Aug. 23, 1966 A. BILCO ETAL 3,267,774

COAXIAL CABLE STRIPPER

Filed Aug. 28, 1961 2 Sheets-Sheet 1

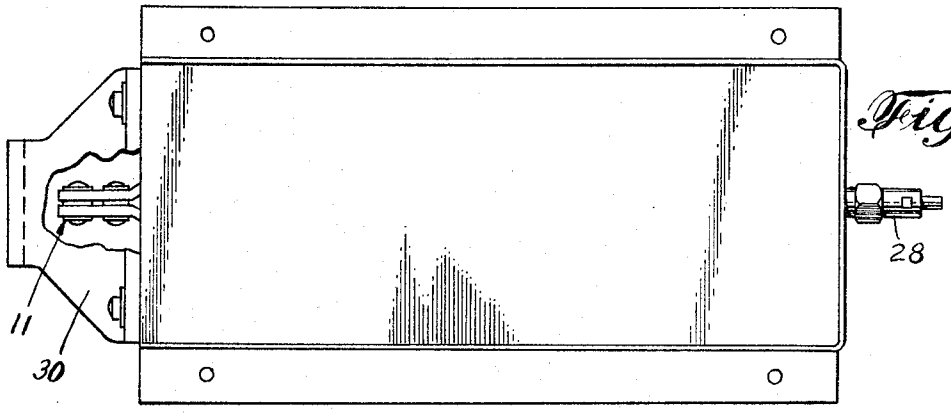


Fig. 1.

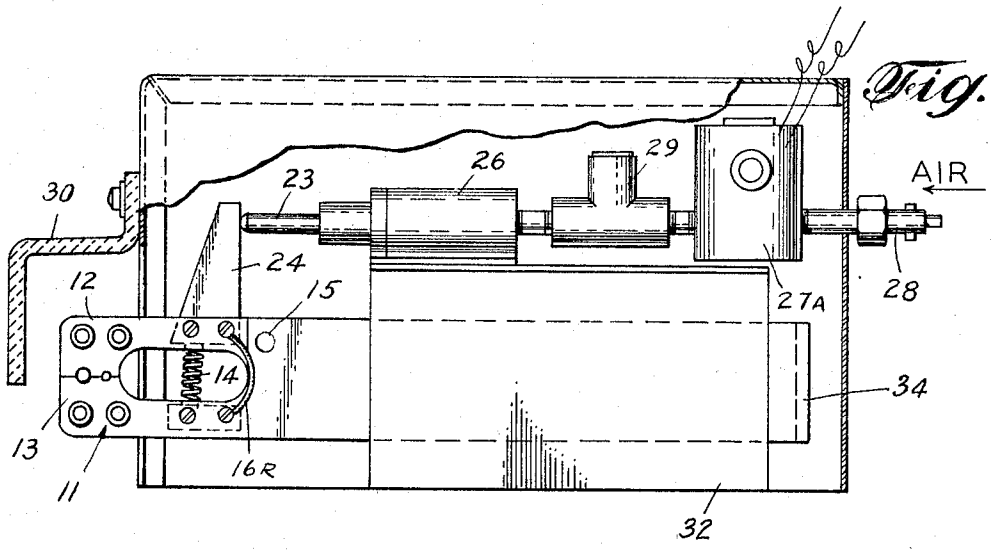


Fig. 2.

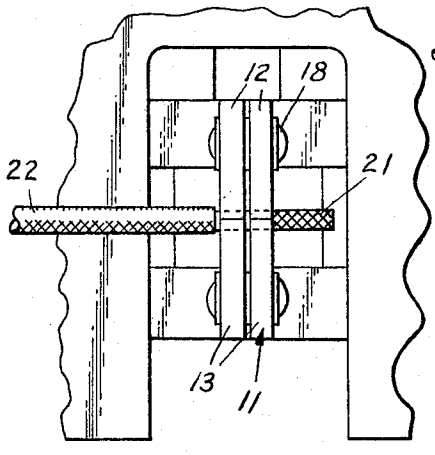


Fig. 3.

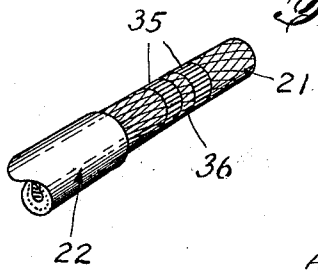


Fig. 4.

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COAXIAL CABLE STRIPPER

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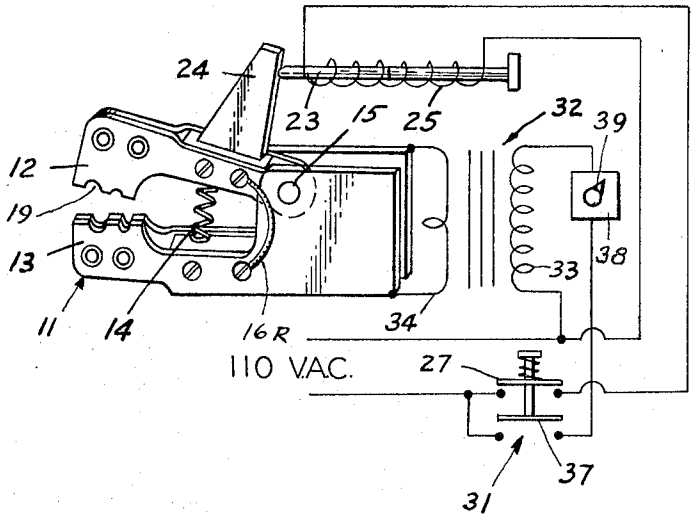


Fig. 5.

Fig. 6.

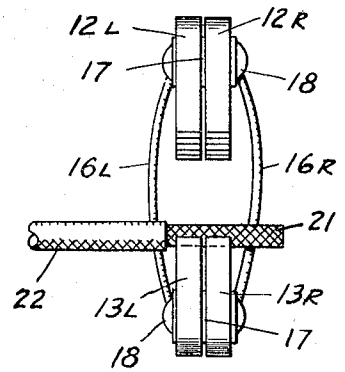


Fig. 7.

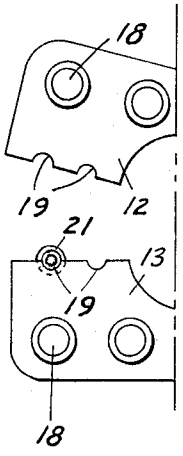
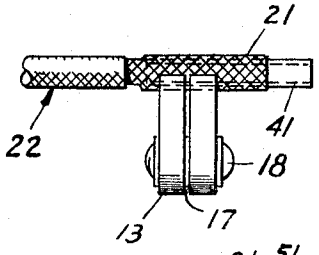


Fig. 8.



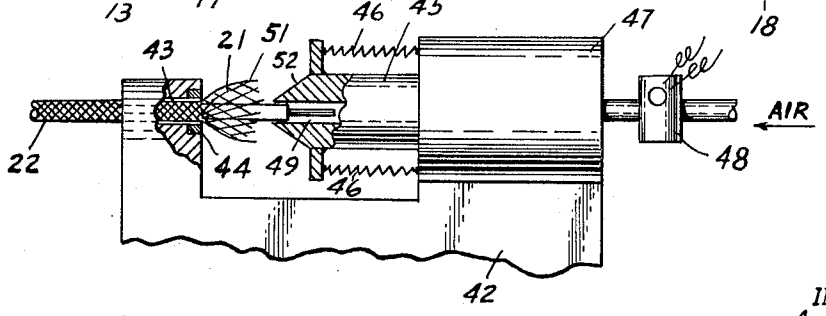


Fig. 9.

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COAXIAL CABLE STRIPPER

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15 Claims. (Cl. 81—9.51)

This invention relates to apparatus for and methods of treating electrical conductors, and more specifically to the art of stripping shielding from coaxial cable and the like.

It is common practice when connecting certain circuit components to use conductors having not only a layer of insulation protecting the conductor wire but also a shroud or shield enclosing the insulation, to electrostatically shield the conductor. Commonly also the shielding is protected from abrasion by an outer protective layer of a suitable plastic material, the entire assembly being known in the trade as coaxial cable.

The shielding sometimes comprises a single or multiple-wire coil or foil enclosure for the insulated conductor, but more frequently it comprises a tubular braid of relatively fine-gauge copper wires. When making a termination, it is customary to more completely electrically isolate the shield from the center conductor by removing a section of the braided material at the end of the conductor, an operation referred to commonly as stripping.

Because of the close proximity of the braid to the adjoining insulation material, it has long been a problem to strip the shielding in a neat and effective manner without injuring the subjacent insulating material, and without leaving objectionable stray wires, from the shield that create an electrical hazard. In the past it has not been uncommon to employ simple hand tools such as small shears to girdle the shielded conductor, a time-consuming and uneconomical method.

A principal object therefore of the present invention is to provide improved methods and apparatus for stripping tubular electrostatic shielding from an insulated conductor cable; to provide such methods and apparatus wherein the stripped shield is reinforced about its outer exposed edge to form a stronger terminus to the shielding and to preclude further unraveling of the wires, while also eliminating the physical hazard otherwise resulting when the fine sharp wire ends of the braid material are left exposed; and to provide in such methods and apparatus a provision for expanding or dilating the braided material to receive a subsequent insert commonly employed as a part of the terminating procedure. These and other objects of the invention will become more apparent from the ensuing description and from the appended drawings.

In the drawings,

FIG. 1 is a plan view of one form of apparatus that has been built and successfully employed in carrying out the objects of this invention, certain parts of a protective shield having been broken away for a more complete disclosure.

FIG. 2 is a longitudinal vertical sectional view of the apparatus of FIG. 1, with certain parts in elevation.

FIG. 3 is an enlarged detail view with the shield removed.

FIG. 4 is an enlarged perspective view of a coaxial cable termination with the outer insulating jacket partially removed, and illustrating the annular braided area in which the stripping action is to take place.

FIG. 5 is a diagrammatic view with certain of the electrical components shown schematically, illustrating a slightly variant form of apparatus for carrying out the invention.

FIG. 6 and FIG. 7 are front and side views respectively of portions of the jaws in the open position showing a coaxial conductor in position for stripping.

FIG. 8 is a front view of the lower jaw receiving a coaxial conductor, of which the shielding layer has been dilated prior to stripping, and

FIG. 9 is a diagrammatic view partly in section of apparatus incorporating slightly different operating means for carrying out the principles of the invention.

Generally speaking, the invention comprehends establishing an annular zone about a tubular braided or similar type shield, and severing the shield in one single operation at the annular zone mechanically or electrically. In one preferred form of the invention, the severing operation is accomplished by passing through the annular zone an electric current of sufficient intensity to melt and disintegrate a narrow circular section of the wires forming the shield, freeing the terminal section of the shield for removal. Optionally the braided shield material may be expanded or dilated to provide a slight increase in its diameter, thereby separating it from the insulation to provide thermal or mechanical isolation, to facilitate removal of the terminal portion, and at the same time to provide an intervening space for the subsequent possible insertion of a grounding bushing, as will appear.

Referring again to the drawings and more particularly to FIGS. 1, 2 and 3, one preferred form of the invention comprises a clamp **11** consisting mechanically of an upper jaw **12** and a lower jaw **13** normally moved to and held in an open position, as best seen in FIG. 5, in some suitable manner, typically by means of compression spring **14**, to release a shield following a stripping operation. The respective jaws may be arranged for relative movement in any conventional manner, though they are herein illustrated for pivotal movement about an axis **15**, with the lower jaws shown as rigidly supported, and the upper jaws movable.

Although the upper and lower jaws each operate as a unit, they comprise left segments **12L** and **13L** respectively, electrically connected one to the other as by means of a jumper **16L**, but electrically insulated from adjoining segments, **12R** and **13R** respectively, which in turn are mutually connected by means of jumper **16R**. The right and left sections of both the upper and lower jaws form two sets that are spaced apart a short distance as by means of an insulating washer **17**, shown in FIG. 6 as being held in position by means of insulated fasteners such as grommets **18**. If it should be found necessary or desirable to adjust the spacing between the left and right sections of each jaw, to adapt the apparatus to different operating conditions, the fasteners **18** may be made removable to receive washers of differing thickness.

Each of the jaws may be provided with one or more recesses or grooves **19** to receive and closely encompass the outside surface of a braided shield **21** of a conventional coaxial conductor or similar shielded wire **22**. Where the tubular shield is generally cylindrical in shape, it is common practice for the recesses **19** to be of semi-circular shape, of a size slightly to grip or constrict the braided shield at two places a close distance apart when the jaws are in the closed position shown in FIG. 3. The jaws of both sets may be controlled in unison in any conventional manner. One simple actuator, best seen in FIG. 2, comprises a normally retractable piston or rod **23**, normally engaging a projection **24** connected to the movable jaw **12** as best seen in FIGS. 2 and 5. The rod **23** may be actuated in any conventional manner, typically by means of a solenoid **25** as shown in FIG. 5 or by an air cylinder **26** as seen in FIG. 2. In either case the operation may be controlled as by a switch element **27** of a sequential switch **31** which may be used to control the solenoid **25** directly, or to operate a sole-

noid **25** directly, or to operate a solenoid valve **27A**, in turn regulating the flow of air from the input connection **28**. If desired a needle valve **29** may be employed to control the speed of the operation. A transparent shield **30** may partially cover the clamp **11**.

Low voltage with relatively high available current is applied to the left and right jaws respectively, preferably by regulatory means such as a switch element **37** of the sequential switch **31** which conducts electrical energy to the jaws after they have firmly closed from the open position diagrammatically illustrated in FIG. 5. Either direct or alternating current may be used, though in the present embodiment we disclose a transformer **32** suitably supported within a base or housing and preferably having a primary winding **33** which readily may be connected to a standard source of alternating current. The transformer has a low-voltage high current secondary winding **34** which in a typical case comprises a single turn. As illustrated in FIG. 2, the turn may comprise a bus bar partly encircling the iron core of the transformer and forming a part of its support, the terminals of which connect with the left and right jaws respectively, as diagrammatically shown in FIG. 5.

When the jaws are in closed position as shown in FIG. 3, the apertured jaws define axially separated annular or peripheral zones **35** about the shield **21** as best seen in FIG. 4, representing the areas contacted by the right and left electrodes respectively. The intervening peripheral zone **36** is of relatively short length as determined primarily by the thickness of the washer **17** and may be considered an elemental annulus of the tubular shield which is included in the portion of the circuit extending between the zones **35**. When a voltage is applied to the jaws, the zones **35** may be considered to be anodic and cathodic zones respectively, whether direct or alternating current is used. Current flowing to the zones **35** through the upper and lower jaws naturally passes through the intervening zone **36**, and being of adequate intensity, the current melts and disintegrates the intervening zone, completely isolating the two zones **35** by an intervening air gap. The length of the zone **36** measured along the axis is kept to a minimum sufficient nevertheless to preclude sparkling across the gap that is formed when the zone **36** disintegrates. The length of the zone **36** also determines to some extent the amount of metal which tends to fuse back along the exposed wires forming the braid. In some cases it is desirable that enough length exist between the zones **35** to allow an appreciable amount of metal to be melted back thereby fusing the tubular braid circumferentially into a rim, effectively precluding further unravelling of the braid.

The operation may best be seen by reference to FIGS. 5 and 6. A coaxial conductor **22** from which a short length of the outer cover previously has been removed, is laid across the lower jaws with the braided shield **21** nesting in the appropriate recesses **19**. The operator then depresses switch **31** which first operates to close the jaws through upper switch element **27**, and sequentially thereafter to apply current through switch element **37** from the energy source such as transformer **32**. The current in the secondary winding is interrupted upon the disintegration of the zone **36** and accordingly the device tends to shut itself off automatically during each cycle. It has been found desirable nevertheless to provide some measure of control over the line voltage, or over the amount of current passing thru the external circuit. A suitable regulator **38** with adjustment knob **39** may be interposed between the switch **31** and transformer **32** for such regulating purposes. In the simplest form, regulator **38** may comprise a variable resistance effective to reduce the applied voltage to transformer **32**, or if desired the regulator **38** may comprise a conventional adjustable timing device effective to meter the duration of the operating cycle. In a typical case, the transformer may have 100 primary turns, providing a 100 to 1 increase in the secondary current and a corresponding reduction in the voltage. In a typical case, the applied voltage may be of the order of several volts or less, while the current may well be over 100 amperes, according to the size of the shield and the size of wires employed in its manufacture.

In some instances it may be desirable to dilate the braided shield. For example, in certain instances following the stripping operation it may be required to insert a bushing between the shield and the insulation covering the central conductor. By radially expanding the shield prior to stripping a space for such a bushing automatically may be formed. One method that has been employed successfully for dilating the shield is illustrated in FIG. 8 wherein a tubular dilator or arbor **41**, preferably with tapered leading edge is inserted manually inside the shielding causing the shield to shrink back moderately in length as the diameter increases. The dilator **41** successfully has been formed of a heat resistant insulating material, typically of Poly-tetra-fluorethylene. Dilation offers the additional advantage of thermally insulating the underlying material from the effect of the heat generated during the operation. In many instances the insulating material covering the wire is formed of a thermo-plastic material and the use of a fixed or manually insertable dilator **41** accordingly affords protection to the material from the overheating effects of the fused metal. Also a dilated shield provides additional clearance between the braid and the wire insulation which facilitates the removal of the terminal section of the braided shield following the stripping operation, and reduces the possibility of mechanically or thermally damaging the subjacent insulating material. Since the severed ends are quite completely fused together into a reinforced edge about an enlarged periphery, the dilated condition of the shield is preserved even when the dilator **41** is removed, not only at the rim where the cutting and fusion occurs, but to a greater extent also over the length of shielding previously affected by the dilator. The generation of the annular space between the insulation material and the shield, the reinforcing of the terminal rim of the shield by the fusion action, and the absence of the customary random projecting individual braid wires favors the subsequent insertion of a grounding sleeve or bushing commonly employed in the space originally occupied by the dilator.

An alternate means for dilating the braided shield is illustrated in FIG. 9 which shows also an alternate form of apparatus for performing the stripping operation. A frame **42** comprises a tubular guide **43** for receiving a coaxial cable **22**. An annular shearing die **44** is located at the free end of the guide **43**. Concentrically aligned with the guide and movable axially in relation thereto is a plunger **45** having means for returning it to one end of its stroke, diagrammatically illustrated as a pair of expansion springs **46**. A cylinder **47** having a supply of air or other fluid under pressure, as controlled by a solenoid valve **48**, is operable to force the plunger **45** in the direction of the shear die **44**. A cavity **49** within the plunger and aligned with the guide **43**, receives the projecting end of the cable **22**, and communicates with the compressed air supply.

In operation, the device of FIG. 9 forces air or other fluid through the cavity **49** under significant pressure against the inner periphery of the shield causing the shield to dilate into an expanded annular section **51**, and thereby increasing the area within the shield exposed to the air jet. Air under pressure may be directed separately from the air supply or may be bled from the cylinder **47**. Meanwhile the plunger **45** is forced outwardly from the cylinder **47**, beyond the mid-stroke position illustrated, preferably at a controlled rate, until a leading hardened conical edge **52** thereof engages the inner periphery of the shield and opposes the outer die **44**, constricting or crushing the braided wires **21** of the expanded section **51**, hence shearing the braid about an annular zone corre-

sponding in diameter to the inside diameter of the die 44. Upon completing the shearing operation, the plunger 45 is returned to its original position within the cylinder 47, and the cable 22 which had been held in operating position may be removed.

Various modifications may be made to the herein disclosed apparatus without departing from the spirit of the invention or sacrificing its advantages as we contemplate any methods or apparatus properly within the scope of the appended claims.

We claim:

1. A method of stripping a tubular electrostatic shield from a wire having a central conductor and an insulating wire covering within said shield, said method comprising dilating a portion of said shield to isolate said shield from said covering forming a circuit of an elemental annulus of said dilated tubular shield, and passing through said annulus electric current of sufficient magnitude to melt and disintegrate said annulus.

2. A method of stripping a braided tubular wire shield from a coaxial conductor, comprising radially expanding said shield to increase its diameter, severing said shield about an annular zone in the region of such increased diameter, and concurrently fusing the exposed wire ends of said expanded shield into a reinforced rim.

3. A method of stripping a braided tubular shield from a coaxial conductor, comprising isolating said shield from said conductor by increasing the normal diameter of a portion of said shield, and resistance heating said shield electrically so as to melt through said shield about an annular zone in the region of such increased diameter.

4. A method of stripping a braided tubular shield from an electrical wire having a conductor and an insulating cover between said conductor and said shield, said method comprising thermally isolating said cover from said shield in the region to be stripped, forming a circuit of an elemental annulus of said tubular shield, and passing through said annulus electric current of sufficient intensity to melt and disintegrate said annulus.

5. A method of stripping a tubular electrostatic shield from a wire having a central conductor and an insulated wire covering within said shield, said method comprising dilating said shield to isolate said shield from said covering forming axially-separated substantially annular anodic and cathodic zones of said shield, thereby defining an intervening annulus of said tubular shield, and passing through said annulus between said zones electric current of sufficient intensity to melt and disintegrate said annulus.

6. A method of stripping a section of braided tubular shield from the end of a coaxial cable having a central conductor and an insulating cover between said conductor and said shield, said method comprising directing a fluid jet in a generally axial direction against said end of said cable principally within the inner periphery of said shield so as to flare the open end of said shield, thereby increasing the annular area between said inner periphery and said central conductor exposed to said jet, and severing said shield about an annular zone of said dilated section.

7. Apparatus for stripping a section of braided tubular shield from the end of a coaxial cable having a central conductor and insulating cover between said conductor and said shield, said apparatus comprising means for directing an air jet substantially coaxially against said end of said cable for dilating said section of said shield, and severing means comprising a die surrounding said braided shield adjacent to said section, and including a member movable within said dilated section for constricting a single wall section of said shield between said die and said member, so as to sever said shield about an annular zone of said dilated section.

8. Apparatus for stripping a section of tubular shield from the end of a coaxial cable, comprising axially separated electrodes, electrode-positioning means for effecting engagement of said electrodes about mutually-separated annular zones of said tubular shield, and regulatory means conditioned upon the operation of said electrode-positioning means for controlling the passage of electric current between said electrodes and through an intervening annular area of said shield, to sever said shield about said area.

9. A method of stripping a braided tubular shield from an electrical wire having a conductor and an insulating layer between said conductor and said shield, said method comprising expanding said shield to thermally isolate said layer from said shield in the region to be stripped, and severing said braid in said region.

10. Method as claimed in claim 9 wherein said shield is expanded to form an enlarged portion for a substantial distance back from the severed edge, and wherein the exposed wires of said terminus are fused to maintain said portion of said shield in expanded condition following said severing operation.

11. A method of stripping a braided tubular shield from an insulated conductor, comprising radially expanding a portion of said shield to separate said portion from said insulated conductor, and connecting a pair of electrodes to said shield to melt through said shield about a peripheral zone in the region of such expanded portion.

12. A method of stripping a section of braided tubular shield from the end of a coaxial cable having a central conductor and an insulating layer between said conductor and said shield, said method comprising dilating said section of said shield enough to thermally isolate said section from such insulating layer, and severing said section from the remaining shield by connecting electrodes to said shield to melt through an annular zone of such dilated section.

13. A stripping machine comprising a base, a tubular arbor made of temperature resistant insulating material and adapted to fit inside the shielding of an object to be stripped and thereby expand said shielding, two sets of electrode jaws spaced apart a short distance, grooves in each of said electrode jaws dimensioned to fit the outside of shielding expanded by said arbor, said two sets of electrode jaws being thereby adapted to grip shielding expanded by said arbor at two places a short distance apart, one electrode jaw of each set being rigidly mounted on said base, another electrode jaw of each set being movably supported by said base, and means mounted on said base for shifting said movably supported electrode jaws of both sets in unison to two alternative positions in one of which the electrode jaws of both sets are closed to grip shielding expanded by said arbor and in the other of which positions the electrode jaws of both sets are opened to release shielding expanded by said arbor.

14. A method of stripping a braided tubular wire shield from an electrical wire having a conductor and an insulating layer between said conductor and said shield, said method comprising expanding said shield to thermally isolate said layer from said shield in the region to be stripped, severing said braid annularly in said region, and reinforcing the enlarged exposed outer edge of said shield so as to strengthen the edge for subsequent terminating operations.

15. Method as claimed in claim 14 wherein said reinforcing step comprises fusing the exposed wire ends at the terminus of said expanded shield to form an enlarged strengthened circumferential rim.

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