F. C. WICKEL.

DIFFUSER FOR PRODUCING A UNIFORM JET OF UNLIMITED WIDTH.

APPLICATION FILED MAY 18, 1911.

1,085,313.

Patented Jan. 27, 1914.

3 SHEETS—SHEET 1.

Fig. 1.

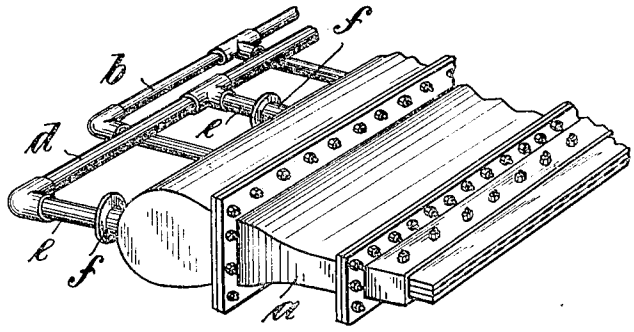



Fig. 2.

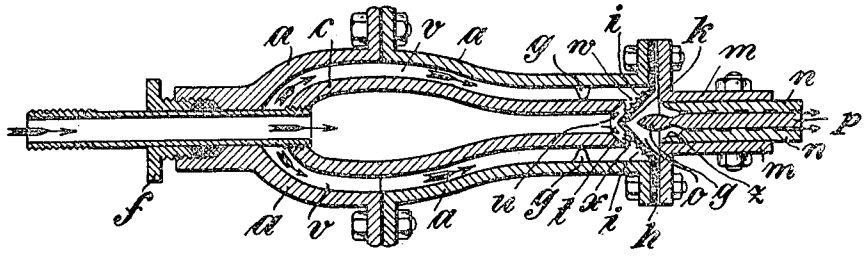
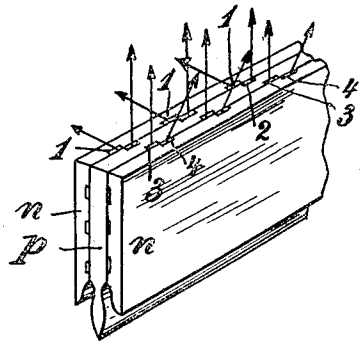



Fig. 3.




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Fig. 4.

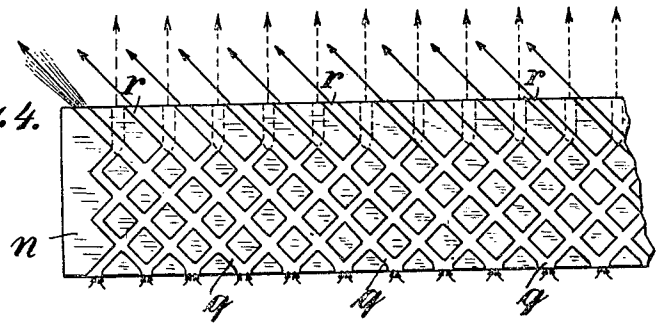



Fig. 5.

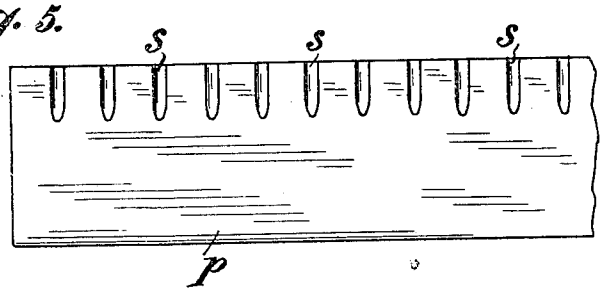



Fig. 6.

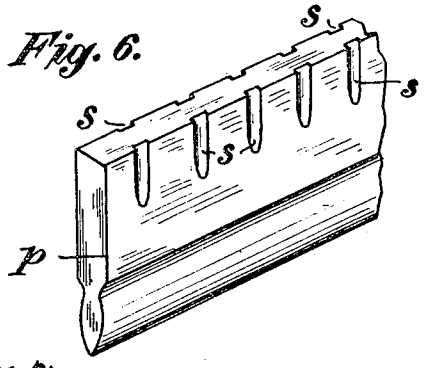
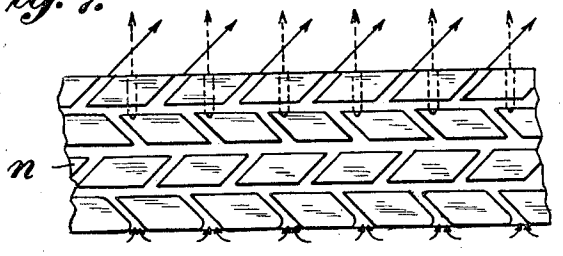



Fig. 7.




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3 SHEETS—SHEET 3.

Fig. 8.

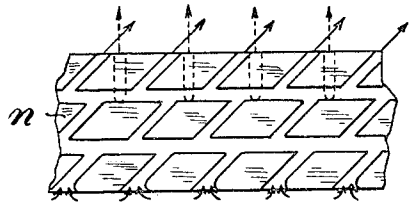



Fig. 9.

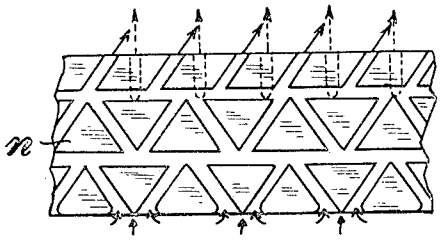



Fig. 10.

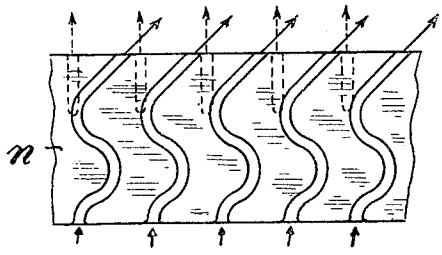



Fig. 11.

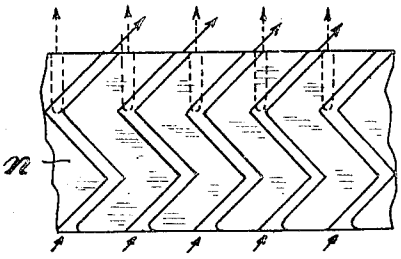
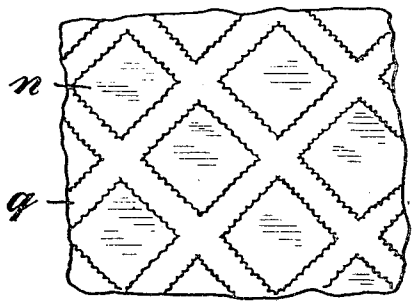



Fig. 12.




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# UNITED STATES PATENT OFFICE.

FRITZ C. WICKEL, OF PARIS, FRANCE.

## DIFFUSER FOR PRODUCING A UNIFORM JET OF UNLIMITED WIDTH.

1,085,313. Specification of Letters Patent. Patented Jan. 27, 1914.

Application filed May 18, 1911. Serial No. 628,109.

*To all whom it may concern:*

Be it known that I, FRITZ C. WICKEL, chemist, a subject of the German Emperor, residing at 5 Rue Michel Chasles, Paris, France, have invented certain new and useful Improvements in Diffusers for Producing a Uniform Jet of Unlimited Width, of which the following is a specification.

The present invention relates to a diffuser for producing a uniform jet of unlimited width.

In recent times the practice of applying liquids such as paints and the like by means of diffusers has replaced the previous method of applying them with a brush. More or less good forms of such diffusers have become known in a large number, which fulfil their purpose in all instances, in which small quantities of liquid are to be applied to a given space of limited size, the diffuser being manipulated in a skilled hand. With the known diffusers the liquid say paint, glue or the like is applied in a similar manner as with the brush, but with a much greater speed, and gradually in a uniform manner over the whole breadth of a given surface. If large surfaces have to be covered the same part will have to be several times gone over in order to obtain a uniform coat. This is the consequence of the fact that the jet of paint produced by the diffuser in any case approximately has the shape of a hollow cone, in the point of which is the maximum quantity of paint. Toward the base of the cone the specific quantity of paint will gradually decrease, so that here the paint or other liquid sprayed on to the respective surface will thin out into a mere faint line. If now wide surfaces are to be covered at a time, much difficulty will be encountered in consequence of the uneven application. So it has been tried to couple a plurality of pneumatic single nozzle diffusers so as to be able to cover large surfaces in a rapid and uniform manner. If the orifices of these nozzles are arranged parallel to each other, streaks of an uneven color will be produced on a band of paper or the like moved along in front of them; if the nozzles are given a reciprocating motion these streaks will have a zigzag shape. If the individual nozzles are arranged at convergent angles somewhat more favorable results are obtained, provided the article to be covered is at exactly the proper distance from the nozzles, the cones of paint do not meet unevenly, no nozzles become choked, a sufficient number of nozzles is employed at the same time and these are attended in a fully uniform manner with regard to the supply of paint and compressed air. These favorable results will, however, disappear as soon as the slightest disturbance occurs. Disturbances are, however, almost unavoidable, as it will be extremely difficult to combine all the hereinbefore stated conditions, as each diffuser nozzle is an independent apparatus. The uniform painting of articles having any considerable width is therefore practically impossible with the known means. Much greater difficulties are, however, encountered, and any defects become the more apparent, if moving articles such as bands of paper or fabric are to be uniformly covered with paint or another liquid. This was hitherto only possible if the speed of such band was extremely slow, and even then the formation of streaks could not be avoided altogether. Another difficulty is encountered in the varying composition of the liquids to be applied and the varying quantity of liquid to be applied at a time, so that the difficulties and sources of defects grow enormously with the apparatus hitherto known.

The present invention relates to a diffuser which has the purpose of producing a uniform jet of unlimited width and power, which can be immediately used for liquids of any consistency, admits of these being heated or cooled, and which may be readily adjusted and cleaned.

Contrary to the known devices this diffuser consists of one integral apparatus though the number of nozzles is unlimited; nevertheless its design is extremely simple and its manufacture therefore cheap.

The essential features of the device forming the subject of the present invention consist in the centralized feed of the substances to be diffused, in the mixing of the said substance to be diffused which has been disintegrated as far as possible in the device, with another substance, such as compressed air, in the complete disintegration and, practically, pulverization of the substance or mixture of substances by the same being sent through passages having roughened walls and, if necessary, also crossing each other, and finally in the diffused substance or mixture of substances emerging from a plural-

ity of passage and nozzle orifices arranged in different planes and pointing in sets alternately straight ahead, at an angle to the right and at an angle to the left respectively or otherwise, said orifices being of suitable rectangular section. The result of such arrangement is a centralized control of the quantity of substance being diffused, the possibility of uniformly heating or cooling the substance to be added such as compressed air, an optional varying of the ratio of mixture of several substances for an unlimited number of nozzles, an unlimited constructional length of the apparatus, so that it may be adapted to shops of any width, and lastly the production of a final compound jet of absolute uniformity, great width but small height, which has a great striking force and will therefore produce a secure adherence of the substance or mixture of substances to the article to which they are applied.

In place of compressed, heated or cooled ordinary air a gas or a substance in gaseous form, a mixture of gases or of gases and air or the like may in certain cases be employed, in order to produce a physical or chemical effect on the substance or the mixture of substances respectively to be diffused before, during or after such diffusion. So for instance lacs, varnishes and the like may be applied intimately mixed with oxygen in order to accelerate by such means their oxidization.

The drawing exemplifies a constructional form of the present invention which is intended for diffusing liquids, such as paints, by means of compressed air.

Figure 1 is a perspective view of the diffuser. Fig. 2 is a cross section through the same. Fig. 3 is a multiple orifice nozzle of the diffuser. Fig. 4 is one of the distributing or diffusing plates of the nozzle according to Fig. 3; and Fig. 5 is an auxiliary plate arranged between each two diffusing plates according to Fig. 4. Fig. 6 is a perspective view of this auxiliary plate. Figs. 7 to 11 show various modifications of the plates according to Fig. 4, and Fig. 12 is a modification of the walls of the passages in the plates according to Figs. 4 to 6 and Figs. 7 to 11.

In the drawing *a* is a housing of any desirable length which is preferably made in two parts so as to admit of a convenient cleaning; this housing may have a section resembling an elongated horseshoe. Into this housing compressed air is supplied at suitable points through pipe *b*. Within the housing *a* is fitted a hollow body *c*, preferably open on one side. This hollow body *c* is preferably made of a similar section and the same length as the housing *a*. Between the housing *a* and the body *c* remains a free space, in which the compressed air can flow around said body. The inside of the hollow body *c* serves to receive the substance to be diffused, say paint, which in the constructional form under discussion is supplied into the said body *c* at about the same pressure as the compressed air. The liquid is supplied to the said body through pipes *e*, which are branched off from a pipe *d* and are displaceable in stuffing boxes *f* in the housing *a*, so as to allow of adjusting the hollow body *c*, guided on pins *g* or the like in a transverse direction in the housing for the purpose of regulating the ratio of mixture between the air and the paint.

At its open end, in Fig. 2 on the right hand side, the housing is closed by a plate *h*, which is made of the same length and preferably of a V-shaped section. The apex of this V-shaped plate will fit into the slotted opening *n* of the said hollow body *c*, bordered by correspondingly beveled flanges *t*, on the said body *c* being accordingly advanced, so that the liquid emerging from this opening will be distributed uniformly on both sides of plate *h*. The plate *h* is perforated throughout its whole length by holes *i* preferably with exception of the part close to the point of the V-shaped section. These holes are disposed between projections *k* or the like of prismatic or other shape, and turned toward the hollow body *c*. These projections form passages, through which the liquid coming from the hollow body *c* must pass, whereby it will be divided into a plurality of currents, which on passing through the holes *i* will be seized by the compressed air flowing from the housing *a* and will be still further divided thereby.

In front of plate *h* is secured a hood *m*, which is of the same length as the housing *a*. This hood contains the hereinafter described multiple orifice nozzle *n*, *p* and leaves between the latter and the plate *h* a free space *o*, which serves as a mixing chamber. Into this chamber enter the fine streams passing through the holes *i* in plate *h* and consisting of a mixture of air and liquid, where they are still further distributed by the compressed air partly expanding in this chamber. The thus treated mixture of air and liquid which contains the liquid in an already finely distributed state is now diffused by the multiple orifice nozzle *n*, *p*. This multiple orifice nozzle consists preferably of a plurality of narrow plates having the length of the housing *a*, combined to one block, Fig. 3, and containing a plurality of passages. These passages are so arranged, that they will on the one hand produce as effective a division as possible of the mixture of air and liquid, and on the other hand diffuse this mixture in jets, which preferably lie in groups in different planes, the jets in each group having the same direction, the direction of the jets of the several groups however differing from each other. So for instance the nozzle according to Fig. 3 will pro-

duce jets emerging in four different directions. The jets of the first group are directed with regard to Fig. 3 at an angle of 45° from right hand below to left hand top, the jets of the second and third group at an angle of 90° alternately to each other and the jets of the fourth group at an angle of 45° from left hand below to right hand top, to the longitudinal axis of the nozzle body. By such means a bundle of jets is obtained which will cover a surface in front of the nozzle in a uniform non-striated manner with the liquid diffused.

The nozzle according to Fig. 3 is made of three plates, of which the two outer ones *n* may be identical, while the middle one *p* differs from these in shape. As it is evident from Fig. 4 the plates *n* are provided on their one side with a plurality of crossed passages *q*, which have discharge openings *r* having the same direction. As evident from Fig. 5 the plate *p* need have short passages *s* only, but these are arranged, as shown in Fig. 6, on both sides of the plate. The two sets of passages *s* in plate *p* are alternated to each other. The plates *n* and *p* are combined to the block shown in Fig. 3 in such a manner, that on a plate *n*, according to Fig. 4, the plate *p* is placed in such a manner, that the passages *s* on the one side of this plate coincide with the upper row of crossings of the passages *q* in plate *n*, as is indicated by the dotted lines in Fig. 4. Then the second plate *n* is placed on plate *p* in such a manner, that the upper row of crossings of the passages *q* in this second plate *n* again coincide with the passages *s* on the other side of the plate *p*. By this arrangement four rows of orifices are obtained sending out jets in three directions. The plates *n* and *p* may for instance be made of copper plates ground against each other, in which the groove-like passages *q*, *r* and *s* of preferably rectangular section are formed by engraving, etching or other means. According to the purpose intended the section of the plates *n* and *p* may be varied, so they may be made instead of a rectangular of a wedge shaped section, whereby the passages will no more lie in parallel but in convergent planes. The wedge shaped section may for instance be employed if all jets of the nozzle are to be united in as narrow a band as possible. Of course, the multiple orifice nozzle may also be composed of more than three plates. So for instance three plates *n* may be combined with two plates *p* in which instance the middle plate *n* would be provided with passages *q*, *r* on both sides. By such means eight groups of jets in eight different planes would be obtained. It is besides not absolutely necessary to have the passages in the plates *n* run in the directions as shown in Fig. 4. They may also be arranged in the manner shown in Figs. 7 to 11. The essential feature is that they repeatedly change their direction, so as to have in consequence of the impact produced at each change of direction as great a disintegrating effect as possible on the liquid currents. The same purpose will be served by the roughened form of the walls of the channels shown in Fig. 12.

As the compressed air entering into the housing *a* flows around the hollow body *c*, either heated or cooled compressed air may be employed for heating or keeping hot the liquid in the hollow body, in case such heating should be desirable, to compensate the drop of temperature caused by the evaporation in consequence of the diffusion, or for cooling the liquid in the hollow body *c* respectively.

The operation of the diffuser is as follows: The compressed air is introduced through pipe *b* at several points into the housing *a* (Fig. 1) and passes into the space *v* between the hollow body *c* and the wall of the housing *a* (Fig. 2). If either a warm or hot or a cold compressed air is employed, a liquid contained in the hollow body *c* will be kept warm or heated, or the drop of temperature produced by the expansion of the compressed air is compensated, or the said liquid is cooled respectively. The liquid to be diffused passes from pipe *d* through pipes *e* into the hollow body *c* preferably under the same pressure as that at which the compressed air enters the housing *a*. From the hollow body *c* the liquid passes into the passages *w* and *x* formed between the beveled edges *t* of the hollow body and the plates *h* where it meets with the compressed air coming from chamber *v*. The liquid is then divided in the passages between the projections *k* on plate *h* and forced in numerous fine streams through the holes *i* in plate *h* and then further distributed by the compressed air partly expanding in chamber *o*. The liquid is thrown against the preferably ribbed lower edges *y* and *z* of plates *n* and *p*, preferably beveled for forming V-shaped longitudinal grooves and is then driven through the only possible exit, namely the passages in plates *n* and *p*. In these passages the liquid is completely disintegrated and emerges in form of a fine dust from the orifices of the passages arranged in different planes and pointing in groups in three alternate directions. By the directions of the various sets of rays alternating, whereby the formation of cones occurring with diffusers of known design is considerably reduced, and by the various groups of orifices being arranged in different planes it is obtained on the one hand, that each individual jet will be strongly formed up to a given distance from the orifice by a mixing of several jets being avoided, on the other hand that by the jets of the various groups crossing

each other a bundle of jets is produced of the greatest possible uniformity, great power and unlimited width (even up to several meters). It is out of question for parts of the work to remain uncovered or be doubly covered. The coöperation of the jets, of which preferably the same number is directed vertically and obliquely in the two directions results in the production of longitudinally overlapping elliptic fields, a consequence of the rectangular shape of the orifices. The effect is therefore a broad powerful band of paint on the piece of work in which the two longitudinal edges are but slightly defined. As the hollow body *c* can be displaced in the housing *a* by means of tube *e*, the section of the passages *w* and *x* can be varied thereby and the outlet of liquid from the hollow body *c* be controlled. The displacing of the hollow body *c* in the housing may also be effected in any other suitable manner.

The subject matter of the present invention is suited for diffusing liquid but also dry pulviform substances by means of compressed air, gas or the like, and also for diffusing a liquid under pressure without the use of compressed air or the like, or several substances liquid or pulviform, or liquid and pulviform, under the same or different pressures, introduced separately into and mixed in the apparatus.

I claim:

1. A diffuser comprising a system of passages of a width corresponding to the width of the piece of work, into which system of passages the substance to be diffused is fed, the said system of passages having orifices adapted to let the said substance escape in finely diffused jets, the passages in said system of passages arranged in groups in different planes, the passages lying in the same plane repeatedly changing its direction in order to increase the fine disintegration of the substance to be diffused, the orifices of the passages of each group having the same direction, the direction of the orifices of the various groups being at an angle to each other.

2. A diffuser comprising a system of passages of a width corresponding to the width of the piece of work, into which system of passages the substance to be diffused is fed, the said system of passages having orifices adapted to let the said substance escape in finely diffused jets, the passages in said system of passages arranged in groups in different planes, the passages lying in the same plane repeatedly changing its direction in order to increase the fine disintegration of the substance to be diffused, the orifices of the passages of each group having the same direction, the direction of the orifices of the various groups being at an angle to each other, the said system of passages consisting of channels formed on the side of several narrow plates fitted exactly on each other in such a manner, that by the combination of said plates, each plate forming the roof of the channels in the adjoining plate, a long narrow body is produced transected by said system of passages in various directions, and adapted to serve as multiple orifice nozzle.

3. A diffuser comprising a system of passages of a width corresponding to the width of the piece of work, into which system of passages the substance to be diffused is fed, the said system of passages having orifices adapted to let the said substance escape in finely diffused jets, the passages in said system of passages arranged in groups in different planes, the passages lying in the same plane repeatedly changing its direction in order to increase the fine disintegration of the substance to be diffused, the orifices of the passages of each group having the same direction, the direction of the orifices of the various groups being at an angle to each other, the said system of passages consisting of channels formed on the side of several narrow plates fitted exactly on each other in such a manner, that by the combination of said plates, each plate forming the roof of the channels in the adjoining plate, a long narrow body is produced transected by said system of passages in various directions, and adapted to serve as multiple orifice nozzle, and a mixing chamber provided in front of the composite body containing the system of passages.

4. A diffuser comprising a system of passages of a width corresponding to the width of the piece of work, into which system of passages the substance to be diffused is fed, the said system of passages having orifices adapted to let the said substance escape in finely diffused jets, the passages in said system of passages arranged in groups in different planes, the passages lying in the same plane repeatedly changing its direction in order to increase the fine disintegration of the substance to be diffused, the orifices of the passages of each group having the same direction, the direction of the orifices of the various groups being at an angle to each other, the said system of passages consisting of channels formed on the side of several narrow plates fitted exactly on each other in such a manner, that by the combination of said plates, each plate forming the roof of the channels in the adjoining plate, a long narrow body is produced transected by said system of passages in various directions, and adapted to serve as multiple orifice nozzle, a mixing chamber provided in front of the composite body containing the system of passages, and a long perforated plate, leading the substance to be diffused and the substance to be mixed thereto into said mixing chamber in a plurality of currents.

5. A diffuser comprising a system of passages of a width corresponding to the width of the piece of work, into which system of passages the substance to be diffused is fed, the said system of passages having orifices adapted to let the said substance escape in finely diffused jets, the passages in said system of passages arranged in groups in different planes, the passages lying in the same plane repeatedly changing its direction in order to increase the fine disintegration of the substance to be diffused, the orifices of the passages of each group having the same direction, the direction of the orifices of the various groups being at an angle to each other, the said system of passages consisting of channels formed on the side of several narrow plates fitted exactly on each other in such a manner, that by the combination of said plates, each plate forming the roof of the channels in the adjoining plate, a long narrow body is produced transected by said system of passages in various directions, and adapted to serve as multiple orifice nozzle, a mixing chamber provided in front of the composite body containing the system of passages, into which mixing chamber the substance to be diffused and the substance to be mixed thereto are introduced in a plurality of currents, the entrance of said substances into the mixing chamber leading through a long perforated plate, and studded with projections of suitable shape, between which the entrance holes are disposed and thereby adapted to divide the substance to be diffused and the substance to be mixed thereto into a plurality of currents in the passages formed by said projections, said currents being further divided on passing through said holes.

6. A diffuser comprising a system of passages of a width corresponding to the width of the piece of work, into which system of passages the substance to be diffused is fed, the said system of passages having orifices adapted to let the said substance escape in finely diffused jets, the passages in said system of passages arranged in groups in different planes, the orifices of the passages of each group having the same direction, the direction of the orifices of the various groups being at an angle to each other, the said system of passages consisting of channels in several narrow plates fitting exactly on each other in such a manner, that by the combination of said plates, each plate forming the roof of the channels of the adjoining plate, a long narrow body is produced transected by said system of passages in various directions, and adapted to serve as multiple orifice nozzle, a mixing chamber provided in front of the composite body containing the system of passages, into which mixing chamber the substances to be diffused and the substances to be mixed thereto are introduced in a plurality of currents, the entrance of said substances into the mixing chamber leading through a long perforated plate, and studded with projections of suitable shape, between which the entrance holes are disposed and thereby adapted to divide the substances to be diffused and the substance to be mixed thereto into a plurality of currents in the passages formed by said projections, said currents being further divided on passing through said holes, the inside hollow body containing the substance to be diffused arranged in a similar outside hollow body containing the substance to be mixed to the substance to be diffused, so as to leave a free space all around.

7. A diffuser comprising a system of passages of a width corresponding to the width of the piece of work, into which system of passages the substance to be diffused is fed, the said system of passages having orifices adapted to let the said substance escape in finely diffused jets, the passages in said system of passages arranged in groups in different planes, the orifices of the passages of each group having the same direction, the direction of the orifices of the various groups being at an angle to each other, the said system of passages consisting of channels in several narrow plates fitting exactly on each other in such a manner, that by the combination of said plates, each plate forming the roof of the channels of the adjoining plate, a long narrow body is produced transected by said system of passages in various directions, and adapted to serve as multiple orifice nozzle, a mixing chamber provided in front of the composite body containing the system of passages, into which mixing chamber the substances to be diffused and the substance to be mixed thereto are introduced in a plurality of currents, the entrance of said substances into the mixing chamber leading through a long perforated plate, and studded with projections of suitable shape, between which the entrance holes are disposed and thereby adapted to divide the substances to be diffused and the substance to be mixed thereto into a plurality of currents in the passages formed by said projections, said currents being further divided on passing through said holes, the inside hollow body containing the substance to be diffused arranged in a similar outside hollow body containing the substance to be mixed to the substance to be diffused, so as to leave a free space all around, said inside hollow body displaceable in said outside hollow body in a manner adapted to vary its distance from the said perforated cover plate of the mixing chamber and therewith also the ratio at which said substances are mixed.

8. A diffuser comprising a system of passages of a width corresponding to the width of the piece of work, into which system of

passages the substance to be diffused is fed, the said system of passages having orifices adapted to let the said substance escape in finely diffused jets, the passages in said system of passages arranged in groups in different planes, the orifices of the passages of each group having the same direction, the direction of the orifices of the various groups being at an angle to each other, the said system of passages consisting of channels in several narrow plates fitting exactly on each other in such a manner, that by the combination of said plates, each plate forming the roof of the channels of the adjoining plate, a long narrow body is produced transected by said system of passages in various directions, and adapted to serve as multiple orifice nozzle, the walls of said passages being roughened in a manner adapted to increase the fine disintegration of the substance to be diffused, a mixing chamber provided in front of the composite body containing the system of passages, into which mixing chamber the substances to be diffused and the substance to be mixed thereto are introduced in a plurality of currents, the entrance of said substances into the mixing chamber leading through a long perforated plate, and studded with projections of suitable shape, between which the entrance holes are disposed and thereby adapted to divide the substances to be diffused and the substance to be mixed thereto into a plurality of currents in the passages formed by said projections, said currents being further divided on passing through said holes, the inside hollow body containing the substance to be diffused arranged in a similar outside hollow body containing the substance to be mixed to the substance to be diffused, so as to leave a free space all around, said inside hollow body displaceable in said outside hollow body in a manner adapted to vary its distance from the said perforated cover plate of the mixing chamber and therewith also the ratio at which said substances are mixed, an edged rib protruding from said long narrow body and leading the substance to be diffused and the substance to be mixed thereto to the said groups of passages.

9. A diffuser comprising a system of passages of a width corresponding to the width of the piece of work, into which system of passages the substance to be diffused is fed, the said system of passages having orifices adapted to let the said substance escape in finely diffused jets, the passages in said system of passages arranged in groups in different planes, the passages lying in the same plane repeatedly changing its direction in order to increase the fine disintegration of the substance to be diffused, the orifices of the passages of each group having the same direction, the direction of the orifices of the various groups being at an angle to each other, the said system of passages consisting of channels formed on the side of several narrow plates fitting exactly on each other in such a manner, that by the combination of said plates, each plate forming the roof of the channels in the adjoining plate, a long narrow body is produced transected by said system of passages in various directions, and adapted to serve as multiple orifice nozzle, the walls of said passages being roughened in a manner adapted to increase the fine disintegration of the substance to be diffused, a mixing chamber provided in front of the composite body containing the system of passages, into which mixing chamber the substances to be diffused and the substance to be mixed thereto are introduced in a plurality of currents, the entrance of said substance into the mixing chamber leading through a long perforated V-shaped plate, studded with projections of suitable shape, between which the entrance holes are disposed and thereby adapted to divide the substances to be diffused and the substance to be mixed thereto into a plurality of currents in the passages formed by said projections, said currents being further divided on passing through said holes, the inside hollow body containing the substance to be diffused arranged in a similar outside hollow body containing the substance to be mixed to the substance to be diffused, so as to leave a free space all around, said inside hollow body displaceable in said outside hollow body in a manner adapted to vary its distance from the said perforated cover plate of the mixing chamber and therewith also the ratio at which said substances are mixed, an edged rib protruding from said long narrow body and leading the substance to be diffused and the substance to be mixed thereto to the said groups of passages.

In testimony whereof I affix my signature in presence of two witnesses.

FRITZ C. WICKEL.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.