

[72] Inventor **Donald F. Zeidhack**
Portland, Oreg.
[21] Appl. No. **836,693**
[22] Filed **June 26, 1969**
[45] Patented **July 20, 1971**
[73] Assignee **Tektronix, Inc.**
Beaverton, Oreg.

FOREIGN PATENTS

625,018	3/1963	Belgium	174/107
159,553	2/1940	Germany	174/36

OTHER REFERENCES

"New Products," *ELECTRONICS WORLD*, Vol. 72, No. 5 Nov. 1964, pp. 118, Tk 6540—R 623

Primary Examiner—Lewis H. Myers

Assistant Examiner—A. T. Grimley

Attorney—Buckhorn, Blore, Klarquist and Sparkman

[54] **SHIELDED CABLE HAVING AUXILIARY SIGNAL CONDUCTORS FORMED INTEGRAL WITH SHIELD**

11 Claims, 5 Drawing Figs.

[52] U.S. Cl. 174/36,
174/102, 174/107, 174/115
[51] Int. Cl. H01b 11/06
[50] Field of Search. 174/36,
115, 113, 117, 117.2, 107, 102, 104

[56] **References Cited**

UNITED STATES PATENTS

2,415,652	2/1947	Norton	174/115 X
2,663,752	12/1953	Wier	174/36

ABSTRACT: A shielded flexible coaxial cable is described in which auxiliary outer signal conductors are formed integral with the shield surrounding the inner conductor. The shield is formed by a plurality of uninsulated shield wires wrapped about a dielectric core so that they are in electrical contact. The shield wires may be woven together to form a braided shield, or wound in a spiral to form a spiral-wrapped shield. The auxiliary outer conductors are in the form of insulated wires wrapped together with the shield wires simultaneously with the forming of the shield so that the resulting cable is not increased in diameter. A metal foil layer may also be provided beneath the wires to increase the shielding attenuation.

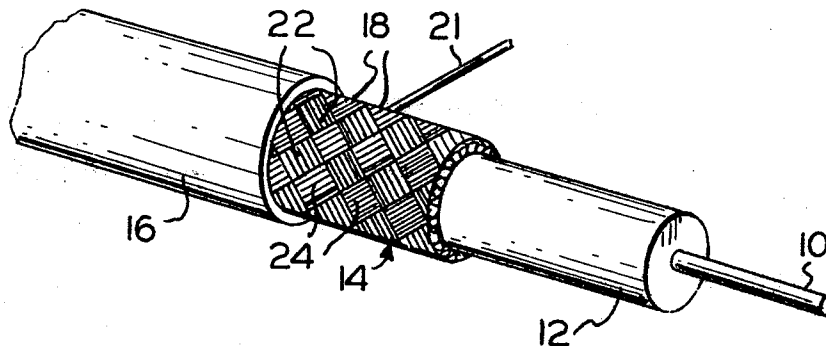


FIG. 1

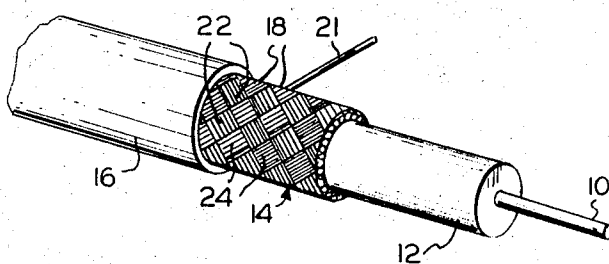


FIG. 2

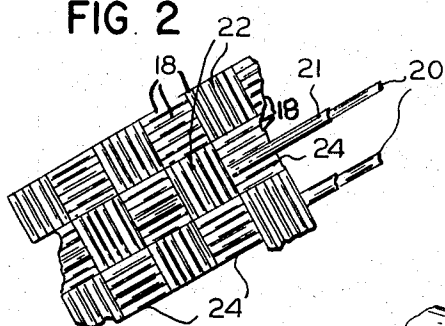


FIG. 3

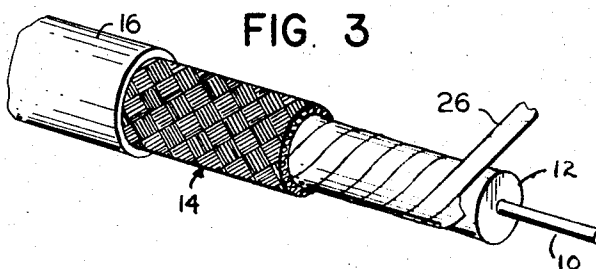


FIG. 4

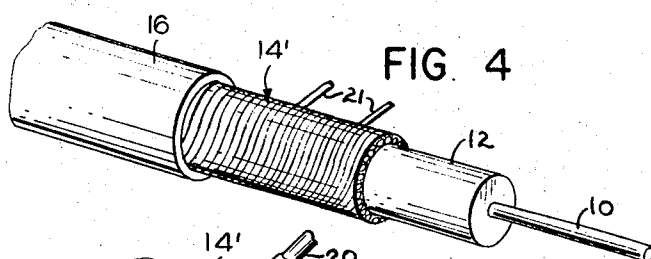
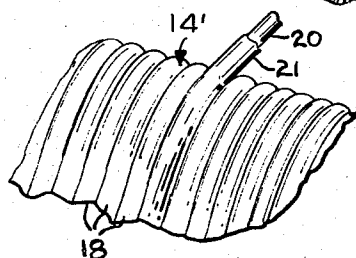


FIG. 5



DONALD F. ZEIDLHACK
INVENTOR

BY
BUCKHORN, BLORE, KLARQUIST & SPARKMAN
ATTORNEYS

SHIELDED CABLE HAVING AUXILIARY SIGNAL CONDUCTORS FORMED INTEGRAL WITH SHIELD

BACKGROUND OF THE INVENTION

The subject matter of the present invention relates generally to shielded electrical conductor apparatus, and more specifically to flexible shielded cables which include an inner conductor surrounded by a shield having auxiliary outer conductors formed integrally therewith. The auxiliary outer conductors are provided by insulated wires which are wrapped together with the shield wire about the dielectric core, either by weaving to form a braided shield, without increasing the diameter of the cable. The present invention is especially useful on a coaxial cable but may be employed with any type of shielded cable.

Previously shielded cables have been provided with auxiliary conductors by employing a plurality of inner conductors or by employing a plurality of outer conductors in the form of insulated wire supported on the outside of the shield surrounding the inner conductor of a coaxial cable. The former construction has the disadvantage that the inner conductor is not shielded from the auxiliary conductors while the latter construction has the disadvantage that the auxiliary outer conductors must be put on separately after the shield is formed, greatly adding to the expense and also increasing the diameter of the resulting cable. These problems are avoided by the present invention.

The fact that the outer diameter of the cable is not increased is especially important for small cable applications with electronic instruments, such as probe cables used for connecting external probes to cathode-ray oscilloscopes. Frequently such probes contain electrical circuitry which must be supplied with bias voltages from power supplies within the oscilloscope through auxiliary conductors. These auxiliary conductors are easily provided by the outer conductors forming part of the shield in the cable of the present invention. At the same time, the probe output signal is transmitted through the inner conductor of the cable which is shielded from any external fields. In order to increase this shielding as well as to shield the inner conductor from the outer conductors, it may be desirable to provide a metal foil layer beneath the shield wires. In this case, the shield wires are still necessary to provide the cable with strength and to secure the foil in position even though most of the electrical shielding is done by the foil.

It is therefore one object of the present invention to provide an improved shielded cable in which auxiliary conductors are provided as insulated wires formed integral with the shield to save time and expense in construction and to prevent any increase in cable diameter.

Another object of the present invention is to provide flexible shielded cable having outer conductors in the form of insulated wires which are wrapped together with uninsulated shield wires about a dielectric core to form the shield member surrounding the inner conductor.

The further object of the present invention is to provide a shielded flexible coaxial cable having auxiliary outer conductors woven into a braided shield.

Still another object of the present invention is to provide such a cable with a higher shielding attenuation by employing an intermediate foil strip wrapped beneath the auxiliary conductor wires and the shield wires.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will be apparent from the following detailed description of certain preferred embodiments thereof and from the attached drawings of which:

FIG. 1 is an elevation view of one embodiment of the shielded cable of the present invention;

FIG. 2 is an enlarged view of a portion of the braided shield in the cable of FIG. 1;

FIG. 3 is an elevation view of a second embodiment similar to that of FIG. 1 but employing a metal foil layer beneath the braided shield;

FIG. 4 shielded an elevation view of a third embodiment of the present invention in which the shield is in the form of spiral wrapped wires; and

FIG. 5 is an enlarged view of a portion of the shield in the cable of FIG. 4.

DESCRIPTION OF PREFERRED EMBODIMENTS

A flexible, shielded coaxial cable made in accordance with one embodiment of the present invention is shown in FIG. 1. The cable includes an inner conductor 10 of metal surrounded by dielectric core 12 of plastic or other suitable flexible insulation material and a shield member 14 as well as a protective jacket 16 of tough, water impermeable plastic. The shield member 14 may be a braided shield formed by bare metal wire strands 18 which are not coated with insulating material but contact one another so that they are electrically connected together to shield the inner conductor 10 from external electrical fields. In addition, the shield member 14 includes several insulated outer conductor wires 20 which are woven together with the shield wires 18 but are insulated therefrom by a coating 21 of abrasion resistant plastic such as polyvinyl formal polyamide provided on such outer conductor wires. The insulated outer conductor wires 20 provide auxiliary conductors in the cable without increasing the diameter of such cable since they are woven into the shield member during braiding.

The wire strands of the shield 14 are arranged in groups of strands or carriers 22 and 24 with one set of carriers 22 extending in one direction at a wrap angle of about 45° with respect to the cable axis and the other set of carriers 24 extending in another direction at a wrap angle of 45° to such axis. The carriers 22 and 24 intersect one another at right angles and are woven alternately over and under each other as shown in FIG. 2. Of course a different wrap angle and a different carrier angle may be used depending upon the flexibility and strength required. It should be noted that two outer conductors 20 are ordinarily not adjacent each other but are placed in different carriers for better shielding since the insulating coating around such outer conductors does provide a small gap in the shield member through which a portion of an external electrical field leaks.

In order to reduce the amount of electrical field penetrating through the shield, an intermediate shield layer of metal foil 26 may be provided beneath the braided shield 14 as shown in FIG. 3. This metal foil layer 26 may be in the form of a strip of aluminum which is spirally wrapped about the dielectric core 12 in overlapping fashion before the shield 14 is applied. The foil may have a backing layer of plastic for greater strength. In one example of the embodiment of FIG. 1, the braided shield 14 was formed with 16 carriers of six strands each, eight of such carriers being made entirely of tin-plated copper wire and eight of such carriers each being made with four strands of 38 AWG (0.0040 inch diameter) tinned copperweld for added strength and two strands of tin-plated copper wire. The auxiliary outer conductors 20 are made of 38 AWG (0.0040 inch diameter) copper wire insulated with polyvinyl formal polyamide. The attenuation of this shield on a signal applied to the auxiliary conductor and measured on the inner conductor is about 20 decibels for the cable of FIG. 1, and for the embodiment of FIG. 3 is 90 decibels or more.

As shown in FIGS. 4 and 5, the shielded cable of the present invention may be made with a spirally wrapped shield 14' rather than the braided shield 14 of FIG. 1. In this embodiment, the uninsulated shield wires 18 and the insulated outer conductor wires 20 are wrapped together in a spiral about the dielectric core 12 to provide such outer conductors as an integral part of the shield 14' without increasing the diameter of the cable. In addition, the spiral wrapped shield embodiment of FIGS. 4 and 5 may be provided with a foil layer similar to foil layer 26 of FIG. 3, beneath the shield 14' if a greater attenuation is desired.

When the cable of the present invention is used as a probe cable for connecting an external probe to the input of an oscilloscope, the inner conductor 10 forms the signal conductor for the output signal of the probe. The auxiliary outer conductors 20 may be employed to apply DC supply voltages to amplifier circuits within the probe from a power supply within the oscilloscope. It is also possible to employ additional outer conductors to transmit triggering signals or gating pulses. Thus the cable of the present invention has the advantage of being of extremely small diameter and great flexibility while providing a plurality of signal conductors.

It will be obvious to those having ordinary skill in the art that many changes may be made in the details of the above-described preferred embodiments of the present invention not departing from the spirit of the invention. For example, the present cable need not be a coaxial cable because several inner conductors may be employed within the shield. Therefore the scope of the present invention should only be determined by the following claims.

I claim:

1. Electrical conductor apparatus comprising:
flexible shielded cable including an inner signal conductor capable of transmitting a first electrical signal, dielectric material surrounding said inner signal conductor, and an electrical shield surrounding the inner signal conductor and separated therefrom by said dielectric material;
said shield being flexible and including a plurality of shield conductors which are wrapped about the dielectric material and in electrical contact with each other; and
at least one auxiliary signal conductor wrapped with the shield conductors around the inner signal conductors and provided as part of the shield but being electrically insulated from said shield conductors by a layer of insulator material to enable said auxiliary signal conductor to transmit a second electrical signal along the cable.
2. A conductor apparatus in accordance with claim 1 in which the shield conductors are bare wire strands supported on said dielectric material and the auxiliary signal conductor is an insulated wire having the insulation material coated thereon.
3. A conductor apparatus in accordance with claim 2 in

which the wire strands and insulated wire are woven together to form a braided shield member.

4. A conductor apparatus in accordance with claim 2 in which the wire strands and insulated wire are wrapped together in a spiral to form the shield member.

5. A conductor apparatus in accordance with claim 1 in which the flexible cable means is a coaxial cable and the auxiliary signal conductor is spaced the same distance from the inner conductor as the shield conductors.

6. A conductor apparatus in accordance with claim 1 in which the shield has a substantially uniform diameter throughout its length.

7. A conductor apparatus in accordance with claim 2 which includes a plurality of insulated wires providing a plurality of auxiliary signal conductors.

8. A conductor apparatus in accordance with claim 2 in which the insulating coating is made of an abrasion resistant plastic material.

9. A conductor apparatus in accordance with claim 8 in which the plastic is polyvinyl formal polyamide.

10. A conductor apparatus in accordance with claim 1 in which the shield also includes a metal foil layer between the dielectric material and the shield conductors and the auxiliary signal conductor.

11. A coaxial cable comprising:

a center conductor means for carrying a primary signal;
insulation layer means surrounding said center conductor means; and

electrical shield means surrounding said insulation layer means, said electrical shield means including bare electrical conductor means in electrical engagement with each other and extending around said insulation layer means and insulated electrical conductor means as part of said electrical shield means, said insulated electrical conductor means being insulated from said bare electrical conductor means to enable it to carry a secondary signal there along and said electrical conductor means having substantially the same diameter so that said electrical shield means has a substantially uniform diameter along said cable.

45

50

55

60

65

70

75

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,594,491 Dated July 20, 1971

Inventor(s) Donald F. Zeidlhack

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the specification:

On column 1, line 13, after "shield" insert --or by merely winding to form a spiral wrapped shield--.

On column 2, line 4, after "Fig. 4" change "shielded" to --is--.

In the claims:

On column 3, claim 1, line 30, after "least" change "on" to --one--.

Signed and sealed this 15th day of February 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents