April 3, 1951 F. D. MITCHELL ET AL 2,547,405

HERMETICALLY SEALED RESISTOR

Filed June 7, 1945

Fig. 1.

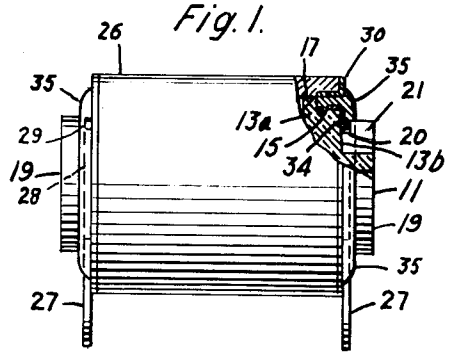


Fig. 2.

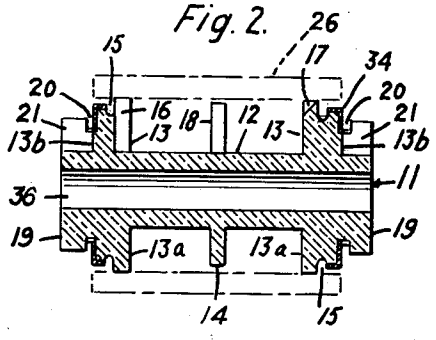


Fig. 3.

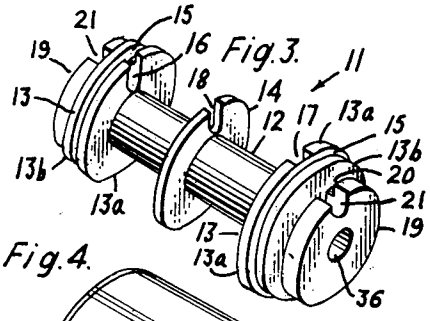


Fig. 4.

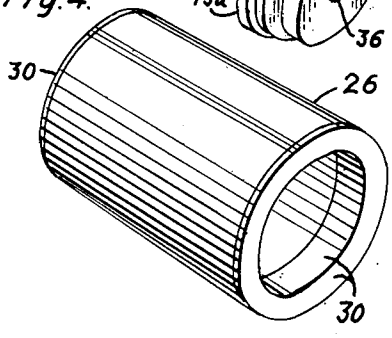


Fig. 5.

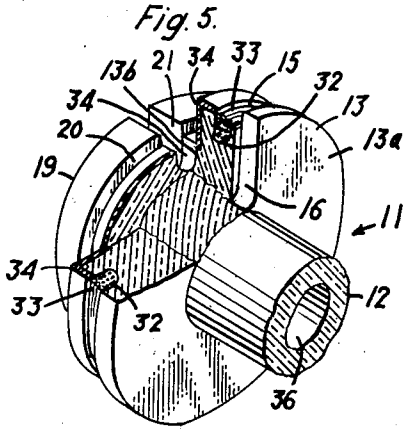


Fig. 6.

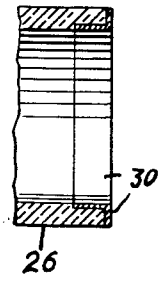


Fig. 7.

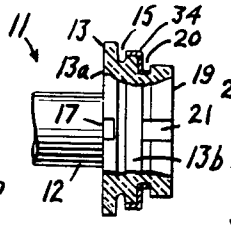


Fig. 8

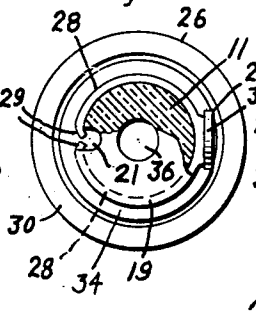
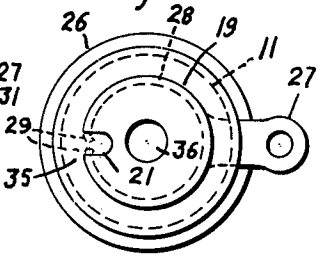


Fig. 9.



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HERMETICALLY SEALED RESISTOR

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16 Claims. (Cl. 201—67)

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The present invention relates to method and means for hermetically sealing electrical units such as resistors, condensers, and coils. The principles of the invention will be described in connection with resistors, by way of example.

In electrical units, such as resistors, intended for installation and use in electrical apparatus, radio, electrical measuring instruments, testing equipment, and the like, a high degree of precision and accuracy is required to be maintained under many and varied conditions of service, and the electrical characteristics thereof are readily disturbed by conditions of high humidity, moisture, extremes of temperature, and vibrations. Various attempts have been made to protect resistors from leakage losses, but such arrangements as have come to our knowledge are fragile and bulky, or require undesirable manufacturing processes, or special mountings, and do not protect the resistors otherwise.

It is one object of our invention to provide a hermetically sealed resistor, or other electrical unit, the functioning of which is unaffected by humidity and moisture, wide temperature variations, vibrations and rough handling.

Other objects of our invention are to provide a method of manufacture of hermetically sealed resistors, and the like, which is capable of use in mass production methods, and may be used with wire wound resistors of either the multiple layer or the single layer type.

Further objects of our invention are to provide unitary hermetically sealed resistors, and the like, in which the connecting wire portion does not extend outside the seal and no external circuit connection extends inwardly beyond the seal; and wherein means may be provided to prevent the deleterious effects of the products of decomposition within the hermetically sealed unit.

Still further objects of our invention are to provide hermetically sealed units which may be mounted in a very simple manner, in fact in the same manner as unsealed resistors and the like now being marketed, and likewise one in which normal or usual terminal connection arrangements may be used.

Other objects and features of our invention by which we have produced a hermetically sealed electrical unit that is efficient and durable will be understood from this specification taken in conjunction with the accompanying drawings, wherein—

Figure 1 is an elevational view of an assembled, hermetically sealed resistor, equipped with terminal lugs, parts being broken away to facilitate the illustration;

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Fig. 2 is a central sectional view of the winding bobbin;

Fig. 3 is a perspective view of the winding bobbin;

Fig. 4 is a perspective view of the covering sleeve;

Fig. 5 is a fragmentary detail in perspective of the starting end of the bobbin; and

Figs. 6, 7, 8 and 9 are fragmentary views of one end of the resistor, illustrating structure and steps in sealing the resistor.

In the drawings, the parts are shown enlarged for convenience and clarity in illustration.

It will be understood that the illustration and description of the principles of this invention in connection with wire wound resistors is by way of example only, the disclosure nevertheless being of the best mode of practicing the invention insofar as the same is known to us.

In carrying out our invention as illustrated, a bobbin for the resistance wire has closed ends fitting inside a sleeve the internal diameter of which is substantially the same as the external diameter of said ends. Adjacent portions of the ends of the sleeve and bobbin are provided with metallized surfaces and in the sealing operations these metallized portions are joined together by means of solder. The construction is such that no part of the resistance wire is brought to the outside of the unit, and no part of the connecting terminal or mounting arrangement extends inside the sealed unit. In the sealing operations a partial vacuum is created inside the unit and provisions are made whereby this vacuum may be preserved.

Referring to the drawings, in wire wound resistors, resistance wire of suitable size for the desired selected value is wound upon a bobbin 11 comprising a core 12 and end discs or "flanges" 13. In the multiple winding type one or more intermediate discs or "flanges" 14, preferably of less diameter than the end discs, are distributed along the core 12. The end discs are alike and comprise inner and outer sections 13A and 13B separated by a shallow circumferential groove 15. The inner sections 13A are slightly larger in diameter than the outer sections 13B for purposes hereinafter described. At the end of the bobbin where the winding is started, the inner section is provided with a radial slot 16 extending to the core and opening inwardly. At the opposite or finish end the inner section of the end disc has a short tapered slot 17 which also

opens inwardly. The intermediate discs 14, where used, also are provided with a radial slot 18.

Extending outwardly from each end disc is an extension or head 19, of reduced diameter, and joined to the disc section 13B by the undercut throat 20. The heads 19 and throats 20 are each provided with a radial groove 21.

The bobbin, except for the protruding heads 19, is, in final assembly, enclosed by the cylindrical shell 26. As will be seen from Fig. 2, the internal diameter of the shell is substantially the same as that of the sections 13A of the end discs, and the ends of the shell are aligned with the outer surfaces of the sections 13B of the end discs. In the assembled position, therefore, the only points of support between the bobbin and shell are the end disc sections 13A until the bobbin and shell are sealed together, as will be described.

The resistor carries terminal lugs 27 which are fastened at each end of the bobbin. The terminal lugs are alike, each having a pair of legs 28 at one end thereof and arranged to be received in the throat 20, as seen in Fig. 8. The free ends of the legs 28 are turned inwardly into the groove 21, as indicated at 29, to clamp the lug in place. At the start of the assembly operation the lugs are bent outwardly, as indicated at 31. (Fig. 8.)

Before starting winding of the resistor, a few turns of one end of the wire are laid in the groove 15, this portion having been stripped of all insulation. The resistance wire is usually extremely small in diameter, and to facilitate the obtaining of a good mechanical and electrical connection, it is usual to wrap a few turns of a heavier wire in the groove so as to overlie the turns of resistance wire therein. This arrangement is seen in Fig. 5, the resistance wire being indicated at 32 and the overlying bonding wire at 33. The groove 15 is then substantially filled with solder, but care is taken, according to our construction, to leave no protruding ends of the resistance wire or of the heavier bonding wire. The resistance wire 32 is usually enamel covered, and the wire, so covered, is brought from the groove 15, through the radial slot 16 to the core 12. Thereafter the wire is wrapped upon the core between the portions 13A and 14, in proper amount according to the particular selected value. The resistance wire is then extended from the first coil through the radial slot 18 in the intermediate disc 14, and a second coil is wound upon the bobbin between the disc 14 and the opposite end portion 13A. Usually, but not necessarily, these windings are in reverse directions so as to reduce or eliminate inductive effects therebetween.

When the required length of wire has been wound upon the bobbin, the wire is passed through the groove 17 and a few turns thereof are wrapped around the groove 15 in that end disc, but the wire is not sealed therein at this stage. To insure accuracy of the resistor, the same may be properly aged at temperatures high enough to relieve any mechanical and other stresses which might have been set up during the winding process. This aging is usually carried out from 24 to 48 hours at temperatures from 120° C. to 130° C. After the aging, the resistor is calibrated and adjusted, following which a few turns of the resistor wire, stripped of insulation, are wrapped in the groove 15 at the finish end of the bobbin, and bonded in place as heretofore described for the starting end, viz., by wrapping heavier bonding wire thereover and soldering, again exercising care that no end of the bonding wire or resistor wire protrudes outside the groove.

The bobbin 11 and the shell 26 are preferably formed of a suitable ceramic material, such as steatite, and the outer surfaces of the shell and bobbin may be glazed.

The structure and method of hermetic sealing the unit will now be described. As indicated in Figs. 6 to 8, the groove 15, the perimeter and outer flat surface of the end section 13B and the throat 20, including that portion of the groove 21 which extends into the throat 20, are all provided with a metallized coating 34. Any suitable metallized coating may be used, one which we have found satisfactory consisting of an electro-deposited layer of silver over which is plated a layer of copper and over which is an outer layer of tin. Each edge of the cylinder is provided with a similar metallized coating, indicated by the cross hatching in Fig. 6. The metallized coating is continued on the interior surface of the cylinder to form a band 30 at each end of the shell, which bands are at least as wide as the area of the perimeter of the end disc 13B plus the groove 15. When the shell 26 is mounted in place on the bobbin, the coating on the edge portions thereof is flush with the metallized coating on the flat portion of the adjacent end disc 13B, this relationship being suggested in Fig. 2. It will be understood that in all instances the metallized coatings are shown in exaggerated proportions in the drawings, for the sake of clarity.

To accomplish the hermetic sealing, the following procedure has been found effective: the ceramic shell 26 is fitted over the bobbin 11 as indicated in Fig. 2, and the metallized coatings at one end of the bobbin and shell are soldered together, the solder 35 (Fig. 1) being flowed into the annular joint between the end disc 13B and the shell 26, and the protruding portion 13A forming a barrier to the further passage of the solder into the interior of the unit. The solder also covers all the end of the assembly, except the head 19, and is flowed into the throat 20 and its groove 21, and over the now straightened lug 27, as illustrated in Fig. 9.

With one end of the resistor unit thus completely sealed, the unit is heated in an oven for a period of approximately one hour at a temperature of the order of 105° C. to drive moisture and gases from the interior of the unit through the unsealed end of the unit. At the end of this baking or heating step, and while the unit is still hot, the unsealed end is sealed in the same manner as described above for the opposite end, namely, the two metallized coatings being bonded together and the solder flowed over the end flat surfaces and lug and into the throat 20. The unit is then allowed to air cool in the open room, and when the unit has reached room temperature it is subjected to final test and checking. The vacuum created in these final heating and cooling steps is preserved by the sealing, and the vacuum tends to draw the solder further into the joint between the end disc and the shell at the finish end.

From the foregoing description it will be seen that a rigid, unitary construction is produced and wherein no part of the resistor wire or its connecting lead is brought outside the unit and no part of the external connecting terminal extends inside the unit. Instead, the electrical circuit

connection therebetween is made through the sealing material.

The finished resistor unit may be mounted by any suitable means, the form described allowing the use of a clamp about the shell; or a central hole **36**, extending entirely through the bobbin, may be provided for mounting purposes.

Certain other optional and alternate matters and arrangements may be noted here. For example, before any winding is put on the bobbin, all the interior surfaces thereof may be coated with a suitable protective lacquer which may or may not be of the thermosetting type. The glazed outer surface of the shell, useful in reducing the formation of a leakage path between the ends of the shell and the terminals especially under conditions of high humidity, may be replaced by a coating of a moisture proof, fungus resisting substance such as a thermo-plastic organic resinous compound containing a fungicide.

Furthermore, the enamel coating on the wire apparently is subject to deterioration and decomposition under some conditions of use, notwithstanding the hermetic sealing of the resistor, and the result is failure of the resistor. It has not been determined whether or not this is the source of gases and volatile decomposition products, but if present, these may be desirably and effectively absorbed by the use of a suitable absorbent material, such as powdered activated charcoal. This charcoal may be put inside the resistor in any suitable manner. For example, it may be incorporated in a lacquer vehicle. Strips or bands thereof may be painted on the interior of the shell **27** before assembly thereof, and it is desirable to have the same opposite each section of the resistor as they are defined by the one or more intermediate discs **14**.

While reference has been made above to the use of a bobbin and shell of steatite and the particular metallized coating bonded thereto, it will be understood that other materials may be used throughout, in which event the times and conditions of the steps in the method of hermetically sealing will be correspondingly varied, as will be understood. Also, differences in size of the unit will necessitate variations in the times of treatment.

The above description and illustration have been made in connection with one type of wire wound resistor but the principles set forth are applicable to the other types of wire wound resistors, as will be apparent to those acquainted with this industry. It is also obvious that with the construction described above other methods and means may be used for sealing the unit.

We claim:

1. A hermetically sealed resistor unit comprising a ceramic bobbin having a pair of end discs, metallized coating bonded to the ceramic material about at least a portion of the perimeter of each end disc, resistor wire carried by said bobbin, the ends of said wire terminating at and being secured to said metallized coatings respectively, a ceramic shell in which the bobbin is enclosed, the shell having bands of metallized coating in position to and of a size to cooperate with the coated portions of said end discs, and the metallized coatings of the end discs and shell being joined by solder so as to entirely seal the respective joints between the shell and the end discs of the bobbin and also establish electrical connections with the ends of said resistor wire.

2. A hermetically sealed resistor unit comprising a ceramic bobbin having a pair of end discs, metallized coating bonded to the ceramic material about at least a portion of the perimeter of each end disc, resistor wire carried by said bobbin, the ends of said wire terminating at and being secured to said metallized coatings respectively, a ceramic shell in which the bobbin is enclosed, the shell having bands of metallized coating in position to and of a size to cooperate with the coated portions of said end discs, the metallized coatings of the end discs and shell being joined by solder so as to entirely seal the respective joints between the shell and the end discs of the bobbin and also establish electrical connections with the ends of said resistor wire, the solder extending from said joints externally of the sealed unit, and terminal lugs mounted on said unit and electrically connected to said solder externally of the sealed unit.

3. A hermetically sealed resistor unit comprising a ceramic bobbin having a pair of end discs, metallized coating bonded to the ceramic material about at least a portion of the perimeter of each end disc and externally thereof, resistor wire carried by said bobbin, electrical connectors from said wire and terminating at and being secured to said metallized coatings respectively, a ceramic shell in which the bobbin is enclosed, the shell having bands of metallized coating in position to and of a size to cooperate with the coated portions of said end discs, and a portion of the shell coating extending externally of the assembled bobbin and shell, the metallized coatings of the end discs and shell being sealed together so as to entirely close the respective joints between the shell and the end discs of the bobbin and with said connectors inside the sealed portion so that the metallized coatings form part of the electrical circuit, and terminal lugs mounted on said unit and electrically connected to the metallized coatings externally of the sealed unit.

4. A hermetically sealed resistor unit comprising a ceramic bobbin having a pair of end discs, metallized coating bonded to the ceramic material about at least a portion of the perimeter of each end disc, the portions of the bobbin between said end discs having a protective coating, resistor wire carried by said bobbin, electrical connectors from said wire and terminating at and being secured to said metallized coatings respectively, a ceramic shell in which the bobbin is enclosed, the shell having bands of metallized coating in position to and of a size to cooperate with the coated portions of said end discs, the metallized coatings of the end discs and shell being sealed together so as to entirely close the respective joints between the shell and the end discs of the bobbin and also establish electrical connections with said connectors, terminal lugs mounted on said unit and electrically connected to the sealed metallized coatings externally of the sealed unit, and a protective coating over the exterior of the shell between the ends thereof.

5. A hermetically sealed resistor unit comprising a member carrying the resistance element and having a pair of end discs, metallized coating bonded to and about at least a portion of the perimeter of each end disc, electrical connectors from said element and terminating at said metallized coatings respectively, a shell in which the member and end discs are enclosed, the shell having bands of metallized coating in position to and of a size to cooperate with the coated portions of said end discs, the metallized coatings of the

end discs and shell being sealed together so as to entirely close the respective joints between the shell and the end discs and also establish electrical connections with said connectors, terminal lugs mounted on said unit and electrically connected to the sealed metallized coatings externally of the sealed unit, and protective coatings applied over the interior and exterior portions of the unit between the ends thereof.

6. A hermetically sealed resistor unit comprising a member carrying the resistance element and having a pair of end discs, metallized coating bonded to and about at least a portion of the perimeter of each end disc, electrical connectors from said element and terminating at said metallized coatings respectively, a shell in which the member and end discs are enclosed, the shell having bands of metallized coating in position to and of a size to cooperate with the coated portions of said end discs, the metallized coating of the end discs and shell being sealed together so as to entirely close the respective joints between the shell and the end discs and also establish electrical connections with said connectors.

7. A hermetically sealed electrical unit comprising a mounting member for the unit and having a pair of end discs, metallized coating bonded about at least a portion of the perimeter of each end disc, electrical connectors extending from the unit and terminating at said metallized coatings respectively, a shell in which the mounting member and end discs are enclosed, the shell having on the interior thereof bands of metallized coating in position to and of a size to cooperate with the coated portions of said end discs, the metallized coatings of the end discs and shell being sealed together so as to entirely close the respective joints between the assembled shell and end discs and also establish electrical connections with said connectors.

8. A hermetically sealed electrical unit comprising a mounting member for the unit and having a pair of end discs, metallized coating bonded to and about at least a portion of the perimeter of each end disc, a shell in which the mounting member and end discs are enclosed, the shell having on the interior thereof bands of metallized coating in position to and of a size to cooperate with the coated portions of said end discs, the metallized coatings of the end discs and shell being sealed together so as to entirely close the joints between the shell and the end discs.

9. The method of hermetically sealing an electrical resistor unit comprising a mounting member having end discs provided with metallized coatings bonded thereon and a cooperating enclosing shell with complementary metallized coatings thereon, which consists in first soldering together the metallized coatings of one of the end discs and shell, then baking the unit to expel the moisture and other vapors through the unsoldered end and to dry the air on the interior of the shell, and before the unit cools soldering together the complementary metallized coatings at the opposite end of the unit so as to completely close the same.

10. In a hermetically sealed resistor, a bobbin having a pair of end discs respectively provided with circumferential grooves, heads of reduced diameter extending outwardly from said end discs and joined thereto by means of an undercut throat, a metallized coating over each end disc of the bobbin, said coating being applied in the circumferential grooves and throats as well as over at least a portion of the perimeter of the end discs and the outer flat faces thereof, resistance wire wound upon said bobbin and having the ends thereof received in and terminating in said circumferential grooves respectively and soldered to the metallized coating therein, a cylindrical shell enclosing said bobbin and having bands of metallized coating on the edge portions thereof and internally of the shell, the shell and bobbin being of a size that when assembled together the metallized coatings of the end discs and shell are adjacent each other, terminal lugs secured in each of the respective throats, the respective sets of metallized coatings being soldered together in a manner to completely close the joints therebetween, the layer of solder extending across the end discs and into the throats so as to form continuous mechanical and electrical connections between the terminal lugs and the resistance wire through the metallized coating.

11. In an hermetically sealed resistor, a bobbin having a pair of end discs and one or more intermediate discs of less diameter, a head also of reduced diameter extending outwardly from each of said end discs and joined thereto by means of an undercut throat, a plurality of windings of resistance wire upon said bobbin, a shell enclosing said bobbin and end discs, the shell and bobbin being of a size respectively that only a narrow gap exists between the peripheries of the end discs and the shell, and means for sealing together the end discs and shell to close the space within said shell, with the heads and throats outside the sealed space.

12. An hermetically sealed electrical unit comprising a mounting member for the unit and having a pair of end discs, metallized coating bonded about at least a portion of the perimeter of each end disc, electrical connectors extending from the unit and terminating at one end at said metallized coatings respectively, a shell in which the mounting member and end discs are enclosed, the shell having on the interior thereof bands of metallized coating in position to and of a size to cooperate with the coated portions of said end discs, the metallized coatings of the end discs and shell being sealed together so as to entirely close the respective joints between the assembled shell and end discs and in electrical circuit connection with said connectors, and an absorbent material for gases within the enclosed space.

13. An hermetically sealed resistor unit comprising a hollow bobbin having a pair of end discs respectively provided with a peripheral groove, resistor wire mounted upon said bobbin and having end lengths thereof located in said grooves, electrical connector elements engaging said end lengths in said grooves respectively and extending outwardly in said grooves, a metallized coating on each of said end discs and engaging the respective electrical connector elements, a shell enclosing the bobbin and provided with metallized coating in position to cooperate with the coated portions of said end discs, and means for sealing together the metallized coatings of the end discs and shell so as to completely enclose the bobbin and the grooved portions of its end discs in the shell, the sealed area being defined by the shell and the end discs.

14. An hermetically sealed resistor unit comprising a hollow bobbin having a pair of end discs respectively provided with a peripheral groove and an external head spaced from each disc, resistor wire mounted upon said bobbin and having end lengths thereof located in said grooves,

electrical connector elements engaging said end lengths in said grooves and extending outwardly in said grooves, a metallized coating on each of said end discs electrically engaging the respective connector elements and extending into said external spaces, a shell enclosing the bobbin and provided with metallized coatings in position to cooperate with the coated portions of said end discs, means for sealing together the metallized coatings of the end discs and shell so as to completely enclose the bobbin and the grooved portions of said end discs in the shell, and electrical terminal connections mounted in said spaces and connected to the projecting portions of the metallized coatings on said end discs.

15. A hermetically sealed electrical unit comprising a pair of discs, said unit being supported by said discs, metallized coating bonded about at least a portion of the perimeter of each disc, a shell in which said unit and discs are enclosed, said shell having on the interior thereof bands of metallized coating in position to and of a size to cooperate with the coated portions of said discs, the metallized coatings of the discs and shell being sealed together so as to close the joints between the shell and the discs, and electrical circuit connections from the enclosed unit and extending externally of said discs.

16. A hermetically sealed electrical unit comprising a pair of discs, said unit being located therebetween, metallized coating about at least a portion of the perimeter of each disc, a shell in which said unit and discs are enclosed, said shell having bands of metallized coating in position to and of a size to cooperate with the coated portions of said discs, the metallized coatings of the discs and shell being sealed together so as to close the joints between the shell and discs, and electrical circuit connections from the enclosed unit and extending externally of said discs.

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