT} produced at the circuit node 18 is applied to the input side of a voltage-converting and energy-limiting device 10 which converts this voltage (power) to 6 V and 6.4 V, respectively. This voltage-converting and energy-limiting device 10 possesses the characteristic feature of optimally adapting itself to the internal resistance of the dynamo generator 1. In the case of a low input voltage due to a low traveling speed, the voltage-converting and energy-limiting device 10 sets up the resulting voltage (power). In the case of a higher traveling speed and thus of a high output voltage and output power of the dynamo generator 1, the voltage-converting and energy-limiting device 10 sets down the voltage available at the circuit node 18 to preferably 6.4 V at an output side U_a and keeps this voltage substantially constant or stabilized with a variation range of approximately $\pm$ 10mV. By virtue of the provision and application of electronic components representing the latest state of the art, such as Schottky diodes and power FETs (field effect transistors), there can be achieved an efficiency of 85% and even better for the voltage-converting and energy-limiting device 10. This efficiency is about 85% in the case of low voltages, but can lie above 90% when there are relatively high input voltages, e.g. about 9 V, at the circuit node 18.

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The overall functioning and performance of the electronic circuitry 5 will be better understood when consideration is now given to the function and mode of operation of a first threshold-value switch 13, a second threshold-value switch 15, as well as a delay circuit 17 and a battery monitoring circuit 19.

First threshold-value switch 13

the output voltage of the dynamo generator 1 is rectified by means of a rectifier consisting of two diodes D_3 and D_4 and smoothed by a capacitor C_4. This voltage V_x is proportional to the traveling speed. It is divided by means of a first voltage divider 12, which consists of two resistors R_1 and R_2, and applied as voltage U_{T1} to the input of the first threshold-value switch 13. This first threshold-value switch 13 activates a gate circuit T_1 at an input voltage higher than $V_x = 0.8$ V. This means that, by means of the gate circuit T_1, the voltage of an accumulator battery 4 is supplied to the summing circuit node 18 by means of a switch S_1 of an electronic switchgear 16 and via a protective diode D_1. A further output of the first threshold-value switch 13 sets the delay circuit 17 to zero (static).

If the input voltage at the first threshold-value switch 13 is lower than $V_x = 0.8$ V, the delay circuit 17 is started. The latter comprises an oscillator and counting chains which are here not particularly illustrated. The battery voltage remains available at the summing circuit node 18 by means of the gate circuit t_1, the electronic switchgear 16 and the protective diode D_1 until the output of the delay circuit 17 opens the electronic switchgear 16 by means of the gate circuit T_1. The

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battery voltage is then cut off. The gate circuit T_1 is thus activated with the first threshold-value switch 13 and moves up with the start of the delay circuit 17. In case the rechargeable accumulator battery 4 is completely discharged or defective or non-existent, the activation at the circuit node 18 will be prevented by means of the battery monitoring circuit 19.

Second threshold-value switch 15

The speed-proportional voltage V_x of the dynamo generator 1 resulting at the capacitor C_4 is supplied via a second voltage divider 14, which consists of two resistors R_3 and R_4, to the second threshold-value switch 15. The resulting input voltage is designated by reference character U_{T2}. The second threshold-value switch 15 activates by means of an output signal the voltage-converting and energy-limiting device at a dynamo-generator output voltage lower than 4.5 V at V_x, whereby an output voltage of the voltage-converting and energy-limiting device 10 of (adjustable) 4.5 V to 6 V (U_{a1}) is reached. If the output voltage of the dynamo generator 1 is above 4.8 V, the voltage-converting and energy-limiting device 10 is set by means of the output signal of the second threshold-value switch 15 in such a manner, that the voltage-converting and energy--limiting device 10 produces 6.4 V (U_{a2}) at the output thereof. This implies that, by virtue of the function and mode of operation of the preferred exemplary embodiment of the electronic circuitry 5 depicted in Figure 3, at an input voltage U_{T2} of the second threshold-value switch 15 when V_x of the latter is lower than 4.5 V, voltage is procured from the battery 4 for the purpose of producing standstill, position or parking light, and that at an input voltage U_{T2} of the second threshold-value switch 15 when V_x is higher than 4.8 V, output voltage, i.e. traveling

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voltage, is procured from the dynamo generator 1. Change-over from battery operation to dynamo operation occurs smoothly.

To the output of the voltage-converting and energy--limiting device 10 there is connected a battery charging device 20 which feeds the accumulator battery 4 as soon as the output voltage U_a exceeds 6.1 V and rises to 6.4 V by proportionally increasing in dependence on the charge condition of the accumulator battery 4. It is thereby ensured that no battery charging occurs during battery standstill-light operation. It is furthermore ensured that the voltage does not fall below 6 V when the energy of the dynamo generator 1 is insufficient.

At the output of the voltage-converting and energy--limiting device 10 there is connected a resistance voltage divider R_5, R_6 which supplies a control signal U_{T3} for the control of the output voltage U_a (feedback). This control voltage is influenced by the second threshold-value switch 15.

The functioning and mode of operation of the electronic circuitry 5 schematically illustrated in Figure 3 will be discussed more fully hereinafter, particularly in conjunction with the description of Figures 4a to 4e and Figures 5a to 5c.

Figures 4a to 4e schematically show in graphical representation the chronological dependence of the voltages U_g (approx. V_x), U_{T1} and U_{T2} (a component voltage of the voltage V_x), which are respectively produced by the first voltage divider 12 and the second voltage divider 14 and which are applied to the first threshold-value switch 13 and the second threshold-value switch 15, respectively. The approximately linear and speed--proportional dependence of these voltages is thereby assumed such

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that they rise from zero starting at a moment of time t1(t1') up to a moment of time t3(t3') in accordance with an assumed increase in speed from zero to 30 kmph, and then again drop approximately linearly from t3(t3') to a moment of time t5(t5'). At the moment of time t1(t1'), at which the component voltage U_{T1} is reached at V_x = 0.8 V, the first threshold-value switch 13 is activated, and at the moment of time t5(t5') at which the aforementioned voltage U_{T1} falls short at V_x = 0.8 V, the first threshold-value switch 13 is deactivated (start and travel operation). Between the moments of time t1(t1') and t5(t5') the delay circuit remains inactive. At the moment of time t5(t5') the delay circuit 17 starts measuring the delay of, for example, four minutes, which is terminated at a moment of time t8 as depicted in Figure 4c, and opens the electronic switchgear 16 by means of the gate circuit T_1 and thereby cuts off the battery voltage. If the dynamo voltage rises prior to the end of the delay time (for instance four minutes) t5-t1' as depicted in Figure 4a, the delay circuit 17 is made inactive by the first threshold-value switch 13 and the functions re-commence as at the moment of time t1(t1').

The second threshold-value switch 15 (Figure 3) is activated at a moment of time t2 by means of the second voltage divider 14 (Figure 3), i.e. by the component voltage U_{T2} when the voltage V_x exceeds 4.8 V as shown in Figures 4a and 4d. When the voltage V_x falls short of 4.5 V at a moment of time t4 as seen by again referring to Figures 4a and 4d, the second threshold-value switch 15 is deactivated by the voltage U_{T2} and by means of the second voltage divider 14. During the activation period of the second threshold-value switch 15, the voltage-converting and energy-limiting device 10 (Figure 3) converts the output voltage U_{a2} to a preferred level of 6.4 V. This occurs

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as soon as the traveling speed exceeds the range of 5 to 7 kmph (Figures 4a and 4e). In the inactive range of the second threshold-value switch 15, i.e. when the traveling speed is lower than 3 kmph, the voltage-converting and energy-limiting device 10 converts the output voltage U_{a1} to 4.5 V up to 6 V, but preferably stabilized and set to, for instance, 5.5 V as shown in Figure 4e.

The voltage-speed/time diagram depicted in Figure 4a and the four voltage/time diagrams depicted in Figures 4b to 4e are combined in a voltage/speed diagram illustrated in Figure 5a. The change-over from U_a = 4.5 V to U_a = 6.4 V occurs at a traveling speed of approximately 5 to 7 kmph.

The function/time diagrams illustrated in Figures 4a to 4e depict, dependent on and subject to the voltage-speed/variation-in-time (Figure 4a), the function of the first threshold-value switch 13 (Figure 4b), the function of the delay circuit 17 (Figure 4c), the function of the second threshold--value switch 15 (Figure 4d) and the function of the output voltage U_a, i.e. U_{a1} and U_{a2} (Figure 4e).

The delay circuit 17 is activated when the threshold voltage V_x falls short of approximately 0.8 V. In other words, the bicycle comes to a stop. The delay circuit 17 now supplies by means of gate circuit T_1 and switch S_1 the voltage of the battery 4 during a period of four minutes to the circuit node 18 and thus to the voltage-converting and energy-limiting device 10. The latter now produces the output voltage for standstill lighting. At the end of the time interval of four minutes, the switch S_1 is opened and the entire system is thereby switched off. In case the first threshold-value switch 13 exceeds the

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control signal V_X, when during the delay interval the voltage V_X is equal to 0.8 V, the delay circuit 17 is set back to zero and there commences the normal traveling program as described hereinbefore under the title "First threshold-value switch 13".

In short, this means that when the bicycle comes to a stop, the standstill or parking light will burn at least four minutes long. Upon starting anew, the lighting system changes over without interruption to the traveling program.

The battery monitoring circuit 19 depicted in Figure 3 monitors the charge condition of the accumulator battery 4 and the operational capability of the latter. In case the battery is discharged or defective, the battery monitoring circuit 19 will prevent the connection of the accumulator battery 4 to the circuit node 18, so that the system is run and operated according to Figure 5a directly by the dynamo generator 1 (voltage U_g), in such case without bicycle-standstill light, and by the voltage-converting and energy-limiting device 10. It is thereby ensured that such accumulator batteries are protected against total discharge.

In Figures 5a, 5b and 5c there is illustrated the course of the output voltage U_a achieved by the bicycle lighting system constructed in accordance with the invention. The course or progression of such output voltage U_a is depicted in the form of a curve K_1 extending between two areas defined by legal Standards and shown in a hatched representation. The course of the output voltage is designated by the reference characters U_{a1} and U_{a2} as will be recognized in Figure 5b. On the other hand, in Figure 5a there is depicted a curve K_2 showing the course of the output voltage of a conventional bicycle lighting

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system. The bicycle standstill-light area is conveniently designated by reference character STL in Figure 5c and extends over a speed range from zero to approximately 5 kmph.

The aforedescribed bicycle lighting system in accordance with the invention brings many advantages, above all the advantages listed hereinbelow:

- The dynamo generator 1 disposes of a comparatively very high efficiency which produces a power output of more than 4.5 W at a traveling speed of approximately 5 to 7 kmph;

- This dynamo power is converted to 6.4 V and kept constant at a traveling speed above approximately 5 kmph by means of the converter of the electronic circuitry having a voltage set-up and set-down mode of operation;

- This energy is directly available, on the one hand, for charging the battery and, on the other hand, for producing light;

- The electronic circuitry 5 operates already from 2 V with an input voltage starting from 1.5 V and up to 80 V, whereby 80 V would correspond to a traveling speed of approximately 80 kmph;

- The ratio of energy apportioning in travel light and standstill light is obtained in a ratio of 1-2:1, that is two units travel light and one unit standstill light, irrespective of the traveling speed. This apportioning ratio is currently still quite limited by the charging capacity of accumulator batteries. The ratio can be substantially reversed in the case of an

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improved charging capacity and could be, for instance, a ratio of 0.5:1. However, such batteries are still not available or have other drawbacks;

- The bicycle lighting system in accordance with the invention meets by far all legal requirements, standards and specifications relating to the dynamo-travel power curve, because constant and adequate energy for lighting and battery charging is non-intermittently available;

- By virtue of the effected division of the output voltage of the voltage-convertting and energy-limiting device 10 of the electronic circuitry 5 to provide an output voltage of 4.5 V up to 6 V below a speed of approximately 5 kmph and a "travel voltage" of 6.4 V, the Standard exacting 3W for standstill and travel at any speed is perfectly fulfilled;

- The battery charging balance is very reliably ensured;

- By virtue of the comparatively superior efficiency of the entire bicycle lighting system there is achieved a far lower riding resistance. In other words, the cycling or pedaling energy required on the part of the rider to actuate and drive the dynamo system is substantially reduced in spite of increased dynamo power;

- The application of the air-core coil 23 in the dynamo generator 1 eliminates magnetic ripple formation;

- The dynamo generator 1 has very low inductive losses, requires no sliding contacts and is, therefore, better and more reliable; and

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- The rotary motion of the entire magnetic circuit, i.e. the inner circuit 21 and the outer circuit 22, eliminates magnetic losses of the dynamo generator 1.

Figure 6 shows a preferred exemplary, accomplished embodiment of the electronic circuitry 5 realized by means of a customized, solid-state, integrated switching circuit 50, at pins of which there are connected external circuit or control elements of the converter circuit.

Since all electronic functions are complex and costly and since the construction, which includes integrated standard switching circuits, would require a large number of components and component parts as well as a great deal of space, there are sensibly and efficiently realized all functions, digital and analog functions, together in a One-Chip-ASIC 50. A bicycle lighting system being a mass-produced or bulk article, it is evident that mass production of the customized, solid-state, integrated switching circuit 50 is also economically very worth-while. The components that cannot be integrated or cannot be sensibly integrated, such as the rectifier 11, the capacitors C_1 to C_4, a transformer, a power output transistor and further component parts, are connected to the pins of the customized, solid-state, integrated switching circuit 50 in the circuit arrangement illustrated in Figure 6.

By virtue of the provision of a customized solid-state, integrated switching circuit 50 for the electronic functions of the electronic circuitry 5, there is rendered possible a compact and comparatively small electronic circuitry which together with the battery 4 can be accommodated in an adequately small housing, which is either integrated with the dynamo housing or separately mountable thereon.

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Figure 7 shows a longitudinal sectional view of an exemplary embodiment of the dynamo generator 1 constructed in accordance with the present invention as a side dynamo including an integrated accumulator battery 4 and an integrated electronic circuitry 5. The dynamo system is mounted in known manner on a swivel arm 34 and comprises an upper housing portion 30, which encompasses the rotating inner and outer circuits 21, 22 and the stationary coil sections 23.1 through 23.6, and a lower housing portion 31 which encompasses the battery and the electronic circuitry, this lower housing portion 31 being fixedly connected to the upper housing portion 30. the coil sections 23.1 through 23.6 are integrally formed with a housing base or bottom 37, and the electronic circuitry 5 is connected by means of guide pins 39 with the coil sections 23.1 through 23.6. Connections or leads 33 to lamps or lights 2 and 3 schematically shown in Figures 3 and 6 are located in the lower part of the lower housing portion 31. A sensor 32, designated by reference character S_2 in Figures 3 and 6, is advantageously accomodated in the housing of the swivel arm 34. This sensor detects that the complete dynamo system is not ready for operation in the idle position thereof and supplies a signal to the electronic circuitry 5, thereby immediately interrupting the existing or lit standstill or parking light. In other words, the sensor serves to deenergize the entire bicycle lighting system when the dynamo on the swivel arm 34 is tilted away from the side of a tire of the bicycle. A driving friction wheel 35 for engaging such bicycle tire is fixedly fitted with a dynamo arbor or shaft 38 which, in turn, is connected to the support core of the inner circuit. This shaft 38 is freely rotatably mounted in an upper pivot bearing 36 and a lower pivot bearing 36'. Although the dynamo system as shown in the longitudinal sectional view in Figure 7 is constructed as a

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laterally mounted bicycle dynamo system, it will be readily clear to those skilled in the art that the aforedescribed characteristics of the dynamo system constructed according to the present invention are also applicable for a roller dynamo system as illustrated in Figure 8 or for a hub dynamo system.

As also clearly evident by referring to Figure 6, there can be provided an alternative exemplary embodiment of the dynamo system in that the electronic circuitry 5, the external components or component parts thereof and the battery 4 are kept apart from the dynamo generator 1 and arranged separately on the bicycle.

While there are shown and described present preferred embodiments of the invention, it is to be understood that the invention is not limited thereto, but may be otherwise variously embodied and practiced within the scope of the following claims.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A bicycle lighting system comprising a dynamo system drivable by a ridden bicycle and mounted thereon, at least one front light and at least one rear light, both of which are supplied with electric power from the dynamo system, and an electronic circuitry which converts the electric power output of the dynamo system into a regulated direct-current voltage for producing light and for charging a rechargeable accumulator battery,

characterized in that

the dynamo system is provided with a dynamo generator (1) comprising an inner circuit (21) and an outer circuit (22), both of which are mounted for synchronous rotation in a same direction about a stationary air-core coil (23) consisting of coil sections (23.1 to 23.6), whereby said inner and outer circuits (21, 22) each comprise n pole shoes (a-f and g-m, respectively) in identical pole pitch, and between said n pole shoes (a-f) of the inner circuit (21) there are disposed n permanent magnets (24-29) in such a manner that in each case said permanent magnets (24-29) rest homopolar against both sides of each of the n pole shoes (a-f) of the inner circuit (21), so that from a minimum traveling speed of approximately 5 to 7 kmph said electric power output of the dynamo system is adequate to charge the rechargeable accumulator battery (4) and simultaneously energize the lights (2, 3), and in that the electronic circuitry (5) comprises a converter (10) having a voltage set-up and set-down mode of operation such that, for a determinate stabilized output voltage, a fed input voltage can be lower than, equal to, or higher than said determinate stabilized output voltage, whereby said converter (10) is additionally

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supplied by the accumulator battery (4) as long as said minimum traveling speed of approximately 5 to 7 kmph is not reached.

2. The bicycle lighting system according to claim 1, characterized in that said n pole shoes (g-m) of the outer circuit (22) are structured to nose-shapedly project toward the respective n pole shoes (a-f) of the inner circuit (21).

3. The bicycle lighting system according to claim 2, characterized in that the nose-shapedly protruding pole shoes (g-m) form together with the respective pole shoes (a-f) in each case an air gap defining a shortest possible flux path for a magnetic flux.

4. The bicycle lighting system according to claim 1, characterized in that each inner pole shoe (a-f) comprises in a mid-portion thereof a slot (31-36) extending in radial direction and forming an air gap, thereby reducing mutual interference of respective magnetic poles (M_1-M_{12}) laterally lying against a respective inner pole shoe (a-f).

5. The bicycle lighting system according to claim 4, characterized in that the sum of surfaces (a_1 and a_2) of two magnetic poles (M_1-M_{12}) laterally adjacent to a respective inner pole shoe (a-f) is substantially larger than a peripheral surface (b_1) of the respective inner pole shoe.

6. The bicycle lighting system according to claim 1, characterized in that the inductance of the stationary air-core coil (23) is smaller than 150 µH.

7. The bicycle lighting system according to claim 1, characterized in that the coil resistance of the air-core coil (23) and the

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internal resistance of the dynamo generator (1) are smaller than 1.5 ohms.

8. The bicycle lighting system according to claim 1, characterized in that the air-core coil (23) is divided per pole field into two identical coil sections (23.1 through 23.6) which are pole-correctly connected in series.

9. The bicycle lighting system according to claim 1, characterized in that the number of poles n is at least four, but is preferably six.

10. The bicycle lighting system according to claim 1, characterized in that the power output at a traveling speed of 3.5 to 5 kmph and a load of 3 ohms is at least 3 W and at a traveling speed of 7 kmph more than 4.5 W.

11. The bicycle lighting system according to claim 1, characterized in that the produced output voltage of the dynamo generator (1) varies by approximately 0.8 to 1.2 V per 1 kmph variation in speed.

12. The bicycle lighting system according to claim 1, characterized in that the dynamo system with the dynamo generator (1) is constructionally realized as a side dynamo.

13. The bicycle lighting system according to claim 1, characterized in that the dynamo system with the dynamo generator (1) is constructionally realized as a friction roller dynamo.

14. The bicycle lighting system according to claim 1, characterized in that the converter of the electronic circuitry (5) comprises

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a voltage-converting and energy-limiting device (10) for converting the input voltage into a determinate stabilized output voltage and for limiting the converted energy to a determinate maximum energy value, and in that the electronic circuitry (5) further comprises a threshold-value device (12 through 17) which detects a rectified dynamo output voltage (U_{eDYN}), whereby in case the threshold-value device detects that a determinate minimum voltage of the dynamo generator (1) is exceeded, the voltage (U_{BATT}) supplied from the accumulator battery (4) is fed by means of an electronic switchgear (16), in addition to the rectified dynamo output voltage (U_{eDYN}) of the dynamo generator, to the voltage--converting and energy-limiting device (10), and that the output voltage (U_a) of the voltage-converting and energy--limiting device (10) lies - during battery operation - within a first constant output voltage range (U_{a1}) and - during dynamo operation - within a second constant output voltage range (U_{a2}), the latter lying above the first constant output voltage range (U_{a1}), and in that the electronic circuitry further comprises a battery charging device (20) which is activated above an output charging voltage (U_0) which lies between the first constant output voltage range (U_{a1}) and the second constant output voltage range (U_{a2}).

15. The bicycle lighting system according to claim 14, characterized in that the first constant output voltage range (U_{a1}) of the electronic circuitry (5) lies in a range from 4 V to 6 V, preferably from 4.5 V to 6 V, and the output charging voltage (U_0) is preferably 6.1 V.

16. The bicycle lighting system according to claim 14, characterized in that the voltage-converting and energy-limiting device (10)

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limits the output of the electronic circuitry (5) invariably between 4 and 6 W, preferably between 4.5 and 5 W.

17. The bicycle lighting system according to claim 14, characterized in that the electronic circuitry (5) further comprises:

- a rectifier circuit (11) for producing the rectified and smoothed dynamo output voltage (U_{eDYN}) which is supplied to the voltage-converting and energy-limiting device (10);

- a first voltage divider network (12, R_1, R_2) which converts a first rectified output voltage of the dynamo generator (1), which output voltage is proportional to the traveling speed, into a first component voltage (U_{T1}) and supplies this component voltage to a first threshold-value switch (13);

- a second voltage divider network (14, R_3, R_4) which converts the rectified output voltage (U_{eDYN}) of the dynamo generator, which output voltage is proportional to the traveling speed, into a second component voltage (U_{T2}) and supplies this component voltage to a second threshold-value switch (15), whereby

the first threshold-value switch (13)feeds the battery voltage (U_{BATT}) to the voltage-converting and energy-limiting device (10) by means of the electronic switchgear (16) when the rectified voltage (U_{eDYN}) supplied from the dynamo generator has exceeded a first threshold voltage detected by the first threshold-value switch (13), and the second threshold-value switch (15) supplies to the voltage-converting and energy-limiting device (10) a signal to switch over the output voltage of the latter from the first constant output voltage (U_{a1}) to the second constant output voltage (U_{a2}) and vice

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versa whenever the second threshold-value switch (15) detects that a second threshold voltage is not reached or is exceeded, respectively;

- a delay circuit (17) which is connected to the output of the first threshold-value switch (13) and to the electronic switchgear (16), and which - in case the rectified voltage (U_{eDYN}) supplied from the dynamo generator falls short of the first threshold voltage - opens the electronic switchgear (16) at the end of a predetermined period of time, in order to switch off the voltage (U_{BATT}) of the accumulator battery (4) from the input of the voltage-converting and energy-limiting device (10), and

- the battery charging device (20) which is coupled at the output side thereof to the voltage-converting and energy-limiting device (10) and which, in the case of battery operation, also remains activated for charging the accumulator battery (4).

18. The bicycle lighting system according to claim 14, characterized in that there is provided in the dynamo system a sensor (S_2, 32) which detects that the dynamo system in the idle position, e.g. when the dynamo is tilted away from engaging a bicycle rim or tire, is not ready for operation and transmits to the electronic circuitry (5) a signal which immediately puts out said lights (2, 3) when the bicycle is at standstill.

19. The bicycle lighting system according to claim 14, characterized in that the electronic circuitry (5) comprises a customized, solid-state and integrated switching circuit ASIC (50).

20. The bicycle lighting system according to claim 1, characterized in that the electronic circuitry (5) is kept apart from the

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dynamo generator and is arranged together with the rechargeable accumulator battery in a separate housing.

21. The bicycle lighting system according to claim 20, characterized in that said separate housing is mounted on the housing of the dynamo generator.

22. The bicycle lighting system according to claim 1, characterized in that the electronic circuitry and the rechargeable accumulator battery together with the dynamo generator are arranged in a two-parted housing.

23. A generator comprising an inner circuit and an outer circuit, both of which are mounted for synchronous rotation in a same direction about a stationary air-core coil, these inner and outer circuits having n inner pole shoes and n outer pole shoes, respectively, in identical pole pitch, characterized in that between the n inner pole shoes (a-f) there are disposed n permanent magnets (24-29) in such a manner that in each case respective magnetic poles (M_1-M_{12}) of said permanent magnets (24-29) rest in homopolar configuration against both sides of each of the n inner pole shoes (a-f), and in that said n outer pole shoes (g-m) facing said n inner pole shoes (a-f) are structured to nose-shapedly project toward the latter.

24. The generator according to claim 23, characterized in that the nose-shapedly protruding outer pole shoes (g-m) form together with the respective inner pole shoes (a-f) in each case an air gap defining a shortest possible flux path for a magnetic flux.

25. The generator according to claim 23, characterized in that each inner pole shoe (a-f) comprises in a mid-portion thereof a slot (31-36) extending in radial direction and forming an air gap,

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thereby reducing mutual interference of respective magnetic poles (M_1-M_{12}) laterally lying against a respective inner pole shoe (a-f).

26. The generator according to claim 23, characterized in that the sum of surfaces (a_1 and a_2) of two magnetic poles (M_1-M_{12}) laterally adjacent to a respective inner pole shoe (a-f) is substantially larger than a peripheral surface (b_1) of said respective inner pole shoe (a-f).

27. The generator according to claim 23, characterized in that the air-core coil (23) is divided per pole field into two identical coil sections (23.1-23.6) which are pole-correctly connected in series.

28. The generator according to claim 23, characterized in that the number of poles n is at least four, but is preferably six.

29. The generator according to claim 23, characterized in that the inductance of the stationary air-core coil (23) is smaller than 150 µH.

30. The generator according to claim 23, characterized in that the coil resistance of the air-core coil (23) and the internal resistance are smaller than 1.5 ohms.

Dated this 17th day of April 1998

EDWIN SCHWALLER
By his Patent Attorneys
COLLISON & CO

AUSTRALIAN PATENT OFFICE

ABSTRACT OF THE DISCLOSURE

There is provided a bicycle lighting system comprising a dynamo generator (1) and an electronic circuitry (5). Hitherto known systems operate with conventional dynamos, the efficiency of which is basically too low to provide power for energizing lamps and simultaneously charging batteries at a speed below 15 kmph. To provide power for slow night-travel or standstill lighting, known systems rely on separate or rechargeable battery packs. Therefore, it is suggested to construct a generator such that a rotating magnetic-circuit arrangement (21, 22) with a stationary air-core coil (23), special pole shoes (a-f, g-m) and specially positioned permanent magnets (24-29) can achieve at least 90% efficiency. At approximately 5 kmph, 4 W electrical energy is produced to energize lamps and simultaneously charge an integrated battery. Below 5 kmph, an integrated electronic circuitry and the lamps are additionally fed by the battery, a converter of the electronic circuitry having a special voltage set-up and voltage set-down function to provide a determinate stabilized output voltage. Above 5 kmph, energy apportioning for lighting and charging in ratios of 1-2:1 is possible.

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13086/95

Fig. 1a

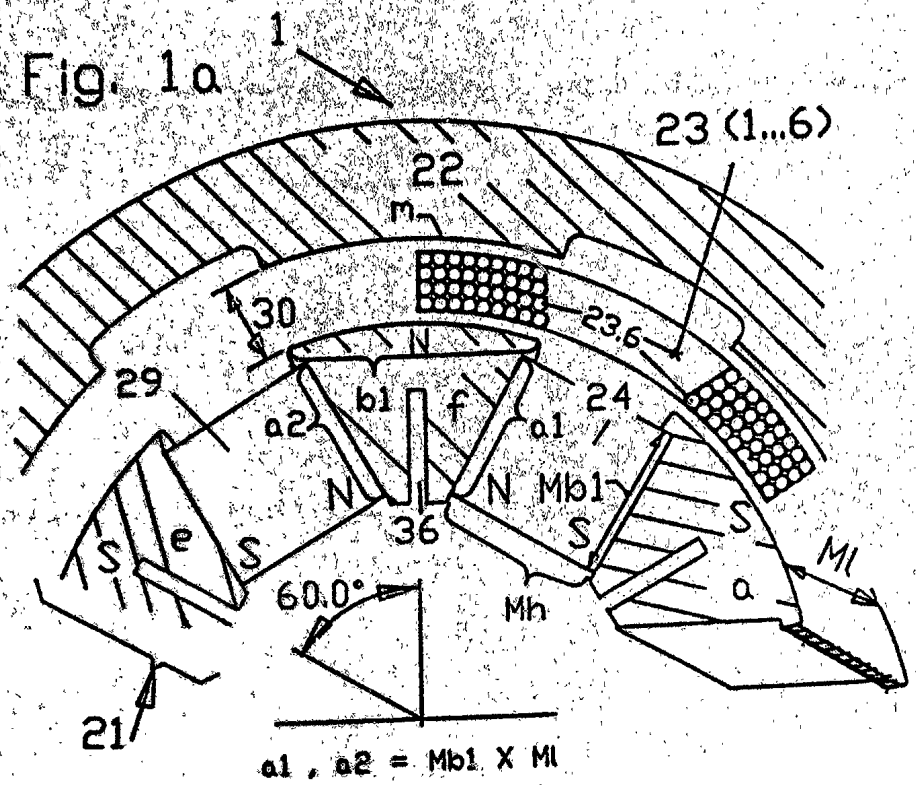
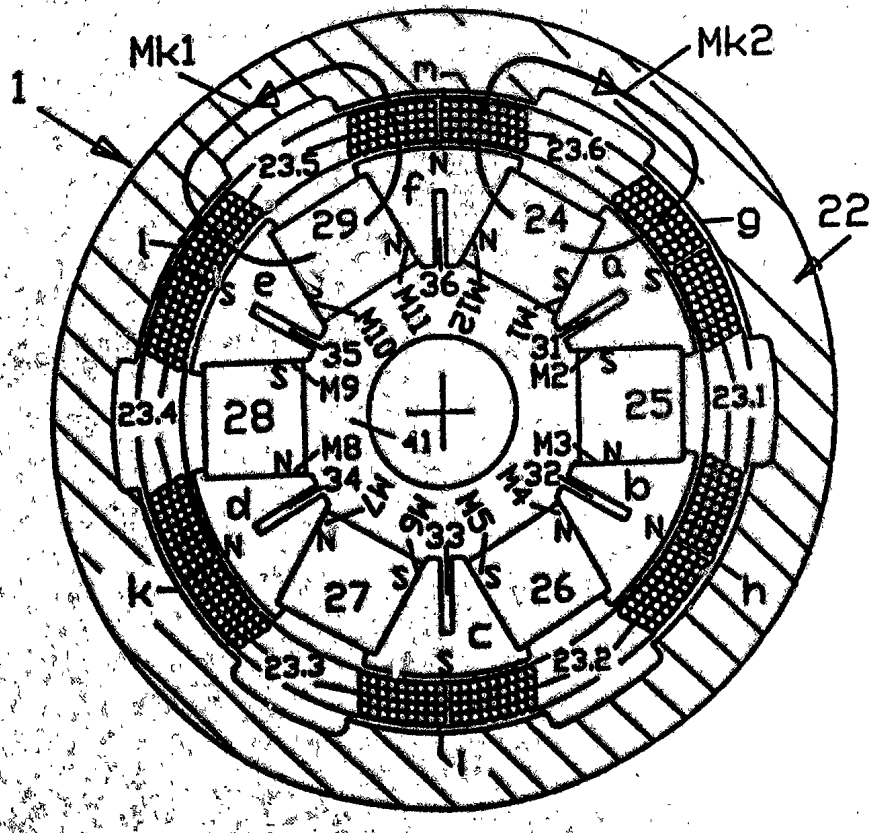


Fig. 1b



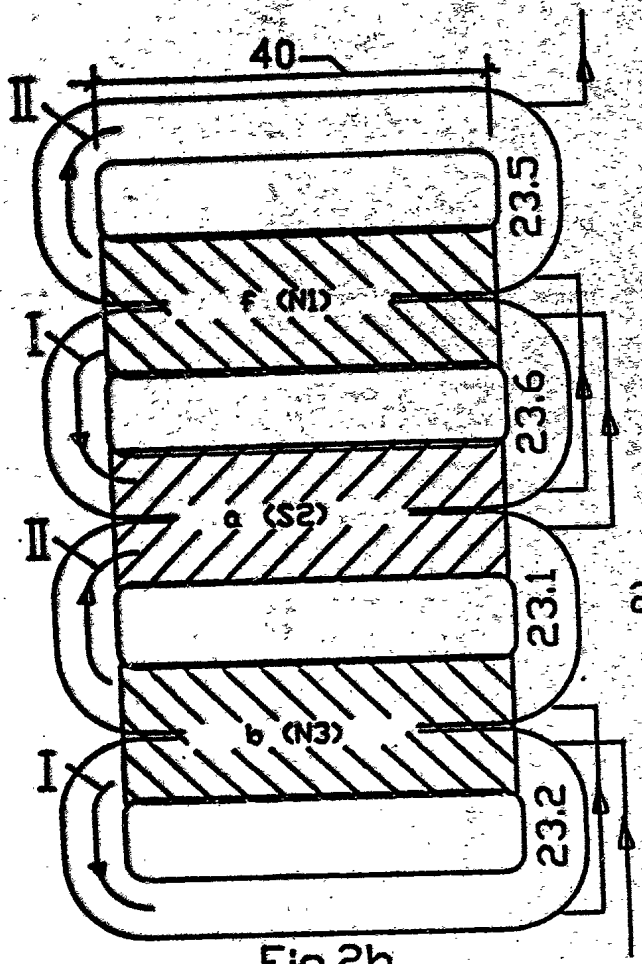

40
II
I
II
I
23.5
23.6
23.1
23.2
f (N1)
a (S2)
b (N3)

Fig.2b

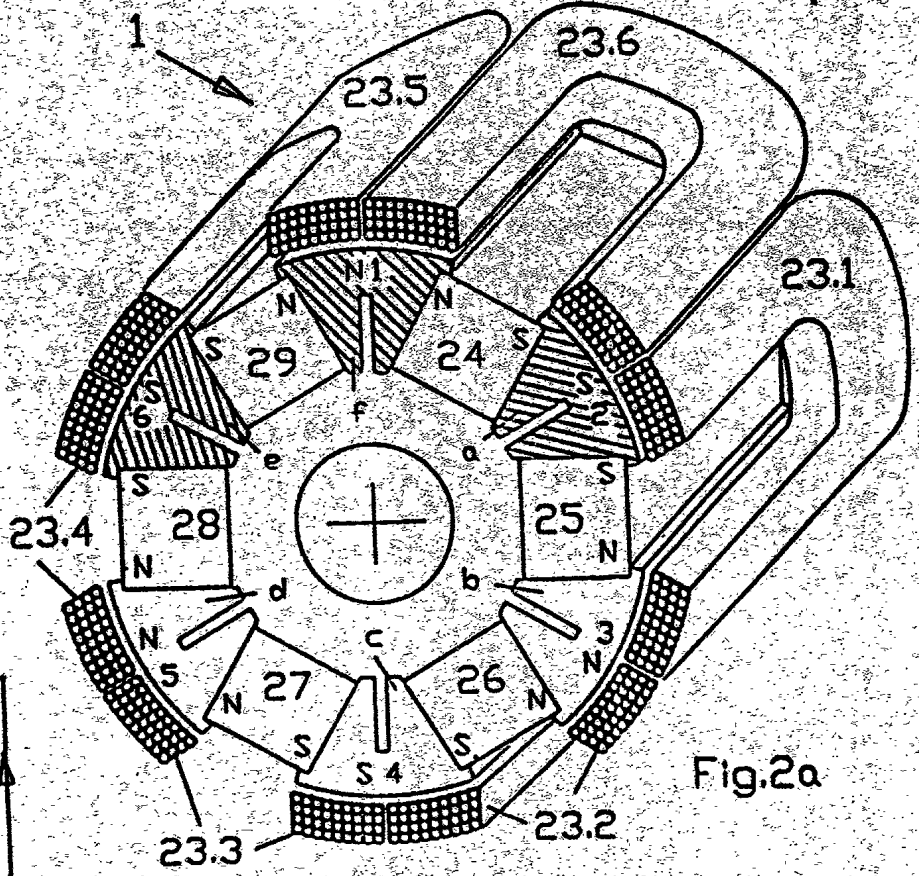
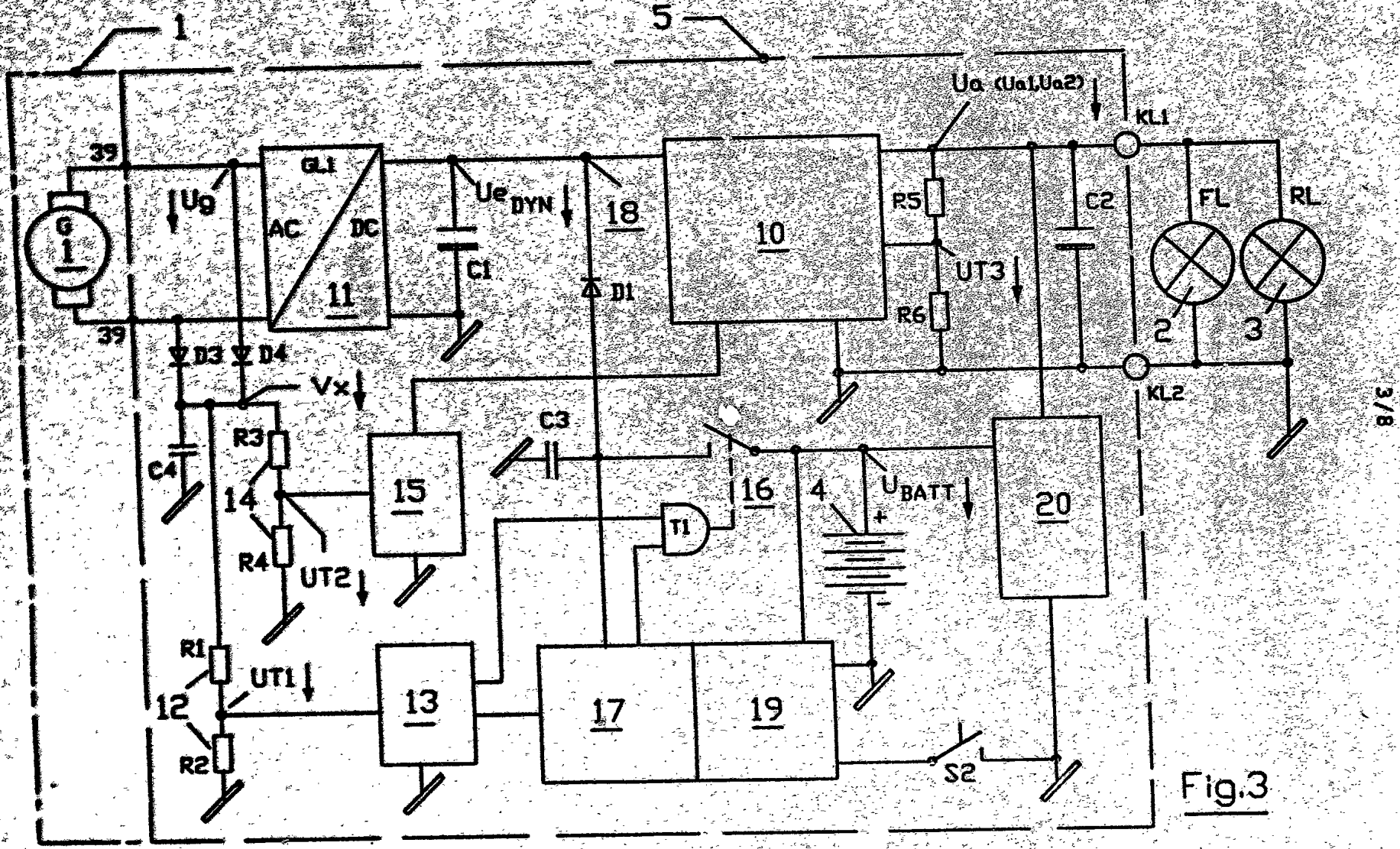

1
23.5
23.6
23.1
23.4
23.3
23.2
N1
29
24
28
25
27
26
S4
a
b
c
d
e
f

Fig.2a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5
39
G
Ug
GL
AC
DC
11
Ue DYN
C1
18
D1
10
Ua (Ua1,Ua2)
KL1
R5
UT3
R6
C2
FL
RL
2
3
KL2
39
D3
D4
Vx
C4
R3
14
R4
UT2
15
C3
16
T1
4
UBATT
+
-
20
R1
UT1
12
R2
13
17
19
S2

Fig.3

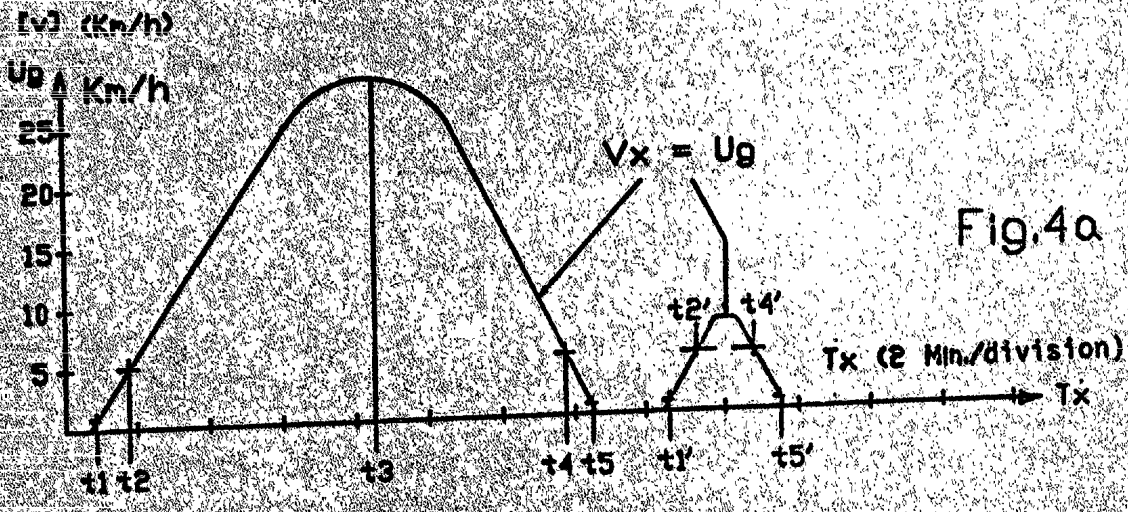


Fig.4a



Fig.4b

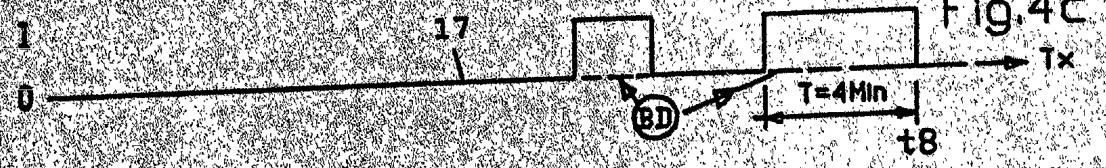


Fig.4c

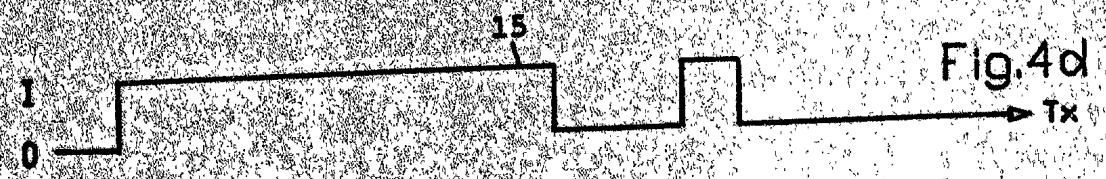


Fig.4d

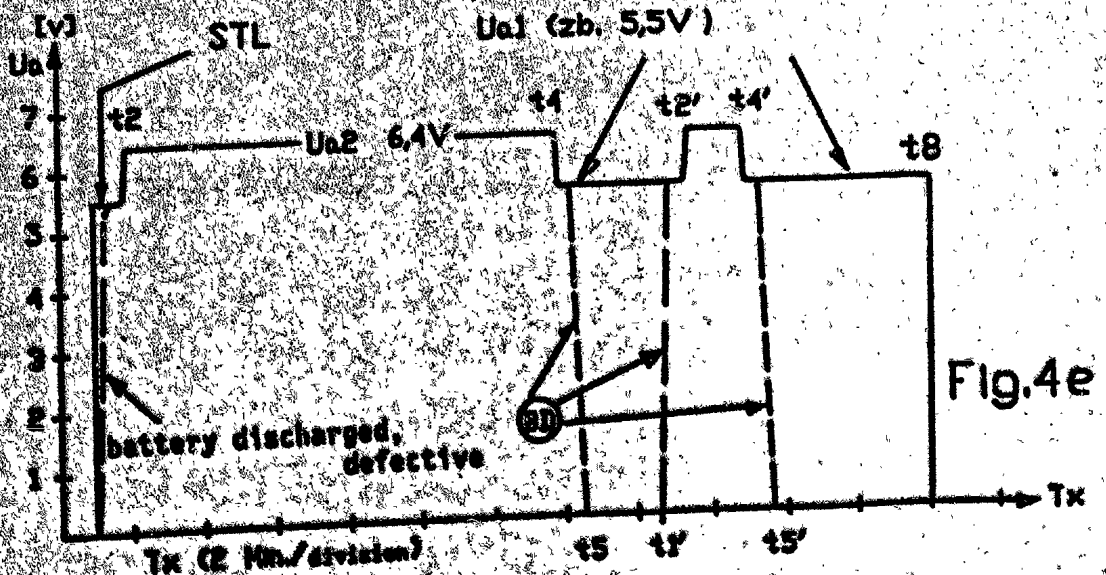


Fig.4e

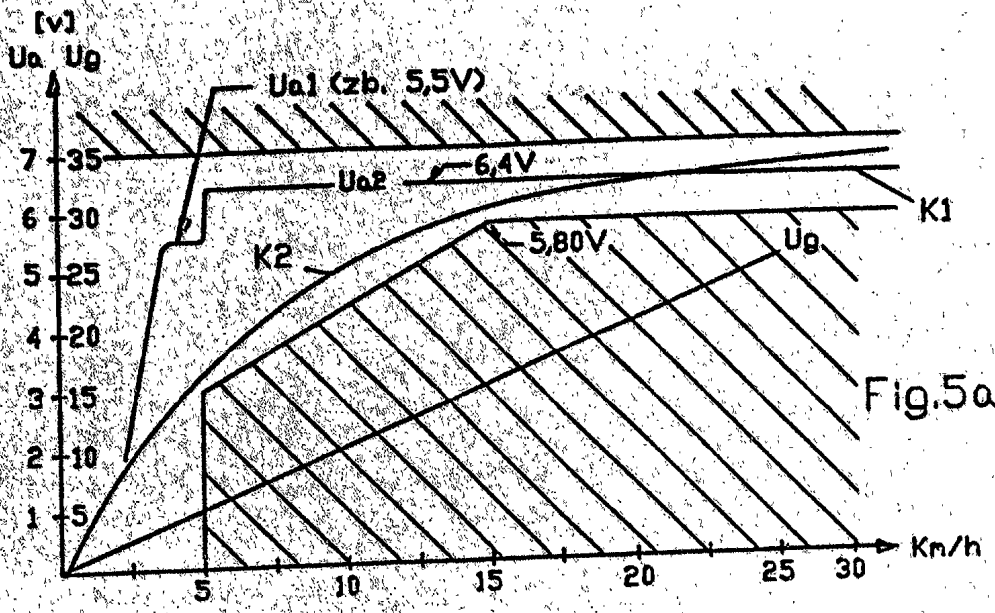


Fig.5a

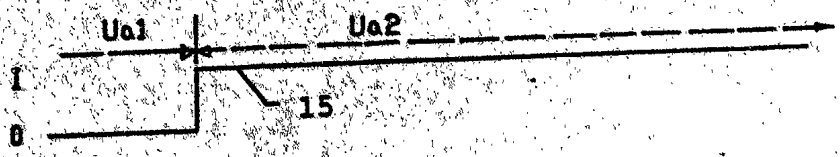


Fig.5b

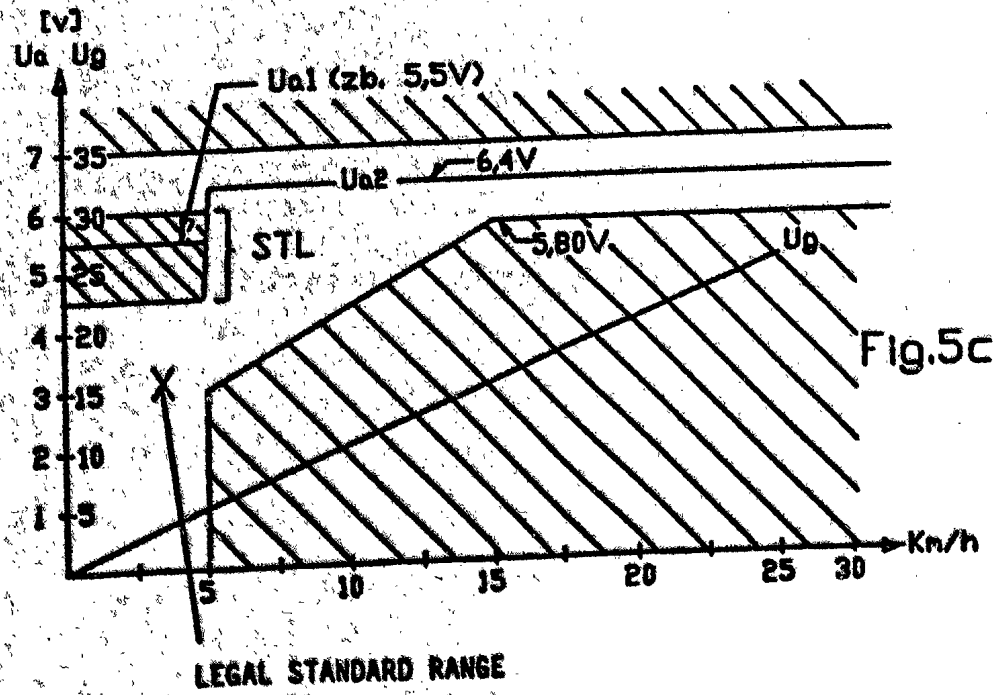
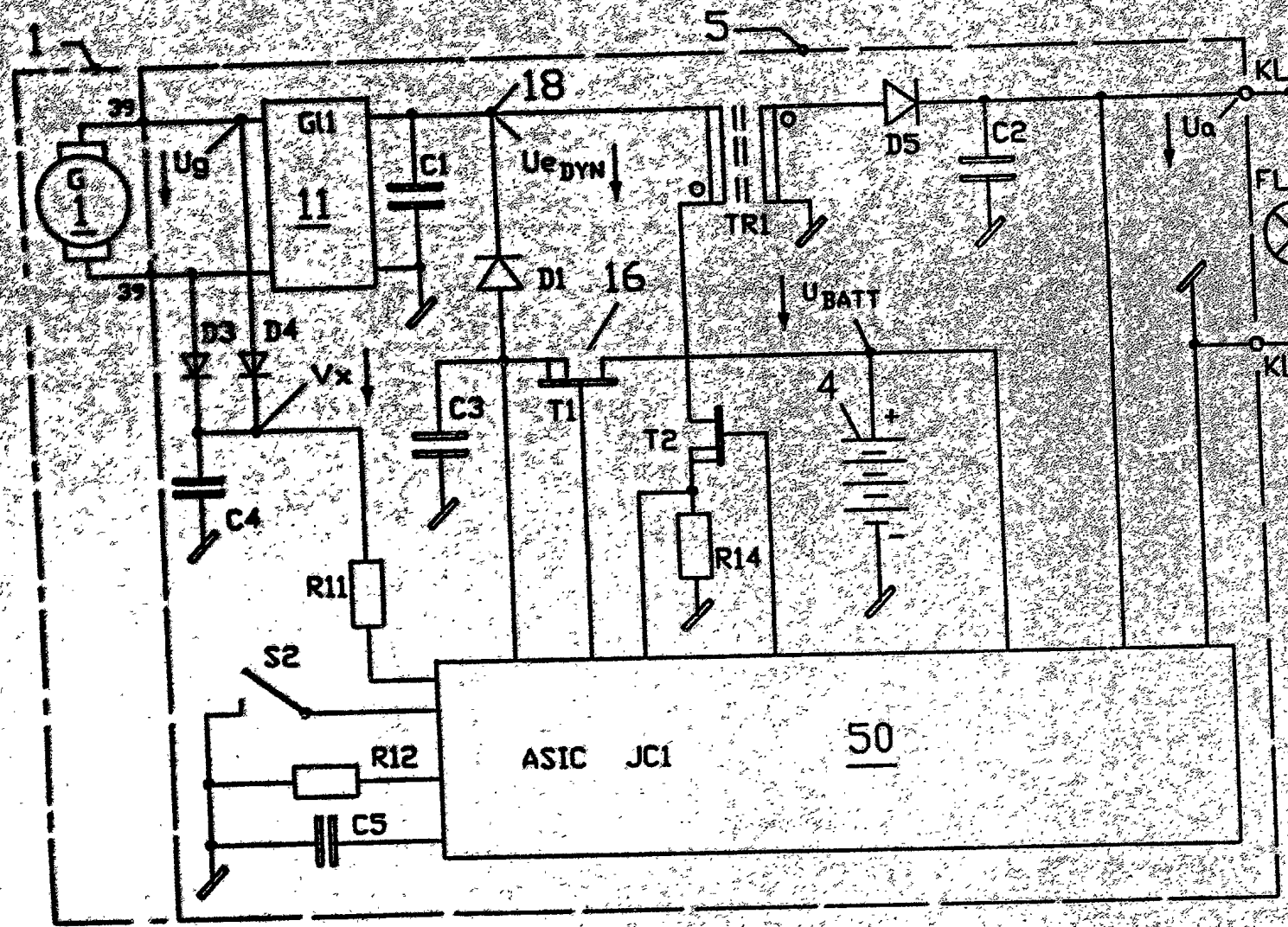


Fig.5c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5
39
G
1
Ug
Gl1
11
C1
18
UeDYN
D1
16
TR1
D5
C2
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KL1
FL
RL
2
3
KL2
UBATT
4
+
-
D3
D4
Vx
C3
T1
T2
C4
R14
R11
S2
R12
C5
ASIC JC1
50

Fig.6

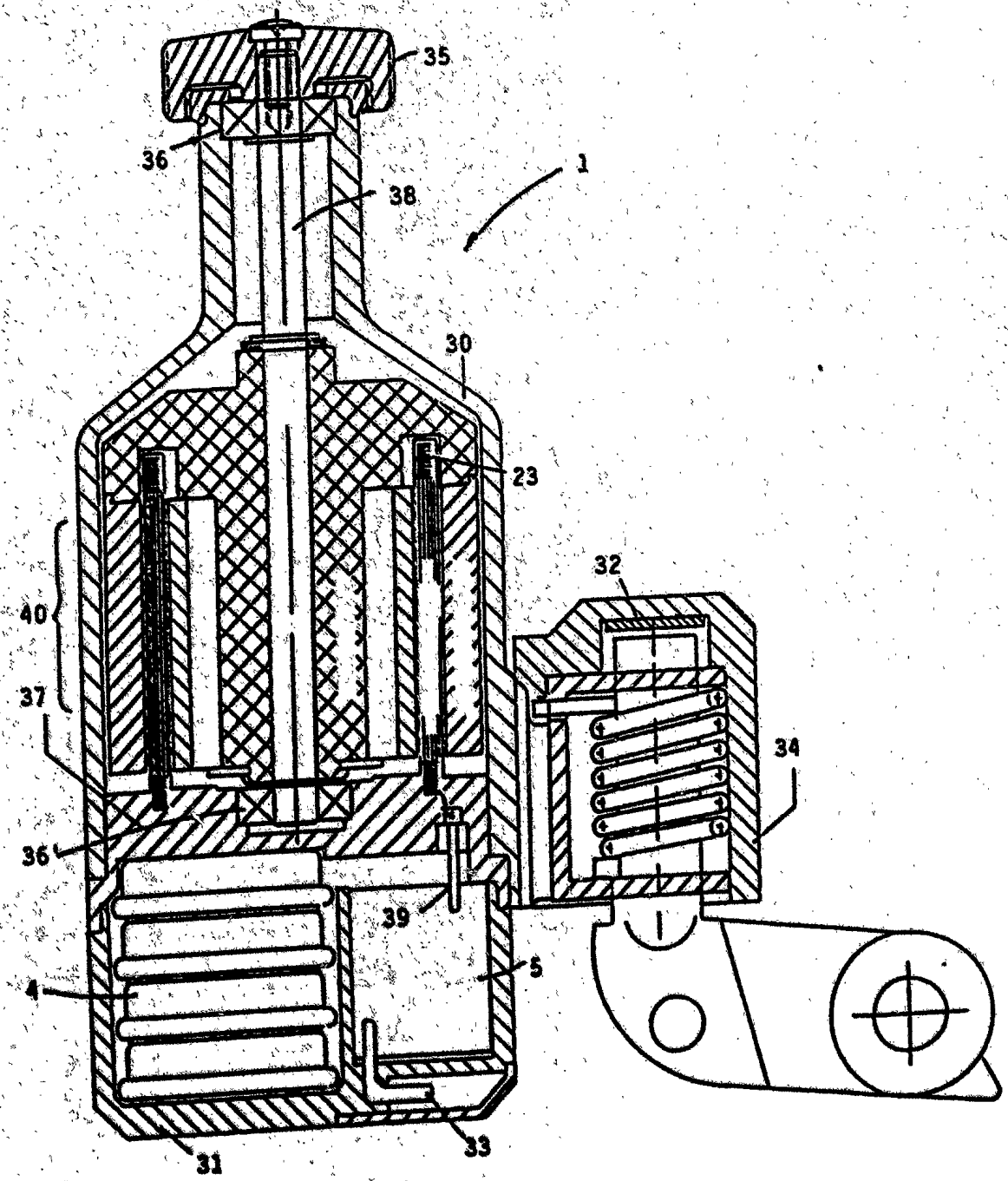

Fig. 7

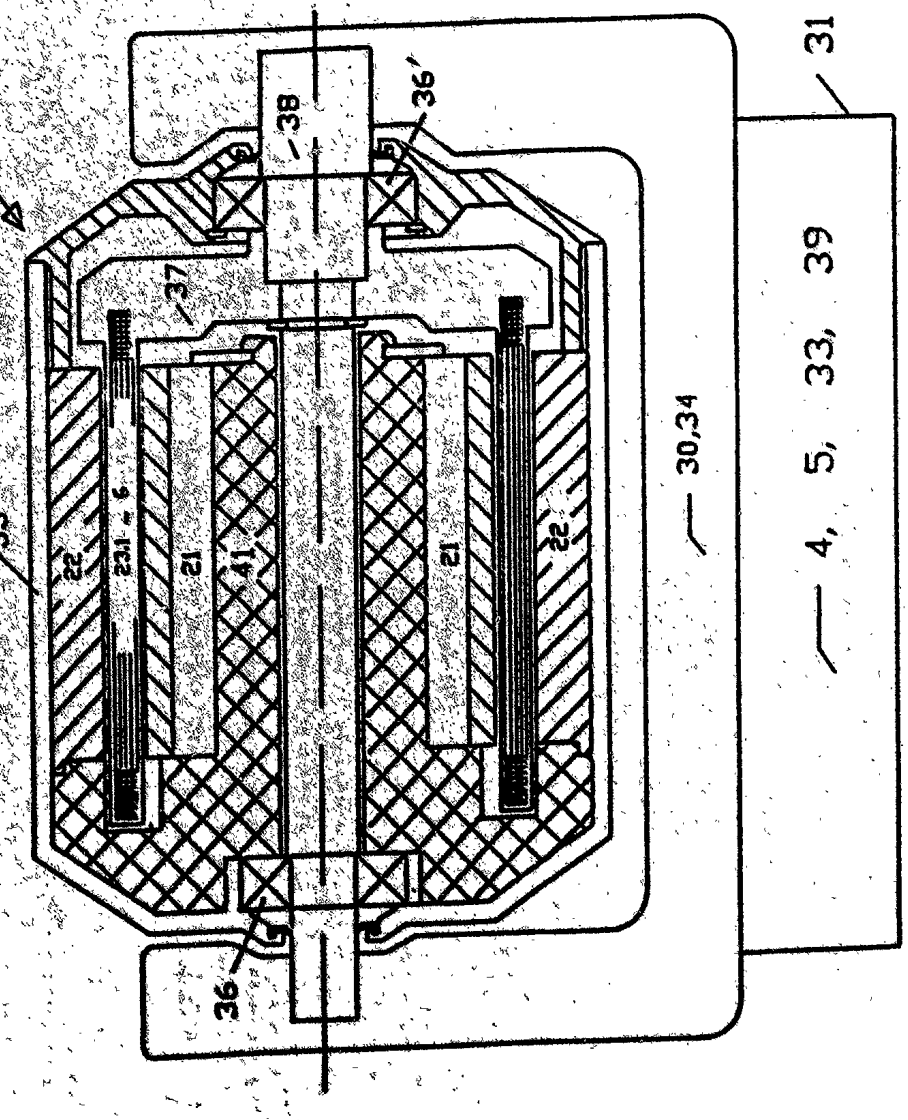

Fig.8

INTERNATIONAL SEARCH REPORT

Intern al Application No
PCT/CH 95/00004

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B62J6/00 B62J6/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B62J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR,A,2 464 175 (SOCIETE LES PILES WONDER) 6 March 1981 see claim 1 ---	1
A		2-5
X	DE,U,92 06 609 (HURZELER) 20 August 1992 see line 119 - line 123; claims 1,2 ---	1
A	EP,A,0 460 585 (SCHWALLER) 11 December 1991 see abstract; figure 1 ---	1-5
A	EP,A,0 528 347 (SCHWALLER) 24 February 1993 see abstract; figure 1 ---	7-18
A	GB,A,2 161 040 (MACKINNON) 2 January 1986 see abstract; figure 1 ---	1
	-/--	

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[X] Patent family members are listed in annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 March 1995	07.04.95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Onillon, C

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INTERNATIONAL SEARCH REPORT

Inter ial Application No
PCT/CH 95/00004

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO,A,81 01274 (MURPHY) 14 May 1981 see abstract; figure 1	1
A	GB,A,2 126 438 (SKINNER) 21 March 1984 see abstract; figure 1	1

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INTERNATIONAL SEARCH REPORT

Interr ial Application No
PCT/CH 95/00004

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
FR-A-2464175	06-03-81	NONE		
DE-U-9206609	20-08-92	NONE		
EP-A-0460585	11-12-91	DE-D-	59100747	03-02-94
		HK-A-	70894	29-07-94
		US-A-	5247430	21-09-93
EP-A-0528347	24-02-93	CH-A-	681840	28-05-93
		DE-D-	59200087	21-04-94
		ES-T-	2050551	16-05-94
		JP-A-	5199719	06-08-93
		US-A-	5268602	07-12-93
GB-A-2161040	02-01-86	NONE		
WO-A-8101274	14-05-81	EP-A-	0040204	25-11-81
GB-A-2126438	21-03-84	NONE		

INTERNATIONALER RECHERCHENBERICHT

Intern ales Aktenzeichen
PCT/CH 95/00004

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
IPK 6 B62J6/00 B62J6/06

Nach der Internationalen Patentklassifikation (IPK) oder nach der nationalen Klassifikation und der IPK

B. RECHERCHIERTE GEBIETE

Recherchierter Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
IPK 6 B62J

Recherchierte aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie*	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
X	FR,A,2 464 175 (SOCIETE LES PILES WONDER) 6. März 1981	1
A	siehe Anspruch 1	2-5
X	DE,U,92 06 609 (HÜRZELER) 20. August 1992 siehe Zeile 119 - Zeile 123; Ansprüche 1,2	1
A	EP,A,0 460 585 (SCHWALLER) 11. Dezember 1991 siehe Zusammenfassung; Abbildung 1	1-5
A	EP,A,0 528 347 (SCHWALLER) 24. Februar 1993 siehe Zusammenfassung; Abbildung 1	7-18
A	GB,A,2 161 040 (MACKINNON) 2. Januar 1986 siehe Zusammenfassung; Abbildung 1	1

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[X] Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen

[X] Siehe Anhang Patentfamilie

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13. März 1995	07.04.95

Name und Postanschrift der Internationalen Recherchenbehörde	Bevollmächtigter Bediensteter
Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Onillon, C

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INTERNATIONALER RECHERCHENBERICHT

Interr ales Aktenzeichen
PCT/CH 95/00004

C.(Fortsetzung) ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie*	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	WO,A,81 01274 (MURPHY) 14. Mai 1981 siehe Zusammenfassung; Abbildung 1	1
A	GB,A,2 126 438 (SKINNER) 21. März 1984 siehe Zusammenfassung; Abbildung 1	1

1