June 23, 1964 A. F. RAAB 3,138,678

AUTOMATICALLY CALIBRATED ELECTROMAGNETIC RELAY

Filed Feb. 5, 1962 4 Sheets-Sheet 1

Fig. 1.

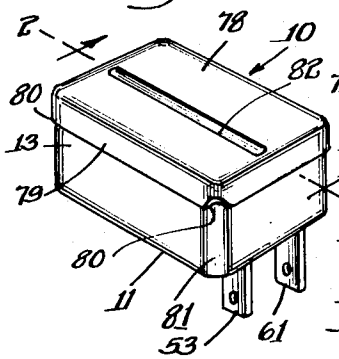


Fig. 2.

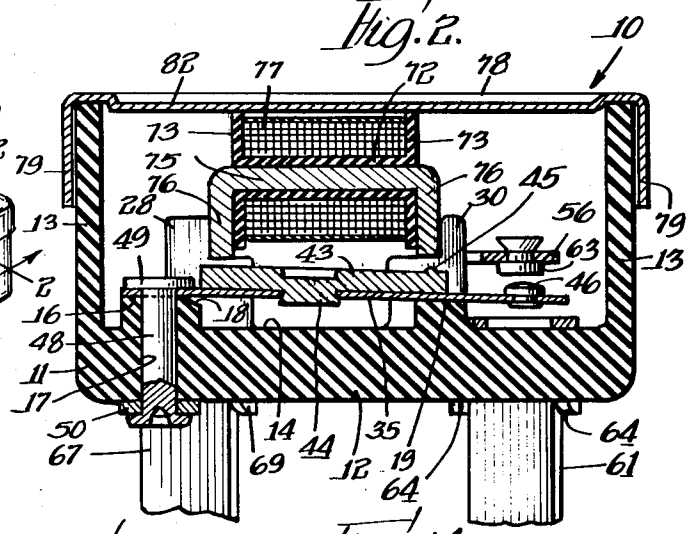


Fig. 11.

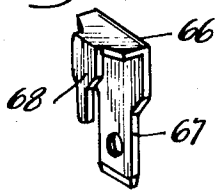


Fig. 12.

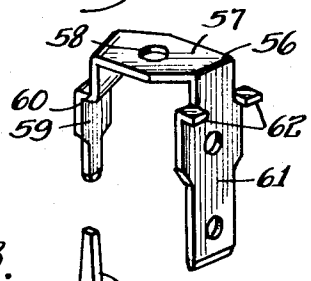


Fig. 14.

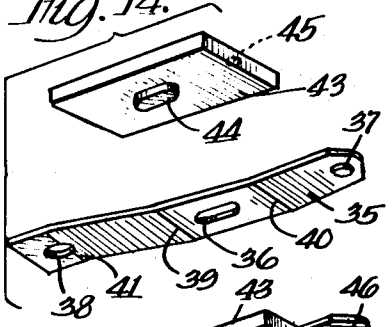


Fig. 13.

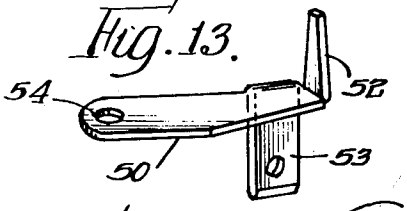


Fig. 15.

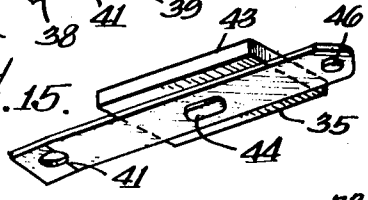


Fig. 16.

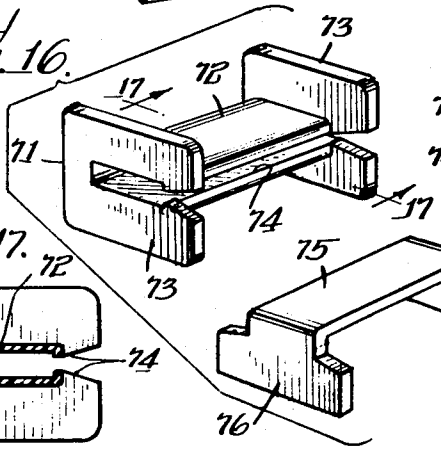


Fig. 17.

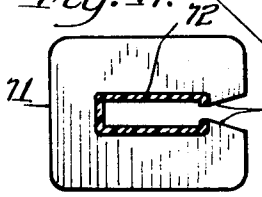
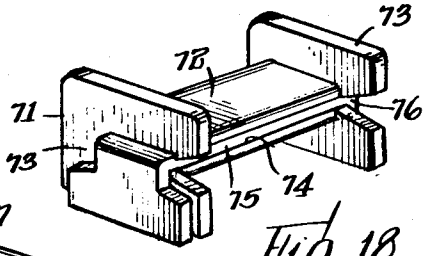


Fig. 18.



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June 23, 1964 A. F. RAAB 3,138,678

AUTOMATICALLY CALIBRATED ELECTROMAGNETIC RELAY

Filed Feb. 5, 1962 4 Sheets-Sheet 2

Fig. 3.

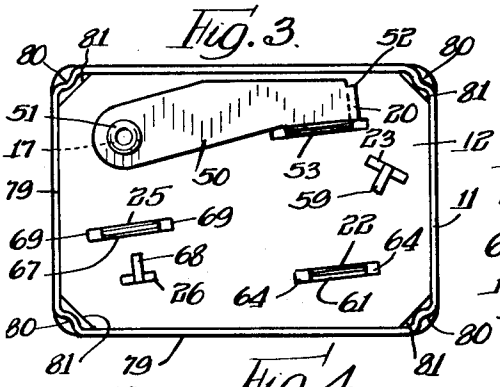


Fig. 5.

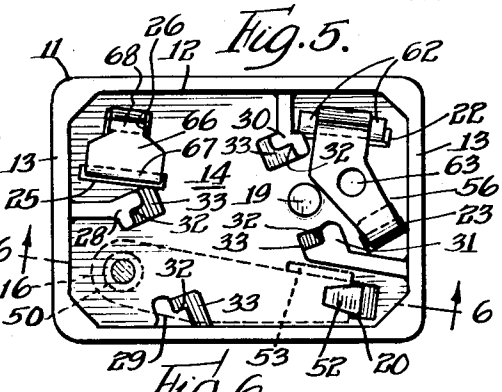


Fig. 4.

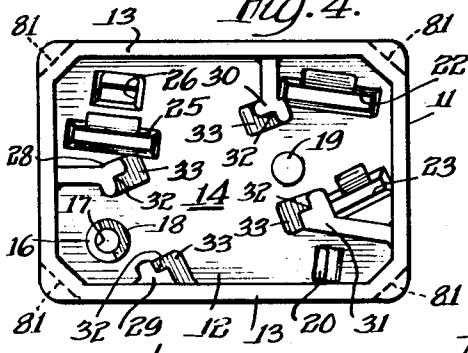


Fig. 6.

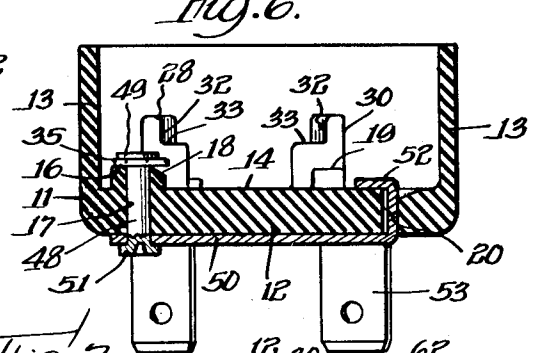


Fig. 7.

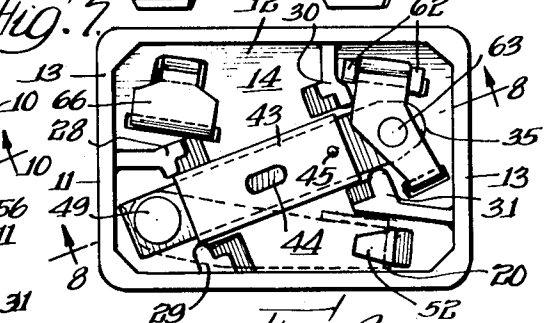


Fig. 9.

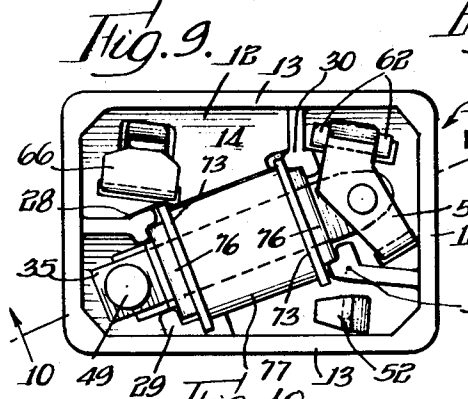
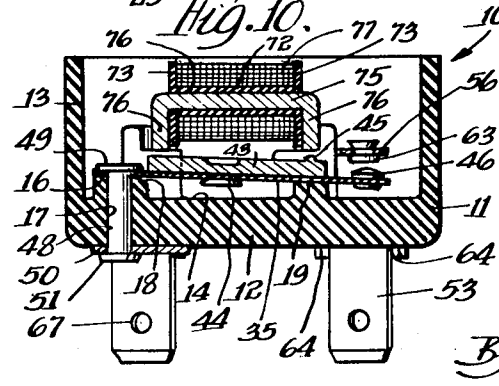
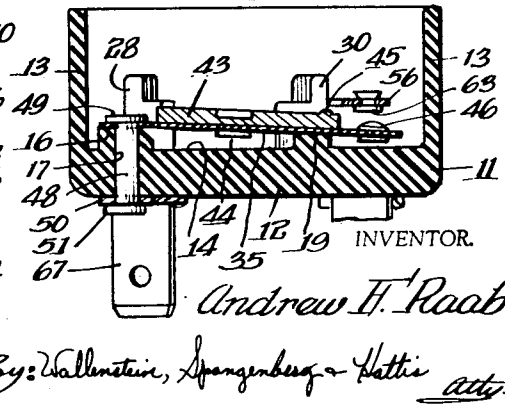


Fig. 8.



Fig. 10.





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June 23, 1964 A. F. RAAB 3,138,678

AUTOMATICALLY CALIBRATED ELECTROMAGNETIC RELAY

Filed Feb. 5, 1962 4 Sheets-Sheet 3

Fig. 19.

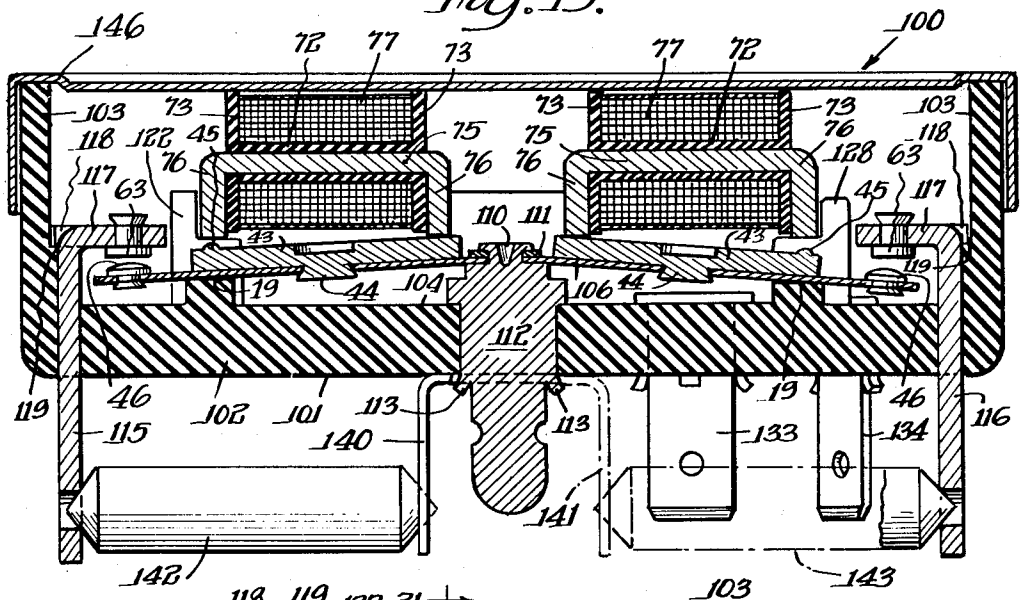


Fig. 20.

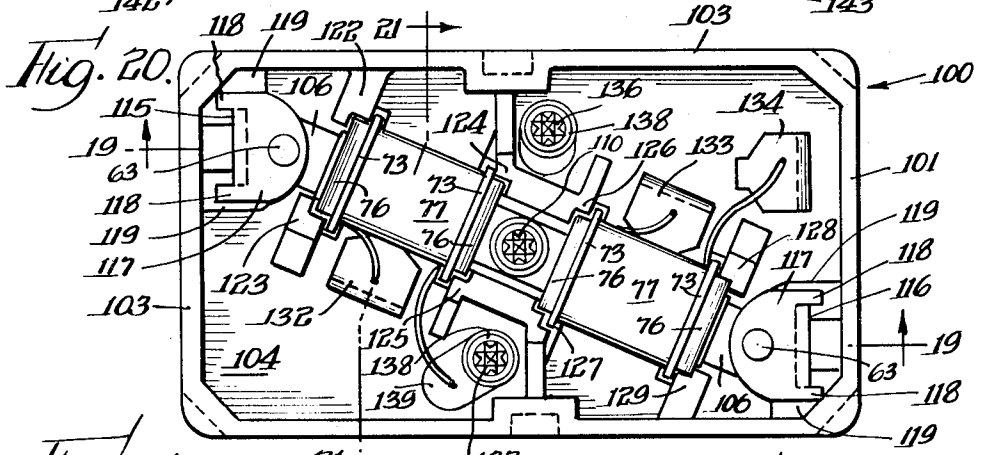


Fig. 21.

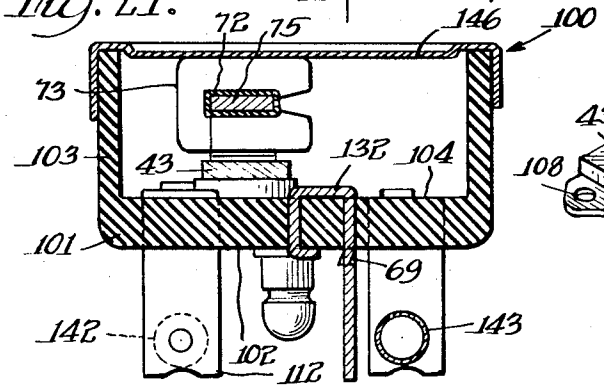
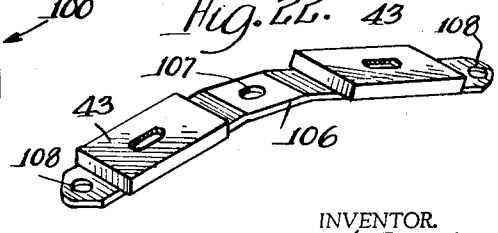


Fig. 22.



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AUTOMATICALLY CALIBRATED ELECTROMAGNETIC RELAY

Filed Feb. 5, 1962 4 Sheets-Sheet 4

Fig. 23.

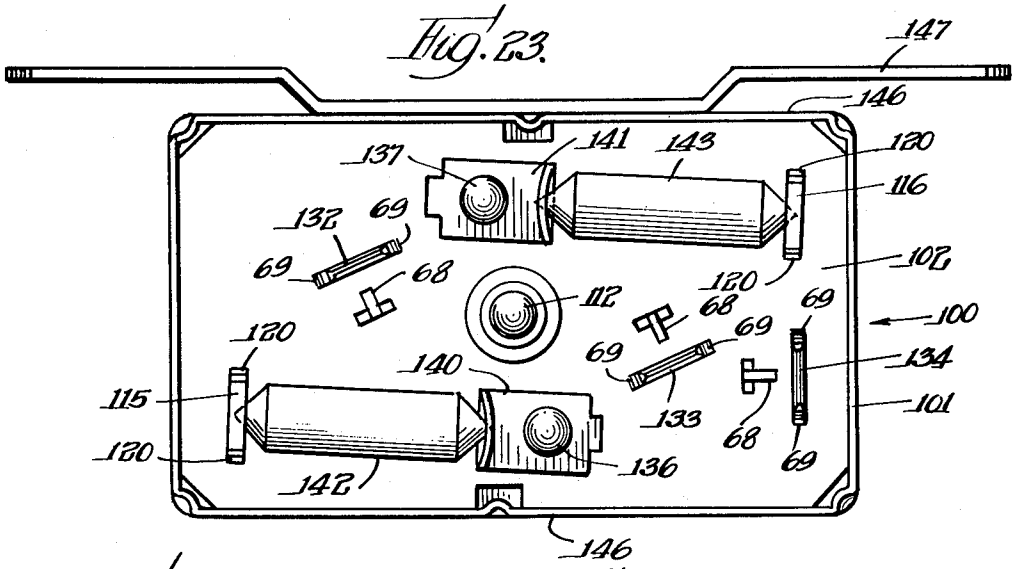


Fig. 24.

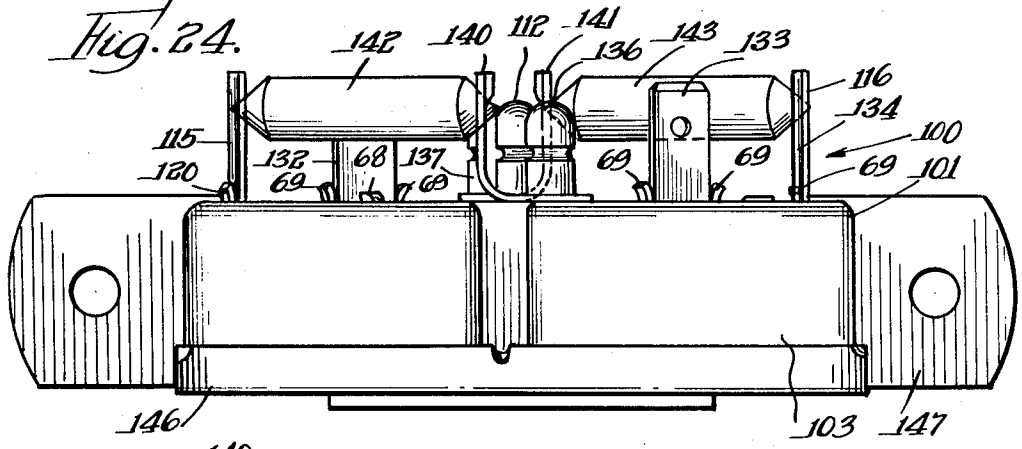
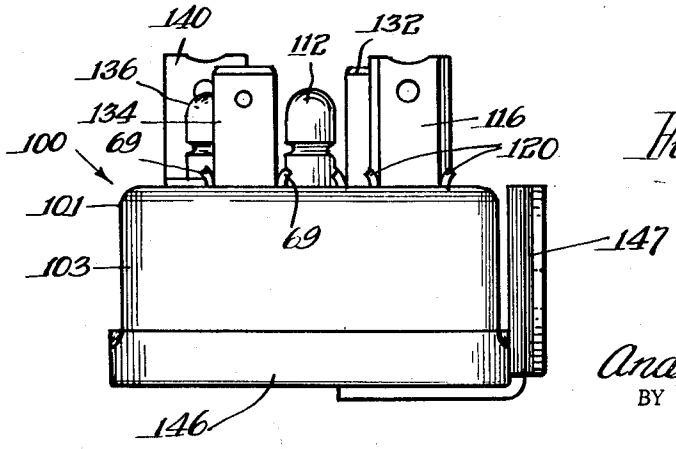


Fig. 25.



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United States Patent Office 3,138,678 Patented June 23, 1964

3,138,678

AUTOMATICALLY CALIBRATED ELECTROMAGNETIC RELAY

Andrew F. Raab, Morton Grove, Ill., assignor to Littelfuse, Inc., Des Plaines, Ill., a corporation of Illinois

Filed Feb. 5, 1962, Ser. No. 171,185
12 Claims. (Cl. 200—87)

The principal object of this invention is to provide an improved relay which is relatively small in size but yet rugged in construction, which is accurate, efficient and foolproof in operation, which is inexpensive to make and assemble, which is automatically calibrated during assembly, and which requires no testing or adjustment after assembly.

Briefly, the relay of this invention includes an armature assembly having a spring arm, an armature carried by the spring arm intermediate the ends thereof, a contact carried by the spring arm adjacent one end thereof, and a mounting portion on the spring arm adjacent the other end thereof. It also includes a fixed contact assembly having a fixed contact and a mounting portion, and a coil assembly having a coil form, a coil winding carried by the coil form and a core carried by the coil form. The armature assembly, the fixed contact assembly and the coil assembly are individually pretested for construction, tolerances and operation before being assembled into the relay.

The relay also includes an accurately molded insulating housing member having a reference surface and supporting surfaces for the armature assembly, the fixed contact assembly and the coil assembly at fixed distances with respect to the reference surface. The mounting portion of the spring arm of the pretested armature assembly is secured to its supporting surface on the housing member for fixing the position of the armature assembly with respect to the reference surface of the housing member. The mounting portion of the pretested fixed contact assembly is secured to its supporting surface on the housing member for fixing the position of the fixed contact with respect to the reference surface of the housing member and with respect to the contact of the armature assembly. The core of the pretested coil assembly is secured to its supporting surface on the housing member for fixing the position of the core of the coil assembly with respect to the reference surface of the housing member and with respect to the armature of the armature assembly.

By so assembling the pretested armature, fixed contact and coil assemblies on the housing member, the relay is automatically calibrated during the assembly thereof, so that subsequent testing and adjustment after assembly are not required. This is one of the factors which makes possible the inexpensive manufacture and assembly of the relay of this invention and the attainment of the other advantages thereof.

The relay of this invention may take various forms, as for example, a single relay form of general utility or a dual relay form wherein a common spring arm is utilized for both armature assemblies, the latter dual relay assembly having particular utility in the automotive field for switching the high and low beams of headlights for warning purposes.

Further objects of this invention reside in the details of construction of the relay and in the cooperative relationships between the component parts thereof.

Other objects and advantages of this invention will become apparent to those skilled in the art upon reference to the accompanying specification, claims and drawings in which:

FIG. 1 is a perspective view of one form of the relay of this invention;

FIG. 2 is an enlarged vertical sectional view through the relay taken substantially along the line **2—2** of FIG. 1;

FIG. 3 is a bottom plan view of the relay illustrated in FIGS. 1 and 2;

FIG. 4 is a top plan view of the housing member of the relay;

FIG. 5 is a top plan view of the housing member with the fixed contact assembly, a terminal connector and a portion of the armature assembly mounted in place thereon;

FIG. 6 is a vertical sectional view taken substantially along the line **6—6** of FIG. 5;

FIG. 7 is a top plan view similar to FIG. 5 but illustrating the complete armature assembly mounted on the housing member;

FIG. 8 is a vertical sectional view taken substantially along the line **8—8** of FIG. 7;

FIG. 9 is a top plan view of the housing member, similar to FIGS. 4, 5 and 7, but illustrating the complete assembly of the relay;

FIG. 10 is a vertical sectional view taken substantially along the line **10—10** of FIG. 9;

FIG. 11 is a perspective view of a terminal utilized in the relay;

FIG. 12 is a perspective view of a portion of the fixed contact assembly;

FIG. 13 is a perspective view of the terminal portion of the armature assembly;

FIG. 14 is an exploded perspective view of the spring arm and armature forming the armature assembly;

FIG. 15 is a perspective view illustrating the armature attached to the spring arm and forming the armature assembly;

FIG. 16 is an exploded perspective view of the coil form and core forming a part of the coil assembly;

FIG. 17 is a vertical sectional view of the coil form taken substantially along the line **17—17** of FIG. 16;

FIG. 18 is a perspective view showing the coil form and core in assembled relation;

FIG. 19 is an enlarged vertical sectional view through another form of the relay of this invention and it being taken substantially along the line **19—19** of FIG. 20;

FIG. 20 is a top plan view of the relay illustrated in FIG. 19 but with the cover removed;

FIG. 21 is a vertical sectional view taken substantially along the line **21—21** of FIG. 20;

FIG. 22 is a perspective view of the armature assembly utilized in the relay of FIG. 19;

FIG. 23 is a bottom plan view of the relay illustrated in FIG. 19;

FIG. 24 is an inverted side elevational view of the relay of FIG. 19;

FIG. 25 is an inverted end elevational view of the relay of FIG. 19.

Referring first to FIGS. 1 to 10, one form of the relay of this invention is generally designated at **10**. It includes a housing member **11** having a bottom wall **12** and side walls **13**. The housing member **11** is formed

from a thermo-setting synthetic plastic material, such as a phenolic resin, by pressure molding the same between male and female dies, the dies being accurately machined. The lower face of the male die forms an accurate reference surface **14** along the upper side of the bottom wall of the housing member. A boss is also molded on the upper side of the bottom wall **12** by the male die and this boss has a supporting surface **16** which is accurately positioned a fixed distance from the reference surface **14**. A hole **17** extends from the supporting surface **16** centrally through the boss and the bottom wall **12** of the housing member **11**. A portion of the upper surface of the boss is also chamfered as indicated at **18**. The supporting surface **16** of the boss is utilized for mounting the armature assembly at a fixed distance from the reference surface **14**. The upper side of the bottom wall **12** of the housing member is also provided with another boss having a surface **19** at a fixed distance from the reference surface **14**. This boss acts as a stop for limiting the retracting movement of the armature assembly. The bottom wall **12** of the housing member is further provided with a slot **20** therethrough for receiving an arm of a terminal member, illustrated in FIG. 13, forming a part of the ultimate armature assembly.

The bottom wall **12** of the housing member is further provided with a pair of slots **22** and **23** therethrough for the purpose of mounting the fixed contact assembly as illustrated in FIG. 12. The bottom wall **12** of the housing member also has slots **25** and **26** extending therethrough for the purpose of mounting a terminal assembly as illustrated in FIG. 11. Also molded on the upper side of the bottom wall **12** of the housing member are a plurality of bosses **28**, **29**, **30** and **31**, each of these bosses having a corner **32** and a supporting surface **33**. The surfaces **33** are accurately positioned by the male die a fixed distance from the reference surface **14**. These corners **32** and supporting surface **33** are utilized for mounting the core of the coil assembly, illustrated in FIGS. 16 to 18, for accurately fixing the position of the coil assembly with respect to the reference surface **14**.

As shown more clearly in FIGS. 14 and 15 the armature assembly includes a spring arm **35** which has a slot **36** therethrough adjacent the center thereof, a hole **37** adjacent one end thereof for carrying a contact and a hole **38** adjacent the other end thereof for mounting the armature assembly on the mounting surface **16** of the boss on the housing member. In its initial condition the spring arm **35** is bent along the lines **39** and **40** for the purpose of making the same slightly concave upwardly. Adjacent the hole **38** the leaf spring is also bent along the line **41** so as to bias the spring arm **35** downwardly when it is mounted on the housing member **11**. The armature assembly also includes an armature **43** formed of suitable paramagnetic material. The central portion of the armature **43** is deformed downwardly by a suitable tool to form a downwardly extending projection **44**. In assembling the armature **43** to the spring arm **35** the projection **44** is inserted through the slot **36** and is then staked over as illustrated in FIGS. 2 and 15. During this staking operation the spring arm **35** is brought flat against the bottom surface of the armature **43** and is maintained flat against that surface by reason of the tension of the spring arm **35** afforded by the initial bends **39** and **40** in the spring arm **35**. In this way accurate positioning of the spring arm **35** against the armature **43** is assured. The one end of the upper surface of the armature **43** is provided with a small upwardly extending projection **45** which is adapted to engage against one of the legs of the core of the coil assembly when the armature is attracted by the coil assembly. A contact **46** is suitably secured in the hole **37** of the spring arm **35**, this contact being adapted to engage and disengage a fixed contact as the armature is operated by the coil assembly.

In mounting the armature assembly in place on the housing member **11**, the mounting portion at the other end of the spring arm **35** is seated upon the mounting surface **16** of the boss formed on the bottom wall **12** of the housing member. A rivet **48** is inserted through the hole **38** in the spring arm **35** and the hole **17** in the boss and housing member, the head **49** of the rivet holding the mounting portion of the spring arm **35** firmly against the mounting surface **16** for fixing the position of the armature assembly with respect to the reference surface **14** and, also, establishing electrical connection between the spring arm **35** and the rivet **48**. The rivet **48** also extends through a hole **54** in a terminal bracket **50**, the rivet being peened over and firmly clamping the parts in assembled relation. The terminal bracket **50** of the armature assembly, as shown in detail in FIG. 13, has an upwardly extending finger **52** which extends through the slot **20** in the bottom wall **12** of the housing member, the upper end of the finger **52** being bent over and also firmly securing the terminal bracket **50** to the housing member. The terminal bracket **50** is also provided with a downwardly extending portion **53** to which electrical connection may be made. The terminal portion **53** is electrically connected through the bracket **50** and the rivet **48** to the spring arm **35** and hence to the contact **46**.

The fixed contact assembly, as shown in detail in FIG. 12, includes a bracket **56** having a mounting surface **57** provided with a hole **58** which receives and mounts a fixed contact **63**, the fixed contact **63** being suitably riveted in place. One end of the bracket **56** is provided with a downwardly extending arm **59** which extends through the hole **23** in the bottom wall **12** of the housing member. This arm **59** is provided with an offset or shoulder portion **60** which rests against the reference surface **14** of the housing member. The end of the arm **59** which extends through the bottom wall **12** of the housing member is bent over for securely clamping the bracket **56** to the housing member. The other end of the bracket **56** is also provided with a downwardly extending arm **61** which extends through the slot **22** in the bottom wall **12** of the housing member. This arm **61** has a pair of lugs **62** bent outwardly therefrom, the lugs **62** also engaging the reference surface **14** of the housing member for fixedly positioning the bracket **56** on the housing member. The tapered portions of the downwardly extending arm **61** are staked as indicated in **64** by a suitable tool for firmly securing the bracket **56** to the housing member. In this way the bracket **56** is fixedly secured to the bottom wall **12** of the housing member in a fixed position so that the top portion **57** of the bracket and hence the fixed contact **63** carried thereby are positioned in fixed positions with respect to the reference surface **14**. The fixed contact **63** overlies the contact **46** of the spring arm **35** so as to be engaged and disengaged thereby upon attraction and release of the armature **43**. The spring arm **35** normally biases the armature **43** and the contact **46** downwardly with the spring arm **35** engaging the stop surface **19** on the boss formed on the housing member. When the armature **43** is attracted by the coil assembly the contact **46** is moved into engagement with the fixed contact **63**, the spring arm **35** flexing somewhat to provide substantial contact pressure between the contacts **46** and **63**.

A terminal assembly **66**, as shown in detail in FIG. 11, includes a pair of downwardly extending arms **67** and **68**. These arms **67** and **68** extend through the slots **25** and **26**, respectively, in the bottom wall **12** of the housing member. The top portion of the terminal bracket **66** sets against the reference surface **14** of the housing member and the end of the arm **68** is bent over for securing the terminal bracket **66** in place. The tapered portions of the arm **67** are also staked by a suitable tool as indicated at **69** for also securing the terminal bracket **62** in place. The arm **67** extends downwardly from the housing member and forms a terminal connection. The terminal bracket **66** is utilized for establishing electrical connection to the coil assembly.

The coil assembly, as shown in more detail in FIGS. 16 to 18, includes a coil form 71 accurately molded from a suitable synthetic plastic material such as nylon or the like. The coil form 71 includes a central tubular or tube like portion 72 and end flanges 73. The coil form including the tubular or tube like portion 72 and the flanges 73 is provided with a longitudinally extending slot 74. The coil assembly also includes a U-shaped core of suitable paramagnetic material having an elongated U-portion 75 and end portions or pole pieces 76. The elongated portion 75 of the core is inserted and snapped through the longitudinally extending slot 74 into the tubular or tube like portion 72 of the coil form 71 with the end legs 76 lying adjacent to and on the outside of the flanges 73 of the coil form. In this way the core is accurately positioned and firmly held in the coil form 71. After the core is so secured in the coil form a coil winding 77 is wound around the tubular or tube like portion 72 of the coil form between the flanges 73 thereof.

The coil form is inserted in the housing part 11 with the end legs 76 of the core engaging the bosses 28, 29, 30 and 31 formed in the housing member 11. In this respect the edges of the end legs 76 of the core engage in the corners 32 of these bosses and the bottom of the legs 76 rest upon the mounting surfaces 33 of these bosses. As a result the core and hence the coil assembly are accurately positioned within the housing member 11 and the positions thereof are fixed with respect to the reference surface 14 of the housing member. The end portions 76 of the core assembly overlie the ends of the armature 43. When the coil 77 is electrically energized, the end portions 76 of the core attract the armature 43 into engagement therewith against the action of the spring arm 35 to engage the contact 46 with the fixed contact 63. When the armature 43 is so attracted the small projection 45 on one end of the armature 43 engages one end portion 76 of the core so as to provide an air gap therebetween. By reason of this air gap the armature 43 quickly releases from the core of the coil assembly when the coil winding 77 is de-energized, thus providing an extremely fast operating relay assembly. One end of the coil winding 77 is connected by a lead to the rivet head 49 by welding the lead thereto and the other end of the coil winding is connected to the terminal bracket 66 by a lead welded thereto, all as shown in FIG. 9. Thus, when a circuit is completed across the terminals 53 and 67, the coil winding 77 is energized to attract the armature and when this circuit is broken the coil is de-energized to allow rapid release of the armature. When the contact 46 engages the fixed contact 63 a circuit is completed from the terminal 53 to the terminal 61, this circuit being under the control of the relay assembly.

The housing member 11 is provided with a cover 78 which in turn is provided with a downwardly extending skirt 79 extending over the side walls 13 of the housing member. The open top of the housing member is substantially rectangular and the corners of the housing member below the top thereof are provided with recesses 81 thereby providing outwardly extending shoulders at the corners of the top of the housing member. The lower portions of the depending skirt 79 of the cover are pressed into the recesses 81 as indicated at 80, underneath the shoulders, for the purpose of firmly securing the cover 78 in place on the housing member. The cover is preferably provided with a longitudinally extending detent portion 82 which engages the tops of the flanges 73 of the coil form for holding the coil assembly firmly in place on the bosses 28, 29, 30 and 31 in the housing member.

As expressed above the armature assembly, the fixed contact assembly and the coil assembly are all individually prechecked and pretested before assembly into the ultimate relay assembly, the prechecking and pretesting having to do principally with dimension tolerances and operation of the individual assembly. Since the armature assembly, the fixed contact assembly and the coil assembly are all positioned at fixed distances with respect to the reference surface 14 of the housing member the relay assembly is automatically calibrated upon the assembly thereof, there being no need for adjusting the position of the coil assembly with respect to the armature assembly, the position of the contact 46 with respect to the fixed contact 63 or the resiliency or bias of the spring arm 35 as has been usual and necessary heretofore in the manufacture of relays.

Referring now to the other form of the relay illustrated in FIGS. 19 to 25, there is here provided a dual relay assembly 100 which is particularly adaptable for use in the automotive field for controlling the high and low beams of the headlights of a vehicle for warning purposes. Here the same coil assemblies and substantially the same armature assemblies are utilized and like reference characters have been utilized for like parts. In this form of the relay there is utilized an elongated housing member 101 having a bottom wall 102 and side walls 103, this housing member being formed of suitable thermosetting synthetic plastic, such as a phenolic resin, and being molded in male and female dies as described above. Here, also, the upper side of the bottom wall 102 forms a reference surface 104.

The armature assembly for the dual relay, as shown in more detail in FIG. 22, includes a single elongated spring arm 106 for mounting the dual armatures 43, the dual armatures being secured thereto in the manner described above. The center of the spring arm 106 is provided with a mounting hole 107 and the ends of the spring arm 106 are provided with holes 108 for receiving the contacts 46. The dual armature assembly is centrally mounted on a center terminal post 112. The post 112 has a portion extending through the hole 107 in the spring arm 106 and a washer 111 overlies the spring arm. The extending portion of the post 112 is then riveted over as indicated at 110 for firmly securing the spring arm 106 of the dual armature assembly to the post 112. The post 112 is mounted in the bottom wall 102 of the housing member, and it is secured in place by staking the post as indicated at 113. Thus, the terminal post 112 operates to secure the dual armature assembly at a fixed distance from the reference surface 104. The dual leaf spring 106 normally maintains the armature assemblies in retracted position with the spring arm engaging the stop surfaces 19 on bosses formed on the upper side of the bottom wall 102. A pair of fixed terminal assemblies 115 and 116 extend through suitable slots in the bottom wall 102 of the housing member. The upper ends of the fixed contact assemblies 115 and 116 are each provided with a horizontally extending portion 117 for carrying the fixed contacts 63. These horizontally extending portions 117 are also provided with horizontally extending ears 118 which are adapted to engage horizontally extending mounting surfaces 119 molded on the housing member and being at a fixed distance from the reference surface 104. The fixed contact assemblies 115 and 116 are staked to the bottom wall 102 of the housing member as indicated at 120 for firmly securing the same to the housing member in their fixed positions.

The housing member is also internally provided with a plurality of bosses 122, 123, 124, 125, 126, 127, 128 and 129, these bosses having corners and mounting surfaces, like those described above, for mounting the dual coil assemblies, the end portions 76 of the cores of the coil assemblies setting in those corners and resting on those surfaces in the manner described above. In this way the coil assemblies are accurately positioned in the housing member 101 and at a fixed distance from the reference surface 104. As above, when the coil windings 77 are electrically energized, the armatures 43 are attracted against the core ends 76 to move the contacts 46 into engagement with the fixed contacts 63 and when the coil windings 77 are de-energized, the armatures 43 retract under the action of the leaf spring 106 to disengage the contacts 46 from the fixed contacts 63.

The bottom wall **102** of the housing member carries three terminal members **132**, **133** and **134**, these terminal members corresponding to the terminal member **46**, as illustrated in FIG. 11. These terminal members rest upon the reference surface **104** and are secured to the housing member in the manner described above in connection with the terminal member **66**. The terminal members **132**, **133** and **134** are for the purpose of making electrical connection to the coil windings of the dual coil assemblies, the electrical leads for so doing being illustrated in FIG. 20.

The bottom wall **102** of the housing member also carries a pair of terminal posts **136** and **137**, these posts being secured in place by riveting the upper ends thereof over washers **138**. The post **137** extends through a tab **139** which is held in place by the washer **138**, the tab being electrically connected to one of the coil windings **77**. The post **136** extends through a hole in a clip **140** and the post **137** extends through a hole in a clip **141**, these clips being held in place by the firmly secured posts **136** and **137**. The clip **140** and the fixed contact member **115** support a fuse **142** therebetween and, likewise, the clip **141** and the fixed contact member **116** support a fuse **143** therebetween, the fuses **142** and **143** being in series with the contacts **46** and **63** and providing protection for the high and low beam head lamps controlled thereby. The dual relay assembly is also provided with a cover **146** which is secured in place in the manner described above. This cover **146** also operates to hold the coil assemblies in fixed position against the bosses **122** to **129**. Here the cover **146** is provided with a mounting bracket **147** suitably secured thereto as by welding or the like.

All of the features and advantages of the relay **10** of one form of the invention are incorporated in the dual relay **100** of the other form of the invention and what has been said above in connection with relay **10** applies equally as well to the dual relay **100**. Basically, the dual relay **100** differs from the relay **10** in that it utilizes two coil assemblies and two armature assemblies, the two armature assemblies being carried by a common single spring arm **106**. The other differences between the two relay assemblies reside in the fuses and the terminal arrangements which are of particular utility in the automotive field for controlling high and low beams of the vehicle headlights.

While, for purposes of illustration, two forms of this invention have been disclosed, other forms thereof may become apparent to those skilled in the art upon reference to this disclosure and, therefore, this invention should be limited only by the scope of the appended claims.

I claim as my invention:

1. An automatically calibrated relay comprising, a molded insulating housing member having a reference surface, a pretested armature assembly including a spring arm, an armature carried by the spring arm intermediate the ends thereof and a contact carried by the spring arm adjacent one end thereof, armature assembly supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the other end of said spring arm on said mounting surface for fixing the position of the armature assembly with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the spring arm of the armature assembly, a fixed contact in alignment with the contact of the armature assembly to be engaged and disengaged thereby, fixed contact supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the fixed contact on said mounting surface for fixing the position of the fixed contact with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the fixed contact, a pretested coil assembly including a coil form, a coil winding carried by the coil form and a core carried by the coil form in alignment with the armature of the armature assembly for attracting the armature against the action of the spring arm when the coil winding is electrically energized to engage and disengage said contacts, and coil assembly supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the core on said mounting surface for fixing the position of the coil assembly with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the coil winding.

2. An automatically calibrated relay comprising, a molded insulating housing member having a reference surface, a pretested armature assembly including a spring arm, an armature carried by the spring arm intermediate the ends thereof and a contact carried by the spring arm adjacent one end thereof, armature assembly supporting means carried by the housing member and including a boss formed on the housing member and having a mounting surface at a fixed distance from the reference surface of the housing member, a rivet extending through the boss and the housing member and mounting the other end of said spring arm on said mounting surface for fixing the position of the armature assembly with respect to the reference surface of the housing member and means connected to the rivet and having a terminal for completing an electrical connection to the spring arm of the armature assembly, a fixed contact in alignment with the contact of the armature assembly to be engaged and disengaged thereby, fixed contact supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the fixed contact on said mounting surface for fixing the position of the fixed contact with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the fixed contact, a pretested coil assembly including a coil form, a coil winding carried by the coil form and a core carried by the coil form in alignment with the armature of the armature assembly for attracting the armature against the action of the spring arm when the coil winding is electrically energized to engage and disengage said contacts, and coil assembly supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the core on said mounting surface for fixing the position of the coil assembly with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the coil winding.

3. An automatically calibrated relay comprising, a molded insulating housing member having a reference surface, a pretested armature assembly including a spring arm, an armature carried by the spring arm intermediate the ends thereof and a contact carried by the spring arm adjacent one end thereof, armature assembly supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the other end of said spring arm on said mounting surface for fixing the position of the armature assembly with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the spring arm of the armature assembly, a fixed contact in alignment with the contact of the armature assembly to be engaged and disengaged thereby,

fixed contact supporting means carried by the housing member and including a contact terminal bracket having a mounting surface portion carrying the fixed contact, a reference portion engaging the reference surface of the housing member and fixing the mounting surface at a fixed distance from the reference surface of the housing member for fixing the position of the fixed contact with respect to the reference surface of the housing member and a terminal portion extending through the housing member for completing an electrical connection to the fixed contact, a pretested coil assembly including a coil form, a coil winding carried by the coil form and a core carried by the coil form in alignment with the armature of the armature assembly for attracting the armature against the action of the spring arm when the coil winding is electrically energized to engage and disengage said contacts, and coil assembly supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the core on said mounting surface for fixing the position of the coil assembly with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the coil winding.

4. An automatically calibrated relay comprising, a molded insulating housing member having a reference surface, a pretested armature assembly including a spring arm, an armature carried by the spring arm intermediate the ends thereof and a contact carried by the spring arm adjacent one end thereof, armature assembly supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the other end of said spring arm on said mounting surface for fixing the position of the armature assembly with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the spring arm of the armature assembly, a fixed contact in alignment with the contact of the armature assembly to be engaged and disengaged thereby, fixed contact supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the fixed contact on said mounting surface for fixing the position of the fixed contact with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the fixed contact, a pretested coil assembly including a coil form, a coil winding carried by the coil form and a core carried by the coil form in alignment with the armature of the armature assembly for attracting the armature against the action of the spring arm when the coil winding is electrically energized to engage and disengage said contacts, and coil assembly supporting means carried by the housing member and, including bosses formed on the housing member having a mounting surface at a fixed distance from the reference surface of the housing member, means for holding the core on the mounting surface of said bosses for fixing the position of the coil assembly with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the coil winding.

5. An automatically calibrated relay comprising, a molded insulating housing member having a reference surface, a pretested armature assembly including a spring arm, an armature carried by the spring arm intermediate the ends thereof and a contact carried by the spring arm adjacent one end thereof, armature assembly supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the other end of said spring arm on said mounting surface for fixing the position of the armature assembly with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the spring arm of the armature assembly, a fixed contact in alignment with the contact of the armature assembly to be engaged and disengaged thereby, fixed contact supporting means carried by the housing member and including a mounting surface at a fixed distance from the reference surface of the housing member, means mounting the fixed contact on said mounting surface for fixing the position of the fixed contact with respect to the reference surface of the housing member and means extending through the housing member and having a terminal for completing an electrical connection to the fixed contact, a pretested coil assembly including a coil form, a coil winding carried by the coil form and a core carried by the coil form in alignment with the armature of the armature assembly for attracting the armature against the action of the spring arm when the coil winding is electrically energized to engage and disengage said contacts, and coil assembly supporting means carried by the housing member and including bosses formed on the housing member having a mounting surface at a fixed distance from the reference surface of the housing member, a cover carried by the housing member enclosing the armature assembly, the fixed contact and the coil assembly and engaging the coil form of the coil assembly and holding the core on the mounting surface of said bosses for fixing the position of the coil assembly with respect to the reference surface of the housing member, and means extending through the housing member and having a terminal for completing an electrical connection to the coil winding.

6. An automatically calibrated relay comprising, a molded insulating housing member having a reference surface, a pretested armature assembly including a spring arm, an armature carried by the spring arm intermediate the ends thereof and a contact carried by the spring arm adjacent one end thereof, armature assembly supporting means carried by the housing member and including a boss formed on the housing member and having a mounting surface at a fixed distance from the reference surface of the housing member, a rivet extending through the boss and the housing member and mounting the other end of said spring arm on said mounting surface for fixing the position of the armature assembly with respect to the reference surface of the housing member and means connected to the rivet and having a terminal for completing an electrical connection to the spring arm of the armature assembly, a fixed contact in alignment with the contact of the armature assembly to be engaged and disengaged thereby, fixed contact supporting means carried by the housing member and including a contact terminal bracket having a mounting surface portion carrying the fixed contact, a reference portion engaging the reference surface of the housing member and fixing the mounting surface at a fixed distance from the reference surface of the housing member for fixing the position of the fixed contact with respect to the reference surface of the housing member and a terminal portion extending through the housing member for completing an electrical connection to the fixed contact, a pretested coil assembly including a coil form, a coil winding carried by the coil form and a core carried by the coil form in alignment with the armature of the armature assembly for attracting the armature against the action of the spring arm when the coil winding is electrically energized to engage and disengage said contacts, and coil assembly supporting means carried by the housing member and including bosses formed on the housing member having a mounting surface at a fixed distance from the reference surface of the housing member, a cover carried by the housing member enclosing the armature assembly,

the fixed contact and the coil assembly and engaging the coil form of the coil assembly and holding the core on the mounting surface of said bosses for fixing the position of the coil assembly with respect to the reference surface of the housing member, and means extending through the housing member and having a terminal for completing an electrical connection to the coil winding.

7. A relay coil assembly comprising a synthetic plastic coil form having a hollow tube like portion and outwardly extending end flange portions and provided with a longitudinal slot extending from the exterior of the coil form laterally through the tube like end flange portions into the interior of the coil form, a substantially U-shaped core having its central portion snapped through said slot and arranged within the tube like portion of the coil form and its end portions arranged along side the flange portions of the coil form, and a coil winding around the tube like portion and between the flange portions of the coil form.

8. In a relay having an energizing coil and double ended core, a stationary contact and an armature assembly comprising an elongated spring arm having an elongated hole adjacent the center thereof, a contact adjacent one end thereof for engaging the stationary contact and mounting means adjacent the other end thereof, and an elongated armature longitudinally arranged along the elongated spring arm and centrally carried by the central portion of the spring arm to be attracted by the double ended core when the coil is energized and having an elongated punched projection thereon extending through the elongated center hole of the spring arm and staked over for securing the armature at its center to the spring arm, said spring arm normally lying flat against the armature but being flexed away therefrom when the armature is attracted by the double ended core and the spring arm contact engages the stationary contact.

9. A relay comprising a coil assembly including a synthetic plastic coil form having a hollow tube like portion and outwardly extending end flange portions and provided with a longitudinal slot extending therethrough, a substantially U-shaped core having its central portion snapped through said slot and arranged within the tube like portion of the coil form and its end portions arranged along side the flange portions of the coil form, and a coil winding around the tube like portion and between the flange portions of the coil form, an armature assembly including an elongated spring arm having a hole adjacent the center thereof, a contact adjacent one end thereof and mounting means adjacent the other end thereof, and an elongated armature centrally carried by the central portion of the spring arm and having a punched projection thereon extending through the center hole of the spring arm and staked over for securing the armature to the spring arm, said spring arm normally lying flat against the armature but adapted to be flexed away therefrom, a stationary contact, and means for mounting the coil assembly, the armature assembly and the stationary contact in position with the ends of the armature in alignment with but spaced from ends of the core and with the contact on the spring arm in alignment with but spaced from the stationary contact so that, upon electrical energization of the coil winding, the armature is attracted by the core against the action of the spring arm into engagement with the ends of the core, the spring arm contact is engaged with the stationary contact and the spring arm is flexed to provide substantial contact pressure.

10. A relay comprising a coil assembly including a synthetic plastic coil form having a hollow tube like portion and outwardly extending end flange portions and provided with a longitudinal slot extending therethrough, a substantially U-shaped core having its central portion snapped through said slot and arranged within the tube like portion of the coil form and its end portions arranged along side the flange portions of the coil form, and a coil winding around the tube like portion and between the flange portions of the coil form, an armature assembly including an elongated spring arm having a hole adjacent the center thereof, a contact adjacent one end thereof and mounting means adjacent the other end thereof, and an elongated armature centrally carried by the central portion of the spring arm and having a punched projection thereon extending through the center hole of the spring arm and staked over for securing the armature to the spring arm, said spring arm normally lying flat against the armature but adapted to be flexed away therefrom, a stationary contact, and means for mounting the coil assembly, the armature assembly and the stationary contact in position with the ends of the armature in alignment with but spaced from ends of the core and with the contact on the spring arm in alignment with but spaced from the stationary contact so that, upon electrical energization of the coil winding, the armature is attracted by the core against the action of the spring arm into engagement with the ends of the core, the spring arm contact is engaged with the stationary contact and the spring arm is flexed to provide substantial contact pressure, said armature being provided with a projection which engages one of the core ends when the armature is attracted by the core to provide a flux gap and ready release of the armature and movement thereof by the spring arm when the coil winding is de-energized.

11. A dual relay comprising a pair of magnetically isolated and aligned coil assemblies, each including a coil form, a coil winding carried by the coil form and a core having end legs carried by the coil form, a dual armature assembly including an elongated spring arm, mounting means at the center of the spring arm, a pair of magnetically isolated armatures carried by the spring arm on opposite sides of the center mounting means and a pair of contacts carried by the spring arm adjacent opposite ends thereof, a pair of stationary contacts in alignment with the aligned coil assemblies at opposite ends thereof, and means for mounting the pair of aligned coil assemblies, the dual armature assembly and the pair of stationary contacts in position with the armatures respectively adjacent to but spaced from the end legs of the cores and with the spring arm contacts respectively adjacent to but spaced from the stationary contacts so that, upon electrical energization of either coil winding, its associated armature is attracted by the core against the action of the spring arm into engagement with the end legs of the core, the associated spring arm contact is engaged with its associated stationary contact and the associated portion of the spring arm is flexed to provide substantial contact pressure.

12. The method of assembling and automatically calibrating a relay comprising, forming an armature assembly including a spring arm, an armature carried by the spring arm intermediate the ends thereof, a contact carried by the spring arm adjacent one end thereof, and a mounting portion on the spring arm adjacent the other end thereof, forming a fixed contact assembly including a fixed contact and a mounting portion, forming a coil assembly including a coil form, a coil winding carried by the coil form and a core carried by the coil form, forming a housing member having a reference surface and supporting surfaces for the armature assembly, the fixed contact assembly and the coil assembly at fixed distances from the reference surface, individually pretesting for appropriate construction, tolerances and operation the armature assembly, the fixed contact assembly and the coil assembly, securing the mounting portion of the spring arm of the pretested armature assembly to its supporting surface on the housing member for fixing the position of the armature assembly with respect to the reference surface of the housing member, securing the mounting portion of the pretested fixed contact assembly to its supporting surface on the housing member for fixing the position of the fixed contact with respect to the reference surface of the housing member and with respect to the contact of

the armature assembly, and securing the core of the pretested coil assembly to its supporting surface on the housing member for fixing the position of the core of the coil assembly with respect to the reference surface of the housing member and with respect to the armature of the armature assembly.

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