# United States Patent [19]

**Gallen**

[11] **3,900,000**

[45] **Aug. 19, 1975**


[54] **APPARATUS FOR SPRAY COATING ARTICLES**


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[22] Filed: **Nov. 28, 1973**

[21] Appl. No.: **419,569**

[52] **U.S. Cl.** ..... **118/630;** 118/629; 239/15

[51] **Int. Cl.**[2] ..... **B05B 5/02;** B05C 5/04

[58] **Field of Search** ..... 118/621, 627, 629, 630; 117/93.4; 239/3, 15



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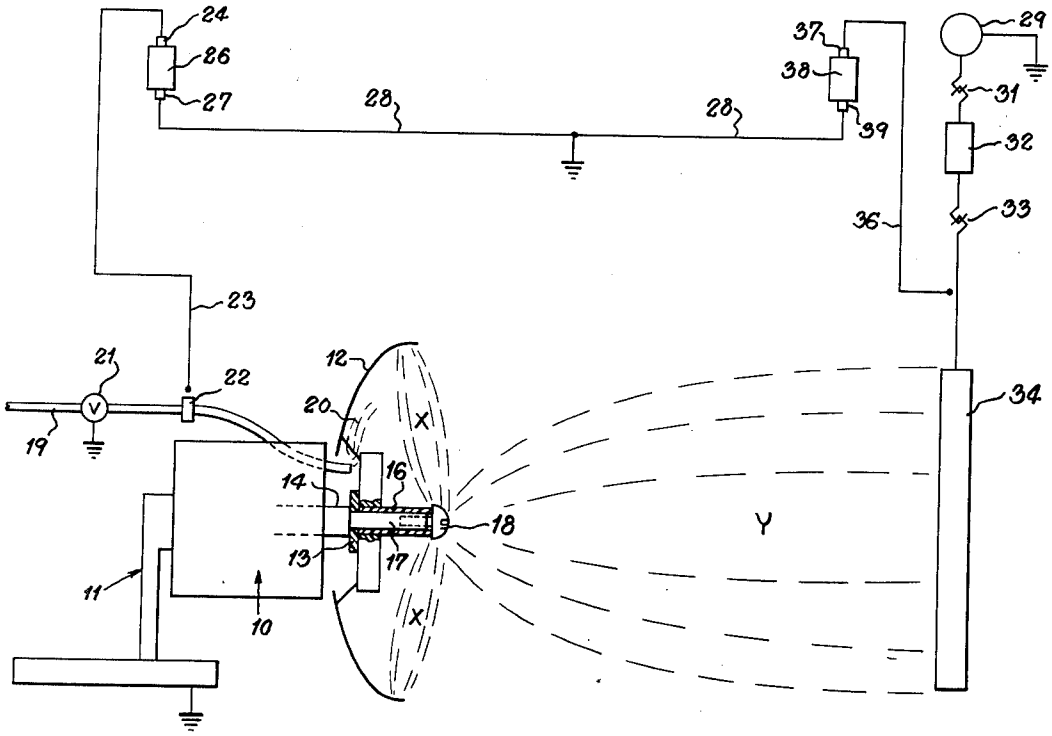
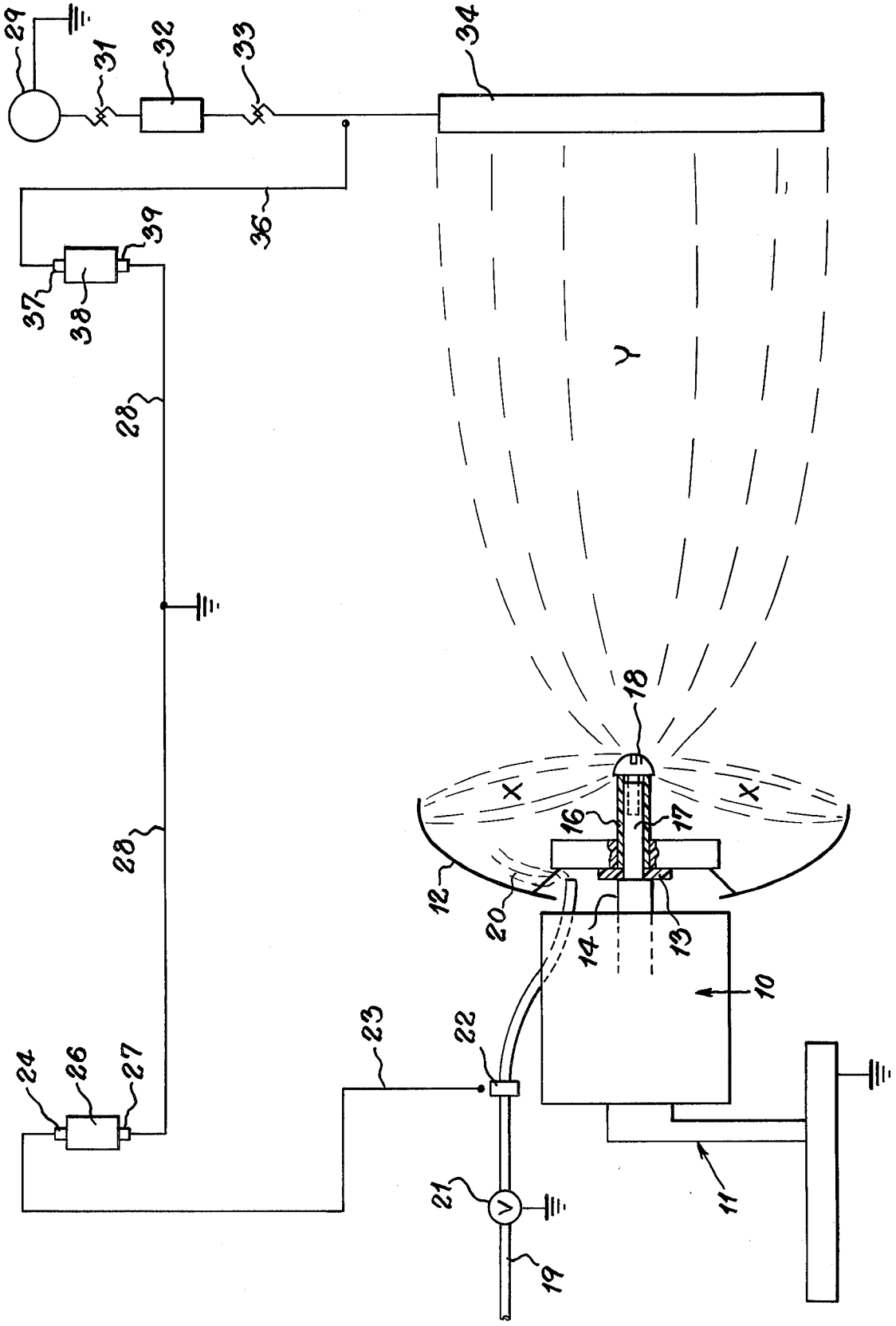
[57] **ABSTRACT**

A sub-ionization spray coating system having a spray gun at ground potential with an ungrounded high speed disc atomizer for spraying ungrounded coating having an electrical potential of one polarity upon an inductively charged workpiece having an electrical potential of an opposite polarity, the potentials of which are substantially lower than those of the prior art.


**10 Claims, 1 Drawing Figure**

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# APPARATUS FOR SPRAY COATING ARTICLES

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and apparatus for spray coating articles of manufacture and, in particular, to an arrangement wherein atomized coating particles of one electrical sign are ejected from an atomizer and directed towards inductively charged work pieces of opposite electrical sign.

2. Description of Prior Art

Heretofore, as disclosed in U.S. Pat. Nos. 3,473,946, **3,376,156, 3,113,037, 2,893,894, 2,893,893, 2,794,417, 1,855,869** and others of like import, the voltages employed have been rather high in order to produce ionization of the air and spray particles. But ionization as so produced in the prior art renders it difficult to spray paint work pieces having sharp edges and or recesses. Such ionizing edges pull more finely atomized particles to their emission points than do the uniformly emitting flat or circular surfaces and thereby provide articles with paint build-up on their ionizing edges. In other words, the prior art practice does not produce articles with a uniform coating on all surfaces thereof.

## SUMMARY OF THE INVENTION

Accordingly, an object of the invention is to provide an improved method and apparatus for spray coating material (paint or powder) onto any shaped article (conductive or non-conductive) to form a more uniform coating of suitable thickness thereon, and with minimum waste.

Another object is to provide a spray coating arrangement wherein the voltages employed are substantially lower than in the prior art practice with resultant savings in energy.

A further object is to provide a spray coating arrangement that is safer to personnel operating the same.

A still further object is to accomplish the foregoing objects in a simple, practical and economical manner.

Other and further objects will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

In accordance with the present invention, the foregoing objects are generally accomplished by performing the spray coating in a sub-ionization field wherein the voltage is quite low as compared to the high voltages in conventional practice. With the lower voltage used in this invention there is insured a vast improvement in the uniformity of coating thickness on various shaped articles.

Important features of the present invention are:

1. The spray gun is at ground potential for operator safety.
2. The disc atomizer or coating emitting head is insulated from the spray gun and thus not connected to ground.
3. The coating itself is insulated from ground and so introduced into the disc atomizer or emitting head.
4. The coating ejected from the disc atomizer or emitting head has a charge applied to it prior to its entering the atomizer or emitting head, which charge is of an electrical sign opposite to that of the charged work piece, the coating charge being even as low as 1 volt.
5. The movement of air is controlled so as to be moved from the rear of the atomizer or emitting head across the path of the work piece, at a rate that will not overcome attraction of the coating particles by the charged work piece.
6. A conductor having a voltage well above that of the charged coating induces a charge of opposite sign to that of the coating particles onto the work piece. The voltage induced on the work piece is about 15,000 volts at a 10 to 12 inch average distance from the atomizer or emitting head.



The advantages of the above features are many, including:

1. The atomizing disc or emitting head being insulated from ground receives only the voltage sign deposited on its surface by the charged coating material, which has had either a positive or negative sign of at least 1 volt placed upon it prior to its entrance through the insulated disc or emitting head. Therefore, the field required to attract the atomized coating material can be reduced from an actual 28,000 to 30,000 volts, as required in U.S. Pat. No. 3,376,156, to a field of about 14,000 to 15,000 volts. Thus, it is evident that 14,000 to 15,000 additional volts are required in the above patent to do the work of pulling the opposite voltage sign from ground (which is balanced and equally positive and negative).
2. The same work, that is, additional voltage, is required in U.S. Pat. Nos. 2,794,417, 2,893,893, and 2,893,894. The prior art parts being normally grounded, this 14,000 to 15,000 volt minimum is required for deposition of the coating material onto the part. Since grounded parts are equally positive and negative, in the above patents where the coating material is charged to one sign, then the grounded part, being equally positive and negative, would be coated with a 50% efficiency. The field must consequently be strong enough to pull the opposite sign from that on the coating material to a predominant position on the grounded part in order to attract the coating material, with the almost 100% theoretical efficiency as afforded by the above patents. In the above patents the normal field, as described therein, is about 100,000 volts. This high voltage is supplied because said patents require 14,000 to 15,000 volts minimum for emission or deposition, as explained hereinbefore, plus 14,000 to 15,000 volts for attraction and dispersion, as indicated by the invention herein, and the work of atomization, which is performed by ionization of air at the edge of the atomizing disc, can amount to 70,000 volts more or less depending upon the degree of atomization needed.
3. In U.S. Pat. No. 3,376,156 with the field at about 28,000 to 30,000 volts there is a very slight amount of ionization that takes place. This has no significant effect on atomization, as shown by the other hereinbefore mentioned patents, but it is enough to cause some difficulty with work pieces that have sharp edges and or recesses. The ionizing edges pull more finely atomized coating particles to their emission points than do the uniformly emitting flat or circular surfaces. By eliminating the 14,000 to

15,000 voltage required by U.S. Pat. No. 3,376,156, it is found that there are no ionizing edges whatsoever and the coating material is pulled uniformly by both flat surfaces and edges of the part. This allows a more dense coating material to be applied all over the surface of the part without runs and or tears at the edges. More coating material goes into corners and recesses uniformly because it is not overly attracted to the edges on its way in.

4. Over the years many companies have made conductivity meters to measure the conductivity of the coating material. These have helped in coating formulation to conteract to some extent the coating build-up on ioning edges. Since these ionizing edges are eliminated under the invention herein, there is no difference in coating quality, whether the coating is 1.5 megohms or 5.0 megohms.
5. The fact that the field under the invention herein is about 15,000 volts is a substantial improvement in safety conditions. Since the coating material is charged with only enough voltage to give it an opposite and uniform sign to that of the work piece, as low as one volt, it is evident that the operator can safely handle the atomizer and even the fluid hose itself.
6. Highly conductive paints, powders, aqueous solutions, etc., may thus, in the instant invention, be handled by the specially constructed atomizers with no danger whatever of voltage backing up to the coating container. In practice, the apparatus of this invention has been operated with about 100 volts, as well as 5,000 volts, on the coating material and showed no significant difference in coating operation or quality. It is not how much voltage, but how little voltage that is important in order to control the sign of the coating material, as to positive with relation to negatively charged part, or the reverse.
7. By inductively charging the part, as in U.S. Pat. No. 3,376,156, many spray booths may be operated with slightly different field voltages with one power supply operating all booths, and the several fields being controlled by different induction gaps. The high speed atomizer is the only mechanical method of getting particle size down to minimum where the extremely low field of 15,000 volts will attract with an efficiency approaching 100%.
8. The inductively charged work piece and the extremely successful high speed rotary atomizer with paint polarity (sign) being controlled in this invention, as opposed to putting a high voltage on the work piece via charging the atomizer head, is the main difference between this invention and U.S. Pat. No. 3,113,037. The latter patent eliminates the voltage required for deposition due to not using a grounded electrode, but requires more voltage to aid in atomization. This is because the rotary head squirts jets of paint that would not atomize to the degree necessary at a 15,000 volt field and therefore not be attracted with a high efficiency in view of the paint's higher particle size and weight.
9. U.S. Pat. No. 1,855,869 requires that the work piece have one charge while the atomizer places an opposite charge on the paint, the field being variable in order to prevent arcing between the work pieces being coated and the atomizer. Since atomization at the time of this patent was believed to be caused by air, nevertheless there exists an electrostatic influence on its atomization because the paint fluid is emitted into the field from the end of the fluid tube that acts as one electrode in the field. It will work at its maximum efficiency if only enough air is used to lift or venturi the liquid up the siphon tube to its forward edge and let the electrostatic field do the work of atomization, so that the less air involved the less forward velocity and turbulence given the fluid particles, the more efficiency.

U.S. Pat. No. 2,698,814 teaches that non-conductive work pieces have been semi-successfully coated with varying techniques, such as giving the pieces conductive backing or heating or wetting the article. On the contrary the instant invention readily coats non-conductive work pieces. U.S. Pat. No. 2,698,814 charges the atomizer one sign of high voltage and puts a rake shaped electrode with high voltage of the opposite sign behind the work piece. This is done to electrostatically atomize, disperse, and attract particles of paint to the non-conductive work piece. A principle fault with this patent was because of the detearing effect of the oppositely charged grid. The instant invention paints non-conductive work pieces perfectly and has no grids to detear and cause poor or inadequate coverage.

As far as applicant is aware, the invention herein is the only highly efficient system known that uses voltages below the ionization level in the coating field between the atomizer and the work piece. This invention has been installed and successfully operated in a commercial plastic coating application, with odd size and shape work pieces with a field voltage of 13,000 volts. The invention has been tested on powder, as well, and the main feature that happens with powder and paint, that is more easily seen with powder than with paint is:

With paint, as the voltage in the paint is increased, the dispersion is wider and is primarily seen as dryer paint on the work piece, since it is dispersed over a wider area.

With powder, the pattern can be raised in diameter from 4 to 16 or 20 inches by increasing voltage on the powder.

## BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention has been chosen for purposes of illustration and description and is shown in the accompanying drawing, forming a part of the specification, wherein:

FIG. 1 is a diagrammatic elevational view of a preferred form of spray painting apparatus according to the present invention.

Referring now to the drawing in detail, there is shown a spray gun **10** mounted on a supporting structure **11**, both of which are grounded. The spray gun **10** has mounted on its discharging end a disc **12** which is insulated from ground and therefore insulated from the spray gun, as by a plastic washer **13** separating the disc **12** from a grounded motor shaft **14**, a plastic shield **16** placed around an end portion **17** of the shaft **14**, and a grounded screw **18**, insulated from the disc **12**, for holding the disc onto the shaft **14**. The spray gun **10** is supplied by means of a plastic, non-conductive fluid

hose **19** with paint fluid or powder **20** from paint source (not shown). A valve **21** is provided for controlling paint flow and this valve is grounded, as shown. A metallic hose coupling **22**, preferably brass, is shown in the hose line and this coupling is energized, through induction, from an electrical conductor **23**, by a voltage of negative (−) polarity, the conductor **23** being connected to a negative (−) terminal **24** of a transformer **26**, the positive terminal (+) **27** of which is grounded by a conductor **28**.

As is conventional in paint spraying systems, an overhead conveyor **29**, similar to that described in U.S. Pat. No. 3,376,156 and shown here diagrammatically, has suspended therefrom, in seriatim, hooks **31**, insulator **32**, hooks **33** and a work piece **34**. The work piece in this instance may be of plastic or non-conductive material and is energized by induction from an electrical conductor **36** (in a manner similar to that in U.S. Pat. No. 3,376,156) having a voltage of positive (+) polarity and being connected to a positive (+) terminal **37** of a transformer **38**, the negative (−) terminal **39** of which is grounded by the conductor **28**, which was also used in grounding the negative (−) terminal **27** of the transformer **26**. It has been found taht the voltage at the transformer **38** need be no greater than 28,000 volts and that the induced voltage upon the work piece about 15,000 volts. Also, it has been found that the voltage at the transformer **26** need be no greater than 5,000 volts and that the induced voltage upon the paint material **20** may be as low as 1 volt. Further the distance between the work piece **34** and disc **12** is about 10 inches.

In operation, the spray gun **10** being at ground potential and the paint particles **20** being at a negative (−) potential, since the disc **12** is insulated from the spray gun **10**, the paint particles **20** are ejected from the atomizer disc **12** and across the path of the work piece **34**. It is to be noted that the electrostatic field developed around the work piece **34** is below ionization. As a result, regardless of the shape of the work piece **34**, whether angular with sharp corners, round and smooth, or flat, the coating of the work piece **34** is accomplished in an even thickness and most efficient manner, uniformly covering all surfaces including front, back and sides. As explained hereinbefore, the reduced voltage of about 14,000 volts at the work piece **34** is too low to cause ionization with the unforeseen result that attraction of the paint particles to the work piece **34** coats all surfaces thereof evenly.

From the foregoing description, it will be seen that the present invention provides an efficient sub-ionization spray coating system which uniformly coats all surfaces of a work piece, especially those work pieces having sharp edges. It is to be noted that each of the three factors, namely, atomization, dispersion and attraction, used in coating the work piece of this invention is independently controlled. The atomization of the coating particles is controlled by the speed of the disc **12**, that is, the greater the speed the greater the attraction. Dispersion of the coating particles is controlled by the voltage applied at the field shown as X on the drawing, that is, between the disc **12** and the spray gun screw **18**, the dispersion increasing as the voltage is increased at the hose coupling **22** by bringing the end of wire **23** closer to the coupling. Attraction is controlled by the voltage inductively applied to the work piece **34** and producing the field Y shown on the drawing, that is, between the work piece **34** and the spray gun screw **18**, the attraction increasing as the voltage is increased.

As various changes may be made in the form, construction and arrangement of the parts herein, without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matters are to be interpreted as illustrative and not in any limiting sense.

What is claimed is:

**1.** A sub-ionization spray coating system comprising, in combination, a grounded spray gun, a disc rotated by said spray gun for atomizing coating material, means for insulating said disc from said spray gun, a non-conductive hose for supplying said coating material to said disc, means for applying inductively a voltage of one polarity to said coating material while in said hose, whereby said coating material voltage is imparted to said disc to create an electrostatic field between said disc and said spray gun upon discharge of said coating material from said spray gun, a work piece to be coated with said coating material, and means for applying inductively a voltage of opposite polarity to said work piece, whereby an electrostatic field is created between said work piece and said spray gun.

**2.** A sub-ionization spray coating system in accordance with claim **1**, wherein said means for applying an inductive voltage of said one polarity to said coating material includes a transformer having a terminal for said one polarity, a hose coupling attached to said hose, and a conductor having one end connected to said transformer terminal and having its other end disposed at a predetermined distance from said coupling to inductively impart the desired voltage to said coupling and in turn to said coating material within said hose.

**3.** A sub-ionization spray coating system in accordance with claim **2**, wherein said inductively applied voltage to said coupling and coating material is less than 1,000 volts.

**4.** A sub-ionization spray coating system in accordance with claim **2**, wherein said means for applying inductively a voltage of opposite polarity to said work piece includes a transformer having a terminal for said opposite polarity, and a conductor having one end connected to said transformer opposite polarity terminal and its other end disposed at a predetermined distance from said work piece to inductively impart the desired voltage to said work piece.

**5.** A sub-ionization spray coating system in accordance with claim **4**, wherein said inductively applied voltage to said work piece is less than 15,000 volts.

**6.** A sub-ionization spray coating system in accordance with claim **5**, wherein said inductively applied voltage to said coupling and coating material is less than 1,000 volts.

**7.** A sub-ionization spray coating system in accordance with claim **6**, wherein said coating material is non-conductive.

**8.** A sub-ionization spray coating system in accordance with claim **7**, wherein said work piece is non-conductive.

**9.** A sub-ionization spray coating system in accordance with claim **6**, wherein said coating material and said work piece are conductive.

**10.** A sub-ionization spray coating system in accordance with claim **9**, wherein each of said transformers has a second terminal, and a grounded conductor interconnecting said second transformer terminals.

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