

## FIELD ELECTRIC SEMI-CONDUCTORS

Inventor: Ákos KUN, Electrical Engineer, Budapest

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The field electric semi-conductor embodied in the invention is a novel type of semi-conductor element, made up of semi-conductor layers of widely different concentration levels, in which charge carriers can stream without meeting a reverse junction, and in accordance with the balance of power prevailing in the electric field.

The modern types of semi-conductor appeared almost without exception after the advent of vacuum tubes, gradually displacing the thermal emission rectifier and amplifier elements which had prevailed on the market for several decades.

However, one element of the up-to-date semi-conductor components was known well before the vacuum tube, although in an indigenous form, and that is the semi-conductor diode. The galena detector was rediscovered in the wake of the first

transistor, and it became more and more reliable with time, and applicable to an ever wider range of tasks. Since operation of the field electric semiconductor embodied in the invention is directly based on the two-layer diode known for many years, let us first survey the control mechanism of the traditional rectifying diodes.

As is known, in the initial condition of two semiconductor layers of different crystal orientation a mutual compensation process occurs on the contact surface, under the effect of which the neutral state of the junction ceases, its "p" side getting negative, and its "n" side positive /Fig. 1/a/. Since this so-called spontaneous diffusion process is self-controlled, an equilibrium condition sets in after a while between the majority charge carriers of the two junctions. If the differential concentration of the minority and majority charge carriers of the two layers is the same, symmetrical diffusion occurs in the junction, i.e. diffusion potential is evenly distributed between the two semiconductor layers of different charge, but of identical concentration level.

Should the levels of concentration be different, i.e. the differential concentration level of minor-

ity and majority charge carriers be lower in one layer than in the other, an offset asymmetrical diffusion occurs in the junction, in other words the diffusion results in shifting off the discharged layer in the junction towards the layer of lower concentration level at a degree corresponding to the difference between the concentration levels of the two layers. The diffusion potential arising in the junction is, however, influenced not only by the mutual attractive force of the opposing charge carriers, but also by the degree of doping of the two layers, i.e. the differential concentration of minority and majority charge carriers within their respective layers. The higher the differential concentration of charge carriers within a layer, the higher the diffusion potential arising in the junction.

However, spontaneous diffusion potential arises not only on the junction of two semiconductor layers of different crystal orientation, but also on that of a p-type semiconductor layer and a metallic conductor, as illustrated on Fig. 1/b. As stated before, diffusion potential is generated in the junction by the mutual attraction of opposing charge carriers, as well as by the differential

concentration of majority charge carriers in both layers. Owing to the fact that the conductor involved in the process is metallic, its negative charge concentration is very high. Comparing that very sizeable negative charge concentration to the positive charge concentration of the semi-conductor layer, a significant difference is obtained. That large-size asymmetry of charge concentrations then triggers off a stepped-up asymmetrical diffusion along the junction, in the manner described before. The fact that no diffusion potential is obtainable between the outlets of a finished capsule-type diode /Fig. 1/c/ in dead condition can be explained with this powerful diffusion occurring between metal and semi-conductor. Although some spontaneous potential does arise between the two semi-conductor layers of the diode having opposite crystal orientation, but by connecting a metallic armature to the two layers, the anode side off armature sucks the positive majority charge carriers off the junction through contact potential, thus preventing the occurrence of a diffusion process between the two semi-conductor layers. On applying an external forward voltage on the diode, an initial diffusion field none the less occurs between

the two semi-conductor layers, since the polarity of anode side armature is at once reversed on the appearance of external voltage, as a result of which its attractive force ceases on the p-type semi-conductor layer /Fig. 2/a./. Thus in the present case the initial diffusion field is generated between the two semi-conductor layers by external forward voltage itself by cutting off contact potential at the anode side. In view of the fact that external forward voltage acts against the diffusion potential existing between the two semi-conductor layers, the potential barrier gradually decreases with the increase of external voltage. Through their repulsive effect, the two metallic armatures force more and more charge carriers over the gradually lowering potential barrier to the adjoining layer, where they get recombined with the numerous positive holes of the opposite polarity and many negative electrons, thus establishing forward current of the diode. Charges are actually compensated in the discharged range of the junction, and this accounts for the fact that if the rate of charge carrier stream constantly increasing with the increase of external voltage is not checked, the two layers of different crystal

orientation melt along the junction, and the diode is ruined through thermal breakdown.

Let us now apply external reverse voltage on the diode /Fig. 2/b/. As a result, initial diffusion potential significantly increases, also increasing electric field intensity in the junction, in relation to spontaneous diffusion. That increased diffusion field then acts against the stream of charge carriers. With the increase of external voltage, the discharged layers gradually widen at both sides of the junction, and the artificially increased contact potential arising at both sides generates a gradually increasing electric field between the armatures. However, the increase of electric field only results in gradually cutting the rate of flow of majority charge carriers, whereas for the minority charge carriers the electric field results in a sudden change after a certain level has been passed. This is so because the increase of electric field attracts the valance electrons in the junction, releasing them from their bonds, and thus inducing an increasing rate of charge carrier stream in the diode. With the increase of potential, the sudden increase of minority charge carriers is only enhanced by the occur-

rence of impulse ionization, resulting in the end by a quick avalanche-like process in the electric field of junction. This then leads to the thermal release of the electron bonds in the junction, thus fusing the two layers of different crystal orientation and causing a thermal breakdown in the diode. Such a lasting reverse-oriented overvoltage occurs relatively seldom in diode rectifier units in practice. What causes a much more frequently occurring danger in diode rectifiers occurs in the wake of transient peak voltages in d.c. and a.c. mains alike. Both the silicon and the germanium based diodes are highly sensitive to these reverse-oriented peak voltages, for they seriously damage the intermediate layer between the semi-conductors.

The field electric diode embodied in the invention is essentially free from the deleterious effects of the above-mentioned phenomena. As apparent from Figs. 3/a and 3/b, the invention has three semi-conductor layers, as against the two layers usually found in the traditional diodes. Although seeming to be nothing else but a simple bipolar transistor at the first glance, the new type of semi-conductor element has fully retained the rectifying capability of the traditional two-layer diodes.

Let us now follow the functioning of the field electric or three-layer diode embodied in the invention. Let us call the two outer layers of the n-type three-layer diode /Fig. 3/a./ source layer and drain layer, respectively. Let us apply negative potential on the source-end armature and positive potential on the drain end one. In Accordance with the relations between semi-conductor and semi-conductor, as well as between metal and semi-conductor, described before, a spontaneous diffusion process occurs under external voltage in the  $n_1$  - p junction at the source end, while the drain armature having a reversed polarity develops another diffusion junction along the contact surface of layer marked  $n_2$ . Owing to the high difference in concentration levels, the diffusion field of the drain end contact potential is significantly higher than that of the p -  $n_1$  junction, and this is why no diffusion process can occur in the p -  $n_2$  junction. After the power relations determined by external voltage have set on, the part of the semi-conductor layers falling outside the charge range becomes electrically neutral, i.e. it will have neither an attractive role nor a repulsive one in the functioning mechanism from then on. Consequent-



ly, the electric power relations will be easily controllable in the charge ranges, thus the invention can be put to use in an extensive manner. As mentioned before, the size of a diffusion field is determined by the level of external potential and the differential concentration of the charge carriers present in two adjoining layers. Consequently, in order to achieve a charge carrier stream in the semi-conductor element shown on Fig. 3/a at the highest degree of efficiency possible, the drain end contact potential must be significantly higher than diffusion potential prevailing in the  $n_1 - p$  junction. In view of the given level of external voltage coupled to S - D, the suction effect of the drain end contact potential can only be increased by raising the concentration level of layer  $n_2$ . In order to produce a suction effect as high as feasible. Layer  $n_2$  must be very strongly doped. Since the degree of doping is in a close correlation with the tolerance of reverse voltage in any semi-conductor, in the present case the actual task is to lower the reverse voltage of the  $p - n_2$  layer as far as technologically feasible. By meeting that requirement, a highly effective semi-conductor element having a linear characteris-

tic is achieved; in the set-up shown on Fig. 3/a, the element exerts a suction effect on the negative majority charge carriers accumulated in the  $n_1 - p$  junction, this being sufficiently high to break through the weak potential barrier at the junction and stream at a very high speed towards layer  $n_2$ . Since no potential barrier could occur between  $p$  and  $n_2$  because of the afore-mentioned reasons, and the zones concerned are outside the charge range anyway, thus being electrically neutral, the majority charge carriers streaming through them meet almost no hindrance, and get made in the electric field of the drain armature.

Considering the spontaneous diffusion field at side  $n_1 - p$ , the highly powerful metal - semiconductor potential at the drain end, and the electrically neutral layer marked  $p - n_2$  between them, the semi-conductor element illustrated on Fig. 3/a can be regarded as a field electric diode under forward bias, in which forward effect is generated not by the control voltage applied on the intermediate layer, but - as against the traditional transistors - the very strong electric fields prevailing at either side of the discharged layers.

Considering the invention from another point

of view, the field electric diode can also be regarded as a single-layer diode, separated at the centre /Gunn diode/. Working in co-operation with the drain electrode, layer  $n_2$  produces adequate suction force. Layer  $n_1$  is necessary for maintaining a continuous stream of charge carriers, as well as for producing an appropriate reverse voltage. In order to prevent the drain armature from sucking the majority charge carriers off layer  $n_1$ , thus depleting the stream of charge carriers, a layer of different crystal orientation need be inserted between the two layers concerned. The intermediate layer is capable of performing its task even at a quite low concentration level and a miniscule layer thickness, since it forms a neutral zone along its matching surface with layer  $n_2$  which blocks the further suction effect of the drain armature on layer  $n_1$ . Thus similarly to the Gunn diodes, a continuous stream of charge carriers can occur in the invention only after a certain level of field intensity has been attained.

Let us now interchange the source and drain outlets /Fig. 3/b./. As in the two-layer diodes, also the field electric diode embodied in the invention is to close down in this mode of operation.

On taking a look at the diffusion potentials, no difference is apparent as regards the conditions of forward oriented charge carrier streams dealt with before. If field intensity is sufficiently high, the stream of majority charge carriers comes from the negative layer, directed through layer p towards the layer coupled to positive potential. Thus it can be rightly stated that - as against the traditional two-layer diodes - no closing effect can occur in the invention either, since reverse currents are reversed by the field electric diode, thus transforming them to forward current. Thus there is only a single method for producing the closing effect absolutely necessary for rectifying diodes: the diffusion voltage already established is to be so influenced as to let the opening effect characteristic of the three-layer diode occur only over a certain potential level, with the diode being used in closing direction. In view of the fact that external voltage is given, an appropriate field intensity can be influenced only by means of the concentration level of the semiconductor layer exerting a suction effect. This method has already been made use of on layer  $n_2$ , but with the opposite polarity, since by applying the diode

in forward direction the aim was to let the charge carriers start streaming at the lowest external potential possible. However, in the present case our aim is the opposite of this, and this is why by decreasing the doping of layer  $n_1$  the potential of layers  $p - n_1$  need be increased, so as to prevent the majority charge carriers from being sucked out of layer  $n_2$  by the diffusion force generated by layer  $n_1$  and the source armature. By this method it has been achieved that the three-layer diode embodied in the invention lets the current made up of majority charge carriers pass through in forward direction at a very high degree of efficiency, whereas in reverse direction the flow of charge carriers can start only over a certain potential level. As regards the rectifying effect, that potential level corresponds to the reverse voltage level of a two-layer diode. Thus regarding its physical essence, the field electric diode embodied in the invention is nothing else but a rectifying diode having no junction. In lack of a junction, the three-layer diode is loaded only by field electricity even in reversed operation, as a result of which no avalanche effect can be triggered off by impulse ionization, and as regards field emission, it does

not suck off the majority charge carriers accumulated in a large number in the junction, but breaks the electron bonds in the junction instead, thus inducing a reversed flow of charge carriers. As against the traditional two-layer diode, the invention three-layer diode can only be damaged beyond repair by overload, resulting from either a sudden increase of load out of all proportions, or a short-circuit.

The three-layer diode embodied in the invention can of course be produced not only in the "n" design, but also in the "p" one. In the latter, the physical processes are the same as described before, only their polarity being the opposite. By consistently applying the particulars of operation given for the metallic - semi-conductor diffusion, it seems that no spontaneous diffusion necessary for the field electric effect can occur in the  $p_1 - n$  layer, because of the large suction effect of the source armature. This, however, is characteristic only of dead condition, for as soon as external forward voltage appears, polarity of the source armature is reversed, thus automatically cutting off the suction effect applied on the  $p_1 - n$  diffusion.

Reverting to the laminar structure of the three-layer diode illustrated on Fig. 3/a-b, let us transform layer  $n_1$  located at the source end to a layer doped to the same degree as layer  $n_2$ . This results in a highly doped semi-conductor of symmetrical structure which has actually lost its semi-conductor character, for the high degree of doping has done away with closing capacity of layer  $n_1$ . Having lost its rectifying effect, this semi-conductor based element actually behaves as a metallic conductor, being capable of conducting current both ways with a very little loss. Since this variant of the original design has no semi-conductor characteristic, let us call it from now on field electric contact.

Conductivity of the field electric contact is influenced by external voltage, instead of forward voltage applied on the central layer; thus in this respect, the novel element is similar to the three-layer diodes. This is so because with the increase of external voltage also the attraction of drain contact potential increases on the majority charge carriers in the source, thus increasing the current flowing through the semi-conductor based contact.

With the load increased, the same process

occurs, owing to the fact that the drop of load resistance applies a correspondingly higher potential on the source - drain armatures, thus stepping up the stream of charge carriers between the semiconductor layers. By increasing the load over the permitted level, the number of charge carriers joining in the stream increases until the heat developed by strong current damages the junctions, thus resulting in a thermal breakdown.

However, by losing its rectifying effect, the semiconductor based contact embodied in the invention has not lost a highly advantageous property of the three-layer diodes: incapability of reversing the current flowing through it in either direction. The chief practical benefit of this lies in the fact that when series-connected with a traditional semiconductor element of any type the semiconductor based contact can eliminate the deleterious effects of a reverse-oriented load.

Both the field electric diode and the semiconductor based contact can be manufactured in the "p" and "n" designs alike, and as regards their practical use, neither of these variants makes any difference. Characteristic of the n-type semiconductor elements, the simpler and cheaper production tech-



niques give a preference to the variants shown on Figs. 3/a - b. Laminar structures and recommended symbol systems of the field electric diodes and semi-conductor based contacts made out of either material are shown on Figs 4/a - b.

On using n-type three-layer diodes, the symbols given on Fig. 4/a are the same for forward and reverse current conditions as those specified for the traditional rectifying diodes; consequently, the source-drain polarity signs may be replaced by the generally adopted anode and cathode signs. In view of the symmetrical laminar structure, the terminals of the semi-conductor based contact can be interchanged at like, and this is why the polarity marks used with the asymmetrical three-layer diode may be omitted here.

As regards practical application, the three-layer diode embodied in the invention can be used not only for rectification, but - due to its special characteristics - for other tasks in electronics. Among others, forward threshold voltage can be altered with ease by means of the three-layer diode, and by coupling it in reverse direction, the element is suitable for use as a high-capacity cutting diode. Of the special application, the following

deserves special mentioning: low-pass diode, suitable for separating a given d.c. voltage from the a.c. voltage superimposed on it.

The cutting or low-pass effect mentioned before is readily apparent from Fig. 5, where the field electric diode embodied in the invention is used in a two-cycle half-way rectifying mode of operation in a half-way rectifying circuit, producing symmetrical d.c. voltage out of a plain a.c. input voltage.

The other major group of field electric semi-conductors embodied in the invention include various field electric transistors. Regarding its functioning, the field effect transistor is directly built upon the conduction mechanism of field electric diodes, but on establishing the diffusion relations, other aspects need be adhered to.

As apparent from Figs. 6/a - b, the most essential difference between the two types of semiconductor element is in the design of the central layer: passage capacity of the field electric transistors is influenced not only by external potential, but also by the control voltage applied on the gate armature located on the central layer. When coupled to external forward voltage, the field

electric transistor functions like the three-layer diode, described before the only difference being in the design of the drain semi-conductor layer /Fig. 6/a/. Should the concentration level of layer  $n_2$  be the same as the level characteristic of the drain semi-conductor layer of the field electric diodes, the field electric transistor put under forward potential would show free passage in direction S - D. Since, however, the present aim is to utilize the transistor as fully as possible, let us slow down the stream of charge carriers. Owing to the reasons already dealt with under "Field Electric Diodes", this requirement can be met in forward direction only by decreasing the doping of layer  $n_2$ . Since the degree of doping of both layers is in direct correlation with their reverse-oriented potential is altered, but also a proportional decrease in the main direction stream of charge carriers is achieved. By series-connecting a ballast resistor with the field electric transistor in that state, the rate of charge carriers directed from S to D will set at the level established by external voltage, or by the change of load resistance. However, considering the decrease of concentration level performed on layer  $n_2$  before, the new rate of

charge carrier stream is not the highest feasible.

Let us now couple an external control resistor  $/R_v/$  in between electrodes G and D. Since that control voltage applies a suction effect on the majority charge carriers coming from the source layer, conductivity of the field electric transistor undergoes a change, and the number of majority charge carriers flowing through increases with the increase of control voltage. This well-known transistor effect has, however, rather narrow limits in this case, since by means of the control voltage coupled to the gate electrode the stream of charge carriers can only be stepped up, but it cannot be slowed down, and it is similarly unfeasible to control the flow of current in reverse direction. This is so because in the field electric semi-conductors embodied in the invention the very heavy concentrations make the checking of field electric driven charge carriers impossible. Thus the range of action of the gate armature is practically limited by the reverse voltage of layers p -  $n_2$ . The reason of this is that external control voltage lowers reverse voltage p -  $n_2$  down to minimum, following from the transistor effect, and this is how the rate of flow of charge carriers is propor-

tionally increased. Similarly to the traditional transistors, the inverted load does no harm to the field electric transistor either.

Having interchanged electrodes S and D, only the stream of field electric charge carriers ceases, but the field electric transistor functions in the manner of the traditional bipolar junction transistors. The lack of inverted loadability does not prevent normal use of the semi-conductor element, for the p-type field electric transistor illustrated on Fig. 6/b is a complement pair of the n-type variant dealt with before in every respect. Laminar structure and symbol system of both types of field electric transistor are shown on Fig. 7/a - b.

Since a.c. load can actually be regarded as a d.c. load with periodically changing polarity, if appropriately designed, the field electric transistor embodied in the invention can be put very good use not only in d.c. circuits, but also in a.c. systems.

Illustrated on Figs. 8/a - b - c, the composite junction structure field electric transistor actually is nothing else but two d.c. transistors conducting current in the opposite directions and

mounted in a single capsule. By means of their resistors marked  $R_{V1}$  and  $R_{V2}$ , the p-type and n-type complementer variants separately control the positive and negative half-waves of a.c. voltage, whereas integration occurs in the parallel-connected armatures. The p-type and n-type composite laminar structure field electric a.c. transistors differ only in their manufacturing methods, and are completely equal in applicability, being fully interchangeable with each other. As against the p-type and n-type variants mentioned before, the two transistors making up the complementer variant illustrated on Fig. 8/c are not coupled counter-parallel to each other, and this is why the original polarity marks S and D can be retained. As an interesting property of the complementer variant it need be mentioned that it requires no two separate control circuits. This is feasible because a.c. voltage can be controlled here not only by means of resistors  $R_{V1}$  and  $R_{V2}$  coupled between the work electrodes, but also through a simple control circuit coupled in between the two control electrodes. Besides simplicity, the method entails the added advantage of requiring much less control power than the previous designs. On the other hand,

on applying any of the three types of composite laminar structure a.c. transistor, it is highly essential to strictly adhere to the reverse voltage specified for them. Should service voltage be higher than maximal reverse voltage specified for layers G and S, in both junction transistors a reverse current transformed into forward current is generated which - although not exactly ruining the semiconductor element - deteriorates the efficiency of control circuit to a significant extent. If the field electric transistors are used for a service voltage well below the maximal reverse voltage level specified for layers G and S, the weakened diffusion will result in a loss of efficiency, accompanied in a.c. transistors by a significant wave shape distortion.

An example on the practical application of the field electric transistor embodied in the invention is illustrated on Fig. 9. When used in a d.c. supply unit, the circuit can compensate the fluctuation of input voltage at a high degree of efficiency, thus in such a set-up the n-type field electric transistor functions as a stabilizer element. Made up of members  $T_1 - Z_1 - R_z$ , the control circuit functions on the following well-known prin-

ciple : With the drop of input voltage, proportionally lower voltage drop occurs over diode  $Z_1$ , being followed by a substantially higher current drop, corresponding to the zener characteristic. The current drop results in a sizeable voltage drop over resistor  $R_z$ , as a consequence of which the base of  $T_1$  will be at a relatively higher potential. Since transistor  $T_1$  coupled in between terminals D and G of the Field electric transistor functions as a rheostat  $/R_v/$ , the above-mentioned increase of base potential is sensed by the field electric transistor as a drop in control resistance. As a result, the drain - gate reverse voltage drops, and -- along with the stream of field electric charge carriers that existed so far -- also a stream of charge carriers of the traditional type starts, passing through ballast resistor  $R_t$  and making up the drop of input voltage. In order to ensure appropriate stability, the drain - gate reverse voltage of the field electric transistor used in the circuit should at all times be in harmony with the change expected to occur in input voltage. Should reverse voltage D - G be lower than that value, the circuit will be incapable of making up the entire change in input voltage, whereas if the level of



reverse voltage significantly exceeds the above-mentioned value, efficiency of the circuit will be severely impaired in the form of thermal loss, similarly to the traditional valve transistors.

Since a stabilizer circuit should be capable of making up not only drops of input voltage, but also any sudden increase of it as well, operating point of the control circuit is to be set to the mean value of reverse voltage D - G. Rated voltage of the zener diode used is approximately the same as operating point voltage related to earth. Functioning on the same principle, the a.c. field electric transistor is capable of compensating both transformed a.c. voltage fluctuation and mains voltage fluctuation. On stabilizing mains voltage, the necessary potential reverse should be ensured by transforming up the current to the degree of the voltage drop expected.

Owing to the widely different concentration levels in the individual layers of the asymmetrical structure field electric semi-conductors, field electric power relations fail to follow the increase of external voltage in a linear manner. Along with a charge carrier stream meeting no reverse junction, the above-mentioned main physical property

of the asymmetrical laminar structure field electric semi-conductors is the one that enables the invention field electric diode and field electric transistors to serve also as output voltage stabilizers in both d.c. and a.c. circuits, over and above their traditional functions /rectifying and stabilizing input voltage/.

Suitable for replacing an entire stabilizer circuit through this property of them, the invention field electric diode and transistors are actually based in this respect on the energy level of the individual layers asymmetrically changing under the effect of external voltage /known as quasi-Fermi level/, as a consequence of which the asymmetrical laminar structure semi-conductor elements feature a negative internal resistance. Since that negative resistance is the higher, the larger the difference between the maximal reverse voltage tolerance  $S - G$  of the semi-conductor element and the external voltage, the field electric diodes, as well as a.c. and d.c. field electric transistors, made for different reverse voltages  $S - G$  should be so selected for practical application as to let the increase of output voltage caused by the increase of load compensate the voltage drop occurring at

the input end. Besides a highly effective input voltage stabilization, the n-type field electric transistor illustrated on Fig. 9 is also capable of compensating the voltage drop occurring in the secondary coil of transformer under the increase of load current, thus establishing a cheap and universal stabilizer circuit of almost unlimited capacity, which can replace an entire stabilizer circuit.

The silicon or highly conductive gallium-arsenide based laminar structure of the invention field electric semi-conductors can be best manufactured by the planar or epiplanar technique widely used in traditional semi-conductor engineering.

Claim of Patent:

- 1./ Field electric semi-conductors, characterized by a composite laminar structure consisting of semi-conductory layers of widely different concentration levels, in which majority charge carriers can stream without meeting a reverse junction, and in accordance with the power relations prevailing in the electric field.
- 2./ Field electric semi-conductor as claimed under Para. 1., and as illustrated as a field electric

diode on Fig. 4/a, characterized by a p-type or n-type asymmetrical laminar structure /1/ and a practical system of symbols /2/.

- 3./ Field electric semi-conductor as claimed under Para. 1, and as illustrated as a field electric contact on Fig. 4/b, characterized by a p-type or n-type asymmetrical laminar structure /1/ and a practical system of symbols /2/.
- 4./ Field electric semi-conductor as claimed under Para. 1, and as illustrated as field electric transistor on Fig. 7/a, characterized by a p-type asymmetrical laminar structure /1/ and a practical system of symbols /2/.
- 5./ Field electric semi-conductor as claimed under Para. 1, and as illustrated as a field electric transistor on Fig. 7/b, characterized by an n-type asymmetrical laminar system /1/ and a practical system of symbols /2/.
- 6./ Field electric semi-conductor as claimed under Para 1, and as illustrated as a field electric transistor on Fig 8/a, characterized by a p-type composite laminar structure /1/ and a practical system of symbols /2/.
- 7./ Field electric semi-conductor as claimed under Para.1, and as illustrated as a field electric

transistor on Fig 8/b, characterized by an  
n-type composite laminar structure /1/ and a  
practical system of symbols /2/

8./ Field electric semi-conductor as claimed under  
Para. 1 and as illustrated as a field electric  
transistor on Fig. 8/c, characterized by a  
complementer-type composite laminar structure  
/1/ and a practical system of symbols /2/.

  
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Ákos Kun

### SUMMARY

The field electric semi-conductor embodied in the invention is a novel type of semi-conductor element, made up of semi-conductor layers of widely different concentration levels, in which charge carriers can stream without meeting a reverse junction, and in accordance with the power relations prevailing in the electric field, Coming in various forms of design like field electric diode, field electric contact, d.c. field electric transistor, a.c. field electric transistor, the invention is suitable not only for all tasks characteristic of the traditional types of semi-conductor elements, but also for a number of new electronic applications.